



Summer Calendar

Quarry trips: Martin Marietta has made a business decision to suspend all fossil collecting at all quarries indefinitely.

July

17 NCFC Meeting- NCMNS, 11 West Jones Street, Raleigh. 1:30 pm, Level A conference room. "**News from the Permo-Triassic: Tetrapod Discoveries from Around the World (Despite the Pandemic)**" Speaker will be Christian Kammerer, Curator of Paleontology, NC Museum of Natural Sciences. A zoom link might possibly be used for this meeting, check emails for a notice.

September

18 NCFC Meeting- NCMNS, 11 West Jones Street, Raleigh. 1:30 pm, Level A conference room. Speaker and topic to be announced

President's Message

As a fossil collector, I find I tend to learn a lot about the geologic time periods that are represented at my favorite collecting sites. However, when it comes to other time periods, I may struggle at times when asked to help I.D. something found outside my experience. No matter how much you read about something, nothing compares to hands-on experience. As a paleo volunteer at the NC Museum of Natural Sciences, I have been able to see a lot of specimens from different times and localities, which has boosted my knowledge considerably. Also, as a part-time employee in the Special Exhibits, I have been fortunate to have had opportunities to learn even more. Currently I am working at the new exhibit "Life Before Dinosaurs: The Permian Monsters." The Permian? I confess this is one period I know very little about. Most of my collecting has been done here in North Carolina, with only a few exceptions, and, let's face it- we don't have Permian layers here! So, I am in new territory, and I need to be able to answer many questions from museum visitors as they come through the exhibit.

Luckily, there is a lot of great information on hand, and

one of the world's experts in the Permian, Dr. Christian Kammerer, works at the museum. Christian updated all the written information in the exhibit with the latest scientific research and I was fortunate to be able to attend a talk he gave to museum members at the opening night event. I learned a wealth of information from his short presentation, one of a series offered in conjunction with the exhibit. I asked if he would be willing to give this talk to the NCFC, and he accepted. He will be our July speaker, so all club members will be able to hear about his amazing work in this period. I have also arranged for NCFC members to get a group discount on tickets if you visit the exhibit the day of our meeting, as we will be back in person at the museum A level meeting room. We will still continue to Zoom the meetings as well for now, since we are still dealing with Covid concerns.

Now I am discovering lots of interesting facts about more familiar creatures like Dimetrodon, Gorgonops, Meganeurosis (the giant dragonfly), Seymouria, and Lystrosaurus, and learning about weird creatures like Helicoprion, a shark with a saw-blade jaw; an amphibian called Diplocaulus, nicknamed "Boomerang Head"; a cow-like creature named Moschops Cotylorhynchus, with a very tiny head that looks much too small for its body; and a tiny creature smaller than my cat called Cacops ("ugly face") that is my personal favorite! I have also learned that Dimetrodon was not the only Permian creature with a huge sail on its back. While Dimetrodon was a carnivore, Edaphosaurus had a very similar body shape, but was an herbivore, and both are synapsids. While I knew vaguely about anapsids, synapsids, and diapsids, and the ancestry of mammals that began in this period, it is great to be able to put it into a better perspective. Somehow this period gets overshadowed by the Mesozoic, and all the well-known dinosaurs that seem to get all the attention. Will there ever be a movie called "Permian Park?" Yet before the Permian-Triassic extinction- where 90% of all life on Earth disappeared- there was a fascinating ecosystem filled with all kinds of strange and wonderful terrestrial and marine creatures. Nature seemed to get really creative with body shapes, weird horns, huge sails, and oddly proportioned animals. Many are more fantastic than any dinosaurs and easily rival the Mesozoic in diversity, and a few of these, like Lystrosaurus, even managed to continue into the Triassic!

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On my recent trip to Arizona, I was able to see the Permian Limestone layers in the Grand Canyon and Walnut Canyon, and see fossils in the canyon walls. I took a few photos of these as well as some in the exhibits at The Petrified Forest Visitor Center, where several skeletons are on display. I also had a chance to visit Linda McCall, who recently got to dig at a Permian site in Oklahoma, and see her really interesting finds! So, maybe, when this is all over, I will have acquired a passable knowledge of this extraordinary time period.

Terry Denny
President, NC Fossil Club



Diplocaulus



Cacops



Lynn Moore
1953 - 2022

Upper left: Lynn searching for fossils in Oklahoma Oct. 2014

Lower left: Lynn at Ruck's Pit in Florida

Thanks to Diane Willis and Linda McCall for sharing these photos.

