myFOSSIL

News from the FOSSIL Project

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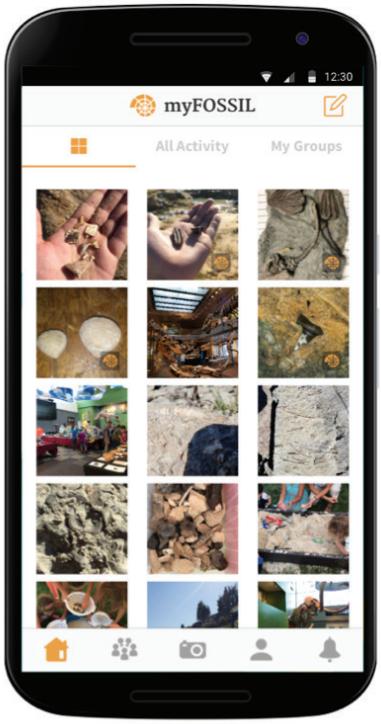
FOSSIL Project Updates

By Sadie Mills

myFOSSIL Mobile App

In August, FOSSIL team members joined students, staff, and volunteers from the Florida Museum on a field expedition to the Nebraska Badlands. In addition to searching for vertebrate fossils from the Eocene-Oligocene transition (approximate 34 million years ago), team members field-tested the myFOSSIL mobile app. You can see some of the great photo uploads and fossil finds here: https://www.myfossil.org/groups/nebraska-badlands/

Glueing a Brontothere Tooth found in the Badlands.



We are pleased to announce that the myFOSSIL mobile app is now available for download in the Apple App Store and Google Play Store! Though we still have some bugs to work out, we are excited to have the public begin using this new paleontological tool. Want to learn more about the app and try it out yourself? Visit https://www.myfossil.org/resources/mobile-app/ for details.

Public Outreach
FOSSIL team members have enjoyed participating in several paleontology-focused public outreach events in Gainesville and in neighboring communities.

In August, FOSSIL assisted with *Pop-Up Museum: Megalodon*, an outreach event focused on separating fact from fiction about the famous ancient

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sharks. Hosted by the Florida Museum, this event was also supported by the International Shark Attack File and the museum's Department of Vertebrate Paleontology.

Next, in September, FOSSIL participated in the Florida Museum's National Fossil Day Celebration timed with the grand opening of the museum's new exhibit: Permian Monsters. Along with museum paleontologists and Florida fossil clubs, FOSSIL helped museum visitors explore life in the past.

Finally, in October, FOSSIL teamed up with the Florida Museum's Department of Vertebrate Paleontology to host a pop-up museum at the North Central Florida Peanut Festival in Williston, Florida. At this event, festival-goers learned about fossil elephant species, may of which were found locally in Levy County.

Pop-Up Museum at the opening of "The Meg"

National Fossil Day celebration at the Florida Museum of Natural History

Pop-Up Museum on Fossil Elephants

Congratulations Dr. Lisa Lundgren!
This October, Lisa successfully defended her dissertation on myFOSSIL's social paleontology community. After earning her PhD, Lisa will be moving on to a postdoctoral associate position at North Carolina State University, where she will be studying the educational outcomes of the *Crowd the Tap* citizen science project. We appreciate all that Lisa has contributed to the project over the years, and wish her the best of luck in her new role!

Upcoming Activities
This November, FOSSIL will head to the Geological Society of America's annual meeting in Indianapolis, Indiana. FOSSIL team members Jeanette Pirlo, Rich Bex, and Lisa Lundgren will present on work they've done through the project. FOSSIL will also host an outreach booth with nearby fossil club, the Cincinnati Dry Dredgers. If you'll be attending, please stop by to say hello!

GSA 2018
4-7 November
Indianapolis, Indiana, USA

Club Corner: The Knoxville Gem & Mineral Society

By David Liles – President, The Knoxville Gem & Mineral Society

I wish to introduce The Knoxville Gem & Mineral society (KGMS). We are a family oriented, nonprofit (501c3), educational and scientific interest group to promote interest and education in the Earth Sciences, including rocks, minerals, gems, and fossils, the lapidary arts, and related research. We offer monthly programs (speakers), field trips, lapidary workshops, the annual Gem Show, and a Facebook page. We also provide scholarships each year to graduate and undergraduate college students.

KGMS is not alone, rather we are one of about 80 similar clubs represented in the Southeast Federation of Mineral Societies (SFMS – the Southeastern USA), which in turn is a member of the American Federation of Mineral Societies (AFMS – includes all USA Regions).

Our organization includes geologists, bead and stone artists, professors, gemologists, students, hobbyists, and those curious about the earth sciences. Leadership roles in the club come from of all of these categories – the only requirement being a willingness to serve. We have our own clubhouse. We made modifications to allow the seating of 40 or so people for a program, and to provide for the club library. We use the clubhouse for monthly programs, business meetings, and picnics. Also, a lapidary shop is being developed in the garage and we will eventually have classes and work sessions.

The KGMS clubhouse

Spring potluck picnic in the clubhouse.

Meetings are held on the third Thursday of the month at 7:30 P.M. Exceptions include picnics in May and September, the October Gem Show, and a Holiday Banquet in December. Fellowship and fun are a priority! Meeting speakers are from industry, academia, and our own membership. Topics vary widely but are in the Earth Sciences realm. In the last year, half of our programs have been on fossils and related research.

Field trips are organized for our own membership, and KGMS also serves as either host or invitee on SFMS field trips. The KGMS only trips tend to be in the Knoxville area, and the SFMS shared trips tend to be further afield. Most field trips include collection of fossils – either as the primary focus, or in addition to the collection of rock and mineral specimens – or examination of rock formations. There is plenty here in both monthly programs and field trips to interest those studying paleontology. A few examples of recent Field trips include:

Dale Hollow lake, TN:

This location provides three separate collecting sites and is scheduled when the water is at winter pool. Found here are Mississippian aged materials such as: coral heads, chert nodules, crinoid stems, geodes, and horn coral. This is top notch trip, but a long day!

Image includes several types of corals, many types of crinoid stems, and fossils and rock geodes.

Crinoid stem with a root structure of another animal, probably a crinoid, stuck onto its stem!

