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Pleistocene Fossils from Joshua Tree National Park, California: the 2003 Pinto Basin Expedition

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In January and early February of 2003, paleontologists from the San Bernardino County Museum (SBCM) in Redlands, California visited the Pinto Basin in Joshua Tree National Park, Riverside County, California to survey for and collect Pleistocene vertebrate fossils. The study was initially set in motion by Greg McDonald of the National Park Service (NPS), who visited the region in 2001 and noted vertebrate fossils – including a partial camel metapodial – eroding out of a small arroyo. Thanks to Greg's efforts, and to the support of the staff of Joshua Tree National Park (JOTR), the SBCM soon arranged to have a team in the field to retrace Greg's steps and relocate the fossils he'd observed.

The field efforts paid off handsomely, resulting in the recovery of a veritable bonanza of vertebrate remains, as well as the promise of more fossils to be uncovered. Not only did the SBCM team relocate and GPS Greg McDonald's initial locality, they found abundant fossils and fossil fragments scattered over several miles of outcrop. Many of the recovered specimens were relatively fragmentary, often exhibiting spiral fractures indicative of "green" bone breakage, but some specimens were relatively complete. Kathleen Springer, Senior Curator of Geological Sciences for the SBCM and leader of the field team, found one localized outcrop with several complete skeletal elements from a small juvenile camel. Camels and horses dominate the overall assemblage, but a small carnivore incisor and a fragment of possible proboscidean tooth – both new records for the area – were also recovered.

Sediments yielding the vertebrate fossils consist of well-bedded lacustrine sandstones, siltstones and claystones exposed as low bluffs in Pinto Basin. These deposits interfinger with local basalt flows dating to the Pliocene Epoch, but the morphology of some of the more identifiable vertebrate fossils – particularly teeth and tooth portions of extinct horse, *Equus* – suggest a Pleistocene age for the lacustrine exposures.

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Eric Scott, a paleontologist from the San Bernardino County Museum collects fossil bone fragments from an outcrop of lacustrine sediments in the Pinto Basin, Joshua Tree National Park, California. Note the GPS receiver used to record positional data for the locality.

Pinto Basin has long been known to be the site of vertebrate fossils. In 1935, Elizabeth and William Campbell reported on the archaeological evidence at the site and briefly mentioned the presence of mineralized vertebrate bones – mainly horse and camel, as with the assemblage recovered by the SBCM. These authors noted that the fossils appeared to be derived from somewhat older sediments than the cultural materials, but nevertheless proposed that the artifacts and the vertebrate fossils might potentially be coincident temporally as well as geographically. In 1972, paleontologist George Jefferson conducted detailed field investigations iin the area, and confirmed that the fossils were separated by a distinct depositional hiatus from the younger, overlying cultural materials. Despite this promising history, however, subsequent investigations – including those by archaeologist Adella Schroth of the SBCM – have concentrated upon the artifacts from the region rather than the fossils.

The next step will be for the SBCM and JTNP to develop and implement a plan to more fully manage and interpret these paleontologic resources, so that these rare and significant remains are not lost to the elements. JTNP has an excellent track record of preserving geological, biological, and cultural resources; including paleontologic resources in the management plan will enable a more richly detailed picture of the evolution of this unique corner of southern California.

Additional Reading

Trent, D.D. and Richard W. Hazlett, 2002. Joshua Tree National Park Geology. Twentynine Palms: Joshua Tree National Park Association: 64 pp.

Close-up of the wearing surface of an exploded horse tooth eroding from lacustrine deposits in the Pinto Basin. The length and shape of the protocone (indicated) of this tooth suggest that this is probably a Pleistocene horse; earlier Pliocene horses has shorter, more rounded protocones.

Exciting New Paleontological Finds at Petrified Forest National Park

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As the last of the summer monsoons move away in the distance, and the cooling winds and rains dissipate leaving Arizona hot and muggy, it is a good time to reflect upon the past summer field season. The interns have gone and now it is time for the real work to begin, preparation and curation of fossils, updating the locality databases, putting field notes in order, and generally just preserving the record of all that has been accomplished over the last few months.