Lynn Ellen Jones Moore, 69, of Ocean Isle Beach, NC, died on June 10, 2022 after a lengthy illness battling Frontotemporal Dementia.

Lynn was born on May 29, 1953 to Val Stephen Jones and Mary Jackson Jones in Buffalo, NY. Lynn graduated from Catawba College in Salisbury, NC in 1974 with a Psychology Degree and went back to get her Education Degree in 1975. She got her Master of Arts in Education at Wake Forest in 1981.

During the next 44 years, Lynn married Jim Moore, moved to Mocksville, NC, had a daughter, Jennifer, and was active in the community. In her 30 years of teaching, Lynn taught almost every grade K through 12 in the Davie County and Forsyth County school systems and finished as a gifted services teacher. She offered courses through the state for teachers wanting Gifted Service Licensure. She was Teacher of the Year in 1992 at Mocksville Middle School in Davie County. In 2008 she retired to Ocean Isle Beach and enjoyed fossil hunting, shell collecting, and line dancing. Once at Ocean Isle, she worked for the Brunswick Community College GED program where she helped so many students achieve their goals. She



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will be remembered for her volunteerism at the Ocean Isle Beach Museum, Planetarium, New Hanover Hospital, and Novant Heath Brunswick Medical Center. She was active in animal rescue with Sea Biscuit Wildlife Shelter and Cat Tails Animal Shelter. She was a board member of the NC Fossil Club and enjoyed many trips across the southeast digging in rivers, creeks, quarries, and mud pits with beloved fellow club members. Her goal was always to help others, teach, and stay positive in her approach to her day-to-day life.

Lynn was preceded in death by her father, Val Stephen Jones, and mother-in law, Bernadette Gsell Watson. She is survived by her husband, Jim Moore of Ocean Isle Beach, NC, daughter, Jennifer Moore of Mooresville, NC, and boyfriend, Chris Gregory and his son Carter; mother, Mary J. Monson of Winston-Salem, NC; father-in-law, Russell Watson of Ocean Isle Beach; sister, Kathy Jones Crouse and husband, Ken of Fallbrook, CA; sister, Susan Jones Platt and husband, Sam of Clemmons, NC; brother-in-law, Craig Barton and wife Marian of Mt. Holly, NJ; nieces and nephews Taylor Crouse, Amanda Worley, Spencer Worley, Hannah Platt Martin, Michael Martin, Coen Martin, Mikala Platt, Alec Barton, Madeline Barton, and Michael Barton.

A service will be held at a later date when her ashes will be interred at Clemmons UMC Garden of Memories. In lieu of flowers, the family requests donations be made to the "Positive Approach to Care" - Scholarship Fund - in Memory of Lynn. Please mail checks to: Positive Approach to Care, PO Box 430, Efland, NC 27243. Lynn was a valued and active member of Positive

Approach to Care (PAC) and was involved in many PAC trainings. Not only did she learn more about dementia and FTD, she was an important part of the team – sharing her real-life experiences and teaching others how to better support people living with FTD. Since Lynn was a teacher, this allowed her the opportunity to continue doing what she loved, making a difference in the lives of others.

For more information, use the link below, that PAC put together in honor of Lynn.

<https://shop.teepasnow.com/product/lynn-moore-scholarship-fund/>

**Photos from the May 15 picnic at Lake Crabtree- club get together, snacks, and silent auction.
The silent auction brought in \$608 which will go toward grants and other expenses.**



