The Paleontograph

A newsletter for those interested in all aspects of Paleontology
Volume 9 Issue 3 July, 2020

From Your Editor

Welcome to our July edition. I hope this issue finds you healthy and safe. As most are, I've been staying home for the most part working around the house and my fossil workshop. I've been getting many large construction projects done with the extra time. I'm also continuing to work thru my backlog of fossils.

I'm lucky in that I've only lost one friend to the virus. It's weird to say that one is lucky to have lost a friend. This whole thing is scary. I don't know why it has become so political. It's a virus. We are nearing 150,000 dead Americans. Why can't we all just wear a mask for a few weeks? Even if that does not work, how much harm is done by being a little uncomfortable, when being near others, for a few weeks? What's the big deal?

I hope you enjoy the issue and stay healthy.

TC

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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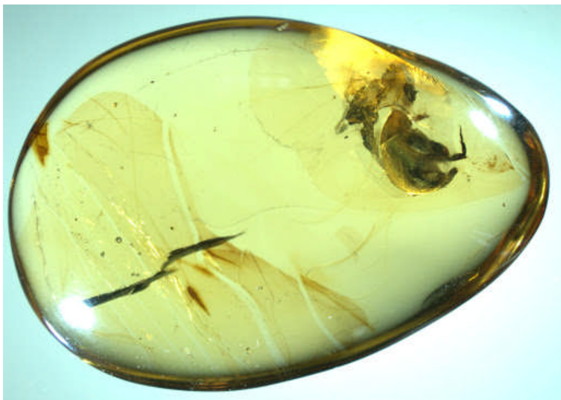
Earliest Angiosperm Pollinator in Amber

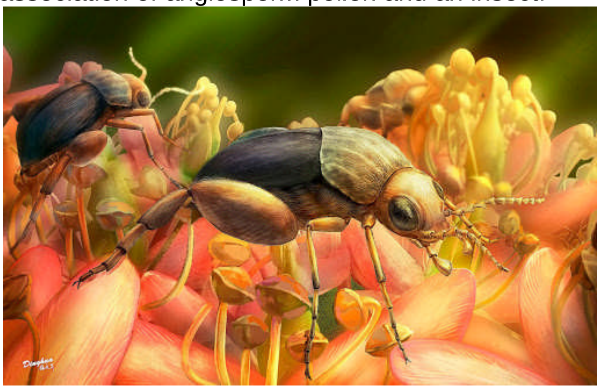
Bob Sheridan November 21, 2019

Angiosperms (flowering plants) originated sometime in the Early Cretaceous. Today, most angiosperm pollen is transported by insects, and the presumption is that this was always true. There are many amber specimens from the same time period containing insects, of which many show attached pollen grains. However, the shape of the pollen grains suggests they are from gymnosperms or cycads. Unambiguous pollination of angiosperms by insects from the Cretaceous is not seen until now.

Bao et al. (2019) describe a specimen of Burmese amber with an age of ~99Myr. This specimen was studied with optical microscopy and also micro-CT scanning. The specimen contains a single beetle that resembles a modern tumbling flower beetle. Tumbling flower beetles, (family Mordellidae) are named for their jumping, turning, and tumbling motion when disturbed. Many have a backward pointing abdominal spine that helps this motion. Many have a hump-backed shape as seen from the side, and a wedge-shape as seen from the top, with the wide end at the head. Modern tumbling flower beetles are (not a surprise) found in flowers and are common pollinators. The specimen in amber, about 0.5 centimeters long, is very round as seen from the side, and has very thick thighs. It is given the name *Angimordella burmitina* ("Angiosperm Mordella-like beetle from Burmese amber").



The most interesting aspect of this specimen in amber is the pollen that is attached to it, and there appears to be only one type of pollen. The pollen grains are 20-30 micrometers long and are described as "tricolpate", i.e. have three grooves on each grain. Such pollen is associated with the eudicot subclass of angiosperm. Tricolpate pollen is known from the fossil records as old as ~125 Myr., but this specimen represents the earliest known association of angiosperm pollen and an insect.