Coon Creek McNairy County, TN:

This involves a visit to the Coon Creek Science Center, and specimens are collected in the creek and surrounding acreage. Fossils include numerous types of Upper Cretaceous marine shells and vertebrate remains – about 73 million years old. The official Tennessee State fossil, the bivalve *Pterotrigonia (Scabrotrigonia) thoracica* is found here. The best collecting is in the stream bed, in the blue layer.

The Tennessee state fossil, Pterotrigonia (Scabrotrigonia) thoracica a clam from the Cretaceous period.

Douglass Lake / Dam, TN:

This is a winter field trip, when the water is at winter pool. Specimens include double terminated quartz crystals, hematite, quartzite, and fossils in limestone – brachiopods, snails, and trilobites.

Water is low in the local lakes and ponds so collecting specimens is much easier!

Large Ordovician snail shell mold stuck in a rock.

Dalton, GA Trilobites:

This location is on a riverbank under a bridge. Trilobite fossils are found here in a Conasagua shale deposit. The shale is soft, and splits apart in layers, revealing the positive and negative image of the trilobite fossils.

Daniel dutifully splitting shales to uncover trilobite treasures.

A close up of the trilobite fossil Daniel found.

Lapidary workshops at Wildacres and William Holland are available to SFMS Member clubs each summer. Both are located in the Blue Ridge Mountains and are surrounded by the beauty of that area. I attended a Gem Identification class at Wildacres in 2016, and then a Silver Casting Class in 2018. Most of the classes are "hands on", allowing one to explore one's creativity while working with metals, stones, beads, and natural fibers and objects. Most really enjoy the experience. For example, I have heard of Wildacres humorously described as "Summer Craft Camp for Adults", where those of all skill levels feel creative and artistic.

Our Monthly Newsletter, Facebook Page, and Webpage have been great outreach tools. As President, I try to participate in as many functions as possible. I write a newsletter introduction each month and I produce a Facebook Album on most KGMS functions in which I am involved – especially field trips. These are posted to our club's page (Knoxville Gem and Mineral Society) to generate interest in field trips and to attract potential members to our club. The page currently has a membership of over 250. Visitors are welcome!

Our largest fundraiser is our annual fall show. The three day 28th Annual Gem, Mineral & Jewelry Show (http://www.knoxrocks.org/gem-show/) opens October 19th at 10 am at the Rothchild Conference Center at 8807 Kingston Pike, Knoxville, TN 37923. Show times are from 10:00 am to 6 pm October 19th – 20th, Friday and Saturday; from 11:00 am to 5:00 pm on Sunday, October 21th. The Gem Show is open to the public and has an admission fee of $6 a

day for adults or $10 for the whole show; children under 12 are admitted free. The Gem and Mineral Show will have many vendors that offer great products including a wide variety of jewelry, rare fossil and mineral specimens, meteorites, gems of all colors, shapes & sizes, lapidary & jewelry equipment, and much more.

We also collect annual dues, and as a 501c3 organization, we get contributions of cash and lapidary supplies. Scholarships are provided each year, in keeping with our mission to promote the study of Geology and the Earth Sciences. This is where we spend the bulk of the money each year beyond operating expenses. Scholarships allow us to acknowledge and reward superior talent and scholastic achievement. In 2018, we funded 12 scholarships for Graduate and Undergraduate Geology students from both The University of Tennessee and East Tennessee State University. In addition, KGMS contributes to, and recommends up to 3 students for scholarships from The MAYO Foundation – established by the late Frank Mayo, the first President of the SFMS.

Well, I hope my introduction has bettered the understanding of our club, and of similar clubs in the AFMS. It is my hope to increase awareness and participation.

Brachiopod assemblage from the Ordovician rocks near Nashville, Tennessee – Sumner Co, TN (Near Gallatin)

This fossil brachiopod assemblage is special because it is a geode!

To make this fossil even cooler – there are beautiful purple fluorite crystals within the geode.

To learn more:

Knoxville Gem & Mineral Society Web Page (http://www.knoxrocks.org/)

Southeast Federation of Mineral Societies (http://www.amfed.org/sfms/index.html)

American Federation of Mineral Societies (http://www.amfed.org/)

2018 Southeast Federation of Mineral Society Workshops (William Holland & Wildacres) (http://sfmsworkshops.com/ Wildacres - www.wildacres.org/)

William Holland School of Lapidary Arts (https://lapidaryschool.org/main.aspx)

Coon Creek Science Center (http://www.memphismuseums.org/coon-creek-science-center/)

The Knoxville Gem and Mineral Society Facebook page (https://www.facebook.com/groups/1668970690004400/) includes detailed albums on the Wildacres and KGMS field trips.

Featured Professional: Emily Lindsey

Editor's note: This issue we feature Emily Lindsey, Assistant Curator and Excavation Site Director at the La Brea Tar Pits (https://tarpits.org/la-brea-tar-pits) in Los Angeles, California. Emily is also Assistant Adjunct Professor of the Environment and Sustainability at UCLA.

Can you describe your path to a PhD in paleontology? Did you begin college with paleontology or graduate school as long term goals?


Emily Lindsey

When I entered college I knew that I wanted to be a field scientist, and I suspected that I would need to go to graduate school, but I actually started out as a marine biologist. I spent several years SCUBA diving in cold murky waters, and even got to go work in Antarctica! I loved ecology – the process of asking questions about how different organisms interact with one another and with their environment – but I also loved the past, and I would sneak off periodically and volunteer on archaeological digs. It wasn't until I had been out of college for a couple of years that I learned that I could combine the two fields!

On your web site, you state that your research "integrates neontological and deep-time information" and that you use primary data from field research and "large-scale biogeographic analyses" to answer questions. Can you explain a little more about what this means—for students or novices to the field?

I am always looking backwards and forwards – what can we deduce about ecosystems that don't exist anymore by looking at modern ecosystems, and what lessons can we learn from what happened to plants and animals a long time ago when the climate changed, or when humans showed up, or when all the big animals went extinct? I study this both by looking at particular sites I am excavating at (like the La Brea Tar Pits!) and also by compiling information from lots and lots of sites and fossils across an entire continent, and looking at patterns — what went extinct when, what else was going on at the time. It's all basically detective work.

