The Paleontograph

A newsletter for those interested in all aspects of Paleontology
Volume 1 Issue 7 August, 2012

From Your Editor

Welcome to our seventh issue. I took a break last month but here is your mid-summer issue. I've done a few trips. I went out to the Green River Formation sites in Wyoming and Colorado for fish, wood and insects. I took a friend out for his first time collecting and we had a good time. I also went south down to Virginia for shells and came back with a ton of stuff. I love being out in the field and getting my hands dirty. I will try to do some more collecting when I take my upcoming vacation with my wife. Not sure how that will turn out but I have to try.

Remember that I need articles. Come on, go ahead and write something. I have an article from a first time writer, my friend Harry, a member of my former club and a guy like myself who is crazy about fossils. Of course, I'm rounding things out with articles from Bob. There is also a public service ad I saw on the web that I thought some of you might relate to.

The Paleontograph was created in 2012 to continue what was originally the newsletter of The New Jersey Paleontological Society. The Paleontograph publishes articles, book reviews, personal accounts, and anything else that relates to Paleontology and fossils. Feel free to submit both technical and non-technical work. We try to appeal to a wide range of people interested in fossils. Articles about localities, specific types of fossils, fossil preparation, shows or events, museum displays, field trips, websites are all welcome.

This newsletter is meant to be one by and for the readers. Issues will come out when there is enough content to fill an issue. I encourage all to submit contributions. It will be interesting, informative and fun to read. It can become whatever the readers and contributors want it to be, so it will be a work in progress. TC, January 2012

Edited by Tom Caggiano and distributed at no charge

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The Teeth of Multituberculates and Their Diversity with Time

Bob Sheridan March 25, 2012

Multituberculates are a group of mammals that lasted from the Middle Jurassic to the Late Eocene. Superficially, they resembled rodents in shape and size, but it is not known how they are related to modern types of mammals. All the unambiguous examples from the northern continents; it is a matter of controversy whether there are any examples from the southern continents. The multituberculates are named for the multiple rows of cusps on their molars and premolars. One distinguishing characteristic is that the fourth premolar is long and sometimes blade-like.

A recent publication in Nature by Wilson et al. (2012) describes an analysis of multituberculate teeth (at least the premolars and molars) from 41 genera. The metric these authors use for "dental complexity" is orientation patch count (OPC) which is generated from a 3D scan of a tooth row and basically is the count of discrete planar surfaces on all the teeth. Generally, among living animals, OPC is higher in herbivores than in carnivores. This makes sense: herbivores need broad molars with many cusps for grinding plant matter. The assumption here is that if there is a large variation of OPC among multituberculates at any given time, this means there are a large number of possible ecological niches filled by these animals.

The major result of this paper is the graph of mean and standard deviation of OPC in multituberculates as a function of time from ~180 Myr. to ~30 Myr. The mean OPC is more or less constant at OPC=100-120. A similar constancy is seen in the mean body size. In contrast, the standard deviation OPC (i.e. variation between animals) starts low in the Jurassic (~100), rises during the Late Cretaceous (up to ~350) and falls sharply (to near zero) in the Eocene. A similar trend is seen in the standard deviation in body size and the number of genera per time. This implies multituberculates radiated into many different sizes and shapes well before the dinosaurs became extinct. However, the multituberculates were confined to a few forms, all with a middle OPC and middle body size, just before they went extinct.

They authors point out that the variation in OPC among multituberculates rises at about the same time as the number of angiosperm genera increased (Middle to Late Cretaceous), and infer that the multituberculates were taking advantage of the new types of plant foods available, which is consistent with the fact that many multituberculates where getting the high OPC associated with a more herbivorous diet. It is also clear that the presence of dinosaurs did not prevent this line of mammals from diversifying.

Sources:

Wilson, G.P.; Evans, A.R.; Corfe, I.J.; Smits, P.D.; Fortelius, M.; Jernvall, J.
"Adaptive radiation of multituberculate mammals before the extinction of dinosaurs."
Nature 2012, 483, 457-460.

A Large Feathered Tyrannosaur

Bob Sheridan April 6, 2012

The Late Cretaceous tyrannosaurs (Tyrannosaurus, Daspletosaurus, Albertosaurus, Tarbosaurus, etc.) are very large (30-40 ft. long) theropods with deep skulls, robust jaws and spike-like teeth. They also are famous for having tiny arms with two-fingered hands. There are probably a dozen or so known tyrannosaur ancestors stretching back to the Jurassic. Not surprisingly, these are smaller and more gracile, with lower skulls, longer arms and three-fingered hands (like most other theropods). A number of these (e.g. Dilong) are known to be feathered.