Interestingly, pollen grains are often too hard to see in amber with regular optical microscopy, especially if it is caught in hairs on the insect. However, this study uses confocal laser scanning microscopy.

Sources:

Bao, T.; Wang, B.; Li, J.; Dilcher, D. "Pollination of Cretaceous flowers." Proc. Natl. Acad. Sci. USA 2019, 118, 24707-2474.

Stupendemys souzai, the Largest Turtle Ever

Bob Sheridan February 17, 2020

Among the very large animals from South America is Stupendemys ("astonishing turtle"), which was first described in 1976 based on partial shells found in Miocene sediments from Venezuela and Columbia. Other shell specimens from large turtles were assigned to the genus Caninemys and others put into a loose category "Podoncnemidae indet." Stupendemys is an example of a pleurodire, i.e. a turtle that withdraws its head by folding its neck sideways. The shape of the shell is consistent with Stupendemys being an fresh-water aquatic turtle.

Based on new specimens from the original localities, Cadena et al. (2020) give further context to Stupendemys. The totality of specimens for Stupendemys includes carapaces (the dorsal part of the shell), plastrons (the ventral part of the shell), a femur, a scapulocoracoid (part of the shoulder girdle), a cervical vertebrae and a lower jaw.

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Big Turtle Cont'd

The largest carapace has a length of 2.4 meters, which would make Stupendemys larger than the previous champion Archelon, a marine turtle from the Cretaceous with a carapace length of 2.2 meters. (The largest living turtle has a shell 2.1 meters long.) Stupendemys would be over metric ton in weight. The authors feel that other large turtles from the same time and place are all specimens of Stupendemys. In particular, the skull from “Caninemys” probably belongs to Stupendemys. Also, they feel the carapaces fall into two categories which either have or lack “horns” protruding forward from the front of the carapace on each side. These the authors assign as “male” and “female”, and suggest the horns, which would be covered in keratin in life, are for combat. Other living and extinct turtles have horns, but seldom in the front of the carapace. However, other sexually dimorphic characteristics in turtles, such as a concavity in the plastron in males, is not seen in Stupendemys.

Turtles have a toothless mandible with an up-curving sharp beak. In some turtles, both upper and lower jaws have “triturating” surface that contact each other and act to crush food. In the case of Stupendemys the triturating surface in the mandible is a deep groove. The anatomy of the jaw is not enough information to infer the diet of Stupendemys. The authors point out that many large turtles, some currently in the Amazon, eat fruit.

Phylogenetic analysis shows that Stupendemys represents a basal example of South American turtles, most of which are from the Miocene, but one of which, Peltocephalus, is living. Peltocephalus is known as the “big-headed Amazon river turtle,” and is not particularly large.

Stupendemys presumably lived in a large lake and river environment called the Pembas system, which existed in the north of South America during the Miocene. Giant forms of rodents, snakes, and crocodilians also inhabited that environment. The authors assign bite marks and an embedded tooth on the carapace of one Stupendemys specimen as being from a 10-meter crocodilians like Purussaurus (a caiman) or Gryptosuchus (a gharial). It is not clear whether such gigantism in Miocene South America is a result of high temperatures or an arms race between predator and prey.

Sources:

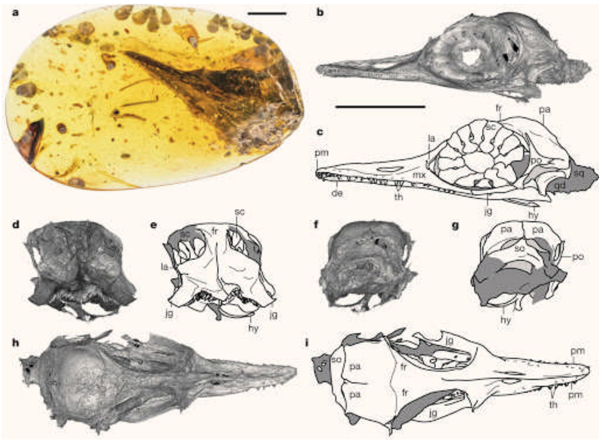
Cadena, E.-A.; Scheyer, T.M.; Carrillo-Briceno, J.D.; Sanchez, R.; Aguilera-Socorro, O.A.; Vanegas, A.; Pardo M.; Hansen, D.M.; Sanchez-Villagra, M.R. “The anatomy, paleobiology, and evolutionary relationships of the largest extinct side-necked turtle.”
Science Advances 2020, 6, eaay459.

