The Paleo Times

Volume 19 Number 6 **June 2021**

The Official Publication of the Eastern Missouri Society for Paleontology

Rick Poropat, Editor

Rick's Ramblings

The June virtual meeting will be held on Friday, June 11 at 7:30 pm. Our program for the evening, *Collecting fossils at the Lee Creek Mine*, will be provided by Rick Poropat.

Members will receive an email prior to the meeting which will include the meeting number and passcode plus instructions on how to log into Zoom. If you need assistance, please contact our Zoom guru, John Christensen.

The Lee Creek Mine, currently owned and operated by Nutrien, is located near Aurora, Beaufort County, North Carolina. It has been one of the most important scientific localities in the world for the study of Miocene and Pliocene marine fossils and specimens have been extensively studied by the Smithsonian Institution and other organizations for over 40 years.

The Lee Creek Mine holds a place of honor among all of the premiere fossil sites on the planet and the number of important discoveries from this locality is countless. Once a Mecca for amateur and professional fossil collectors, it has been closed to fossil collecting by anyone since the Fall of 2009. Will it one day open to collectors again? One can only hope.

The mine itself is an open-pit phosphate mine on the south shore of the Pamlico River which exposes: Pungo River Marl (Lower Miocene), Yorktown (Early Pliocene), Chowan River (Late Pliocene) and James City (Pleistocene) Formations. Fossils are collected at the mine or from tailings used by local highway departments as road fill. The latter usually have a Pungo River origin and are highly fossiliferous.

The Pungo River unconformably overlies the Castle Hayne Limestone (Eocene) and is comprised of 45 feet of interbedded phosphatic sands, silts & clays, diatomaceous clays and phosphatic limestone. The lower phosphatic levels were thought to have been calcareous beds, inner shelf. The 65 feet of Yorktown exposure is primarily clayey sands, often with abundant mollusk fossils. It unconformably overlies the Pungo River with marked channels. The lower units contain reworked Pungo River phosphate pebbles.

During the Miocene, this site was part of the Albemarle Embayment, itself situated in an area between what is today central North Carolina and the Virginia border. Early studies of fossil benthonic foraminifera suggested a cool-temperate Early and warmer Upper Miocene marine environment, which contradicted the limestone deposits in the Pungo River Formation. Subsequent research of marine currents concluded that a strong thermocline existed within this oceanic embayment during the Lower Miocene, leading to these contradictory results. The current opinion is that the Pungo River was created in a sub-tropical marine environment. Lower units were likely deposited in deeper water (to 100-200 meters). The last Pungo River deposits appear to reflect waters of under 70 meters.

The Yorktown unconformably overlies the Pungo River. It is thought that the closing the Panamanian isthmus created a faster oceanic current which ultimately drove the thermocline higher within the embayment leading to a cooler marine environment - warm-temperate. The lowest units are thought to have been deposited in waters from 80 to 100 meters, growing shallower over time. The upper most deposits formed in waters of 15 meters or less. For the purposes of this study, specimens were derived from middle to upper Pungo River and basal Yorktown units.

THE FAUNA

It would be nice to provide an extensive list of what this site yields, but that's well beyond the scope of this article which attempts to limit itself to the sharks and rays. A quick overview of the fauna would include:

SHARKS. Aurora can provide the collector with shark teeth (vertebrae, cartilage and/or dermal denticles) from some fifty species. Most of the species included in the Non-Carcharhiniforme and Carcharhiniforme web pages, are also listed in the Purdy et al (2001), the Smithsonian publication. An attempt has been made to indicate how widely accepted certain identifications are. There is no general consensus on the make-up of the fauna, but it can be safely said that it is quite diverse. The shark list, as presented, places a great emphasis on the opinions of Bob Purdy, Bill Heim and the author. Because there is not 100% agreement, the listing includes comments if there is more than one opinion.

SKATES and RAYS. Batoid teeth are a very common constituent of the tailings but, because of their small size, most are unfamiliar to many collectors. The Ray Species List will provide a guide to many of the species that donated teeth, dermal denticles and vertebrae to the fossil record.

BONY FISH. Like other groups of Lee Creek fossils, the jaws, skull elements, otoliths and vertebrae of many fish accompany the collector home. A faunal overview Teleost species has been provided.

OTHER VERTEBRATES. Reptile material is found in the mine and turtle is most common. Bird bones are often found with Auk (*Alca* sp.) being most common. The author has collected gannet/booby, cormorant, shearwater, loon and what might prove to be a tropic-like bird. After fish, mammals are the most ground-cluttering vertebrate fossils and porpoise & whales are the primary Paleo Litterbugs. Vertebrae and other bones are all over the place. The mine produces material from whales (sperm, the extinct *Squalodon*, etc.), porpoise, walrus and seals. Terrestrial mammal material, (primarily teeth) is also found on occasion.

