The Paleontograph

A newsletter for those interested in all aspects of Paleontology
Volume 7 Issue 2 July, 2018

From Your Editor

Welcome to our latest edition. I hope you are enjoying the warm summer weather. The weather here is always changing with sometime extreme differences.

I made the best find of my collecting career on my annual trip to KS. I came upon a complete 17ft long Mosasaur. It was laid out perfectly just sitting there on the surface. One BIG problem, it had been laying there for a few years too long and just about every bone was fractured into pieces and dust. I was able to collect a section of the neck and another of the tail. The rest fit into a few flats. It is a perfect illustration of the fact that fossils that go uncollected turn to dust. Something the "Lets save the fossils for the future generations" set should learn. Laws set up to protect fossils don't always have the desired effect.

As usual, Bob has served up a varied and well written selection of articles.

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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Why Dinosaurs Matter--A Review

Bob Sheridan October 8, 2017

Who would fail to check out a new book called "Why Dinosaurs Matter." Not me, so here is my review. The author Kenneth Lacovara is geologist and paleontologist at Rowan University (New Jersey). He is best known for discovering Dreadnoughtus, the largest and most completely known titanosaur (from Argentina).

I am familiar with TED talks, but I did not realize there was a series of TED books (about two dozen of them so far) until I saw "Why Dinosaurs Matter". These books seem to be written counterparts to the talks. A video of one relevant TED talk by Kenneth Lacovara is:

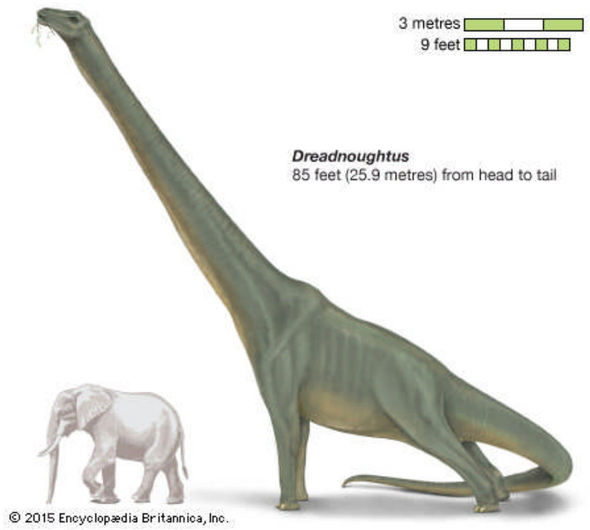
https://www.ted.com/talks/kenneth_lacovara_hunting_for_dinosaurs_showed_me_our_place_in_the_universe

The book "Why Dinosaurs Matter" is divided into 12 chapters, each covering some aspect of dinosaurs or fossil life in general:

1. In defense of dinosaurs. While dinosaurs demonstrated adaptability for 165 million years, we still use the word "dinosaur" to mean "obsolete"
2. Is a penguin a dinosaur? How to distinguish dinosaurs from other extinct reptiles using cladistics.
3. Walking museum of natural history. How evolution depends on history.
4. Fossils underfoot. How people figured out fossils were the remains of ancient life.
5. Deep time. How people figured out how long the history of life really is.
6. Thunderclaps. Uniformitarianism vs. catastrophism in geology.
7. Making sense of monsters. Early interpretation of dinosaurs.
8. The king. What we know about Tyrannosaurus, especially concerning its puny arms.
9. Champions. Extreme dinosaurs.
10. Dreadnoughtus. The discovery of Dreadnoughtus and sauropods in general.
11. Dinosaur apocalypse. The extinction of dinosaurs.
12. Why dinosaurs matter. Why studying the ancient past provides perspective on the present.

You can think of this as a collection of essays, which can be read in any order. There are some illustrations by Mike Lemanski, but these are purely decorative and convey no real information.