Xu et al. (2012) describe three specimens of a previously unknown tyrannosaur from the Yixian Formation (Early Cretaceous) in northwestern China. One specimen is nearly complete and another is missing only the tail. Xu et al. named the animal *Yutyrannus huali* ("beautiful feathered tyrant"). The skulls look very much like those of advanced tyrannosaurs, being deep and having the "keyhole-shaped" eye socket seen in Tyrannosaurus. The pubic boot is also very large, much like in later tyrannosaurs. On the other hand, Yutyrannus retains the primitive three-fingered hand and has feet much like earlier tyrannosaurs. It also has a slender lower jaw, which is more primitive.

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Feathered Rex Cont'd

There are two unique features about Yutyrannus. First, it is unusually large for an early tyrannosaur, almost as large as Albertosaurus. Second, one can see the impression of densely packed filament-like feathers on all three specimens. These feathers are at least 15 cm. long. One cannot tell if Yutyrannus was covered with feathers, but one can be sure that there were feathers on the neck, tail, and legs. Unfortunately, not much detail about the fine structure of the feathers can be seen.

Since it is know that the early small tyrannosaurs were feathered, and since no evidence of feathers has ever been seen in the larger tyrannosaurs, it has usually been assumed that tyrannosaurs lost their feathers as they grew larger. One sees an analogous trend in mammals, e.g. elephants and rhinos are less furry than smaller mammals. However, Yutyrannus is a counterexample to that expectation.

I learned one other tidbit of interest to us in New Jersey. Dryptosaurus (first named "Laelaps" by Edward Drinker Cope) was discovered in 1866 from the Late Cretaceous of New Jersey. It is medium sized (~25 feet long) theropod, one of the few known from the East Coast. Since so little of the animal's skeleton is preserved, it has been hard to definitively assign Dryptosaurus to a theropod family and my last (outdated) impression was that it was considered a dromaeosaur. However, in this paper I found Dryptosaurus depicted as one of the larger Late Cretaceous tyrannosaurs.

From Wikipedia, I found out that a more complete theropod Appalachiosaurus was discovered in Alabama in 2005. Appalachiosaurus is clearly a tyrannosaur, and the resemblance of Dryptosaurus to Appalachiosaurus strongly suggests that Dryptosaurus is also a tyrannosaur, although somewhat more primitive.

Sources:

Xu, X.; Wang, K.; Zhang, K.; Ma, Q.; Xing, L.; Sullivan, C.; Hu, D.; Cheng, S.; Wang, S. "A gigantic feathered dinosaur from the lower Cretaceous of China." Nature 2012, 484, 92-95.

The Dingo Ate My Baby (Thylacine)!

Bob Sheridan May 6, 2012

It's been a while since I wrote an article about extinction, and this time we consider a very recent one. We need two sets of background information. First, the dingo. Dingos are wild dogs (a subspecies of the familiar family pet) found in the outback of Australia. They are thought to have been introduced by human inhabitants a few thousand years ago. In modern Australia they are the largest predator in Australia. A typical adult would be in the range of 40-70 pounds, about the size of a North American wolf. They tend to be yellow to reddish in color.

Second is the thylacine, also called the "Tasmanian wolf" or "Tasmanian tiger". It arose in Australia about 4 million years ago and was the largest predator in its time. It became rare a few thousand years ago on mainland Australia, but survived longer in Tasmania. The last specimen "Benjamin" died in a zoo in 1936. It is usually assumed that hunting by humans, who considered the thylacine a threat to livestock, was responsible for its final extinction. Occasionally there is a supposed sighting of a thylacine in the wild, but none of these have been confirmed.

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Dingo Cont'd

The thylacine is usually held up as a perfect example of convergent evolution, in that, although it is a marsupial, it is almost identical to the placental wolf in size and lifestyle as an apex predator. The skull of a thylacine and wolf (or coyote) look superficially very similar. One has to look at the details of the underside of the skull and the teeth to see the differences.