Where has your field work taken you? Do you have a favorite locality? Have you had any particularly exciting experiences in the field?

One of the reasons I became a paleontologist is because I wanted a job that would let me travel. I've been lucky to work in a number of amazing places, mostly across South America. Most of my recent fieldwork has been at a tar pit site in Ecuador. After Antarctica, probably the most interesting place I've been is Guayana – to get to the site involved a boat trip, a day in a pickup driving through water as deep as the windows sometimes, sleeping in tent-hammocks, and trekking through the rainforest with machetes. And after all that, we learned that the site had been destroyed by superstitious locals who were worried the bones were cursed!


Emily in Guayana

What currently excites you the most about the science of paleontology?

More and more, scientists are starting to recognize that if we really want to know how animals and plants are going to respond to climate change, it would be useful to look at how they have responded to past climate changes thousands or even millions of years ago. It's called Conservation Paleobiology, and it's helping to inform things like land management and the planning of new nature preserves.

Working at the La Brea Tar Pits seems like a pretty unique situation for a paleontologist. Is there any other place like it in the U.S.? Can you describe what your typical day is like as the Excavation Director?

Material excavated from the La Brea Tar Pits

The La Brea Tar Pits is one of the only places in the world where you can go and see the excavation, preparation, and study of fossils all in one visit – certainly the only one in an urban area! My whole title is Assistant Curator and Excavation Site Director. As a curator I am in charge of all of the research activities at the Museum, and as the Excavation Director I have to make sure that the fossils are being excavated in the right way and that all of the important information is being collected with them. I am also responsible for the operations at the excavation site, making sure the excavators have all the equipment they need, etc. We excavate 361 days a year, so it's important that everything is running smoothly!

Do you have opportunities to work with amateurs in your current position at the Tar Pits or have you elsewhere in the past? What are your thoughts about amateur contributions to science?

We have a huge volunteer program at the Tar Pits, with over 80 people helping in the excavations, the fossil lab, and the collections each week! We absolutely could not do what we do without them. We also have been running a program partnering with middle-school classrooms to help sort our microfossils, which include all the tiny lizard jaws, squirrel teeth, bird bones, seed pods, insect wings, clam shells, etc. that are in the dirt stuck to the big bones. These are actually our most important fossils, because they can give us such detailed information about what the Los Angeles ecosystem looked like thousands of years ago, but there is no way we could possibly sort it all ourselves.

Many in our audience are passionate about education and outreach. What kinds of programs do you have at the Tar Pits? Based on your experience, what makes a program successful?

One of the reasons I was drawn to work at a natural history museum was the potential to impact so many people through the museum's exhibits, educational initiatives, and public programs. There is a huge problem of public misunderstanding and mistrust of science right now, but most people trust museums, so they are a good way to teach our community about scientific concepts and empirical reasoning. We have a phenomenal staff and volunteer team who work in the museum gallery and teach visitors about Tar Pits research, and our Excavators and Fossil Preparators give presentations as well. I think every museum needs to have a variety of types of programs, because you reach different groups with each one. But they all have to be engaging in some way, and leverage your most valuable resources – the authenticity of the specimens, the scientific research, and the scientists themselves.

Do you have any advice for someone interested in going into the eld of paleontology?

Study biology, study geology, and if possible get some hands-on experience in the field or in a museum collection. We can always use more volunteers at the Tar Pits!

To learn more:

Visit Emily's website (http://www.emilylindsey.org/)

Ellwood E, Estes-Smargiassi K, Graham N, Takeuchi G, Hendy A, Porter M, Lindsey E (2018) Project Paleo: Citizen Curation and Community Science at the Natural History Museum of Los Angeles County. *Biodiversity Information Science and Standards* 2: e25980. https://doi.org/10.3897/biss.2.25980 (https://doi.org/10.3897/biss.2.25980)

Barnosky, A. D., Hadly, E. A., Gonzalez, P., Head, J., Polly, P. D., Lawing, A. M.,Eronen, J.T., Ackerly, D.D., Alex, K., Biber, E., Blois, J., Justin Brashares, J., Gerardo Ceballos, G. Davis, E., Dietl, G.P., Dirzo, R., Doremus, H., Mikael Fortelius, M., Greene, H.W.,Hellmann, J., Hickler, T., Jackson, S.T., Kemp, M., Koch, P.L., Kremen, C., Lindsey, E.L., Looy, C., Marshall, C.R., Mendenhall, C., Mulch, A., Mychajliw, A.M., Nowak, C., Ramakrishnan, U., Schnitzler, J., Shrestha, K.D., Katherine Solari, K., Stegner, L., Stegner, M.A., Stenseth, N.C.,Wake, M.H., and Zhang, Z. (2017). Merging paleobiology with conservation biology to guide the future of terrestrial ecosystems. *Science*, 355(6325), eaah4787 (https://doi.org/10.1126/science.aah4787).

Lindsey, E. L. (2017). The Lost Megafauna of the American West. *Ecology*, *98*(4), 1181-1182 (https://doi.org/10.1002/ecy.1722).

Amateur Spotlight: Steve Vanlandingham

Editor's note: This issue, FOSSIL Project postdoc Jen Bauer interviews Steve Vanlandingham. Steve is a volunteer in the invertebrate paleontology collections at the Sam Noble Museum of Natural History at the University of Oklahoma. Steve is an avid fossil collector and has helped renowned echinoderm experts and junior scientists better understand the early evolution of this group.

How did you get interested in collecting fossils and how long have you been interested in paleontology?

Steve in the field with his magnifying visor.

I think I've always been interested in paleontology and all things ancient, strange and obscure. Like many kids, I went through a big dinosaur phase at about age 5 or 6. I learned some of the names and remember making up songs and stories in my head about a character named "Bronty the Brontosaurus." Last year I published a book about a trilobite name "Tony", so I really haven't changed all that much. But it was only in the last 5 to 6 years that I became seriously interested in collecting fossils. Before that, I worked in archaeological and seismic survey, as a special education teacher, and as an artist in residence in public schools playing traditional folk music. I went through a period of time where I found it difficult to play music due to tendinitis problems. It was during this time that I caught the fossil bug – I guess I should say it caught me. There doesn't seem to be any cure for it, except more fossils...