Oculudentavis—A Very Tiny Cretaceous Bird

Bob Sheridan March 14, 2020

There is a flood of papers in the literature about inclusions in Burmese amber, which is from the Middle Cretaceous (~99 Myr.). Whereas amber inclusions have been studied with optical microscopy, nowadays, micro-CT scanning is used. Although rare, one type of inclusion in Burmese amber, hardly seen anywhere else, is of birds and bird parts.

Xing et al. (2020) describe a new specimen HPG-15-3 which contains an isolated bird skull. The piece of amber is 32 X 20 X 9 millimeters, and the skull itself less than 10 millimeters long. The authors give this specimen the name *Oculudentavis khaungraae* ("eye-tooth-bird" and after Khuang Ra who donated the specimen). This is by far the smallest fossil bird skull known, and it is smaller than that of the bee hummingbird, which is the smallest modern bird. This is significant if Oculudentavis represents an adult bird; the fused state of some of the skull bones suggest this is true.



Oculudentavis has a slender beak and very large eye sockets relative to the length of the skull. These sockets point clearly to the side, so that Oculudentavis had no stereo vision. Smaller birds tend to have large eye sockets relative to the length of the skull, and Oculudentavis is the extreme case of a well-established trend. In birds and reptiles, scleral ring bones give rigidity to the eyes. In Oculudentavis, the individual scleral bones making up the ring are spoon-shaped instead of flat plates. Also, the scleral ring is quite wide in a radial direction, implying the maximum pupil size is small, which might also imply that Oculudentavis was active during the day. Oculudentavis has tiny conical teeth, which is not unusual for a Cretaceous bird. However, while the upper teeth of most archosaurs (including dinosaurs) do not extend further back than the front of the eye socket, the teeth of Oculudentavis extend back about one-third of the diameter of the eye socket. Also the teeth seemed to be fused with the jaw rather than in sockets, as with other archosaurs.

The skull of Oculudentavis seems to be extensively fused, much more like that of a dinosaur than that of an early bird. Phylogenetic analysis places it among the most primitive birds, somewhere between Archaeopteryx and Jeholornis.

Modern birds cover a large size range, with the bee hummingbird being the smallest (2 grams) and the the ostrich (~100 kilograms) being the largest. Most Cretaceous birds we know about are sparrow- to turkey-sized (10 grams to 10 kilograms), but Oculudentavis gives us evidence that Cretaceous birds could be very small also. We need to be aware of preservation biases. Only animals near the trunk of conifer trees and too weak to escape will be trapped by amber, so of course we would see only very young or very small birds as amber inclusions. In contrast, we know most other Cretaceous birds from limestone deposits in lakes, where very small birds are likely to be crushed during fossilization.

Sources:

Benson, R.B.J.
"Tiny fossil sheds light on miniaturization of birds."
Nature 2020, 579, 199-200.

Xing, L.; O'Connoer, J.K.; Schmitz, L.; Chiappe, L.M.; McKellar, R.C.; Yi, Q.; Li, G.
"Hummingbird-sized dinosaur from the Cretaceous period of Myanmar."
Nature 2020, 579, 245-250.

Oculudentavis—Not a Bird?

Bob Sheridan March 29, 2020

When you follow paleontology as a hobby, every few years you come across an "identity crisis". That is, one group of investigators interprets a fossil as being an unusual version of X. Another group looks at the same fossil and says the fossil is Y, where Y does not equal X. Off the top of my head I can think of several examples.