I am of two minds about this book. It is certainly written in a clear, compact, and engaging style (which is expected from TED talks), and it gives a good paleontological and historical perspective to the lay person, which I am assuming is the target audience. On the other hand, for most paleontology enthusiasts (like most readers of the Paleontograph) most of the material is familiar and the philosophical bits are preaching to the choir. Most of us already appreciate that the common use of the word "dinosaur" to mean "obsolete" is terribly unfair, and we realize that studying ancient life is a good way for human-kind to learn humility, etc. Admittedly, there is some material that is new to me, for instance in the chapter on Dreadnoughtus.



So if you see this book in the library and can read it for free, go ahead and do it. I would buy it only for someone who is not already well-versed in paleontology.

Sources:

Lacovara, K.
"Why Dinosaurs Matter"
TED Books, Simon and Schuster, New York, NY, 2017, 169 pages. $17 (hardcover)

The Sauropod Dinosaurs- -A Review

Bob Sheridan October 22, 2017

Sauropod dinosaurs were colossal; the largest land animals ever (up to 20 times the weight of a large elephant, and up to 60 ft. tall). That is reason enough to be fascinated by them. While there were other prehistoric creatures with long necks, the necks of sauropods were longer (up to 8 times the length of the neck of a giraffe). There is nothing remotely like sauropods today, so it is hard to guess how they functioned. Making it more difficult for paleontologists, sauropods were generally so big they were hard to bury, and thus individual specimens tend to be very incomplete. It is very unusual to find a skull or a full tail.

While I am a dinosaur enthusiast, I generally don't follow the literature on sauropods, and I was glad to come across a popular book on the subject from last year "The Sauropod Dinosaurs" by Mark Hallett and Mathew Wedel. This contains a contemporary summary of what is known, or what can be reasonably speculated about, sauropods. Mathew Wedel is a sauropod expert at the Western University of Health Sciences department of anatomy. He is probably best known for his descriptions of the dinosaurs Aquilops, Brontomerus, and Sauroposeidon. Mark Hallett is a very well-known paleoartist.

The chapters are:

1. Sizing up sauropods.
2. Parting of the ways.
3. A sauropod field guide.
4. Of Bones and bridges.
5. Brontosaur biology: to immensity and beyond.
6. Conifer cuisine.
7. A sauropod in the lab.
8. The next generation.
9. Predator and prey: the ancient race.
10. Around the mesozoic world.
11. End of eden?
12. Summing up sauropods.

The first scrappy sauropod remains discovered in the 1840's were at first mistaken for those of a whale (perhaps only because of their size), and even when identified as reptilian, the name "cetiosaurs" (whale lizard) stuck. (There is still a "wastebasket" group of sauropods named Cetiosaurs after the original specimen.) The idea that sauropods were aquatic or semi-aquatic persisted well into the 20th century when they were depicted as wading armpit-deep in swamps, even when the skeletal evidence suggested that they were fully terrestrial.

The sister group to sauropods is a class of Triassic herbivorous dinosaurs called prosauropods. Plateosaurus (from Germany) is probably the most well-known one. Like sauropods, they had smallish heads on the ends of longish necks. However, they were generally small for dinosaurs (a few tons). For a long time is has been speculated that these animals could be bipedal or quadrupedal depending on the circumstances. However, analyses of the forelimbs suggested that the neutral position of the hands was "palms-in", making it unlikely they could put their hands on the ground. Interestingly, Eoraptor, a turkey-sized Argentinian dinosaur originally thought to be a basal theropod, is now thought to be a basal prosauropod.

Although at a superficial level all sauropods look more or less alike (giant body, long neck, long tail), there are something like a dozen families that differ in the skeletal details: how the toe bones are arranged, how the skull is constructed, how the cervical vertebrae are sculpted, how the tail is disposed, the presence of armor, etc. In retrospect, the diversity is perhaps not surprising since sauropods had from the Early Jurassic to Late Cretaceous to diversify. This chapter has a very nice summary of each family and their typical features. One surprise: the titanosaur family, which persisted into the Late Cretaceous, contain the largest and smallest known sauropods. One does not hear much about dwarf theropods (by "dwarf" one means "smaller than an elephant"), but there are many, mostly from Europe.