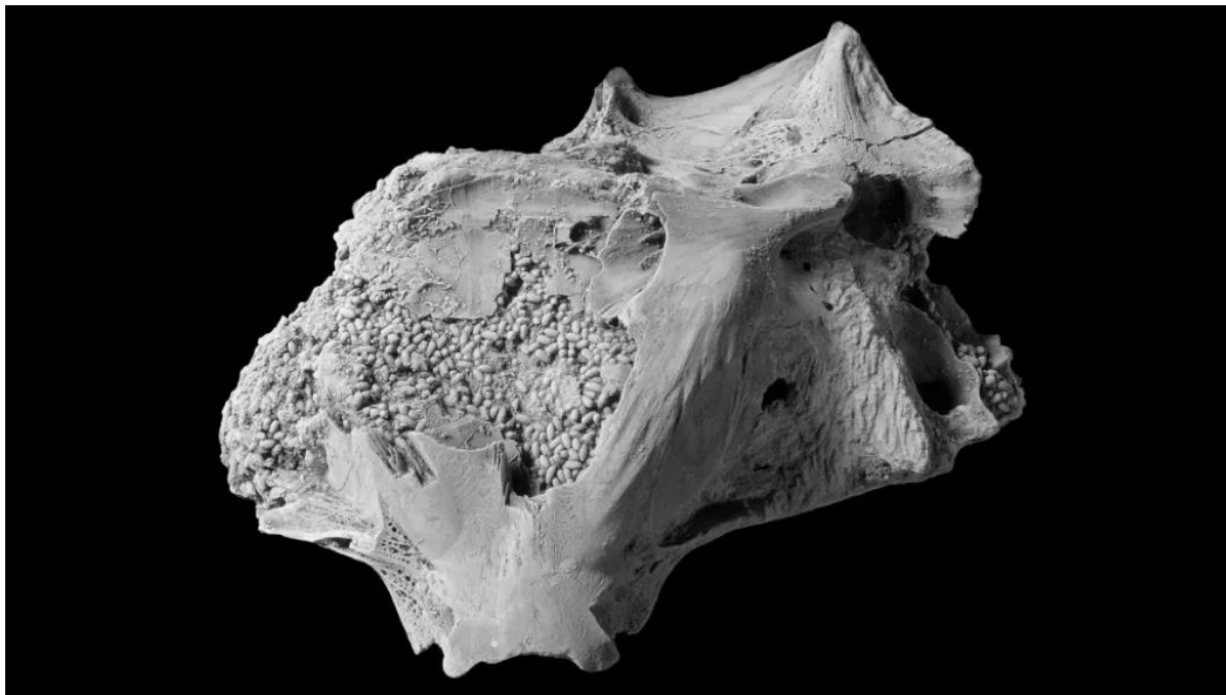
Photos of the NC Fossil Festival. Thanks to Mark McKoy for providing his photos. Bottom photo borrowed from the NC Fossil Club web page- <https://ncfossilclub.org/nc-fossil-festival-2022/>



Fossils in the news

'Wonderfully-shaped feces' found inside ancient fish skull. What left the pretty poops? Scavenging worms left poop piles behind as they devoured the fish's decaying head.

Article by Mindy Weisberger can be found here: <https://www.livescience.com/fossil-fish-brain-worm-poops?>



Worms scavenging the brain of a Miocene fossil stargazer produced the many hundreds of tiny fossilized fecal pellets seen here. This is the first skull known from the fossil record to have its braincase completely filled with fossilized poop. (Image credit: Photo courtesy of the Calvert Marine Museum)

In a first for paleontology, scientists have found hundreds of tiny, fossilized fecal pellets crammed inside a fish braincase dating to about 9 million years ago. The wee fossil poops, also known as coprolites, were deposited by scavengers — probably worms — that devoured the fish's decaying head, including its brain.

As they munched the flesh from the skull, the worms pooped out chains and clusters of oval coprolite beads, each measuring about 0.1 inches (2.5 millimeters) long. Small as they were, those pellets added up over time. When the hungry scavengers were done, they had left behind hundreds of pellets — enough poop to fill the fish's braincase entirely.

Researchers found the coprolite-filled fossil at Calvert Cliffs, a site in southern Maryland that contains fossils dating from about 18 million to 8 million years ago, during the Miocene epoch. The skull belonged to the fish *Astroscopus countermani*, a type of bottom-dwelling ambush predator commonly known as a stargazer, and small, oblong coprolite pellets such as these are known collectively as *Coprolus oblongus*. In addition to the fecal-stuffed skull, the scientists also examined other coprolite pellet deposits that were clustered in sandy sediments, stuck to fossilized snail and bivalve shells, and grouped around preserved barnacles at the site.

Another notable fossil in the group was a much larger coprolite measuring 7 inches (18 centimeters) long, that had been pooped by a vertebrate, possibly an ancient crocodylian. Threading through the preserved poop were deep tunnels that had been dug out by unknown animals eating the poop or digging a home — or both, researchers reported in the March 2022 issue of the journal *Rivista Italiana di Paleontologia e Stratigrafia* (Research in Paleontology and Stratigraphy).

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Many Miocene marine creatures have previously been described from Calvert Cliffs fossils, including sharks and other fish, turtles, crocodiles, seabirds and seals, according to the study. A variety of coprolites have also been collected near the cliffs, though microcoprolites that are produced by invertebrates — such as the coprolites in the fish skull — haven't been as well-studied as poop from animals with backbones, according to the study.



