The Newsletter of the North Carolina Fossil Club *www.ncfossilclub.org*

Janus

2025 Number 4

Time to renew your membership. You can mail in the form printed in this issue of Janus or do it online at www.ncfossilclub.org or visit our new site at https://explore.ncfossilclub.org.

Winter Calendar

December

5 NCFC Club trip to **Onslow Quarry** (full).

19 NCFC Club trip to **Clarks Quarry** (full).

January

18 **NCFC Meeting**- NCMNS, 11 West Jones Street, Raleigh. 1:30 pm, Level A conference room and via zoom. The speaker will be Dr. Alycia Stigall. Her talk is titled "The Great Ordovician Biodiversification Event: how coordinated earth system and biotic change set the stage for modern oceans". Check email for details.

President's Message

Greetings, NCFC!

A couple of months ago, I thought I would be stepping down as President, but somehow here I am again, and I am ready to make this a great year for the NCFC. There are lots of things ahead that I hope will inspire more involvement and be fun as well.

Our Fossil Fair was a great success, with many guests and members participating in Mount Airy. Though some venues might have more foot traffic, we had an enthusiastic response from our attendees and our host museum. We were told that they had their best Saturday attendance ever, and we got some new members in the process. We sold a lot of books and calendars, too.

Our slate of speakers is shaping up very well for the coming year, and I am developing plans to hold those workshops I had hoped to have a couple of years ago. Those ended up being postponed for a variety of reasons, but should be manageable this year. So far, we are hoping to have a workshop on Fossil Preparation, as well as Making Molds and Casts, Curating Your Collection, and Hints for Presenting Outreach. If you have ideas for others, or are willing to host or present a session, please let me know! I am hoping to have these in different locations so at least one might be close by for folks in different parts of the state. We might also be able to have one or two virtually, depending on the topic. Watch for info to come on these sessions. I would love for us to have many opportunities to get together more often outside of trips and meetings. We had a lot of setbacks during the pandemic, and all of these things are helping us to restore energy and vitality to the NCFC. We have come a long way, but there is still room for improvement.

Fall Field Trips have been going well, even with some rain mixed in! Lots of good finds have turned up, and you can be sure we are a dedicated bunch, continuing enthusiastically in spite of the weather! There are still a couple more trips to go, and after that, Spring won't be too far away.

We also would like to hold another Spring Picnic/Auction. We have a number of collections of Aurora fossils prepared by Joy Harrington from donations made by Pat Young (former trip guide in the mine) as well as other items that will be ready when we set a date. These auctions have been very helpful in maintaining funding for our grant program and allow us to promote Paleontological Research and Education.

We have so much to look forward to in the year ahead! Meanwhile, I wish you all a Joyous Holiday Season and Happy New Year! See you in the field!

Terry Denny
President, NC Fossil Club

FOSSILS IN THE NEWS

Exceptionally Preserved 'Dinosaur Mummies' Reveal First-Known Reptile Hooves

By Michael Irving
ScienceAlert
https://www.sciencealert.com/exceptionally-preserved-dinosaur-mummies-reveal-first-known-reptile-hooves

One of the Edmontosaurus mummies on display in the American Natural History Museum. (Claire H./CC BY SA 2.0)

About 66 million years ago, a herd of herbivorous dinosaurs succumbed to drought – tragically, just hours or days before heavy rains fell.

We know this because they left some of the most incredibly well-preserved dinosaur 'mummies' ever found, consisting of clay molds of features such as skin, spikes, and the first known examples of hooves in a reptile.

These mummies belonged to a species called *Edmontosaurus annectens*, duck-billed herbivores that roamed what's now North America like ancient buffalo. They're among the dinosaurs we know the most about, because they're quite common and often preserve well.

Paleontologists at the University of Chicago have now led a study closely examining several dinosaur mummies from the 'mummy zone', a 10-kilometer-wide region in the US state of Wyoming with apparently exceptional preservation conditions.

Two recently discovered specimens reveal some never-before-seen features. The first is a juvenile, estimated to be about two years old when it died. This is the first large-bodied dinosaur to keep its full fleshy profile, which includes a crest that runs down its neck and spine.

The second specimen – an early adult, thought to be between five and eight years old – still bears a whole row of small spikes running down its back, from its hips to the tip of its tail. Some of these have been found before, but never in their entirety.

But the most intriguing find is that the toes of *Edmontosaurus*' hind feet are capped in hooves. This marks not only the first find of hooves on a dinosaur, but on any kind of reptile. On top of that, with an age of 66 to 69 million years, it's the oldest known example of a hoof on any animal.