By timing alone one could reasonably believe that the dingo had something to do with the extinction of the thylacine: early extinction (a few thousand years ago) on mainland Australia where there are dingos and late extinction (decades ago) on Tasmania where there are no dingos. The extinction could be due to one or both of the following:

1. The dingos and thylacines compete for food and the dingo is better at hunting.
2. Dingos could kill thylacines.

A Modern Dingo

A paper by Letnic et al. (2012), by surveying fossil thylacines from mainland Australia and estimating the size of the animals, adds some insight to the second hypothesis. Generally it was thought that dingos and thylacines are roughly the same size, so a systematic advantage in a direct attack of dingo on thylacine is not clear. However, the work by Letnic et al. shows that the thylacines are dimorphic in size. The larger thylacine (presumably the male) is roughly the same size as a dingo, but the smaller thylacine (presumably female) is much smaller. It is possible that female thylacines were vulnerable to direct killing by dingos.

One of the last Thylacines

Critics of this work point out that predators don't necessary compete for the same prey. (For example dingos might hunt during the day and thylacines at night.) Also, apex predators do not necessary kill each other, even given the opportunity. Also, as the authors themselves point out, there are other possible causes of extinction in Australia at the time; where there were dingos, there were also humans.

Sources:

Letnic,M. ; Fillios, M.; Crowther, M.S.
"Could Direct Killing by Larger Dingoes Have Caused the Extinction of the Thylacine from Mainland Australia?"
PLoS ONE 2012, 7, e34877

An Overview of Pycnodont Paleoecology and Extinction

Harry Maisch IV

Pycnodont fish remains consisting of isolated teeth, partial and whole jaw sections, and disarticulated and articulated skeletons are frequently recovered from Cretaceous deposits throughout the world. However, pycnodont remains are known from the late Triassic through middle Eocene; a time range spanning approximately 175 million years. Although, superficially resembling modern butterfly fish, pycnodonts have no known descendants (Nursall, 1996; Poyato-Ariza, 2005).
Having jaws with heterodontous dentitions composed of highly variable insisiform and molariform tooth morphotypes, pycnodonts as a group, had a generalized durophagous diet that included corals, bivalves, gastropods, etc. (Nursall, 1996; Poyato-Ariza, 2005). Previously well-known as being obligate, marine reef fish, pycnodonts are now known to have inhabited brackish and freshwater environments in addition to saltwater reefs.

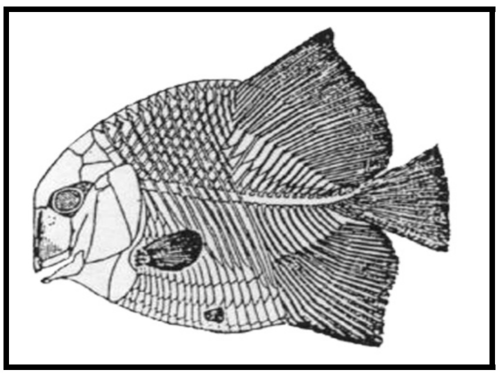

Figure 1: Example of a pycnodont.
From Poyato-Ariza and Wenz (2002)

Evidence supporting the wide range of environments inhabited by pycnodonts includes the presence of anatomical characteristics not exclusive to reefal environments and the recovery of fossils from facies indicative of freshwater depositional environments (Nursall, 1996; Maisey, 2000, p150; Poyato-Ariza, 2005). Most pycnodonts had a deep-bodied, laterally compressed form with well-defined dorsal and anal fins that allowed these fish a high degree of maneuverability while sacrificing the ability to thrive in deep, pelagic environments or those with strong currents (Nursall, 1996; Maisey, 2000, p129; Poyato-Ariza, 2005).

The height of pycnodont diversity occurred during the late Jurassic and early Cretaceous periods and species diversification gradually decreased, leading to the extinction of pycnodonts during the Eocene epoch (e.g. Nursall, 1996; Poyato-Ariza, 2005). Nursall (1996), attributes pycnodont extinction to competition with the rapidly diversifying teleosts, while Kriwet (2001), suggested that pycnodont prey specifications made these fish vulnerable to environmental changes in addition to the increased competition with teleosts.