INVERTEBRATES. In some areas of the mine, the only thing to walk on is fossils; corals, clams and snails are everywhere. With the slightest attention, bryozoans echinoderms, and crab material becomes evident. Finding nice stuff is easy, identifying it is much harder.

Most Lee Creek collectors are there for the teeth and view invertebrates as index fossils for locating vertebrate material and not collectable unless particularly beautiful. With this said, Lee Creek can be a gold mine for invertebrates and there are collectors that visit just for that purpose.

REFERENCES

Gibson, T. 1967. Stratigraphy and Paleoenvironment of the Phosphatic Miocene Strata of North

Purdy, R., Schneider, V., Appelgate, S., McLellan, J., Meyer, R. & Slaughter, R., 2001. The Neogene Sharks, Rays, and Bony Fishes from Lee Creek Mine, Aurora, North Carolina. In: Geology and Paleontology of the Lee Creek Mine, North Carolina, III. C. E. Ray & D. J. Bohaska eds. *Smithsonian Contributions to Paleobiology, No 90*. Smithsonian Institution Press, Washington D.C. pp. 71-202.

Ray, C. (editor) 1987, Geology and Paleontology of the Lee Creek Mine, North Carolina, II. *Smithsonian Contributions to Paleobiology, 61*. Smithsonian Institution Press, Washington D.C. 283 pp.

*Lee Creek overview curtesy of *ELASMO.com* website. I recommend you visit this site for more information, especially about the vertebrate fossils found at Lee Creek Mine.

Although Lee Creek Mine is currently closed to collectors, fossils from the mine can still be collected from huge spoil piles at the Aurora Fossil Museum. (devoted to fossils from mine) Several times a year, material from the mine is dumped in the fossil park across the street from the museum. Visitors can dig in the piles anytime, but only small hand tools are allowed. The museum has tools for loan and will help identify what you find. Good stuff in the piles!

Fossil of the Month

The June "fossil of the month" is a stromatolite-like bryozoan colony, *Fistulipora carbonaria* (Ulrich) from the Upper Pennsylvanian, Upper Series-Virgilian Stage Shawnee Group near Forest City in Holt County, Missouri. The pictured specimen is three inches wide, and was collected from the Holt Shale Member of the Topeka Limestone Formation.

The Shawnee Group is composed of cyclic deposits, limestone and shale with sandstone and siltstone. It includes the Oread FM, Kanwaka FM, Lecompton FM,

Tecumseh FM, Deer Creek FM, Calhoun FM and Topeka FM. The Group is more than 250 ft. thick at its greatest extent and covers about 2% of exposed rock in Missouri. It is mostly marine but plant remains have been found at a few locations.

The Topeka Limestone (marine), contains the uppermost members of the Shawnee Group, named by Bennett in 1896 from outcrops in the vicinity of Topeka, Kansas. Subsequent studies by others resulted in a redefinition of the Topeka to include members that are not present at the type locality.

The Topeka Limestone is typically very fossiliferous and is divided into five limestone and four shale members named in upward order the Hartford Limestone, Iowa Point Shale, Curzon Limestone, Jones Point Shale, Sheldon Limestone, Turner Creek Shale, Du Bois Limestone, Holt Shale and the Coal Creek Limestone (Moore, 1936.)

The highest shale subdivision of the Topeka Limestone Formation is the Holt Shale named from outcrops near Forest City, Holt County, Missouri (Condra and Reed, 1937.) The upper part is bluish-gray in color and typically clayey with some brachiopods and bryozoans present. With increasing depth, the Holt grades into a hard, black fissile shale containing brachiopods and conodonts.

Did You Know?

Bryozoa (also known as the Polyzoa, Ectoproct or more commonly as moss animals) are a phylum of simple, aquatic invertebrate animals, nearly all living in sedentary colonies. There are about 5,869 living species today. One genus is solitary and the rest are colonial.

Typically, individual animals are about 0.5 millimeters (1/16 inch) long. They have a special feeding structure called a lophophore; a “crown” of tentacles used for filter feeding. Most marine bryozoans live in tropical waters, but a few are found in oceanic trenches and polar waters.

The bryozoans are classified as the marine bryozoans (Stenolaemata), the freshwater colonial bryozoans (Phylactolaemata) and the mostly-marine bryozoans (Gymnolaemata) which prefer brackish water. Freshwater bryozoans have been seen at Mark Twain Lake. They look like slimy heads of lettuce.

Colonies take a variety of forms, including fans, bushes and sheets. Single animals, called zooids, live throughout the colony and are not fully independent. These individuals can have unique and diverse functions. All colonies have "autozooids", which are responsible for feeding, excretion, and supplying nutrients to the colony through diverse channels.