The problem of how the sauropod skeleton was constructed to maintain enormous bodies and very long necks can be approached by engineering principles, which are embodied in man-made objects like suspension bridges and cranes. Make the legs more vertical and shorten the toes. Make the head smaller, make the neck lighter by hollowing out the cervical vertebrae, and make the neck more rigid by lengthening the zygapophyses, the bony processes that extend forward and backward from each vertebra.

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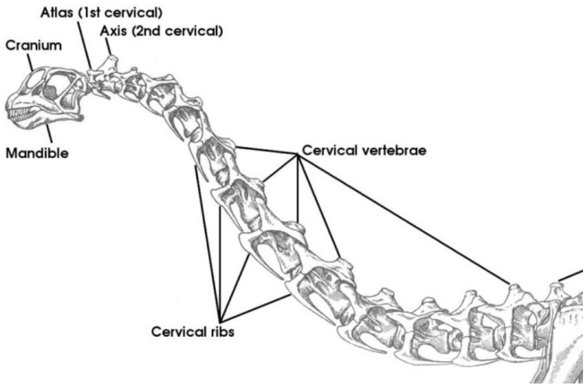
Sauropods Cont'd



Have a "cable" (or two) run along the top of the neck. In this chapter is the discussion of whether sauropods held their necks level with their shoulders or could raise their heads high. Two lines of evidence could be relevant. One is the "osteological neutral position," that is, if all the bony articulations are in the middle of their range of motion, one would expect a level or slightly downward tilt of the neck for sauropods like Diplodocus. On the other hand, in some sauropods like Brachiosaurus, the neutral position seems to suggest an upwardly tilting neck. On the other hand, one expects the horizontal semicircular canal in the inner ear to be parallel to the ground most of the time, and this would suggest that the neck was tilted upward so the head could remain level. This is true for diplodocids also. That is, these two lines of evidence tend to contradict each other. It is likely that some sauropods like to browse low to the ground and some like to reach into the trees. Could sauropods rear up on their hind legs to get their heads extra high? Diplodocids have their centers of gravity close to the hind legs, so it might be plausible. In contrast, brachiosaurs had their centers of gravity close to the front legs and so could probably not rear up.

Being a sauropod means you have a lot of physiological issues due to your size and long neck. Among them:

1. It takes a long time for nerve signal to go from your tail to your brain.
2. You have a tiny brain to control your enormous body.
3. Your body generates a lot of heat and you have to lose it.
4. It takes a lot of pressure to pump blood from your heart to your brain, which might be tens of feet higher. But if you put your head down, the high pressure would give you a hemorrhage.
5. Your trachea is very long, and that means a lot of "dead space." Breathing like a mammal would just push air back and forth inside your trachea and it would never get outside your body.
6. You can't spread your forelimbs apart like a giraffe, so how do you get your head down for a drink of water.

How sauropods solved these issues is still a matter of speculation. I will relay some of the discussion in this chapter: For 2, it appears that sauropod brains are about the correct size for a reptile scaled to sauropod size, so they are not particularly "tiny." For 4, giraffes have a special set of distendable blood vessels that absorb increased blood pressure; it is likely that sauropods had a similar system. For 5, the most plausible answer is that sauropods breathed more like birds with a one-way air flow: air goes from the nostrils and trachea into air-sacs, then to the lungs, and then out through the trachea. For 6, your head would be almost perpendicular to the surface of the water. If your nostrils were at the front of your head, you couldn't drink and breath at the same time. This may be why many sauropods had nostrils toward the top of their heads.

Conifers were the probably the most common type of plant eaten by sauropods. This is based on the observation that conifers were the most abundant plant in the Jurassic and that they could regrow quickly enough. One type of conifer that was common in the Jurassic but is went extinct before the Paleocene are the cheirolepidiaceans. The authors note that this would have made especially good sauropod food. The authors speculate that the loss of this subclass of conifer led to local extinction of certain groups of sauropods. However, for all the discussion about conifers, there is only one known coprolite (from a titanosaur) that provides a direct link between sauropods and conifers. Most sauropods had very simple teeth, good for stripping leaves off branches, but useless for chewing. Reports of gastroliths in sauropods are no longer taken as proof that such stones were needed for digestion, and it is now thought that having a big gut would be sufficient to digest most unchewed plant matter. Different sauropods probably had different food preferences; narrow snouts probably meant selective browsing and broad snouts meant grazing. Microscopic scratch marks on sauropod teeth, presumably made by the food moving past the teeth, are taken as evidence that different types of sauropods fed at different heights.