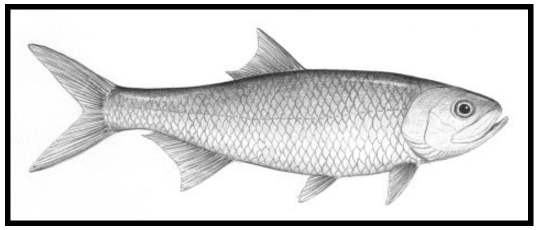

Figure 2: Example of a teleost.
From http://australianmuseum.net.au

A more recent hypothesis on pycnodont extinction is provided by Poyato-Ariza (2005). This hypothesis indicates that the inability of pycnodonts to specialize in other locomotive styles, in particular: accelerating and cruising, coupled with the inability to alter their primary feeding strategies eventually lead to the extinction of pycnodonts and subsequent replacement by the rapidly evolving teleosts.
Nursall (1996) has described the pycnodont jaw structure, once established, to be fairly constant over the 175 million year time span. Poyato-Ariza (2005), asserts that the primary factor leading to pycnodont extinction was their inability to switch feeding styles from mostly manipulation to the ram and/or suction strategy favored by the teleosts.
In summation, it has been hypothesized that pycnodonts were able to adapt to changing environments, although not as quickly as the teleosts. Pycnodonts were not able to compete with the teleosts which were capable of various styles of locomotion including accelerating and cruising combined with a jaw anatomy allowing for a range of feeding styles including manipulation, ram, and/or suction strategies.

Cont'd

Figure 1: Late Cretaceous pycnodont teeth from Monmouth County, NJ.

Pill/reniform-shaped molariform teeth and hook/claw-shaped pharyngeal teeth.

References:

Kriwet, J. 2001.
Feeding mechanisms and ecology of pycnodont fishes (Neopterygii, Pycnodontiformes).
Mitt. Mus. Nat. kd. Berl. Geowiss. Reihe, 4:139-165.

Maisey, J.G. 2000.
Discovering Fossil Fishes.
Westview Press, 223 pp.

Nursall, J. R. 1996.
Distribution and ecology of pycnodont fishes; pp. 115–122 in G. Arratia, and G. Viohl (eds.),
Mesozoic fishes 1: Systematics and paleoecology.
Verlag Dr. Friedrich Pfeil, München, Germany.

Poyato-Ariza, F. J. and S. Wenz. 2002.
A new insight into pycnodontiform fishes.
Geodiversitas 24:139–248.

Poyato-Ariza, F. J. 2005.
Pycnodont fishes: morphologic variation, economorphologic plasticity, and a new interpretation of their evolutionary history.
Bull. Kitakyushu Mus. Nat. Hist., *Ser. A*, 3:169-184.

Field Station: Dinosaurs
A Review

Bob Sheridan June 6, 2012

The late 1980's and early 90's was the heyday of life-size animatronic prehistoric animals in traveling exhibits. When I was first married, I visited "Dinosaurs Alive" and I took my kids to "Sea Monsters", etc. It was that time when model-building and computer technology became good enough and cheap enough to present such exhibitions and make a profit. Also it was far past the Dinosaur Renaissance of the 1980's, so we did not see the old bloated, tail-dragging dinosaurs we had at the 1964-1965 Worlds Fair. (I remember both times equally fondly, however.)

Last weekend a new 20 acre educational attraction opened up in Secaucus, on the grounds of Laurel Hill Park. It is "Field Station: Dinosaurs", where animated life-size dinosaurs are displayed in an outdoor environment. The marketing catchphrase is "Nine miles from Manhattan, 90 million years ago in time." The intended audience is clearly families with children under 10. The CEO of the operation is Guy Gsell, who is a producer of well-regarded educational theater projects and traveling museum exhibits (e.g. the King Tut exhibit) . From the Web site (http://fieldstationdinosaurs.com/), we see the staff is populated by artists, producers, and puppeteers. I do not see any collaborating professional paleontologist listed on the Web site. However, other sources say that FSD is working with the New Jersey State Museum.

I visited FSD with my wife and two daughters yesterday. None of us can be remotely considered children, but we all have enough background in paleontology to be interested in checking out FSD. The last dinosaur theme park I reviewed (in 1999) was the Dinoland USA in Disney's Animal Kingdom (Orlando).

FSD consists of a set of trails, along which are positioned the dinosaur models, plus temporary buildings (tents, quonset huts, etc.) made to look like those one would find in an actual dig. For each dinosaur there is a wood and glass sign giving the name of the dinosaur and a few facts about it. There are a number of "activity areas" (small amphitheaters, "dig sites", etc.) as well. Food and drink is available at only a few outdoor stands. You can cover the entire trail in less than an hour.