Since initiation of our paleontological survey in the summer of 2001 we have made numerous important finds in the field but never have we has a season as successful as the summer of 2003, which could even rival the field seasons of Charles Camp from the 1920s! Routine fossil prospecting at PEFO generally turns up multitudes of scrappy phytosaur and amphibian material, most of it of minor importance and undiagnostic. Occasionally, the rare partial skeleton of one of these animals will be discovered or maybe a small bit of a rarer animal such as a dinosaur or some of the poorly known smaller archosauromorph reptiles. Even more frustrating is the lack of good phytosaur skulls. It seemed that every major institution had traveled to this area in the 1930s and 40s to get a good skull for their collections and were consistently never disappointed. Notable paleontologists such as Charles Camp, Charles Gilmore, and Ned Colbert came in, set up camp, and within a few days had found their prized skull. Amazingly, a well preserved phytosaur skull had not been discovered and collected from the park since 1985. Last season (2002) saw the discovery of a plethora of aetosaur material including the partial skeleton of *Stagonolepis wellesi*, but as far as for new taxa and phytosaur skulls, new discoveries have been wanting.

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Fieldwork – Interns Michelle Stocker (L) and Jeff Shuman (R) taking a break from excavating a metoposaur clavicle.

This season appeared to be immediately promising in March when a phytosaur skull was discovered in the northwestern portion of the park. This specimen was excavated by our group of paleontology interns in May. Preliminary preparation has shown it to be a complete skull of the phytosaur *Leptosuchus*, and just as important, this specimen represents one of the highest stratigraphic occurrences of this taxon. This four foot long skull was encased in solid sandstone. It was chiseled out with small hand tools and then the resultant 200+ pound block was carried several miles to where we could pick it up with a four wheel drive vehicle. Who says paleontology is no fun?

About the same time the skull was discovered, an aetosaur plate was recovered from the southern end of the park. Subsequent analysis has determined this to belong to a new taxon of aetosaur, which will be formally described in the near future. In addition, in May, another aetosaur plate was found belonging to a taxon that was only described just recently from northern New Mexico.

In June, our interns discovered jaw fragments of a very large individual of the archosauromorph *Trilophosaurus*. Although somewhat common in the Triassic of the American southwest, this find represented the first skull material collected from this animal in Petrified Forest National Park. Previous to this, its occurrence in the park had only been documented by a few caudal vertebrae. Spurred on by this sensational find we revisited the area where these vertebrae had been found in the 1980s and within a few minutes had discovered another partial *Trilophosaurus* skeleton. As if this was not enough to keep us busy for a time, a couple of days later the crew discovered a partial skeleton of the enigmatic diapsid reptile *Vancleavea*. This material will certainly add to our knowledge of this animal and hopefully corroborate some recent hypothesis

Sacrum – Archosaur sacrum in the field discovered by PEFO interns

Leptosuchus – View of new skull being prepared.

about the morphology of this animal. Thank goodness we have our new preparation lab up and running.

As the summer started to wind down and the departure date for the interns crept closer we decided to take one more trek into the northwestern portion of the park where the phytosaur skull had been discovered the previous March. Happily, I'd like to report that another potential skull was discovered. It has yet to be collected but will certainly extend my "summer" through the Fall. Of course I have the Winter and Spring to finish preparation of thess specimens, write up new interpretive materials, present these finds in the paleontological literature, and of course, gear up for the next field season. Anyone free next summer?