Some classes have specialist zooids such as hatcheries for fertilized eggs, colonial defense structures, and root-like attachment structures. *Cheilostomata* is the most diverse order of bryozoan, possibly because its members have the widest range of specialist zooids.

They have mineralized exoskeletons and form single-layered sheets which encrust over surfaces, and some colonies can creep very slowly along the bottom by using spiny defensive zooids as legs.

Mineralized skeletons of bryozoans first appear in rocks from the Early Ordovician period, making it the last major phylum to appear in the fossil record. This has led researchers to suspect that bryozoans may have arisen much earlier but were initially unmineralized and may have differed significantly from fossilized and modern forms. Early fossils are mainly of erect forms, but encrusting forms gradually became dominant over time, particularly in the Paleozoic Era, a time of dramatic geological, climatic, and evolutionary change. More than 15,000 species are known in the fossil record.

Bryozoans' evolutionary relationships to other phyla are unclear, partly because scientists' conception of the family tree of animals is mainly influenced by better-known phyla. Both morphological and molecular phylogeny analyses disagree about whether bryozoans’ relationship with entoprocts, whether they should be grouped with brachiopods and phoronids (in Lophophorata) and whether they should be considered protostomes or deuterostomes. Everyone knows what those are, right? Fossil examples, especially the branching varieties, often resemble corals, further confusing collectors.

2021 Calendar

Jun 04-06	Mineral Area Rock Swap Missouri Mines State Historic Site, Park Hills, Missouri
Jun. 25-27	Bedford Swap/Show Lawrence County Fairgrounds Bedford, Indiana
Aug. 08	EMSP Picnic Kirkwood City Park
Aug 20-22	GSLAESC Show Machinists Hall Auditorium Bridgeton, Missouri
Sep. 11-20	Denver Show National Western Complex & Events Center Denver, Colorado
Oct. 22-24	MAPS Fossil Expo Orr Building, Illinois State Fairgrounds Springfield, Illinois
Nov. 19-21	Mineral & Gem Club Show Affton-Rogers Recreation Center

Time for a Mass Extinction Metrics Makeover

Researchers at Yale and Princeton say the scientific community sorely needs a new way to compare the cascading effects of ecosystem loss due to human-induced environmental change to major crises of the past.

For too long, scientists have relied upon metrics that compare current rates of species loss with those characterizing mass extinctions in the distant past, according to Pincelli Hull, an assistant professor of Earth and planetary sciences at Yale, and Christopher Spalding, an astrophysicist at Princeton.

The result has been projections of extinction rates in the next few decades that are on the order of a hundred times higher than anything observed in the last few million years of the fossil record.

"The problem with using extinction rates this way is that their assessment is riddled with uncertainty," said Hull, who has conducted extensive research on mass extinctions of marine life in the ancient world. "We need a better thermometer for biodiversity crises."

Furthermore, the researchers said, mass extinction predictions do not fully convey the severity of damage done to an ecosystem when species are depleted but not entirely wiped out.

In a new study in the journal *Proceedings of the Royal Society B*, Spalding and Hull point out deep flaws in the way mass extinctions are being projected and propose a new model for assessing biodiversity loss.

Part of the problem, they said, has to do with comparing extinctions found in the fossil record over millions of years with human-influenced extinctions from only the past century. Mass extinctions in the ancient world were typically characterized by "pulses" of extinctions, preceded and followed by quieter periods; the longer time frame reduces the historic average because it includes the surrounding quiet periods.

What's more, there are large gaps in the ancient fossil record. For example, it is well documented that frog species today are at high risk of extinction -- yet frogs are only rarely found in the fossil record. In addition, certain habitats with many extinctions today -- such as islands -- are also not represented in the ancient fossil record. Rather, the fossil record tends to be dominated by larger species and geographically larger habitats.

"It's difficult to confidently deduce whether today's rates are objectively higher than those of the fossil record," Spalding said. "Meanwhile, we know that the ecosystems may be totally decimated, yet suffer very few extinctions. In that sense, extinction rates may even underestimate our influence upon the biosphere."

Spalding and Hull took pains to describe the perilous state of the natural world today, beyond the numbers of species extinctions. According to an Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) report in 2019, nearly 75% of all freshwater resources on Earth are used by crop and livestock production; human activities have significantly altered 75% of all ice-free terrestrial environments and 66% of marine environments.

Spalding and Hull's proposal is to change the metric from species loss to changes in the rocks beneath their feet.

"Humans change the rock record as soon as they enter an area, whether it is agrarian societies, beaver trapping, or the damming of rivers," Hull said. "We completely change the way the Earth forms itself and this can be seen in the rocks left behind."

The researchers said a variety of measurable metrics -- such as the chemical composition of sediments and grains of rocks -- are more readably comparable to ancient timescales.

"Historical comparisons offer the hope that we might begin to understand the relative scope and the eventual ramifications of our modification of the biosphere," Spalding said. "If we think these comparisons are important, we need to get them right."