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Field Station Cont'd

Our prolific contributor, Bob with a friend.

We did not see a lot of the special activities (simulated digs, interactive shows, birthday parties, etc.) that are available since we only stayed an hour or so. However, we caught part of one show where a performer wore a 15ft-long costume of a juvenile T. res. The only part of the puppeteer visible was his or her legs, which were in black tights and attached to the inner side of the dinosaur feet. It was a pretty impressive performance.

The marketing material for FSD says there are 31 dinosaurs, but I think that means 31 separate models. I counted 16 unique dinosaurs, two pterosaurs (Quetzalcoatlus and Pteranodon) and a synapsid (Dimetrodon). Tyrannosaurus appears three times in different locations. There are two Ankylosaurus in the same location; same with Pachycephalosaurus. Among the dinosaurs are the two (incompletely known) dinosaurs of New Jersey, Hadrosaurus, and Dryptosaurus. Dryptosaurus is now known to be a tyrannosaur, albeit with three fingered hands, and it is depicted correctly. Hadrosaurus' skull is unknown, but from the rest of the skeleton it is inferred that it had a "Roman nose" like Krittosaurus, an Australian hadrosaur. This is also depicted correctly.

I suppose as animatronic dinosaurs go, this set is about average, based on what I remember from the 90's. The eyes blink, the heads and tails move, and there is a lot of roaring (not necessarily lip-synched with the mouth or the breathing motion). The "skin" of the dinosaurs appears to be some kind of painted rubbery fabric. Generally, from a distance it appears to be realistic, but closeup, the animals look exactly like what they are: rubber puppets. For example, when the Triceratops moves its head, its horns bend in the middle, destroying the illusion. The smaller dinosaurs (Velociraptor and Compsognathus) are not animated.

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Field Station Cont'd

Given the difficulty of making mobile life-size dinosaurs and given that the intended audience is small children, I don't want to be too much of a stickler about "realism" (can I suspend disbelief and convince myself I am looking at a real animal) or "accuracy" (do the animals match our latest ideas about what they should look like). Both are fair at best. Generally, the animals look like enlarged plastic toys. The thing that bothered me the most was that the larger theropods, especially Tyrannosaurus, had extremely thick ankles and enormous feet. I suspect this is a compromise with the requirements of standing up a heavy motorized machine on two legs.

Be aware, a visit to FSD can be pretty pricey: $25 for adults and $20 for children. There is a discount if you order the tickets in advance. There are season tickets, but since once can see the whole thing in an hour or two, I am not sure how often one would visit per season.

As far as I can tell, FSD is meant to be permanent, as opposed to a traveling exhibit. My wife expressed the opinion that FSD cannot last very long if the idea is to make a profit. First, being outdoors, it has to be seasonal (May to November according to the Web site). Second, it is too expensive to visit very often. To that I add that New Jersey sun and humidity in the summer is likely to be harmful to rubber-covered machinery. Freezing temperatures and snow are likely problems off-season, unless somehow the exhibits are going to be well-covered or moved indoors.

If you have small children and some amount of spare cash, FSD is a good spot to visit once or twice. I would stretch this to include adults who are interested in dinosaurs in popular culture. If you are a serious adult paleoenthusiast, you are better off spending your money elsewhere.

Here are some news stories on FSD:
http://newyork.cbslocal.com/2012/05/27/dinosaurs-invade-secaucus-at-field-station-dinosaurs/

http://www.newsday.com/travel/field-station-dinosaurs-in-new-jersey-1.3753368

http://kids.baristanet.com/2012/05/field-station-dinosaurs-bringing-new-jersey-back-in-time/

LAGs Do Not Imply Ectothermy

Bob Sheridan July 28, 2012

Cut a cross-section through the long bone of most modern reptiles and one can see concentric "lines of arrested growth" (LAGs). These presumably represent times where the growth of the bone has slowed, presumably once per year. Therefore, one can use the LAGs to estimate the age of the animal, much as one could with tree rings. Most dinosaurs have LAGs in their bones as well, and there is a whole field that uses the LAG-estimated age of dinosaurs to estimate their growth rate.