What are your favorite fossils and what draws you to them?

When I first started collecting, my favorite fossils were the Devonian trilobites that Oklahoma is known for. Now I have become fascinated by the bizarre echinoderms of the Ordovician Bromide formation- the paracrinoids, rhombiferans and early crinoids, plus eocrinoids and edrioasteroids as well. I was drawn to their strangeness – there is nothing like them around today – but also to their beauty. The paracrinoids, like *Oklahomacystis* in particular, are amazing!

I-35 roadcut through N. Arbuckle mountains.

When I discovered a few at a nearby road cut, I found myself wanting to know more about them: How did they live? Why did they go extinct? Were they held off the seafloor by a stem, or did they rest on the bottom? Why did they form these complex "rosettes" of plates, what were their purpose? So many questions, so much time and water under the bridge. The fact that even the experts don't understand much about these ancient echinoderms draws me to them even more.

A paracrinoid called Oklahomacystis from UEZ Bromide FM Murray Co., OK. Scale bar in mm.

A paracrinoid called Sinclairocystis from UEZ Bromide FM Murray Co., OK. Scale bar in mm.

A paracrinoid called Platycystites from UEZ Bromide FM Murray Co., OK. Scale bar in mm.

How long have you been working with Dr. Roger Burkhalter and what do you do as a museum volunteer?
I volunteered at the Sam Noble museum a little over four years ago, in the summer of 2014. Most of my work in the invertebrate paleontology collections involves photographing fossils for the "Common Fossils of Oklahoma" website. Dr. Burkhalter and Dr. Westrop have given me a wonderful opportunity to work with and learn more about the fossils I love. One of the great things about paleontology is that it is relatively easy for beginners to make a contribution to science. You don't necessarily have to have advanced degrees. Dedicated collectors can find new types of fossils, teach themselves about them, and be a resource to the scientific community. I have found the professionals in invertebrate paleontology to be very accessible and willing to work with amateur enthusiasts. Especially the echinoderm people! (see "Additional Note" below)

I know you do a lot of collecting in Oklahoma, what does a normal field excursion entail for you? What do you hope to discover in the field?
Some people may not know that Oklahoma is a veritable Paleozoic Paradise, with a nearly unbroken record of rock strata stretching 250 million years, from the Cambrian to the Permian. Much of it is exposed in the Arbuckle Mountains of southern Oklahoma about an hour drive from my home. A normal field excursion for me entails collecting at one particular site- a public road cut- that has a great exposure of the upper echinoderm zone (UEZ). (Upper Mountain Lake member, Bromide formation) Since most of the fossils are small, I don't need a lot of equipment. Just some collecting bags, a small probe and my trusty magni-visor, which I wear in the field.

It has been a big help in finding things since I don't have the greatest eyesight anymore. I return to the same spot again and again, picking through the rubble of a lost world hoping to find rare and unusual specimens. So far, I have collected 13 different genera of extinct echinoderms at this one locality, many of them well preserved in the crumbly shale of the UEZ. I'm lucky to have stumbled on to this treasure trove in my own backyard! Every time I go back, I feel like great discoveries are waiting...

Tell us a little bit about your book, "Good Night Trilobite" and your motivation to bring the Paleozoic to young minds.

Cover shot of Good Night, Trilobite

Inspired by the Paleozoic fossils I was finding, I started writing about them. At first a few lines in a journal – "good night trilobite, sleep tight"- then a song, and eventually a book about a trilobite and his friends, including a brachiopod and a bryozoan, plus a villain named "Seth the Cephalopod." (I'm working on a new one about a paracrinoid named Perry) Colorful illustrations by a friend who is a talented artist made the 400-million-year-old creatures come to life. The book project was a way to bring my interests in fossils, music and poetry, teaching and writing together. Chickasaw press of Oklahoma published it last year and I think they did a great job. It was an Oklahoma Book Awards finalist

this year for "best illustration/ best design." You can watch an animated version of Tony the trilobite (https://chickasawpress.com/Books/Good-Night-Trilobite.aspx) on the book page of Chickasaw press.

My motivation with the book is to bring these Paleozoic fossils to life in young minds, to capture their imagination the way that dinosaurs have. Maybe it will broaden their horizons a little, help them see that there is more beneath our feet than meets the eye, that the world is a wondrous place and great discoveries are always waiting.

Additional note: my mentor

Every student, young or old, benefits from a good teacher or mentor. Dr. Jim Sprinkle, retired professor emeritus from Austin Texas, one of the world's foremost experts on extinct echinoderms, has been a mentor to me and many others. His monograph on echinoderms of the Bromide Formation, published in 1982, served as my text and "Bible" when I started collecting in the Arbuckles. After I began finding some good specimens, I wanted to contact him but wasn't sure if he would be receptive or not. Dr. Westrop at the museum knew him and encouraged me to reach out to him. I sent some pictures of a crinoid cup I had found, and he wrote back right away, tentatively confirming my guess about what the genus was and asking if we could meet in the field at my favorite road cut! The man who taught me how to find the upper echinoderm zone wanted me to show him where it was at this particular site. We ended up collecting together in this and other localities several times since, I have donated some of my specimens to him for study and to be described in a forthcoming article in the Journal of Paleontology. Jim is one of the giants of the field, but o one of the giants of the field, but one of the nicest guys around. It's been a real honor to get a chance to meet him and learn from him in the field.

Top view of a recently collected Cleiocrinus species. Scale bar in mm.

A paracrinoid called Platycystites from UEZ Bromide FM Murray Co., OK. Scale bar in mm.

To learn more:

Sam Noble Museum *Common Fossils of Oklahoma* website (https://samnoblemuseum.ou.edu/common-fossils-of-oklahoma/)

Featured Fossil: Ichthyornis dispar

By Christina Byrd, Paleontology Collections Manager, Sternberg Museum of Natural History

Before his first day of college in the summer of 2014, incoming Fort Hays State University (FHSU) freshman Kris Super found a fossil of a bird skeleton in the Late Cretaceous chalk deposits in Gove County, Kansas. Prior to college, Kris had already spent years collecting fossils in western Kansas and was familiar with Western Interior Seaway fauna. Though Super didn't think too much about the fossil when saw the first bones, he soon had a suspicion the fossil may be a bird. He removed a medium-sized slab of rock containing the fossil and took it back to his dorm for a closer look with better tools. As he began to prepare the fossil, he uncovered the coracoid and the sternum – two bones that are distinct in birds. With this discovery, Super knew he had something special. He continued to uncover the fossil until he found the bones of the skull.