Fossilized crocodile poop, broken open showing the burrows made by one or more kinds of poop-eating organism. Notice the feeding gouge marks on the sides of the cylindrical burrows. (Image credit: Photo courtesy of the Calvert Marine Museum)

Scientists determined that the tiny beads inside the skull were fecal pellets "on the basis of their very characteristic size, shape and chemical composition," said lead study author Stephen Godfrey, a curator of paleontology at the Calvert Marine Museum in Solomons, Maryland. Nondestructive X-ray spectroscopy revealed that these microcoprolites had relatively high concentrations of calcium and phosphate, which are commonly found in fossilized feces, Godfrey told Live Science in an email. (While there's no way to tell for sure if the scavengers munched on fish brains, the poop-filled braincase suggests that brains were probably on the dinner menu.)

But whose poo was it? A dead animal's corpse attracts numerous scavengers, many of which "will be perfectly happy to eat your brains and fill your skull with feces," Godfrey said. Micropellets such as these are produced by insects, worms, sea squirts, snails and clams; but since the coprolites came from a marine environment, "we can safely rule out terrestrial insects as the producers," Godfrey said. Sea squirts could also be ruled out, because they spend most of their adult lives attached to rocks, and acorn worms were also crossed off the list due to their habit of defecating outside their burrows.

Because the fecal pellets were found in the innermost parts of a fish skull that measured no more than 2 inches (5 cm) wide, they were probably pooped out by an invertebrate that could squeeze its soft body into tight spaces. "This would probably then rule out snails and clams, leaving polychaete worms and other kinds of worms as the most likely candidates," Godfrey said in the email.

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Fossilized micro-coprolites (probably worm fecal pellets) from the Miocene epoch from southern Maryland (Image credit: Photo courtesy of the Calvert Marine Museum)

The researchers also noticed that all the wee pellets were similar in their size and shape, Godfrey said. In fact, he was "most surprised and actually impressed" by the coprolites' uniformity, compared to the inconsistently shaped fecal output of most vertebrates.

"How and why is it that some worm could produce such uniform and wonderfully-shaped feces is remarkable to me," he said.

Originally published on Live Science.

What Caused This Megatooth Shark's Massive Toothache?

Article by Tracey Peake can be found here: <https://news.ncsu.edu/2022/05/what-caused-this-megatooth-sharks-massive-toothache/>



A hunt gone wrong! Artistic reconstruction Otodus megalodon feeding upon an ancient swordfish ~11 - 3.7 million years ago. A puncture injury to the tooth gum such as this may have caused gemination of the developing tooth buds. Image: Jorge Gonzalez

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Did the world's largest prehistoric shark need an orthodontist, or did it just have a bad lunch?

Researchers from North Carolina State University and the North Carolina Museum of Natural Sciences examined a deformed tooth from an *Otodus megalodon* shark in a search for the root cause: was it developmental, or related to feeding? The work could give paleontologists more insight into the developmental processes associated with tooth injury in ancient sharks, as well as feeding behavior.

At issue is an abnormality referred to as double tooth pathology, in which a single tooth appears “split.” There are several possible causes: during tooth development two tooth buds can fuse into one or one tooth bud can split into two (a process called gemination). Gemination and fusion can be caused by disease, genetics or physical injury to the tooth bud.

“We don’t have a lot of data on double tooth pathologies in ancient shark species,” says Harrison Miller, former NC State undergraduate student and corresponding author of a paper describing the work. “So this was an opportunity to fill in those gaps – and perhaps learn more about the sharks in the process.”

The researchers examined three abnormal teeth: one 4-inch tooth from *O. megalodon*, an apex predator the size of a school bus that ruled the seas in the Miocene and early Pliocene periods (from 11 to 3.7 million years ago); and two from *Carcharhinus leucas*, a much smaller bull shark species that lived during the same period and still roams the seas today.



Normal versus deformed *O. megalodon* and *C. leucas* teeth. Photo: Matthew Zeher.

All three oddly-shaped teeth displayed a form of double tooth pathology. The researchers compared the teeth to normal teeth from both species and performed nano-CT imaging of the deformed teeth so that they could examine what was going on inside.

While the pathological teeth did have more internal canals than normal teeth – confirming either the incomplete splitting or joining of two teeth during development – the researchers were unable to definitively establish a developmental cause.