The Oregon Caves Fossil Jaguar

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The jaguar (*Panthera onca*), the largest new world cat, was once part of the native fauna of the USA, with historical records from Arizona, New Mexico, California and Texas, and possibly a few other states. Other than some recent records of probable releases of captive animals, this species is extirpated from the USA, although it is still on the Endangered Species list (check). Few people know, however, that during the last Ice Ages, the jaguar was much more widespread. Fossil material documents this species as being present throughout much of the USA, from West Virginia and Pennsylvania to Florida in the east, through Nebraska, Nevada and California in the west. It is much more common in the east, especially from Florida where there are almost 40 known localities, with few records from west. The most northerly material recorded so far consists of a few scraps of bone from Oregon (Lake Co. and Malheur Co.), which are barely enough to document the presence of this species. During my research I have re-identified the one record from the state of Washington as being from another fossil cat species.

So it was with great interest that I heard of a skeleton of a jaguar from Oregon Caves National Monument. The specimen was found by Physical Science Technician Steve Knutson. The difficult access to the specimen made it hard to see for a positive identification and initially it was thought to be a bear because of its large size and bear bones have been commonly found in other parts of the cave. Natural Resources Specialist John Roth contacted Greg McDonald, then at Hagerman Fossil Beds,

Maxilla of the skull of the jaguar from Oregon Caves National Monument with skull of modern mountain lion for comparison.

and requested that he work with the park to determine what animal the partial skeleton represented. The recovery of the skull and jaws allowed an immediate identification that the skeleton was of a large cat. The skull and jaw along with other representative bones were collected and Greg showed me these specimens at the annual meetings of the Society of Vertebrate Paleontology where I was able to confirm his initial identification that they were from a jaguar.

Fossil jaguar skeletons are exceedingly rare. Only five localities so far have produced

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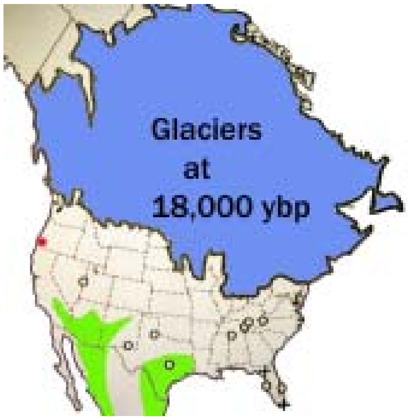

Distribution of fossil jaguars in North America. Red dot is Oregon Cave and green area is the modern jaguar distribution. Map modified from FAUNMAP, 1994.

partial skeletons, and all are from eastern USA or Texas; as yet no complete specimen has been found. To date, only part of the Oregon Cave specimen has been removed from the cave so it is not possible to say how complete it is, although the individual bones are well preserved. While the skull was removed in pieces, both of the maxillae (upper jaw bones) and the braincase were recovered and can be measured and compared with other fossil jaguars as part of its study.

None of the jaguar fossils previously found have been carbon dated yet, so the age of these specimens have to be determined by their associated fossils. Based on our current knowledge, none of the North American jaguars appear to be older than about 1 million years old, so all are from the Pleistocene time period.

I have studied recent jaguar museum specimens from throughout their range and have discerned several patterns. On average, males are larger than females and depending on the particular measurement, female jaguars are on the average between 10% and 20% smaller than males. This difference in size is called sexual dimorphism. Jaguars are most dimorphic in their eyeteeth, or canines. Also, the largest living jaguars exist in the most southerly portions of the present range of this species, in southern Brazil and northern Argentina.

Fossil jaguars in North America tend to be larger than most living jaguars although there is some overlap with the largest race from southern Brazil. Geologically speaking, the older specimens tend to be larger than the younger ones. This speaks of a size change through time for this species. However, the whole animal did not change at the same rate. The limb bones shrunk proportionately more than did the teeth or skull, leaving the living species relatively larger headed and shorter limbed compared to their oldest Ice Age ancestors.

The Oregon Caves individual appears to best compare with the youngest fossil material, in that its limb and foot bones are relatively short, although its teeth are not that small. This suggests to me it might have been a male. Although there are some older faunal elements found in this cave, the proportions of this skeleton suggest that it may not belong with these. In other words, this animal could have come into the cave and died there at a later time than the rest of the material preserved there. Parts of the skeleton were covered with travertine but attempts to obtain a uranium date from the travertine were inconclusive. Given the size and proportions of the animal it is possible that it is young enough to permit carbon 14 dating (it may be less than 50,000 years). Research on this important specimen continues.