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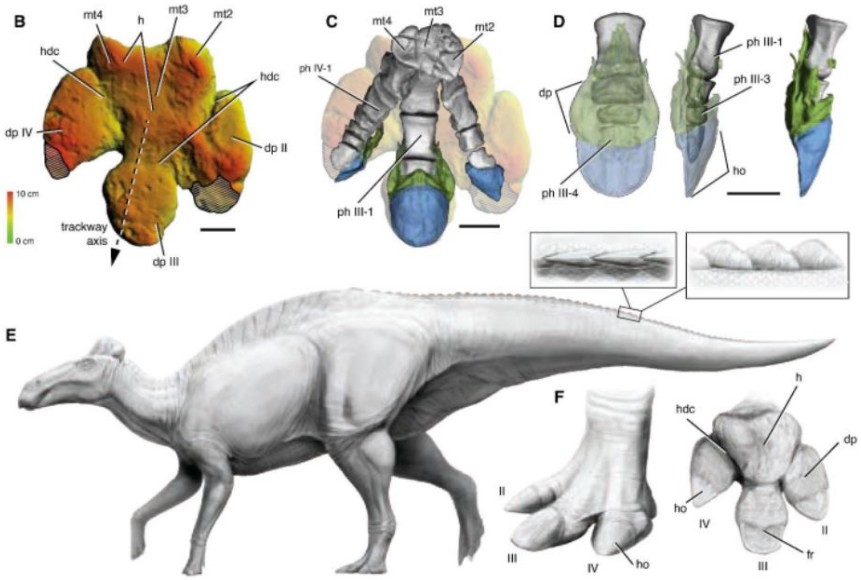

B: *Edmontosaurus* track imprint. C/D: Foot anatomy with hooves highlighted in blue. E: A life recreation of the species incorporating the new information, including the crest and spikes along the back (inset) and the hooved hind feet (F). (Sereno et al., Science 2025)

"Hooves likely evolved even earlier in the Jurassic among armored ornithischians (stegosaurs, ankylosaurs), the manus and pes of which are stoutly proportioned and… are linked to footprints with rounded toe imprints," the researchers write in their paper.

But how were these mummies made? To investigate, the team analyzed the samples with optical scans, X-rays, CT scans, and electron microscopes and found that, sadly, there's no sign of any organic material left, nor any impressions of internal structure.

The *Edmontosaurus* hoof. (Tyler Keillor/Fossil Lab)

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Instead, it looks like all of the external structures are preserved as a thin layer of clay, less than 1 millimeter thick, which was formed by the material congealing onto a microbial biofilm that covered the surface of the carcasses as they decayed.

These finds reveal the story of the animals' deaths in startling detail. Their wrinkly skin, which was closely draped over the bones, indicates the bodies sat out in the hot Sun for a few hours or days after death. A drought has been directly identified as the cause of death for at least some of the mummies.

That makes what happened next tragically ironic. Each mummy seems to have been quickly encased in a big body of sediment, with mixed mud and broken tree trunks in the same layers.

"These details support carcass burial by floodwaters at or near the site of death over a matter of hours or, at most, days," the researchers write. "We conclude that the span of time between death and sudden burial of the four *E. annectens* mummies in the 'mummy zone' was on the order of a week or weeks within a single season."

Clay molds of the *Edmontosaurus* skin. (Tyler Keillor/Fossil Lab)

The majority of what we know about dinosaurs comes from fossilized bones, but occasionally, signs of softer tissues survive. Skin, feathers, scales, and even organs have been found, filling in some of the blanks that bones alone can't fill.

These mummified dinosaurs provide some of the clearest glimpses of ancient animals short of traveling back in time.

The research was published in the journal ***Science***.

New dome-headed dinosaur species is the most complete pachycephalosaur ever found

By James Ashworth
https://www.nhm.ac.uk/discover/news/2025/september/new-dome-headed-dinosaur-most-complete-ever-found.

The name of the new species, *Zavacephale rinpoche*, literally translates as 'head origin precious one' in English. © Masaya Hattori

A new species of dome-headed dinosaur is the oldest of its kind.

Zavacephale rinpoche is an ancient and remarkably complete pachycephalosaur, shining a light on these remarkable but poorly understood dinosaurs.

A well-preserved skeleton is revealing new details about some of the world's most distinctive dinosaurs.