“Part of the difficulty was in applying terminology from work in humans and other mammals to sharks,” says Haviv Avrahami, NC State doctoral student and paper co-author.

“Sharks have cartilaginous skeletons, not boney skeletons, so preservation of their jaws is rare in the fossil record, and usually, we only find the individual isolated teeth. Additionally, sharks have different mechanisms for tooth development – they have continuous tooth replacement, so you can’t look at what is happening in the rest of the jaw to rule out fusion or gemination.”

Given what the researchers know about this kind of pathology in modern shark teeth, however, they lean toward feeding-related injury as a more probable cause.

“With *O. megalodon* in particular, the current understanding is that they fed mostly on whales,” Avrahami says. “But we know that tooth deformities in modern sharks can be caused by something sharp piercing the conveyor belt of developing teeth inside the mouth. Based on what we see in modern sharks, the injury was most likely caused by chomping down on a spiny fish or taking a nasty stab from a stingray barb.”

“We also know that *O. megalodon* had nesting grounds around Panama, and that relatives of modern stingray species also inhabited that area,” Harrison says. “And these spines can get very thick. So a tooth injury of this type could indicate that *O. megalodon* was more of a generalist predator – and that this *O. megalodon* in particular just had a bad day.”

Lindsay Zanno, head of paleontology at the N.C. Museum of Natural Sciences, associate research professor at NC State and co-author of the research, agrees.

“When we think of predator-prey encounters, we tend to reserve our sympathy for the prey, but the life of a predator, even a gigantic megatooth shark, was no cakewalk either.”

The work appears in PeerJ, and was made possible by Mark Kostich’s donation of the pathological *O. megalodon* tooth (NCSM 33639) to the Paleontological Collections of the N.C. Museum of Natural Sciences.

“We’re incredibly grateful to Mark for gifting this specimen to the museum so we could learn more about these ancient animals,” Zanno says. “So many important fossils are hidden away in private collections, where they are unable to shed new light on our wondrous world.”

From the paper- **“Dental pathologies in lamniform and carcharhiniform sharks with comments on the classification and homology of double tooth pathologies in vertebrates”**

Authors: Harrison Miller, Haviv Avrahami, Lindsay Zanno, North Carolina State University and North Carolina Museum of Natural Sciences

Published: May 11, 2022 in PeerJ

Abstract:

Double tooth pathologies are important indicators of trauma, disease, diet, and feeding biomechanics, and are widely documented in mammals. However, diagnosis of double tooth pathologies in extinct non-mammalian vertebrates is complicated by several compounding factors including: a lack of shared terminology reflecting shared etiology, inconsistencies in definitions and key features within and outside of mammals (e.g., gemination, fusion, twinning, concrescence); differences in tooth morphology, heterodonty, regeneration, and implantation between mammals and non-mammalian vertebrates; and the unmet need for diagnostic criteria that can be applied to isolated teeth, which are common in the fossil record.

Here we report on double tooth pathologies in the lamniform and carcharhiniform Cenozoic sharks *Otodus megalodon* (NCSM 33639) and *Carcharhinus leucas* (NCSM 33640, 33641). All three teeth bear a singular bifid crown with mirrored halves and abnormal internal microstructure—a single, bifurcating pulp cavity in *C. leucas* and a more than tripling of vessels in *O. megalodon* (from two to seven main ascending canals). We identify these abnormalities as likely examples of gemination due to their symmetry, which rules out fusion of tooth buds in one tooth file in different developmental stages in polyphyodont taxa; however, we note that incomplete forms of mesiodistal tooth fusion can be morphologically indistinguishable from gemination, and thus fusion cannot be rejected. We further compile and recategorize, when possible, the diversity of tooth pathologies in sharks.

The identification of double tooth pathologies in *O. megalodon* and *C. leucas* has paleobiological implications. Such pathologies in sharks are largely hypothesized to stem from trauma to developing tooth buds. *Carcharhinus leucas* is known to feed on prey documented to cause feeding-related oral traumas (e.g., rays, sawfish, spiny fish, and sea urchins). However, *O. megalodon*, is considered to have largely fed on marine mammals, and perhaps turtles and/or fish, raising the possibility that the dietary diversity of this species is, as of yet, underappreciated.