Figure 1. Ichthyornis dispar specimen prior to CT-scanning. Photo credit: Laura Wilson

Figure 2. Skeletal reconstruction by O.C. Marsh of Ichthyornis dispar based on the holotype.

Super showed the specimen to his FHSU undergraduate advisor, Dr. Laura Wilson, who is also the Chief Curator and Curator of Paleontology at the Sternberg Museum of Natural History. As soon as she saw the specimen, Wilson knew it was significant. Given the shape and the size of the bird bones, Wilson and Super had a pretty good idea that it was an *Ichthyornis dispar* skeleton. With multiple, well-preserved bones exposed, Wilson took the next step to learn more about the bird fossil and what may be hidden beneath the surface of the rock. Wilson and Super enlisted help from HaysMed, the local hospital in Hays, KS, and their Image Center. HaysMed had previously supported Wilson with imaging needs to study and care for fossils at the Sternberg Museum. The resulting CT-scans and X-rays enabled researchers to understand more about the placement of bones in the rock. These images provided a guide for preparators to expose more bones without damaging fragile skeletal elements.

Figure 3. Image of Kris Super and HaysMed staff the day of scanning the specimen. Photo credit: Laura Wilson

Wilson and Super joined a collaboration with a team of experts from Yale University, the University of Kansas, the Alabama Museum of Natural History, Tuscaloosa, and the McWane Science Center, Birmingham, AL studying bird evolution. This team used this fossil and other specimens held in museum collections to reveal the significant role that *Ichthyornis dispar* plays in understanding the transition from non-avian dinosaurs to modern birds. It turns out *I. dispar* has a combination of dinosaur-like and bird-like characteristics in its skull that illustrate the transition, and the Sternberg Museum fossil was key to understanding this.

The addition of the Sternberg Museum specimen to the study not only increases our understanding about *Ichthyornis*, but also aids in further understanding modern bird evolution. This success story emphasizes the power of collaboration, enthusiasm, and curiosity in advancing and forever changing the understanding of natural history.

To learn more:

Field, D.J., Hanson, M., Burnham, D.A., Wilson, L.E., Super, K., Ehret, D.J., Ebersole, J.A., and Bhullar, B.A.S. (2018). Complete Ichthyornis skull illuminates mosaic assembly of the avian head. *Nature*, 557, 96–100.

Fort Hays State University. (2018, May 30). FHSU professor and graduate publish in prestigious journal Nature (https://www.fhsu.edu/news/2018/05/fhsu-professor-and-graduate-publish-in-prestigious-journal-nature).

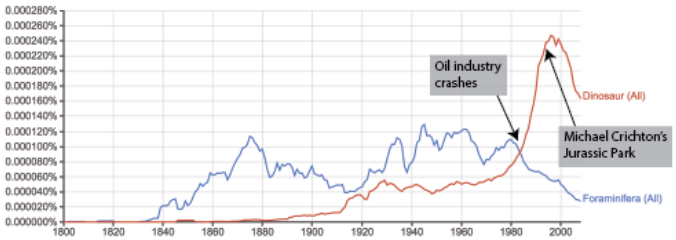
Education: 3D Foraminifera

By Jen Bauer, Maggie Limbeck, and Audrey Parker

Editor's note: Jen and Maggie were both graduate students in the paleontology program in the Earth and Planetary Sciences Department at the University of Tennessee where they met Audrey, an undergraduate completing her degree in geology with an additional focus in early childhood education.

Foraminifera (also called forams) are small single-celled organisms (protists) that float around in the water column eating nutrients. These creatures are found worldwide and are incredibly useful to scientists. Certain species of forams only existed for very specific amounts of time so are good indicators of geologic time when looking at rocks. Since forams are distributed worldwide, we are also able to correlate the same species across continents!

Forams are also incredibly useful for studying climate and ocean circulation. They build their shells (called tests) from elements in the ocean water. This means that the elements within their shells should match the ocean chemistry at the time the organism was making its shell. This can give us information on oxygen and carbon levels in the ocean – helping us better understand ancient climate. The oil industry boom furthered the study and research of foraminifera. For a long time, they were written about more than dinosaurs! Research and literature has declined as oil exploration has slowed.



This is a plot generated through Google ngram that looks at the usage of terms in books through time. We start in 1800 and as we continue to the right foraminifera (blue line) are much more popular in literature until about 1980 with the crash of the oil industry. This crash meant many foraminifera workers were no longer employed and therefore no longer producing work on forams!

For scale, here are some foraminifera specimens on a penny. Notice the lettering and a portion of Lincoln's head!

Because foraminifera are typically quite small (size ranges from about 50 micrometers to 20 cm across), it is impractical to study them in either classrooms or at home. Most people do not have ready access to a microscope or the other tools required to examine foraminfera. Additionally, it is difficult to ensure all students are getting the same experience with the microscope as focusing on the specimens would likely be very time consuming for the educator. Our department was in possession of a large set of plaster foram models that are on average about 4 inches (~100 mm). These large models lack fine detail but the overall shape and ornamentation of the forams remains intact. By making our set of foram models available for everyone we increase the visibility of forams and share a great learning tool! Forams come in all shapes and sizes, span all geologic time, and are useful for all ages.

The set of foraminifera models are now available through the myFOSSIL 3D gallery allowing anyone to examine these microfossils. Gaining access to fossils, especially microfossils, can be incredibly difficult and costly for the regular individual, student, or collector. This increases accessibility and utility of these fossils to a broader audience. In addition to making the models, we created several lesson plans. The lesson plans are designed to be used with a variety of age groups. Topics covered include introductory information about forams, an ecology lesson, and a high-school focused lesson on paleoclimatology. We even wrote one lesson focusing on English Language Arts skills for younger students. The goal of these lessons is for each to be accessible to a wide range of ages and ability levels. The lessons will soon be freely available on myFOSSIL!