Pachycephalosaurs are famous for their thick, bony domed skulls that were likely used in combat between individuals. The highly distinctive fossils have helped them to capture the public imagination through appearances in films, television series and video games.

But while these dinosaurs might be popular with the public, very little is actually known about where they came from. This is because thick skulls often survived the fossilisation process, but the rest of the body didn't.

This has now changed with the discovery of a new species from Mongolia, known as *Zavacephale rinpoche*. Dr Lindsay Zanno, a scientist who co-authored new research into the pachycephalosaur, says that it's helping to reveal key details about these "rare and mysterious" dinosaurs.

"Before *Zavacephale*, our record of pachycephalosaurs was almost exclusively limited to their indestructible domes," Lindsay explains. "With such scanty skeletons, we were left to wonder about basic aspects of their anatomy, like what their arms would have looked like and how their digestive system functioned."

"The well-preserved skeleton of *Zavacephale* is helping us fill in the blanks with its reduced forelimbs, tiny hands and stomach stones for grinding food."

Dr Tsogtbaatar Chinzorig, the study's lead author, adds that *Zavacephale* predates all other known pachycephalosaur fossils by around 15 million years. This means it can also shed light on how these dinosaurs evolved.

"*Zavacephale* was a small animal, measuring less than one metre long, but is the most skeletally complete pachycephalosaur yet found. This makes it an important specimen for understanding how the cranial dome of pachycephalosaurs developed."

The new study was published in the journal Nature.

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The new species was discovered in the rocks of the Khuren Dukh Formation in Mongolia. © Tsogtbaatar Chinzorig

What does Zavacephale reveal about pachycephalosaurs?

Pachycephalosaurs are part of a major group known as the bird-hipped dinosaurs, or ornithischians, that evolved during the Late Triassic more than 230 million years ago. Other bird-hipped dinosaurs include ankylosaurs, iguanodontians and ceratopsians.

Even in such a large and diverse group, pachycephalosaurs stand out. By the time they first appear in the fossil record, they already have their distinctive skulls and other features that set them apart from their relatives. This means they must have been evolving for millions of years beforehand.

But evidence of these earlier species has been hard to find, as pachycephalosaur remains are rare and generally fragmentary. Our dinosaur expert Professor Paul Barrett says it's not entirely clear why.

"On the one hand, pachycephalosaurs might have been genuinely rare in their ecosystems so there weren't many opportunities for them to fossilise," Paul explains. "Alternatively, they might have lived mostly in inland environments where fossilisation occurred less frequently."

"We also know that pachycephalosaurs were quite small, and it's well known that the skeletons of small-bodied dinosaurs are more easily scattered and destroyed by predators, scavengers and erosion than large bones. Generally, the solid domes are the only fossils we find."

This wasn't the case for *Zavacephale*. Over half of its skeleton has been found, including features such as a hand and full tail, neither of which have never been found in pachycephalosaurs before.

The fossil also contained clusters of rocks where the dinosaur's digestive system would have been. Known as gastroliths, these are stones that have been swallowed by an animal to help grind down food, such as tough vegetation.

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The skull of *Zavacephale* suggests that the domes of pachycephalosaurs grow more quickly than the rest of their body. © North Carolina Museum of Natural Sciences

How did pachycephalosaurs use their heads?

Zavacephale is also revealing more about how the iconic pachycephalosaur skull evolved. Similar to the armour of ankylosaurs or the frills of Triceratops, the skull domes of pachycephalosaurs are thought to have played a role in sexual selection.

It's historically been thought that pachycephalosaurs would butt their heads together at high speed, similar to bighorn sheep. Analysis of their domes has shown that many fossils have evidence of wounds caused by a heavy impact, which suggests this is the case.

Other scientists have argued that pachycephalosaurs instead used their domes to shove each other, or perhaps to headbutt the flanks of competitors and predators. The domes could also have been used for display as well, similar to how deer use their antlers to fight and to show off to rivals.

Analysis of Zavacephale's skeleton reveals that most of its bones hadn't fused, meaning that it was still growing when it died. As its skull was already developed, it suggests that the dome formed more rapidly than the rest of the animal's skeleton.

"This young *Zavacephale* specimen had a fully formed cranial dome, which means that these animals were at least practicing their combat skills before reaching their maximum size," adds Lindsay. "If they weren't already fighting over mates and territory, they were at least honing their skills for the future."

While these domes are thought of as an exclusive feature of pachycephalosaurs, *Zavacephale*'s position as the oldest and earliest diverging member of these dinosaurs questions that. It raises the possibility that the domes predate the pachycephalosaurs themselves.