The genetic underpinnings of tooth morphogenesis and regeneration is highly conserved throughout vertebrate evolution, suggesting a homologous framework can be established. However, more research is needed to link developmental, paleobiological, and/or paleoenvironmental factors to gemination/fusion in polyphyodont taxa. We argue that the definitions and diagnostic criteria for dental pathologies in vertebrates require standardization in order to advance macroevolutionary studies of feeding trauma in deep time.

2022 Membership Application - North Carolina Fossil Club



Name (1) _____ email _____

(Primary adult member -18 or older for Single/HH Membership)

Name (2) _____ email _____

(Secondary adult member - 18 or older for HH Memberships)

Address _____

City, State, ZIP _____

Phone (____) _____ - _____

First names of minor (<18) children: _____

Current members need to only complete name, any changes and sign the Liability Statement.

Select **One** Type of Membership

(Enclose check or money order

for the indicated amount.)

Individual (new) \$20.00

Individual (renewal) \$15.00

Household (new) \$25.00

Household (renewal) \$20.00

Children of NCFC members who are dependent minors (<18) and living at home may accompany parents on any trip *except those with specific age restrictions*.

Memberships are effective from January through December of the year (or portion of the year) of the date of application. For example, persons joining in August will need to renew their membership 5 months later in January.

The Fossil Club's newsletter, JANUS, is published four times a year and is available only online for members. You may read it online or download it from the website

NCFC Liability Statement

The Undersigned hereby acknowledges his/her understanding that fossil collecting is an inherently dangerous activity which can result in serious bodily injury or death, and/or property damage and hereby confirms his/her voluntary assumption of the risk of such injury, death or damage.

The Undersigned, in return for the privilege of attending field trips related to the collection of and/or study of fossils, or any other event or activity conducted or hosted by the North Carolina Fossil Club (NCFC), hereinafter collectively and individually referred to as "NCFC Events", hereby releases the NCFC, NCFC Members of the Board, NCFC Event leaders or organizers and hosts, landowners and mine or quarry operators from any and all liability claims resulting from injury to or death of the undersigned or his/her minor children or damage to his/her property resulting from any cause whatsoever related to participation in NCFC Events.

The Undersigned agrees to comply with any and all rules and restrictions which may be communicated to the undersigned by the NCFC Event leader and/or landowner and mine or quarry operator and acknowledges that failure to comply will result in immediate expulsion from the premises.

The Undersigned acknowledges that this release covers all NCFC Events and will remain in effect at all times unless or until it is revoked by written notice to the current President of the NCFC and receipt of such revocation is acknowledged.

The Undersigned further attests to his/her intent to be legally bound by affixing his/her signature to this release.

Name _____ Signature _____ Date _____

Name _____ Signature _____ Date _____

Privacy Policy: The NCFC collects contact information for purposes of contacting you regarding your membership, collecting trips you may have signed up for and for other members who may wish to contact you. Your contact information is also included on a membership list published on a secure location on the NCFC website and is available to other current NCFC members. If you do not wish for your contact information to be included on the published membership list, please send an email to membership@ncfossilclub.org with "membership list opt out" in the subject line. Please note while you will continue to receive information (electronic and paper) from the club; other members, including trip leaders may not have access to your contact information.

Mail To: North Carolina Fossil Club, P.O. Box 25276, Raleigh, NC 27611

NORTH CAROLINA FOSSIL CLUB, INC.

(Founded 1977)

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NORTH CAROLINA FOSSIL CLUB

CODE OF ETHICS AND CONDUCT

1. Please conduct yourselves in a manner that best represents the NCFC.
2. Please make a sincere effort to keep informed of all laws, regulations and rules regarding collecting on private and public lands.
3. Never use the name of the Club to gain access to lands, or scientific sites actively under study by paleontological professionals for personal gain or profit.
4. Please act responsibly and safely on all club outings so as not to bring other members or yourself into harm or danger. Parents are responsible for their children and making sure their children follow all quarry, etc. rules. Firearms are prohibited from all Club functions.
5. Always respect and cooperate with the field trip leader or designated authorities in collecting areas. Do not bring along anyone not signed up for the trip, or any non-member to a trip without clearing it with the field-trip leader first.
6. Never collect a site immediately prior to a scheduled field trip thereby preventing fair collecting opportunities for the rest of the members of the Club. "Scouting" ahead of time by the field trip leader is fine.
7. You are encouraged to contact the appropriate professionals upon discovery of what you consider to be scientifically significant fossils. This includes excavation, preparation, and documentation of the fossils in question. You are encouraged to consider donating such fossils to appropriate facilities.