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Sauropods Cont'd

There is a separate chapter on high-tech (for paleontology) methods applied to study sauropods (or fossils in general): CT scanning of specimens for a non-destructive way to look inside specimens (particularly to look at the brain and inner ear), bone histology, 3D computer reconstruction via laser-scanned specimens, computer modeling of stress on bone, and 3D printing.

We now know know a few sauropod nesting sites, the most extensive in Argentina and India. These contain a large number of eggs that by today's standards we would consider immense (say 10 inches in diameter), probably as large as an egg can physically get. It is somewhat of a mystery how a sauropod, which cannot easily squat because of its columnar legs, can deposit a fragile egg on the ground from a height of ten or more feet. Some have speculated that the females had some kind of extendible tube or "ovipositor."
Current thinking is that sauropods produced a large number of eggs and that hatchlings received no parental care whatever. They were on their own as soon as hatched. Probably they scattered into the underbrush and waited until they were big enough to rejoin a herd. Most hatchlings were probably eaten very soon. To survive, a hatchling would have to go in a few years from weighing a few pounds to many tons. This putative incredible growth rate is similar to that for modern whales. There is some trackway evidence that shows both small and large sauropods going in the same direction, but this is not strong enough to tell us whether juvenile and adult sauropods herded together.

Sauropod eggs and hatchlings were probably easy pickings for predators. (There is one spectacular fossil of a large snake coiled around some eggs.) But what about the adults? It is sometimes argued, by analogy with elephants, that adult sauropods are were too large to be attacked by theropod predators, which are at best one-tenth the weight. However, there are a number of ways that smaller predators can take down a large prey animal. One strategy is "cooperative hunting", by analogy with wolves. Another strategy is to bite and run away until the prey weakens from blood loss or infection, by analogy with the Komodo dragon. Sauropods seem to have developed defenses other than sheer size, which includes whip-like tails, clawed feet, and (in a few cases) clubbed tails and armor. There is fossil evidence of theropod teeth and toothmarks on sauropod bones, but this can imply scavenging, not necessarily imply predation. The authors do not mention the Paluxy River trackways in this chapter. For decades this was considered a record of a theropod attacking a herd of sauropods, but this interpretation has apparently fallen out of favor.

One chapter discusses continental drift and the types of environments one would find in various continents, specifically those dozen or so sites where sauropod skeletons are found in abundance. The site most familiar to most of us is Fruita, Colorado, which in the Late Jurassic was a forested floodplain and home of Diplodocus, Apatosaurus, and Camarasaurus. Less familiar is the archipelago of islands representing Europe in the Late Cretaceous, home of dwarf sauropods like Magyarosaurus in what is now Romania.

The "End of eden" chapter speculates on why many Jurassic families of sauropods went extinct in the Late Jurassic, and were replaced by titanosaurs. The authors speculate that "classical theropods", say diplodocids, went extinct because of the extinction of the cheirolepidiacean conifers. Titanosaurs were most abundant in southern continents early on but eventually spread world-wide until the extinction of the dinosaurs. One anatomical feature of titanosaurs is that they are more wide-bodied than previous sauropods and this is reflected in their trackways.

In the final chapter the authors outline nine aspects of sauropods that remain mysteries.

This books is very thoroughly illustrated. While there are many life-restorations of sauropods in their environment, most of the illustrations are diagrams that help illustrate scientific points. There are also abundant photographs of real fossils.

I can give this book a very high recommendation. In my mind, it is in the same class as "Pterosaurs" by Mark Witten and "Sabertooth" by Mauricio Anton, both of which I have reviewed for the Paleontograph in the past few years. It hits the good middle ground in paleontological writing between a popular work and professional publications. There is enough detail for a knowledgeable amateur to learn new things, but does not assume a great deal of previous technical knowledge on the subject.