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The most famous is the 2003 dispute about *Homo fluorensiensis* as either a primitive, but surprisingly recent, hominin or a modern human with a rare pathology (microcephaly).

This difficulty with identity is due to two things. First, fossils are usually incomplete and there may not be enough information to decide identity unambiguously. Second, the living world is messy and unexpected exceptions are not unheard of.

Just two weeks ago, I wrote up the story about the paper by Xing et al. (2020) in Nature about Oculudentavis. This new genus is described from an isolated skull found in Burmese amber (~99 Myr). The original data was generated by CT-scanning and exists as a 3D virtual model. The authors identified Oculudentavis as a primitive bird, but one that has at least a few unusual characteristics:

1. It is smaller than the smallest known bird, fossil or living.
2. It has a tooth row that extends under the eye socket. This has never before been seen in archosaurs (the reptile group that contains dinosaurs, birds, pterosaurs, and modern crocodilians).
3. The teeth are attached to the bone instead of being in sockets.
4. The bones of the scleral ring have an unusual shape.

However, despite these anomalies, phylogenetic analysis places Oculudentavis among the most primitive birds.

Tom forwarded me a short preprint from Li et al., who reexamined the original CT-scan of Oculudentavis. A “preprint” is a version of a manuscript that has not yet undergone peer review, i.e. has not been vetted by other scientists before formal publication in a journal. Nowadays, each scientific field has its own “preprint server” to which anyone can post a paper. On the one hand, this facilitates timely exchange of data between scientists. On the other hand, the amount of junk that gets through is much higher than articles published in journals.

In the opinion of Li et al., Oculudentavis is a not a bird, but a lizard, or at least some type of squamate (the group of reptiles that includes lizards and snakes). Some points:

1. The attached teeth are characteristic of squamates, as are teeth that extend further back as the front of the eye socket.
2. Oculudentavis does not have an antorbital fenestra like archosaurs, but it does have a lower temporal fenestra, which occurs in squamates.
3. Oculudentavis has a few teeth on its palate, again characteristics of squamates.

Against this, I have to note that Oculudentavis has a very long and narrow snout, something you don’t often see in lizards, but do often see in birds.

Despite this being only a preprint, I think Li et al.’s view will carry the day. It is obviously easier to believe Oculudentavis is a slightly unusual lizard than a very weird bird. However, you never really know what will happen. For example, upon analysis of postcranial material, *Homo fluorensiensis* turned out to be more like primitive hominins than expected, i.e. the “weirder” interpretation won the day.

Some comments:

1. It is very good in this case that the original data was made available to other scientists.
2. Interpretation of anatomy is tricky, especially if bones are missing or crushed, or variation in anatomy is found. In particular, in regard to fenestra (holes in the skull), modern birds have very open and light skulls, and have lost some bones that demarcate the fenestrae.
3. Phylogenetic analysis is only as good as the organisms the original specimen is compared to and what characteristics are selected. Li et al. suggest that Oculudentavis would nest within the squamates if it were compared with squamates instead of dinosaurs and birds.
4. Dealing only with cranial anatomy is tricky. Certainly, if more than the skull had been available, it would have been obvious whether Oculudentavis was a bird or a lizard.

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Bird? Cont'd

5. By nomenclatural rules, we are stuck with the name “Oculudentavis” for this animal even though the “avis” part is probably false. The most famous “misleading name” is “Basilosaurus”, which was named “king lizard” even though it later turned out to be a primitive whale.

Sources:

Xing, L.; O’Connoer, J.K.; Schmitz, L.; Chiappe, L.M.; McKellar, R.C.; Yi, Q.; Li, G. “Hummingbird-sized dinosaur from the Cretaceous period of Myanmar.” Nature 2020, 579, 245-250.

Li, Z.; Wang, W.; Hu, H.; Wang, M.; Yi, H.; Lu, J. “Is Oculudentavis a bird or even archosaur?” bioRxiv preprint doi: https://doi.org/10.1101/2020.03.16.993949.