Source: Yale University. "Time for a mass extinction metrics makeover." ScienceDaily. ScienceDaily, 29 April 2021. <www.sciencedaily.com/releases/2021/04/210429104939.htm>.

Fossil Record Provides New Insights Into Mass Extinctions

Mass extinctions are known as times of global upheaval, causing rapid losses in biodiversity that wipe out entire animal groups. Some of the doomed groups linger on before going extinct, and a team of scientists found these "dead clades walking" (DCW) are more common and long-lasting than expected.

"Dead clades walking are a pattern in the fossil record where some animal groups make it past the extinction event, but they also can't succeed in the aftermath," said Benjamin Barnes, a doctoral student in geosciences at Penn State. "It paints the pictures of a group consigned to an eventual extinction."

The scientists found 70 of the 134 orders of ancient sea-dwelling invertebrates they examined could be

identified as DCW in a new statistical analysis of the fossil record.

"What really fascinated us was that over half of all the orders we looked at have this phenomenon and that it can look like many different things," said Barnes, who led a group of graduate students and a postdoctoral researcher on the study. "In some cases, you have a group that has a sudden drop in diversity and lasts for a few more million years before disappearing from the record. But we also found many orders straggled along sometimes for tens or hundreds of millions of years."

The findings, published in the journal *Proceedings of the National Academy of Sciences*, challenge the view of extinction as a sudden disappearance and suggest that the full impact of mass extinctions lag behind the events themselves longer than previously expected, the scientists said.

"I think it raises questions about how the so-called kill mechanism operates," Barnes said. "We think of mass extinctions as being these selective forces that cause large groups of animals to go extinct, but our results really show there are a lot of instances where it's not so sudden. It raises questions about why that's such a long delay."

Paleontologist David Jablonski first coined the term DCW more than 20 years ago, and since then it has been associated almost exclusively with mass extinctions. Using a wealth of new fossil record data made available over the last two decades, the study found DCW are also common around smaller, more localized background extinction stages, the scientists said.

"Our results suggest that rather than representing a rare, brief fossil pattern in the wake of mass extinction events, DCWs are actually a really diverse phenomenon and that there might be a lot of drivers that produce this pattern in the fossil record," Barnes said. "These DCWs may represent a major macroevolutionary pattern."

The scientists used a statistical technique called a Bayesian change point algorithm to analyze fossil records from the Paleobiology Database, a public record of paleontological data maintained by international scientists.

The method allowed the researchers to search time series data for significant points where the data deviated from the pattern. They were able to identify negative jagged shifts in diversity and rule out that the organism went extinct immediately but instead persisted.

"So, you might be looking in the fossil record and you'll find tons of a type of brachiopod," Barnes said. and perhaps there's only one family that continues to survive."

Those survivors can continue in their niche for millions of years, even into the present. But their lack of diversity makes them more susceptible to future environmental challenges or extinction events, the scientists said.

"I think these findings cause you to reexamine how you measure success," Barnes said. "It's quite possible for an animal group not to produce new families and new genera at a rate like it did before, but if it continues to survive for many millions of years, that's still some form of success. I think it raises a lot of questions about what it means to be successful as a fossil organism and what ultimately are the controls of origination."

Source: Penn State. "'Dead clades walking': Fossil record provides new insights into mass extinctions: Groups of animals that survive an event but never fully recover are more common and long-lasting than expected." ScienceDaily. ScienceDaily, 20 April 2021. <www.sciencedaily.com/releases/2021/04/210420160901.htm>.

Turkey rex. Menace of the Midwest. Hope our Montana travelers don't run into any! Actually, a company makes these arms to be attached to chickens, turkeys and other birds.

Eastern Missouri Society for Paleontology (EMSP)

(EMSP) is a registered Missouri not-for-profit organization dedicated to promoting the enjoyment and scientific pursuit of fossil collecting. It is open to all individuals interested in learning about the history of ancient life on earth. The club membership includes professional paleontologists as well as amateur hobbyists providing an open forum for the exchange of information as well as access to expertise on collecting, identifying, preparing and displaying fossils.
EMSP meetings are held on the second Friday of every month (except July, August and December) at 7:30pm in Room 203, on the second floor of the Earth and Planetary Sciences Building on the campus of Washington University. The building is located at the SW corner of the intersection of Forest Park Parkway and Hoyt Drive. Each meeting includes an informal exchange of information and speakers on a variety of fossil-related topics. Note: the building doors automatically lock at 7:30pm.

Club activities include occasional field trips led by experienced collectors, a great way to augment discussions at the monthly meetings. The club also participates in joint field trips with other paleo clubs, visiting fossil sites throughout the United States. EMSP is also proud to be involved in a partnership with the St. Louis Science Center as well as STEM outreach to classrooms, community events and science fairs.

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