Sources:

Hallett, M.; Wedel, M.J.
"The Sauropod Dinosaurs. Life in the Age of Giants"
Johns Hopkins University Press, 2016, 320 pages
$40 (hardcover)

Hundreds of Pterosaur Eggs

Bob Sheridan December 8, 2017

Pterosaurs are flying reptiles from the Mesozoic. They are not, of course, dinosaurs, but may be related archosaurs. There are some very good popular books on the subject. The most recent one that I have enjoyed (and reviewed for the Paleontograph) is:

Witton, M.P. "Pterosaurs" Princeton University Press, Princeton, 2013, 291 pages. $35 (hardcover).

Today's story concerns pterosaur eggs and hatchlings. Pterosaur eggs are thought to be more like modern lizard or snake eggs, having a flexible "parchment-like" shell, as opposed to dinosaur or bird eggs, which have a rigid calcified shell. Parchment-like eggs are not water-proof and would dehydrate if they were left exposed to the air, so need to be buried to incubate. Based on modern reptiles, that the eggs are buried does not imply anything about whether there is parental care afterward.

Before relatively recently it was usually assumed by paleoartists that pterosaurs would need parental care after hatching, probably because that is the case with birds. However, since about 2004 a few pterosaur eggs were discovered with embryos inside. The fact that the embryos have arm proportions similar to that of adults has given rise to the idea that pterosaurs could fly immediately after hatching. This is in contrast to modern birds, which hatch with stubby arms and are incapable of flying until they are older.

Wang et al. (2017) describe over 200 pterosaur eggs in a single sandstone block from the Early Cretaceous of China, of which 16 contain embryonic material. This is truly a "jackpot", compared to then number of previously know specimens. The eggs are ovoid and 2-3 inches along the longest axis. The large number of eggs indicate that they are originally from a nesting site, although they are jumbled together in such a way as to indicate they were probably transported from their original location, for instance by a flood.

Despite many being deformed, perhaps through dehydration (the shell was flexible after all), the eggs are preserved in three dimensions.

The bones within the eggs are disarticulated and no skeleton is complete. They probably belong to the pterosaur Hamipterus, which is a largish (5-11 ft. wingspan) pterodactyloid pterosaur with many long conical teeth. The embryos appear to be of different sizes, indicating different stages of incubation. Much of the discussion has to do with the state of ossification of the log bones. Even in the largest specimens, the leg bones seem more nearly ossified than the arm bones. Plus the skull bones have no teeth. One possible inference of this is that the hatchlings could not fly or feed themselves, and would require parental care, contrary to previous thought. However, this depends on the assumption that the embryos that are observed here were close to hatching, which is not clear. Also, it depends on the (more plausible) assumption that teeth and completely ossified wings were necessary for the hatchling to live independently.

We must keep in mind that pterosaurs were a diverse group and it is plausible that some types were hatched ready to live independently and some not, analogous to the difference between "precocial" and "altricial" birds.

Sources:

Deeming, D.C.
"How pterosaurs bred."
Science 2017, 358, 1124-1125.

Wang, X.; Kellner, W.A.; Jiang, S.; Cheng, X.; Wang, Q.; Ma, Y.; Paldonia, Y.; Rodrigues, T.; Chen, H.; Sayao, J.M.; Li, N.; Zhang, J.; Bantin, M.; Meng, X.; Zhang, X.; Qiu, R.; Zhou, Z.
"Egg accumulation with 3D embryos provides insight into the life history of a pterosaur."
Science 2017, 358, 1197-1201.

Halszkaraptor: a Weird Kind of Dromaeosaur

Bob Sheridan December 28, 2017

Dromaeosaurs are the closest branch of theropod dinosaurs to true birds. The evidence suggests that they were all feathered. A paper by Cau et al. (2017) describes an unusual specimen of dromaeosaur from the Late Cretaceous of Mongolia (75-71 Myr.) preserved in three dimensions in a block of orange sandstone.