The Inner Ear of Pelagic Crocodylomorphs

Bob Sheridan May 18, 2020

This story concerns the inner ear of vertebrates, and terminology would be helpful at this point. There are two parts to the inner ear: the cochlea (which translates the vibration of the eardrum into a sensation of sound), and the vestibule, a sack-like pocket with the semi-circular canals (three perpendicular loops) at the top. The vestibule detects the orientation of the head relative to gravity and detects acceleration. Fortunately for paleontologists, although inner ears are small, they are hollow spaces surrounded by a bony sheath called the “labyrinth”, and so their shape, size, and orientation relative to the rest of the skull can be discerned by CT-scanning skulls, both of living and fossil animals. One application to fossil animals is due to the expectation that the lateral semi-circular canal should be horizontal; therefore one can guess the habitual orientation of the heads.

It is well-accepted that the inner ears of mammals that are obligatory swimmers are quite different from those of their land-dwelling ancestors. In particular the inner ears of whales, manatees and seals are up to three times smaller relative to the size of the skull. One thought is that large accelerations though the water would overwhelm the senses of these aquatic animals if they had inner ears the size of land-dwelling animals. However, so far this explanation is hard to prove.

Schwab et al. (2020) test the idea that the inner ear changes due to a transition to an aquatic lifestyle, this time in a line of crocodylomorphs called thalattosuchians. These lived from the Early Jurassic into the Early Cretaceous and had a world-wide distribution. Some of these appear fully pelagic (i.e. they swam in open ocean and never walked on land); they are often restored as looking like slender ichthyosaurs. Some thalattosuchians are semiaquatic, and resemble living crocodylians like gharials. There is a related group, supposedly ancestral to thalattosuchians that appear to be land-dwelling; they have long weight-bearing legs. Thus, it appears that some thalattosuchians made a lifestyle transition to marine environments, much like whales did. Modern crocodilians can also be compared to these fossil animals.

The authors produced CT-scans of the labyrinths of a few dozen specimens of fossil and living crocodylomorphs and analyzed their shapes using principal component analysis. Crocodylomorphs with the same lifestyle seem to clustered in this labyrinth shape-space, and well-separated from the other lifestyles. One can also see the difference by eye. The pelagic labyrinths appear shorter from top to bottom and have thicker semi-circular canals, while the terrestrial labyrinths appear taller and have thinner semi-circular canals. The semi-aquatic labyrinths are somewhere between. Size, apart from shape, does not help predict lifestyle.

Thus, thalattosuchians appear to show modifications of the inner ear associated with a change to a pelagic lifestyle, but these are different from the modifications seen in whales and other cetaceans, where only the size changed and not the shape. It should also be noted that thalattosuchians made the transition over a period of tens of millions of years, whereas cetaceans made the transition in only a few million years. Whatever the goal of changing the inner ear to adapt to a pelagic lifestyle, there are at least two different ways of achieving it.

Sources:

Schwab, J.A; Young, M.T.; Neenan, J.M.; Walsh, S.A.; Witwer, L.M.; Herrera, Y.; Allain, R.; Brochu, C.A.; Choineiere, J.N.; Clark, J.M.; Dollman, K.N.; Etches, S.; Fritsch, G.; Gignac, P.M.; Reubenstahl, A.; Sachs, S.; Turner, A.H.; Vignaud, P.; Wilberg, E.W.; Xu, X.; Zanno, L.E.; Brusatte, S.L. “Inner ear sensory system changes as extinct crocodylomorphs transitioned from land to water.” Proc. Natl. Acad. Sci. 2020, 117, 10422-10428.