Additional Reading

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Seymour, K.L. 1989. *Panthera onca.* Mammalian Species 340:1-9.

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Fossils and Caves

The National Park Service manages over 3,600 caves in 79 units. Caves and karst related features include sinkholes, solution caves as well as other features associated with karst and lava tubes. A servicewide survey and inventory of paleontological resources in caves documented fossils preserved in 35 park areas. Cave related paleontolgical resources fall into two categories - fossils preserved in the cave forming bedrock like limestone and fossils that accumulated in the cave after it was formed. Copies of the study:

An Inventory of Paleontological Resources Associated with National Park Service Caves by V.L. Santucci, J. Kenworthy and R. Kerbo is available through the Geologic Resoruces Division of the National Park Service

Hagerman Fossil Beds Helps Kick Off the Summer Season with Fossil Days Celebration

Every Memorial Day weekend the town of Hagerman Idaho starts off the summer with their traditonal Fossil Days Celebration. Activites include a parade and a activites in the city park including live bands. Hagerman Fossils Beds is an active participant and provides tours of the monument and educational activites for children in the city park as part of the festivities.

Hagerman Fossil Beds superintendent, Neil King, and Lonnie Johnson, unit manager of Malad Gorge State Park, keeping "track" of visitors at a booth where children made plaster copies of animal tracks.

Monument paleontologist, Phil Gensler, giving a tour of the Smithsonian Horse Quarry to visitors.

Visitor looking for horse bones in the sand box at the monument visitor center .

Name the Fossil Park

Fossils are found in many parks that we don't think of as being a "fossil" park. Can you name this park that has extensive formations of marine rocks from the Cretaceous? Hint: It's named after a Portuguese explorer.

Answer on page 7

Inset: An example of one of the fossil shells found in the Cretaceous sediments in this park. Photos courtesy of Bruce Nash.

Do you have a photo of a fossil in a national park or monument you would like to submit? Contact the editor of Park Paleontology Newsletter.

Aerial view of Castillo de San Marcos in St. Augustine Florida. Built by Spain from 1672 to 1695 the present fort is constructed of blocks of coquina and replaced nine successive wooden forts which had protected the city since its founding in 1565. Photo courtesy of Castillo de San Marcos National Monument.

Fossils and Forts

The fort at St. Augustine, Florida, Castillo de San Marcos was built in 1695 using a local rock called coquina. Coquina is a term used to describe a sedimentary rock that is composed primarily of water-worn shell fragments, which in some localities are cemented to form a firm rock, but elsewhere may be slightly or not at all cemented. The most common shell is of a small clam of the genus *Donax* but oyster fragments are present as are pieces of a large snail, *Busycon*. Some sand is frequently included in this formation and the cementing material is calcite. This particular shell deposit is called the Anastasia Formation and is found along the east coast of Florida. The thickness of the deposit varies and near St. Augustine the coquina is over 30 feet thick. The deposit formed during the Pleistocene and has been dated at 110 ka in the Cape Kennedy area.

While coquina was used to build many houses and other structures by the Spanish its use in the construction of the fort was particularly advantageous. The rock is rather flexible and not brittle so did not readily crack during shelling by enemy ships, so cannon balls would bounce off the castle walls without causing major damage. Who would have thought that fossil shells from the Ice Age would be just the right material to stand up to heavy shelling.

Closeup of coquina from the Anastasia Formation used in the construction of Castillo de San Marcos showng the fragments of fossil shells.