There has been an implicit assumption that the time of "arrested growth" appears seasonally because, during the winter, the temperature of ectothermic (i.e. "cold-blooded") animals falls, and their metabolism and grow rate falls as well. This idea is consistent with the fact that birds and mammals, which are endothermic, appear to not have LAGs. However, since birds grow very rapidly and most of the mammals examined so far have been small, one can not really distinguish between "LAGs means the animal is ectothermic" and "LAGs mean the animal reaches full growth in one year."

The approach to tease these apart is to examine endothermic animals that do not attain full growth in a year. Kohler et al. (2012) examine the bone histology of 100 wild ruminants (deer, giraffe, bovines, etc.) from a variety of latitudes.

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LAG's Cont'd

Ruminants are ideal for this study because they exist throughout the world, represent advanced mammals, and can take several years to grow. The results are unambiguous. LAGs occur in all the ruminants, from the smallest to largest, and from all climates.

Clearly the LAGs in ruminants do not have to do directly with the temperature of the growing bone, which in mammals should be more or less constant. The authors suggest that LAGs have more to do with annual changes in food availability (plants, in the case of ruminants). In the tropics this would be controlled by with drought vs. the rainy season. At the poles, this would be the amount of sunlight. We know some modern mammals seasonally adjust their metabolism to the season, and this would support that idea.

Not mentioned in this paper are carnivorous animals, who are not directly dependent on plants. We know carnivorous theropod dinosaurs have LAGs. It would be good to next look for LAGs in carnivores like the big cats.

Sources:

Kohler, M.; Marin-Moratella, N.; Jordana, X.; Aanes, R.
"Seasonal bone growth and physiology in endotherms shed light on dinosaur physiology."
Nature 2012, 487, 358-361.

Padian, K.
"A bone for all seasons."
Nature 2012, 487, 310-311.

Turtle Sex from the Messel Shale

Bob Sheridan July 8, 2012

First some background about the Messel Fossil pit (sometimes called the Messel Shale). This is a lagerstatten in Germany that has produced many extremely well-preserved fossils (mammals, birds, reptiles, insects, and fish) from the Eocene. The most famous recent fossil is "Ida" (Darwinius masillae). Most paleontologists believe the Messel shale represents a lake bottom. The exquisite preservation is thought to be due to the fact that the bottom of the lake was anoxic, so that there was little decay before animals were buried.

From time to time volcanic gasses like carbon dioxide or hydrogen sulfide would bubble up from the bottom of the lake and suffocate animals at the surface or in the trees above it.

Since the Messel shale contains a great deal of water, letting specimens dry out would usually destroy them. The usual method of preparation is to split the shale into thin slabs, prepare one side of a slab, then cover that side in transparent resin. One then turns the slab over and prepares the other side. One can cover that side in resin. The result is the bones embedded in resin with most of the shale removed.

Pig-nosed turtles called Allaeochelys are know from the Messel and it was speculated that some of these turtles died while mating because they are found in pairs, and a recent report from Joyce et al. (2012) makes that more certain. One can tell the sex of these turtles by three characteristics: the males are smaller, the males have longer tails, and the males are concave at the ventral surface of the shell. Joyce et al. describe six turtles that were found in pairs, always one male and one female. While the turtles are not preserved copulating as implied by the title of the article, the shells are always touching and in at least one case, the tail of the male is wrapped around the carapace of the female.

Pig-nosed turtles are almost entirely aquatic and mate in the water. The authors speculate that once the male mounts the female at the surface, they would sink to considerable depths before separating. If these turtles respired through their skin, anoxic water at the lake bottom would kill the mating pairs. Alternatively, the turtles might have absorbed some kind of poisonous material from the deep water. This is consistent with the usual ideas about how the lake killed and preserved so many animals. The authors point out an alternative idea: that algae blooms at the surface poisoned animals who drank from the lake. However, they feel it unlikely that turtles would mate at the surface of a poisoned lake.

Sources:

Joyce, W.G.; Micklich, N.; Schaal, S.F.K.; Scheyer, T.M.
"Caught in the act: the first record of copulating fossil vertebrates."
Biol. Lett. 2012, doi: 10.1098/rsbl.2012.0361


1 in 5 children will experiment with palaeontology
'I'm not angry, I just want to know where you got those temnospondyl monographs?'
'How long have you been doing cladistics?'
'Your daughter has been calculating Triassic archosauromorph diversity again...on our bed!'
'Sediment analysis is a gateway to fossil taphonomy'
'I found this *Heterodontosaurus* skull in your room. How could you?'
Know the signs of palaeontology, before its too late