Turtles as Hopeful Monsters —A Review

Bob Sheridan May 17, 2020

Turtles are very unique among living and fossil reptiles. First, they always have a toothless beak. Second, they are covered in a bony box, made of a "carapace" above and a "plastron" below, with the two fused at several points. The shoulder blades of turtles are inside rather than outside their ribs, which is totally unlike any other tetrapod. Most modern turtles can withdraw their heads, and sometimes their limbs, inside the shell. Turtles also tend to have very short tails for reptiles. As with many interesting fossil groups, modern-looking turtles seem to appear very suddenly in the fossil record, in this case in during the Triassic. Trying to figure out which type of reptile is ancestral to turtles based on anatomy is very difficult because there are not many intermediate forms. At one time, it was thought that turtles were descended from very primitive reptiles based on the fact that their skulls have no openings. However, molecular evidence from living turtles suggests they are most closely related to advanced diapsid reptiles like lizards, and perhaps even more specialized diapsid reptiles like archosaurs.

As an amateur paleontologist, I have been following the turtle story in the scientific literature for a while now. Every so often, a new putative turtle ancestor is described, often with a great deal of controversy. When I saw that there was a book "Turtles As Hopeful Monsters", from a few years ago, I endeavored to read it. This book is in the "Life of the Past" series edited by James O. Farlow. With a few exceptions, but the books in this series are excellent.

The author Olivier Rieppel is the Rowe Family Curator of Evolutionary Biology at the Chicago Field Museum, specializing in reptiles. He has published a few hundred technical articles, many of which are on turtles.

Chapters are:

1. Misplaced turtles.

This chapter summarizes the author's early career, including his embrace of cladistic analysis, which is accepted now, but was controversial in the 1970s. Cladistic analysis places turtles close to crown reptiles and not the most primitive reptiles, contrary to traditional thought, but consistent with molecular evidence. Hence turtles were originally "misplaced."

2. Reptile Classification and Evolution

This chapter summarizes the history of thought of how living and fossil reptiles are related to each other. There is an especially interesting story of how turtles were associated with primitive reptiles like pareiasaurs or placodonts, which had no postorbital skull openings and in some cases were heavily armored. Especially interesting is a discussion about how anatomical comparisons are at least a little subjective.

3. Levels of Evolution

This summarizes the history of evolutionary thought as applied to the study of fossils, including discussions about whether Darwin's mechanism of natural selection was sufficient, whether there is "orthogenesis", and whether "ontogeny" really reflects "phylogeny."

4. Hopeful Monsters

Richard Goldschmidt (1878-1958) first used the phrase "hopeful monster" to the idea that evolution could sometimes proceed by "macromutations", i.e. an animal could be born that was very different from its parents. This sort of mechanism is not accepted by modern evolutionary theory. However, we still have no mechanism to explain how large changes in anatomy occur in seemingly very short periods of geological time. The appearance of jaws is a very good example. Obviously, the appearance of turtles is another.

5. The Turtle Shell

How much of the turtle shell is formed from the bones of the internal vertebrate skeleton, and how much from bony plates (osteoderms) in the skin? This has been debated for many decades; the most usual way of addressing the question is to examine turtle embryos. However, different types of turtles may have different developmental mechanisms. There is a "polka dot turtle" hypothesis that turtle ancestors might be covered by separate osteoderms.

6. Fossil Hunting in China

This chapter discusses Triassic reptile fossils from southwestern China, some of which might be putative turtle ancestors. Sinosaurosphargis and Odontochelys are examples. Sinosaurosphargis is covered with dorsal osteoderms (a proto carapace) and has broad ribs that touch each other (not quite forming a plastron). Odontochelys has a fully ossified plastron, but no dorsal armor whatever. Are they both turtle ancestors, or is one or both convergent on a turtle-like plan? Interestingly both seem to had skull openings consistent with being diapsids.

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Turtle Monsters Cont'd

Overall, I am somewhat disappointed with this book. While there is some nice discussion of evolutionary mechanisms and the history of evolutionary theory, there is very little specific about turtles until Chapter 5. Fossils turtles are not treated in any detail until Chapter 6. Compared to most “Life of the Past” books, there are very few illustrations, only a few per chapter. This is a shame because some concepts are easier to understand through diagrams than through words.

Sources:

Rieppel, O.