Finding the origins of these domes will mean uncovering more fossils of early pachycephalosaurs and their ancestors. More fossils will also help to answer other outstanding mysteries about these dinosaurs.

"At the moment, we know relatively little about the biology of pachycephalosaurs because only a few near complete skeletons are known," Paul explains. "If we can find more skeletons, it will help to reveal more about how these dinosaurs moved and behaved."

"The relationships of pachycephalosaurs to the bird-hipped dinosaurs are also contentious, so we need to find fossils of a really primitive pachycephalosaur to help link the group more closely into the dinosaur family tree. This will help us get a better idea of how they evolved into such unusual animals."

Martin Marietta Collecting Rules

Dear NCFC Members,

Great News!

After much negotiation, Martin Marietta (MM) has granted the North Carolina Fossil Club limited access twice-yearly to five quarries (Fountain, Clark's, Onslow, Belgrade and Castle Hayne) for field trips. Our newly negotiated access is contingent on strict adherence to a revised, comprehensive set of rules designed to enhance safety. Therefore, the following new rules will immediately apply to ALL MM Quarry trips. (All field trip procedures to other sites will remain unchanged.)

1. **There will be a maximum of 20 people allowed on each trip** regardless of the quarry.
    a. Anyone not on the approved list will be denied access.

2. **A maximum of 5 vehicles will be allowed into the quarry per trip**, all others will be left in the designated parking area. Two of these will be trip leader vehicles and the trip leader(s) will select the remaining 3 (or 4 if only one trip leader is present).
    a. All vehicles entering the collecting areas must be high clearance and capable of carrying 3 additional passengers and their gear.
    b. There will be 4 participants per vehicle entering the quarry.
    c. The 5 vehicles accessing the quarry must have their wheels chocked the entire time with their parking brake engaged.

3. **No participants under 18 years of age will be allowed.**

4. You ***MUST*** provide your own **safety gear**, including all the following **REQUIRED GEAR**.
    a. Hard Hat
    b. High visibility (Hi-viz) shirt and / or vest. (Orange or safety yellow)
    c. Safety Glasses. Even if you wear prescription glasses, have safety glasses with you. Each quarry will decide if you must wear them or not.
    d. Sturdy, closed toe shoes. Boots preferable. No tennis shoes, etc.
    e. Gloves recommended but not required.

5. **If you show up without all the respective safety gear you will not be allowed in** and will be banned from future MM trips for 6 months. You just cost someone their slot.
    a. If you need to cancel a MM trip you are signed up for - do it as soon as possible. There will be a waiting list.
    b. If you habitually cancel within 24 hours of a MM trip, you will face consequences, including being banned from future MM trips for up to 6 months.
    c. **If you NO SHOW** for a MM trip, you will be banned from attending future MM trips for 6 months.

6. **YOU MUST STAY IN THE QUARRY COLLECTING AREA THE ENTIRE TIME OF THE TRIP.** This is a hard and fast Martin Marietta Rule. If you cannot stay the entire time, do not ask for a spot. (Remember, you are either riding with someone else, or you are transporting 3 other people.) You can't leave to go to the bathroom or go up to the office to go to the bathroom or leave early for any reason other than an emergency.

7. Report all injuries to a trip leader, no matter how minor.

8. **All Martin Marietta rules, and quarry specific rules must be followed explicitly**. Any violations will be immediately dealt with. Consequences can include anything from a verbal reprimand all the way up to a 6-month ban from future MM trips. A lifetime ban from MM trips can occur for serious, dangerous behavior that jeopardizes NCFC future access.

9. **NO pictures** are allowed to be taken inside of the quarry without prior permission from the quarry manager and the NCFC board. This includes pictures of your fossils on the ground. Picture time after the trip at the parking area will be done if we are granted permission at the quarry. All pictures must have the location metadata removed.

10. **No Social Media** posting before, during or after a trip that gives ANY details that could identify a Martin Marietta Quarry. You may say, "I found these fossils in the Castle Hayne Formation of NC." You may not say I found these in a quarry that contains Castle Hayne Formation. Please ensure that Martin Marietta cannot be tied to any post. Again, all location metadata must be scrubbed.

11. You will be required to **sign waiver documents** for Martin Marietta and the NCFC before any quarry entry.

2026 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	☐	Individual (new)	$20.00
(Enclose check or money order	☐	Individual (renewal)	$15.00
for the indicated amount.)	☐	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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GENERAL CONTACT	paleoNC@ncfossilclub.org		

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.