This specimen (now called MPC D-102/109) has an interesting history. It was poached from Mongolia, and passed through the hands of several dealers and collectors, the last of which is Francois Escuillie. In 2015 it was shown to paleontologist Pascal Godefroit at the Royal Belgian Institute of Natural Sciences, and CT-scanned at the European Synchrotron Radiation Facility. CT-scanning was done because some of the specimen is still embedded in rock, and also because it is now common practice to CT-scan unusual fossils to be sure they are not “chimeras”, i.e. fakes assembled from more than one specimen. (Since rock is very dense, one needs a very intense source of x-rays such as produced in Synchrotron facilities.) Arrangements have been made to return the specimen to Mongolia.

The specimen is given the name *Halszkaraptor escuilliei* (after Polish paleontologists Halszka Osmolska who named a closely related species, “robber”, and Francois Escuillie who returned to arranged to return the specimen to Mongolia). The skeleton is essentially complete. In life, the animal would be the size of a duck. It has a very long neck and tiny arms. The skull is very duck-like in shape and contains very numerous (more than expected for any theropod dinosaur) tiny teeth.

Phylogenetic analysis places Halszkaraptor at the base of the dromaeosaurs. It is similar to other previously named, much less completely known, but more conventional-looking dromaeosaur genera such as Mahakala and Hulsanpes. Cau et al. do a detailed analysis of the arm bone proportions of Halszkaraptor and compare them to those various types of birds and dinosaurs. The conclusion is that Halszkaraptor probably lived an aquatic lifestyle, using its feet to push against the water, using its arms to steer, and using its neck to catch prey. This is very unusual for dromaeosaurs, which are thought to be either ground runners or possibly tree-dwellers. There is only one other dinosaur, Spinosaurus, thought to have an aquatic lifestyle.

The authors do not mention it, but to me the long neck, powerful legs, numerous tiny teeth, and tiny arms of Halszkaraptor are very reminiscent of Ichthyornis and Hesperornis, toothed flightless birds from the Cretaceous of Kansas. (The birds are bigger than Halszkaraptor--about swan size--and have no tail.) The birds are assumed to be divers after fish, much like the modern cormorant.

Sources:

Cau, A.; Beyrand, V.; Voeten, F.A.E.; Fernandez, V.; Tafforeau, P.; Stein, K.; Barsbold, R.; Tsogtbaatar, K.; Currie, P.J.; Godefroit, P.
“Synchrotron scanning reveals amphibious ecomorphology in a new clade of bird-like dinosaurs.”
Nature, 2017, 552, 395-399.

Most Primitive Trilobite Eye?

Bob Sheridan January 5, 2018

Trilobites are the oldest known animals with well-preserved eyes and these show up in the Early Cambrian. Trilobite eyes superficially appear much like the “compound eyes” in modern arthropods. A small digression is in order. Compound eyes are shaped like part of a sphere, but they are made of many (sometimes tens of thousands) long, thin, cone-shaped units called ommatidia (singular: ommatidium) that are packed closely together. The wide part of the cone points to the outside world and the narrow part of the cone is close to the center of the eye. It is usually assumed that, from the viewpoint of the arthropod, one ommatidium generates one “pixel” of the image they perceive.

Going from the outside to the inside, each ommatidia (singular ommatidium) consists of:

1. a lens
2. a crystalline cone
3. 5 to 12 sensory cells arranged around a central axis called a rhabdom.

The lenses are visible from the outside as the “facets” of a compound eye. In trilobites, the lens is made of the mineral calcite, and so is very well preserved in fossils. In modern compound eyes there is usually pigment on the outside of each ommatidium to prevent light leaking between them, i.e. so the ommatidium “sees” only what is directly aligned with its long axis.