“Turtles as Hopeful Monsters. Origins and Evolution” 2017, Indiana Press, Bloomington and Indianapolis, 206 pages, $45 (hardcover)

The Tail of Spinosaurus

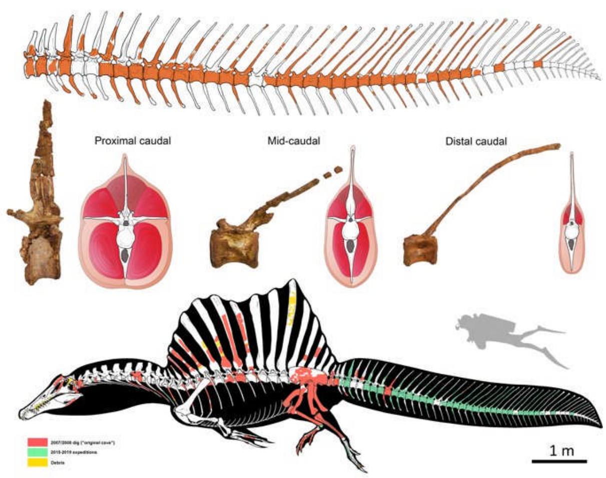
Bob Sheridan May 8, 2020

Spinosaurus was a very large theropod with a large dorsal sail that lived in the Middle Cretaceous of Africa. There are a number of lines of evidence that Spinosaurus was aquatic, very unusual for a dinosaur. Presumably the evidence of an aquatic lifestyle also applies to related theropods (Suchomimus and Baryonyx), which are smaller and lack the sail.

1. Spinosaurus has a long snout with conical teeth, and there is a notch near the tip the maxilla, somewhat like the snout of a crocodile
2. The oxygen isotope ratio in its bones are consistent with a semi-aquatic diet.
3. Its bones tend to be denser than that of other theropods.
4. Based on a new specimen described in 2014, and a composite skeletal reconstruction from several specimens (Ibrahim et al., 2014), Spinosaurus had a very short legs. This makes the bipedal lifestyle of most theropods very unlikely for Spinosaurus; instead a swimming lifestyle makes much more sense.

Ibrahim et al. (2020) describe the tail of Spinosaurus. The caudal vertebrae are from the same quarry in Morocco from which a number of Spinosaurus bones have been excavated for a number of years. Also useful in the description are casts of caudal vertebrae from the holotype specimen discovered by Ernst Stromer in 1912, the originals of which were destroyed in World War II.

The next bit will require some nomenclature concerning the anatomy of vertebra. The central cylinders of dense bone that stack up to form the spinal column are called “centra.” There is a bridge-like “neural arch” that is attached to the dorsal surface of each centrum. The spinal cord runs through the tunnel formed by all the neural arches. A “neural spine” may stick up dorsally from each neural arch. The “sail” of Spinosaurus is formed by very tall neural spines on the thoracic vertebrae. “Transverse processes” stick out sideways from the ventral part of the neural arch. These are mostly for the attachment of muscles and ligaments. There are also “pre-“ and “post-zygapophyses” at the front and rear of the dorsal part of the neural arch. These form joints between adjacent vertebrae in addition to the joints (cushioned by vertebral disks) between the centra. In the caudal vertebrae of reptiles, “chevrons” are attached to the ventral surface of the centra by joints and point downward.



The neural spines on the caudal vertebrae of Spinosaurus are tall, making the tail very deep from top to bottom. Chevrons are not as long, but also contribute significantly to the depth of the tail.

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Whereas in most dinosaur tails, the neural spines and chevrons are wide front-to-back and narrow side-to-side, in Spinosaurus the opposite is true. In most dinosaur tails, the zygapophyses interlock with the zygapophyses of adjacent vertebrae; this makes the tail rigid. In contrast, in Spinosaurus, the transverse zygapophyses are reduced, leaving the tail flexible from side-to-side.