Resurvey of the White River Group Sites in Wind Cave National Park

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In July, the National Park Service's Paleontological coordinator, Dr. Greg McDonald, was invited to Wind Cave National Park to help resurvey and further document a group of Paleontological sites found in the White River Group of deposits known as the Klukas sites. Fossils in these Oligocene-aged sites were first discovered in 1985 by a Park biologist named Rich Klukas, and then investigated by Dr. James Martin from the South Dakota School of Mines and Technology the following year. Dr. Martin identified seven sites in the soft siltstones and claystones. He found that these deposits also contain minor sandstone channel deposits as well as freshwater lake deposits. He determined that these sediments represent the Scenic Member of the Brule Formation, part of the White River Group that is extensively exposed in the Big Badlands to the east. What makes these sites significant is their elevation, as they are nearly 1,500 feet higher than the same aged deposits in Badlands National Park. Researchers were very interested in determining if this elevation difference was due to recent uplift or if the sediments were essentially in situ. In an attempt to answer this question, Dr. Martin analyzed the fauna from these seven sites to determine if elevation was reflected in the faunal distribution. His analysis revealed numerous gastropods in the white, ashy siltstones of these sites. He also found evidence of plant, turtle, lizard, snake, insectivore, rabbit, rodent, canid, and ungulates. This preliminary assessment found that the Wind Cave National Park fauna is identical to the Big Badlands and that elevation had no apparent effect. He announced these discoveries in a paper presented at the 1994 Geological Society of America titled, "Oligocene Fossils from Higher Elevations in the Black Hills, Wind Cave National Park, South Dakota".

A field crew from Wind Cave National Park and the Mammoth Site of Hot Springs, resurvey the Klukas Paleo Sites in Wind Cave National Park. These Oligocene-aged sites probably represent the Brule Formation, with a fauna similar to that found in Badlands National Park.

Because it has been 17 years since Dr. Martin had checked on the condition of these sites, this resurvey was organized to determine if any new material was being weathered out of these easily eroded hillsides. Although Dr. Martin was out of the country and unavailable, the Geologic Resource Division allowed Dr. Greg McDonald to participate in our survey. In addition, as part of a continuing working relationship developed over the previous six months with the Mammoth Site in nearby Hot Springs, two of their employees were invited to join us for this project. This included their geologist, Kris Thompson, and their Curator, Olga Patopova.

In addition to a visual resurvey of each site, we identified several other tasks that needed to be completed to finish documenting these important sites. For each site, this included completing a Paleontological Locality Form – Exhibit 2 from NPS 77, photographic documentation, GPS location, and evaluation of the sites condition. The evaluation portion would help us reach our GPRA goal for the year, which calls for us to see that one of the park's paleo sites is in good condition. Finally, we gave our GIS specialist, Bill Konserak, an opportunity to get out of the office by joining our survey and helping us with the GIS & GPS portion of the project.

We were able to quickly locate each of the seven sites and in the process documented three additional sites. Because prairie grasslands obscure most of the White River deposits in the park, fossil observations are limited to sediment exposed by small slump scarps, buffalo wallows, road cuts, or burrows. Although the extensive grasslands found in the park certainly obscure some paleo resources, they also probably prevent illicit collecting. This is due to three factors: 1) there are very limited numbers of exposures available 2) all of these exposures have been thoroughly collected and 3) all of these sites are now part of a periodic resurvey project intended to catch any new material that might weather out.

Although our presence at these sites was recorded by significant footprints in the soft siltstones and claystones, a rain event a couple of days after our survey completely erased any evidence of our passing. This would seem to indicate that fossils can erode out of these sediments in a relatively short time period, the rapid weathering of the claystone indicates that paleo surveys will have to be conducted more often than a 17 year interval. The park will work with Dr. McDonald to establish a timeline for these periodic resurveys.

In looking at the geology of the area, we determined that several of the freshwater limestone lenses that Dr. Martin used as marker beds could probably be tied together and a stratigraphic column created for the whole sequence of Orellan-aged deposits. We identified this as a research topic that we would like to pursue, possibly with a student from the South Dakota School of Mines and Technology.