Seeing anything other than the outside of the trilobite eye in fossils is rare, and until fairly recently nothing was known about the interior structure. In 2013 Schoenemann and Clarkson used high resolution CT scanning to examine cross-sections of the eyes of a number of trilobite fossils from three Devonian genera: Geesops, Barrandeops, Chotecops. For Geesops, one sees in a cross-section through the upper third of the compound eye, a series of "rosettes" about 500 micrometers in diameter with a star-shaped inner core surrounded by six or so wedge-like shapes. Barrandeops is similar except that the rosettes are about 200 micrometers in diameter, and there are up to twelve wedge-like shapes around the central core. The one specimen of Chotecops has the outermost surface of the eye broken so that one may see the shapes below the surface. The rosettes presumably represents the cross-section of the sensory cells. In size and in having a central cell with a star-shaped cross-section they most resemble the ommatidia of the horseshoe crab Limulus, in particular. This is not surprising given that both are considered primitive chelicerates. So, by the Devonian (~400Myr), it is clear that trilobite eyes were essentially modern compound eyes.

Recently Schoenamann et al. (2017) studied a very much older trilobite: a specimen of Schmidtiellus from the Early Cambrian of Estonia (<500Myr). Schmidtiellus is a short (about the same length as width) trilobite a few inches long. One important aspect of this particular specimen (which happens to be the holotype) is that it is preserved as calcium phosphate, which in other Cambrian specimens tends to keep a lot of detail. Another is that both eyes are abraded so that one may see the internal structure. In particular, one can see individual ommatidia in cross-section with a microscope. Schmidtiellus has fairly simple eyes for a trilobite, with only about 100 facets per eye. There are two unexpected features of the ommatidia of Schmidtiellus. First there does not appear to be a separate lens. Second, the ommatidia do not actually touch each other, as they would in a modern compound eye. There are two implications of this, that the eyes could not form a continuous image, and that there did not have to be pigment to keep leaking between the ommatidia.

Certainly one can conclude that the basic anatomical features of compound eyes developed very early, but what about the details? The assumption is that Schmidtiellus has eye features that represent the primitive state of all trilobites. However, given that there is only one specimen of very early trilobite in which the structure of the eye is visible, it is hard to eliminate the possibility that its eye features are peculiar to that one group of trilobites.

Sources:

Schoenemann, B.; Clarkson, E.N.K.
"Discovery of some 400 million year-old sensory structures in the compound eyes of trilobites."
Scientific Reports 2013, 3, 1429.

Schoenemann, B.; Parnaste, H.; Clarkson, E.N.K.
“Structure and function of a compound eye, more than half a billion years old.”
Proc. Natl. Acad. Sci. USA, 2017, 114, 13489-13494.

Caihong: The Jurassic Dinosaur with Iridescent Plumage?

Bob Sheridan January 17, 2018

China has produced many dozens of exquisitely preserved feathered dinosaurs, most of them from the Early Creteaceous, but some as old as the Middle Jurassic. Hu et al. (2018) describe a new theropod specimen from the Tiaojishan Formation (~161 Myr.), which they have named *Caihong juji* ("rainbow big crest"). This specimen is nearly complete and has clearly preserved plumage on body, arms, and legs. In life the specimen, although probably an adult, would be only 16 inches from nose to tail, smaller than Microraptor, which is considered a very small theropod.

Caihong is more or less similar to most small bird-like theropods (e.g. Archaeopteryx, Anchiornis, Microraptor, Xiaotingia, etc.) in the skeletal characteristics: large eyes, long legs, long arms, long tail, pointed snout with many small teeth. One unusual feature for bird-like theropods is that there is an additional small process pointing up dorsally from the lacrimal bone. This is the "crest" mentioned in the title of the paper. (The authors call it "prominent", but this crest sticks out only a tiny fraction of the skull length; it might not even extend past the layer of feathers on the head.)

Caihong has very long feathers on its arms, tail, and legs in which much detail is preserved. These clearly have asymmetrical vanes, and are therefore "flight feathers." Caihong is the earliest example of an animal with asymmetrical feathers and very long forearms. Caihong joins the small set of feathered dinosaurs that appear more flightworthy than Archaepteryx, but lived 10-6 Myr. earlier. The authors tentatively identify some slender feathers near the thumb of Caihong as analogous to the alula, which are feathers attached to the thumb in modern birds.