To learn more, read these previous newsletter articles about foraminifera:

Research: Larger Benthic Foraminifera and the Eocene-Oligocene Transition (http://www.myfossil.org/research-larger-benthic-foraminifera-and-the-eocene-oligocene-transition/) by Laura Cotton

Foraminifera and the Cushman Foundation (https://www.myfossil.org/foraminifera-and-the-cushman-foundation/) by Jere Lipps

Paleoart: Franz Anthony

Editor's note: This issue, Jen Bauer interviewed paleoartist Franz Anthony. Franz Anthony's personal site can be found here (http://franzanth.com/), his portfolio here (http://behance.com/franzanth), and his art shop here (http://252mya.com/franz-anthony). He is also active on social media where you can see his art featured: Tumblr (http://franzanth.tumblr.com), Twitter (http://twitter.com/franzanth), Instagram (http://instagram.com/franzanth), and Facebook (http://facebook.com/franzanth).

Describe your path to paleoart. Do you have science and/or art training?

Franz Anthony

I've been drawing animals for as long as I can remember. As an Indonesian, I grew up being constantly reminded that there are lots of extraordinary creatures living all around me — even though being a suburban kid in the world's most populated island means I never saw them in person. Luckily, my mom was supportive enough to feed my obsession by an endless stream of books and I consider myself very privileged for this.

Though I devour pretty much all sorts of information about animals, I've always been drawn to creatures that have flashy features like wings, fins, or exoskeleton. Their general weirdness — plus the idea that they're real yet so out of my reach — is often most visible in ancient creatures, especially invertebrates.

Maybe, just maybe, growing up a gamer also amplified my curiosity. 90s kids were, and still are, heavily exposed to all sorts of fictional media that push the idea that somewhere out there, there are "magical" creatures to discover. It's a romanticized view of the actual, natural world, but I feel like fiction plays a big part in nurturing my excitement.

Now that I'm a grown up, my academic and professional experiences actually revolve around art and visual communications. I find graphic design and illustration to be powerful tools that can drive people to empty their wallets, so I hope to use the same principle to spark people's curiosity about the natural world instead. Some years ago, I started posting my dinosaur doodles on tumblr, as an attempt to educate myself more about the creatures and entertaining people at the same time.

This is when the folks of EarthArchives.org found me. Back then, I had no connection in the paleo sphere. That's part of the downside of living in the tropics, I guess. Paleontology is pretty much non-existent here beyond what we see in games and movies. After helping them out with communicating scientific findings in the form of layperson-friendly articles, I then branched out to help their sister project, Pteros.com.

In late 2016, I used my experience working in design agency settings to co-found the artists' collective, Studio 252MYA (https://252mya.com/). The goal was to consolidate EarthArchives and Pteros artists so we can tackle projects that are more elaborate than illustrations. We're a tiny team, but we're growing nicely — right now we're looking into books and other design projects.

How do you decide what to create? I saw your recent echinoderm series and being a Paleozoic echinoderm worker I was overjoyed that the odd and bizarre forms were receiving some desperately needed attention.

Paleoart, to me, is a form of science communication that relies a lot on illustrators. While cameras can now snap us accurate images from the deepest sea, or creatures that are too small and move too fast, we can't say the same about lifeforms that are long gone.

Not gonna lie, I love dinosaurs. But there are so many artists out there covering pretty much every branch of the family tree, yet most other creatures never get this kind of treatment. This is why I decided to shift my attention to fish and invertebrates, to give them their long overdue "new looks" that are more easily comprehensible to the non-scientific crowd.

As a visual communication specialist, I find it tricky to make people pay attention to words and shapes that they don't associate with a personal memory, like dinosaurs. This is why it's so hard to get people to care about invertebrates — they don't usually make it to the big screen. I can't turn people into echinoderm enthusiasts overnight, but I want people to consider their existence.

Parasaurolophus: Illustration from "The Circles of Life" series.

At least, I hope that my visuals are striking enough to make people stop and think, even just a bit. If all else fails, I resort to bad invertebrate jokes and puns.

How long does it typically take to complete a project? Do you have a long process or step of procedures?

These days, I try to post one animal weekly to join Twitter's #FossilFriday bandwagon. Typically, on Wednesday, I would be hunting for the right papers and references. This is often harder than it sounds when dealing with obscure creatures that haven't been touched by scientists for decades.

Miraspis: Illustration from "The Colorful World of the Trilobites" series.

Using specimen photos and line drawings made by the authors of the papers, I sketch out the basic anatomy of the animal directly on my computer, in Photoshop. I also color everything digitally, which simplifies my process. For the pattern and coloration, I look into living animals for references. This involves figuring out their habitat, lifestyle, and what kind of pigment/structural coloration is plausible within the group.

Normally, each animal takes a day or two to finish, depending on the details involved. Finer details like a sea urchin's spines and tube feet or a nautilus' tentacles definitely take longer than say, a fish or a pterosaur.

My invertebrate plates, however, take weeks to finish. Each one of them usually includes 12-20 individual animals that I can only do one per week.

What are the most rewarding and challenging aspects about being a paleoartist?

Actually, the realization came to me when I ran into a similar problem outside of paleo. I was once asked to illustrate 80 fishes from a national park in Sumatra, some of which were very obscure or even new to science. It's really hard to create a full, representative picture of an animal if the specimen is damaged or if we don't know enough about it to make a guesstimate.

On the other hand, this exact problem is what makes scientific illustration in general so exciting. I feel honored when I get to be the first person to illustrate a creature, giving a face to a specimen that would otherwise be unattractive/incomprehensible to the public. It's kind of a big responsibility because my work plays a part in shaping people's perception of the animal.

If someone wanted to pursue paleoart as a possible career, what advice would you give them?

I don't consider myself qualified to answer this because I'd be stepping on the toes of people who have been in the field for decades, but here's what I personally feel, anyway.

Paleoart, or scientific illustration in general, is a very niche field, and opportunities are often limited by budget or geopolitical constraints. But within the niche, there's always room for improvement and diversification.

I'm a 2D illustrator who is clueless about modeling with clay or 3D softwares. I don't have a scientific academic background that gives me easy access to publications or museums' drawers, but I'm academically and professionally trained in graphic design and visual communications. So with the help of invertebrate-enthusiast friends I make along the way, I'm going to call dibs on this intersection between design and invertebrates and own the niche.