After completing the site evaluations, we noticed that all the sites scored between 50 and 90 points on the "Paleontology Locality Condition Evaluation Form". This indicates that these sites are considered to be in marginal condition, with some management actions needed to improve their condition. These actions will probably include some emergency collecting of weathered out specimens and additional periodic surveys.

This resurvey project was very successful. Not only did we better document the White River Group of sites in the park, but we also strengthened our working relationship with the nearby Mammoth Site, and we developed management actions that will better protect these sites in the future.

Additional Reading

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PALEONTOLOGICAL RECONNAISANCE OF THE FREDERIKA FORMATION, WRANGELL-ST. ELIAS NATIONAL PARK AND PRESERVE, SOUTHEASTERN ALASKA

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In late July and early August, NPS paleontologists Ted Fremd and Regan Dunn of John Day Fossil Beds National Monument (JODA) along with two JODA volunteers, Skylar Rickabaugh and Dr. David Graham, traveled to Wrangell-St. Elias National Park and Preserve (WRST) with funds provided through a grant

One of the fossiliferous outcrops of the Frederika Formation on Wolverine Mountain in Wrangell-St. Ellias National Park

from the GRD. The main objective of the expedition was to perform a paleontological reconnaissance (botanical and vertebrate) of a small portion of the Frederika Formation within the park's boundaries. Besides early publication of a geologic map of the area, relatively little is known about the Frederika Formation. Early radiometric dating of volcanic units within the Frederika suggested that the formation was deposited during the middle Miocene. Also noted on the geological map is the occurrence of Miocene-aged plant localities. Jack A. Wolfe, a paleobotanist with the USGS, provided a list of fossil plant taxa collected during the 1960's mapping effort which included *Metasequoia, Alnus, Betula,* and *Acer* to name a few. To more thoroughly understand the potential paleontological resources contained within the Frederika Formation and other rock units in WRST we investigated a set of exposures near McCarthy, Alaska.

What we found is both exciting and daunting. Logistically, getting to outcrop exposures in WRST, the nations largest national park at nearly 14 million, roadless acres was in itself daunting. On a previous exploratory trip to WRST in 2001, Ted Fremd and Skylar Rickabaugh identified excellent outcrop from aerial flights over the park. On the most recent expedition we were flown via bush plane to an area called Contact Gulch where we set up camp some 2.5 miles from our destined outcrop. We were pleased to find that what looked like potentially good fossil plant localities from the air were indeed rich with excellently preserved leaves and plant reproductive structures that were deposited in a lacustrine setting. From one newly identified locality called Wolverine Mountain (WR3), we collected specimens of foliar remains of *Alnus, Acer, Salix, Carya, Ulmus, Equisetum* and taxodiaceous conifer *Sequoia affinis.* We also collected specimens of plant reproductive structures including winged seeds and catkins. Another locality yielded abundant monocotyledons and fern specimens, and we were able to collect samples for palynological analysis from several stratified coal beds.

Perhaps what surprised us most, were not the Neogene rocks that we went there to study at all. The Frederika Formation lies in an angular unconformity atop the Moonshine Creek Formation, a Cenomanian marine shale. Within this shale we found an abundance of ammonites, gastropods, and bivalves preserved with fossil wood and even dicotyledonous leaf impressions. This finding alone will undoubtedly produce interesting taphonomic and paleontological studies in the future.

What we concluded from our expedition was that like Alaska itself with its untouched splendor and extreme vastness, the potential fossil resources in WRST indeed live up to those standards. Of the park's 14 million acres, those which are not covered in ice have the potential to yield fossils from all eras of the geologic timescale. We are lucky to have such an area already protected as a National Park, and we look forward with great anticipation to the new scientific discoveries that have yet to be made within its boundaries.

Block of lacustrine shale showing examples of *Sequoia* and *Alnus* foliage collected from WRST

Answer to Name the Fossil Park. Cabrillo National Monument in California.

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Baculites rex **from the Upper Cretaceous Point Loma Formation of Cabrillo National Monument**

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