Most of the headlines attached to Caihong have to do with its proposed coloration. If you have been following the paleontological literature for the past seven or eight years, you will know that melanosomes are often preserved in fossil feathers and are visible by scanning electron microscopy. Microsomes are microscopic bodies that contain pigment. In modern animals, including birds, the size and shape of melanosomes is correlate with the type and color of pigment. Different types of melanosomes may appear on different parts of the same feather. The assumption is that one can use the size and shape of fossil melanosomes to estimate the color of the feathers of extinct birds and dinosaurs. (One possible complication is that the size may change during fossilization.)

In the case of Caihong, the authors examined the preserved feathers from 66 sections around the fossil, particularly the head, back, and tail. The microsomes found therein are described as "platelet-like" and stacked in layers. The modern configuration of melanosomes most like this is on the iridescent throats of some hummingbirds. Rainbow-like iridescence is produced by the diffraction of visible light by closely-spaced layers, much like a diffraction grating. The exact nature of the pigment does not matter as much to the color. The authors suggest Caihong is therefore a generally black dinobird with iridescence (hence the "rainbow" in its name).

In popular accounts Caihong is reconstructed as a black feathered dinosaur with iridescent blue and green feathers on its head and neck. Very striking, but not what the authors of the paper are suggesting.

Sources:

Hu, D.; Clarke, J.A.; Eliason, C.M.; Qiu, R.; Li, Q.; Shawkey, M.D.; Zhao, C.; D'Alba, L.; Jiang, J.; Xu, X.
"A bony-crested Jurassic dinosaur with evidence of iridescent plumage highlights complexity in early paravian evolution."
Nature Comm. 2018, 9, 217.

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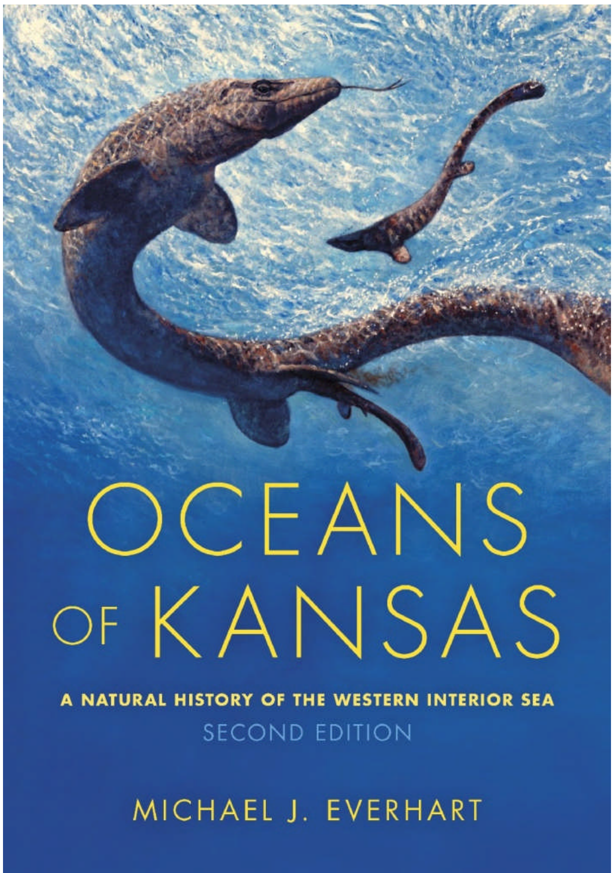

The 2nd Edition of *Oceans of Kansas – A Natural History of the Western Interior Sea* will be available from Indiana University Press on September 11, 2017. The digital version is already available from Amazon. The second edition is updated with new information on fossil discoveries and additional background on the history of paleontology in Kansas. The book has 427 pages, over 200 color photos of fossils by the author (including Tom Caggiano's dinosaur bones in hand shot), is printed on acid free paper, and weighs in at a hefty 3.6 pounds.

A review from *Copeia*....

"Oceans of Kansas remains the best and only book of its type currently available. Everhart's treatment of extinct marine reptiles synthesizes source materials far more readably than any other recent, nontechnical book-length study of the subject."
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