The top-to-bottom depth of the Spinosaurus tail suggests to the authors that it would be specialized for propulsion in swimming. To test this, they constructed an artificial Spinosaurus tail from flat plastic and moved it through water by moving the base side-to-side. They measured the thrust of the tail (force propelling forward), and the power efficiency. They compared this to artificial tails of two modern aquatic animals: the crested newt and a crocodile. They also compared two tails of non-aquatic dinosaurs: Coelophysis and Allosaurus. All artificial tails were scaled to have the same surface area. The artificial Spinosaurus tail is clearly better than the other dinosaur tails in thrust, but not as good as the crocodile and newt. This is enough to convince the authors that propulsion during swimming is at least a plausible use for the tail of Spinosaurus, and therefore a swimming lifestyle seems more probable. In my opinion, the artificial tail experiment is a drastic simplification, in that the authors are assuming that the shape of the tail as seen from the side is the only thing that is important. The artificial tails had a very small and uniform thickness (1 millimeter) and the rigidity of the artificial tails were determined by the plastic from which they were made, so it is not clear how this would apply to real animals with three-dimensional tails, where the rigidity of the tail is determined by muscles and bone.

Also, it occurs to me that the authors did not include a relevant negative control. Long ago it was noticed that hadrosaurs had deep tails from top to bottom, and this was once taken as evidence that hadrosaurs were aquatic, something we now know is not true.

Sources:

Ibrahim, N.; Sereno, P.C.; Dal Sasso, C.; Maganuco, S.; Fabbri, M.; Martill, D.M.; Zouhri, S.; Myhrvold, N.; Iurino, D.A.
"Semiaquatic adaptations in a giant predatory dinosaur."
Science 2014, 345, 1613-1616.

Ibrahim, N; Maganuco, S.; Dal Sasso, C.; Fabbri, M.; Audiore, M.; Bindellini, G.; Martill, D.M.; Zouhri, S.; Mattarelli, D.A.; Unwin, D.M.; Wiemann, J.; Bonadonna, D.; Amane, A.; Jakubczak, J.; Joger, U.; Lauder, G.V.; Pierce, S.E.
"Tail-propelled aquatic locomotion in a theropod dinosaur."
Nature 2020, 581, 67-70.

Ads and events are listed here for free. They must be paleo related and are subject to editorial approval. Submissions can be sent to tomcagg@aol.com

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Ed. Note: As of late July the show is confirmed to be ON. Please check the website for the latest info. A second note is that the show will be relocated from the Denver Coliseum, across the highway to the Events Center, a building not previously used for the show.

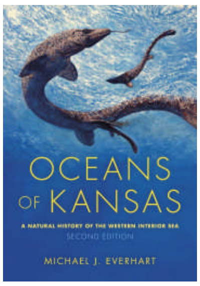
https://www.coliseumshow.com/

NJ GEM, MINERAL AND FOSSIL SHOW at the NJ Expo Center, Edison, NJ

Ed. Note: This show has been rescheduled a second time. Check the website for the latest info.

http://ny-nj-gemshow.com/

Tom Caggiano personal recommendation.



The 2nd Edition of _Oceans of Kansas – A Natural History of the Western Interior Sea_ from Indiana University Press. The digital version is available from Amazon. The second edition is updated with new information on fossil discoveries and additional background on the history of paleontology in Kansas. The book has 427 pages, over 200 color photos of fossils by the author .

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The Paleontograph back issues are archived on the Journal Page of the AAPS website.
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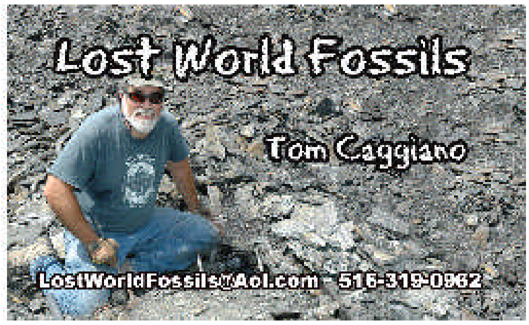

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