Last but not least, technology is advancing very quickly these days. With the rise of paleontology-themed games and animations made by independent developers, I feel like there are so many new, untapped methods we can use to bring ancient landscapes back into life. I'm confident that anyone, as long as they find their own niche, can bring something unique into our shared vision of the past.

Research: Evolution of Metazoan Disparity

By Bradley Deline

Editor's Note: Brad is an Associate Professor in the Geosciences Department of the University of West Georgia. He earned his BS in Geology at the University of Michigan and MS and PhD at the University of Cincinnati.

Figure 1. Halkieria evangelista from the Cambrian Sirius Passet fossil Lagerstätte of North Greenland. The affinity of Halkieriids is still debated as they show similarities to mollusks, brachiopods, and annelids. Currently most paleontologists consider them to be primitive mollusks. Credit: Jakob Vinther, University of Bristol.

In 1989, Stephen Jay Gould published his book, *Wonderful Life*, describing the fossils of the Burgess Shale as well as their importance in understanding the history of life on Earth. He proposed that these weird wonders (such as the animal shown in Figure 1) from the ancient sea represented a zenith in morphologic disparity. Disparity is a measure of the diversity of forms or features found within a group of organisms. In other words, how different are animals from each other. He proposed that life experimented with many different body plans, some of which worked and diversified through time and others failed and went extinct. Therefore, the animals of today are constrained within the body plans of the Cambrian survivors.

For almost thirty years this hypothesis remained largely untested. This was the result of how difficult it is to mathematically compare very different organisms. For example, how similar is a fish to a housefly or a sponge or a seastar? If we could map the evolution of bodies across the animal kingdom this would allow us to answer some fundamental questions about life over the last half billion years.

Back in 2009, I was discussing these ideas at a conference over drinks with Philip Donoghue (University of Bristol) and Kevin Peterson (Dartmouth College) and we formulated a plan to tackle this long-standing hypothesis. Phil proposed we use the recently published work of German anatomist Peter Ax (1996, 2000, 2003). Ax systematically described different animal groups from bilaterians to butterflies listing out the features that defined those groups. From this resource we were able to quantify the anatomy of almost 400 animals based on over 1800 characteristics. We then mapped how all of those characters were related so we could code characters as non-applicable, for example coding the limb structure doesn't make sense for a sponge and we wanted to capture that in the analysis. We then included 80 fossil animals (along with over a hundred new characters from those animals) that would include the range of body forms found during the Cambrian Explosion. The vast majority of these fossils are exquisitely preserved, but half of the characters are still features that have never been seen in the fossil record (for example cellular structures). To correct this, we built an evolutionary tree that incorporated all of the modern and fossil animals. We then used this tree to statistically model evolution to estimate the unpreserved characteristics of the ancient animals.

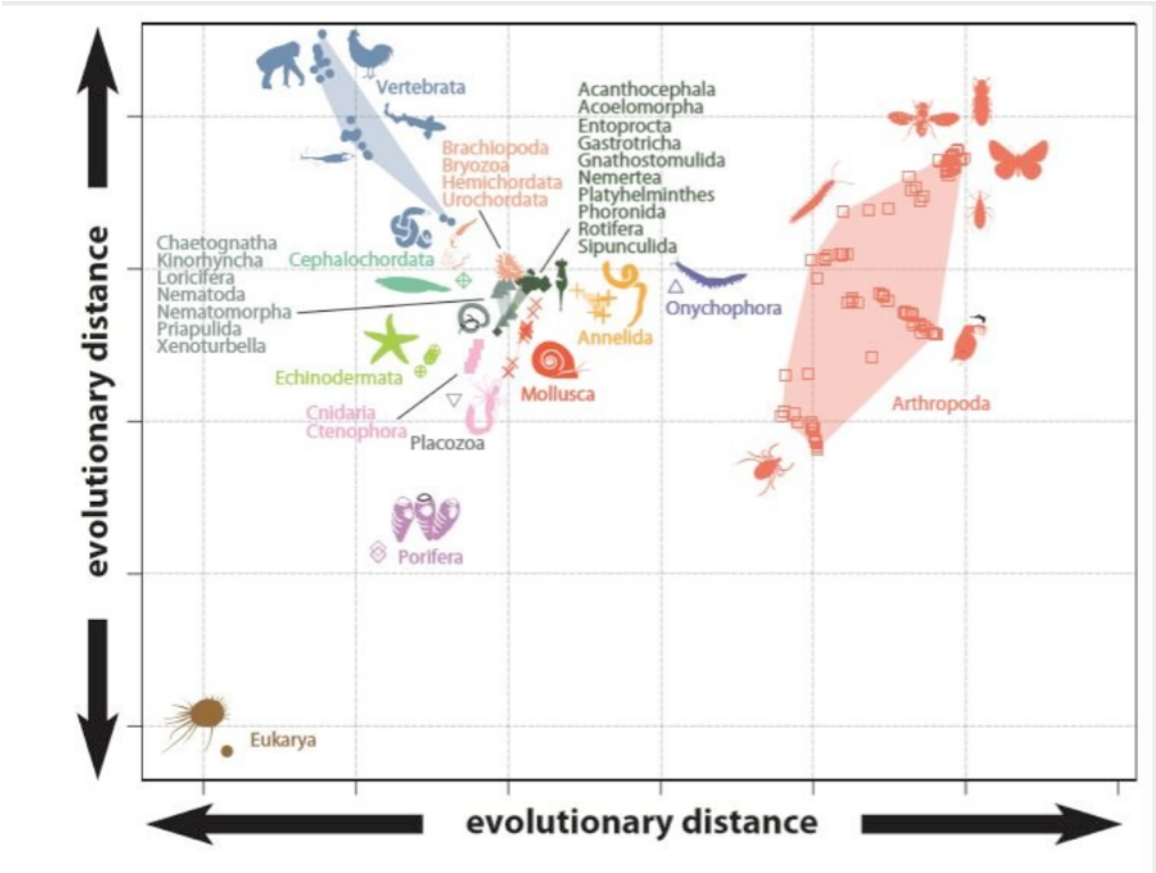
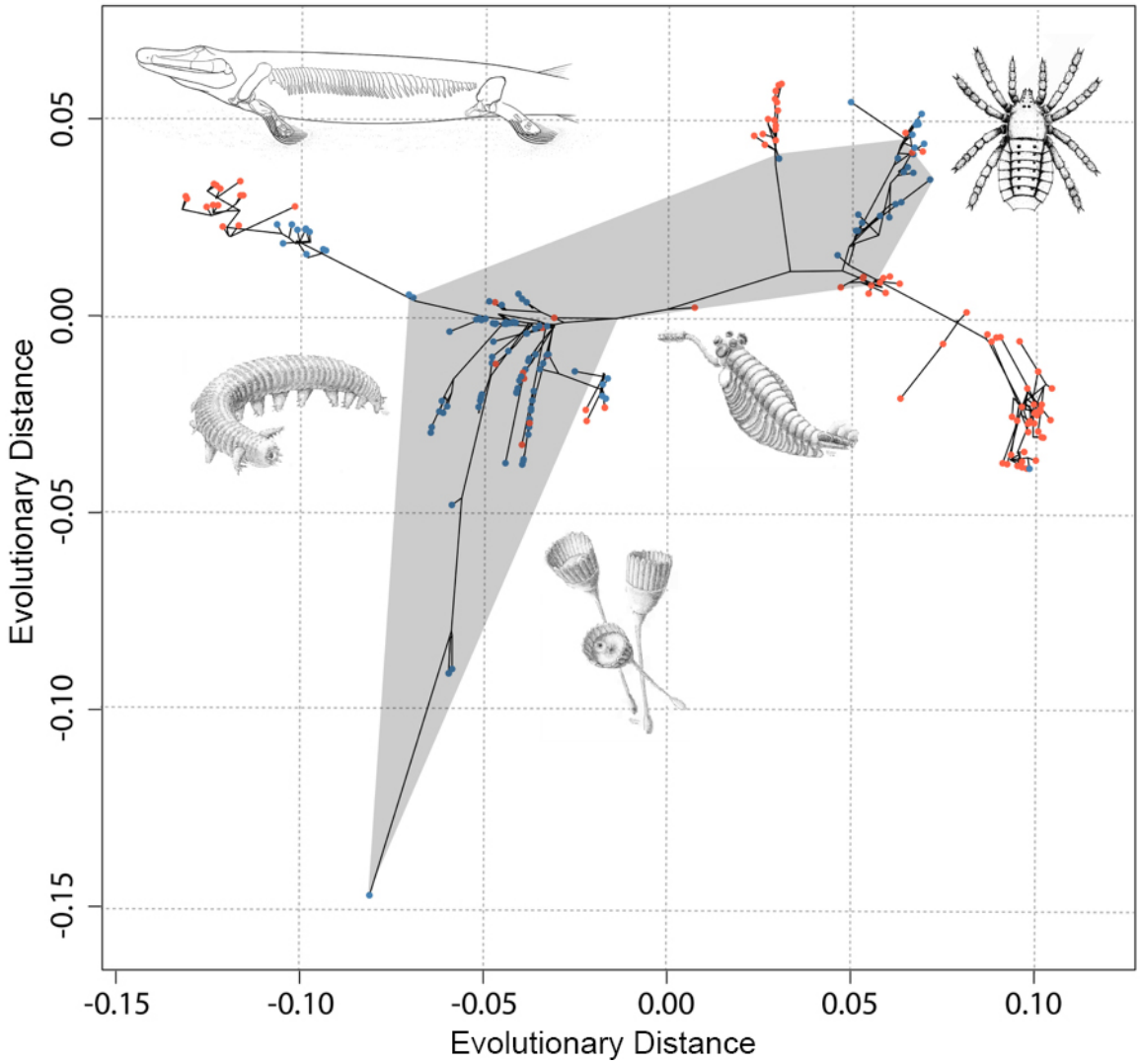


Figure 2. Shape space based on the presences and absence of anatomical features showing the distribution of living animal anatomy. Credit: University of Bristol.

The resulting evolutionary map of animal body plans can be seen in Figure 2. Animals that plot closely together share features giving them an overall similar appearance. Many phyla cluster closely together in the central area of the shape space based on their shared wormy appearance. The extremes of the evolutionary space are occupied by arthropods, such as insects, spiders, and crabs, and vertebrates, such as fish, reptiles, and us. When we included the Cambrian oddities (Figure 3) they plotted in the intermediate areas between modern groups. The implication of this is that modern animal groups appear distinctive because of the extinction of transitional forms rather than rapid early evolution. Also, this means that the weird animals from the Cambrian only appear bizarre because they are unfamiliar compared with what we have in the world today. In other words, today's world is filled with many more weird wonders compared with the ancient ocean. The evolution of body plans wasn't restricted to the Cambrian, but life kept exploring new forms through time. These expansions often correlated with major evolutionary events, such as the transition onto land as seen in vertebrates, mollusks, annelids, and arthropods (Figure 3).



We also wanted to explore the underlying mechanisms for this expansion through time. To do this we collected data on genome lengths as well as the diversity of proteins and regulatory genes for living animals. We found that the distribution of animals in anatomical space correlated with genome length and regulatory genes, but not the type or diversity of proteins. This indicates that the controls on the timing and expression of genes were key to animal evolution.

Overall, this study produces a new prospective on animal biodiversification and the mechanisms that have led to the diversity of life today.

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Upcoming Events

October 19 – October 21
KGMS Gem, Mineral & Jewelry Show (Tennessee)

October 20 – October 21
Florida Fossil Hunters Fossil Fair (Florida)

October 25
"The Lost Bird Project" Public Lecture (Florida)

October 26
Dinos After Dark (Pennsylvania)

October 28 – October 29
Philadelphia Shell Show (Pennsylvania)

October 28
KU Natural History Museum Member Day (& Fossil ID Day!) (Kansas)

October 30
Meet NHMU's Newest Dinosaur: Akainacephalus johnsoni (Utah)

October 31
Dig for a Day: Wyoming Dinosaur Center (Wyoming)

November 3 – November 4
Paleontological Society of Austin Fossil Fest (Texas)

November 4 – November 7
Geological Society of America Annual Meeting (Indiana)

Click here for more information and events.

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