The Paleontograph

A newsletter for those interested in all aspects of Paleontology
Volume 6 Issue 2 September, 2017

From Your Editor

Welcome to our latest edition. This is long overdue and I apologize to Bob, who has continued writing articles even though I was not in a publishing mode. I will try not to be so lazy.

I am still recovering from moving and starting a new life in CO.. I did manage some time in the field, getting in my annual Kansas trip as well as two dinosaur trips to SD. and WY.

I've added a new feature to the newsletter, an advertisement and events page. Feel free to send submissions.

I'm busy getting ready for the Denver show. If you go, please stop by and say hello. I am Lost World Fossils located against the back wall on the main floor of the Coliseum.

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

Tomcagg@aol.com

Are Fossil Feathers Made of Keratin?

Bob Sheridan December 27, 2016

For the past two decades we have many preserved impressions of feathers in both fossil birds and dinosaurs, almost all from China. For the past several years there have been many imaging studies of preserved microscopic bodies (a few micrometers long) embedded in these feathers. These have assumed to be melanosomes, which in modern feathers contain the pigment (melanin) determining the color. Given a correlation between the shape of modern melanosomes and the color of the pigment contained within, attempts have been made to guess the color of fossil feathers. None of this work requires that the original organic feather material be preserved during fossilization, only its size and shape.

It had been assumed that in fossilization all organic material is replaced by minerals. However, the case has been made that at least some of the original organic material (usually abundant fibrous proteins like collagen and keratin) can be preserved in fossils, even those tens of millions of years old. The most famous claim of preservation is blood vessels (including blood cells) being preserved in Tyrannosaurus. Thus, it is conceivable that original feather material (beta-keratin) is present in fossil feathers. On the other hand, it is also conceivable that the feather keratin was replaced with bacterial mats as the fossils lay in the soil, and that the supposed melanosomes are actually bacteria. The only way of determining the difference is to do a chemical analysis of the material. This has been attempted previously with collagen in dinosaur bone, and melanin in the supposed melanosomes. Usually the claim is that the fossil material behaves chemically as expected for the original organic material. Given the small amount of material, however, such analyses are on the edge of being doable. However, analytical chemistry advances and, as time goes on, more detailed analyses can be done with less sample. It is always better, if possible, to apply more than one method of analysis.

Pan et al. (2016) do a number of analyses on a specific specimen of a bird, Eoconfusciusornis, from the Jehol Formation (~130 Myr.). Feathers appear to be preserved here. The analyses includes scanning electron microscopy, transmission electron microscopy, immunochemistry, and ChemiSTEM. The first two are imaging techniques. Immunochemistry involves detecting a specific protein by an antibody designed to bind to that protein. ChemiSTEM is a spectroscopic method for determining the presence of elements in extremely small areas of a sample, in this case small enough to analyze a single melanosome.

SEM images of the fossil feathers and their melanosomes closely resemble those of modern chicken feathers, including microscopic filaments and ovoid microbodies (presumably melanosomes). The only difference is that these objects appear more densely packed in the fossils, the obvious explanation being that feathers had shrunk during fossilization.

Antibodies raised against modern chicken feathers binds to modern feathers, and to a lesser extent to the fossil feathers. On the other hand, antibodies against peptidoglycan, which is produced by bacteria, did not react with the fossil feathers. This is most easily interpreted as the fossil feather being partly composed of keratin and not bacterial mat. ChemiSTEM finds the element sulfur being abundant in the same areas as the anti-keratin antibodies bind to. Since sulfur is a large constituent of modern keratin, this supports the idea that the fossil feathers are indeed keratin. In the fossils, the “melanosomes” seem to have a higher concentration of copper, sulfur, and calcium than the keratin matrix. This is also true of melanosomes in modern feathers.

To be fair, there are some differences between the fossil feathers and modern feathers: Modern feathers seem to contain more carbon and nitrogen. Also the fossil feathers show needle-shaped regions that are high in calcium. This is attributed by the authors to diagenesis, i.e. chemical changes during fossilization.

This study shows that at some original material is preserved in fossil feathers, at least in this one specimen.

Sources:

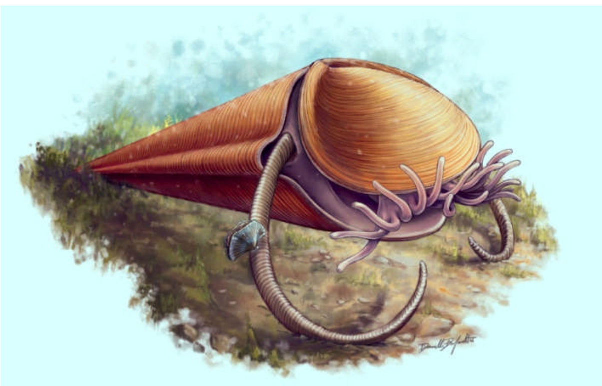
Pan, Y.; Zheng, W.; Moyer, A.E.; O’Conner, J.K.; Wang, M.; Zheng, X.; Wang, X.; Schroeer, E.R.; Zhou, Z.; Schweitzer, M.H.
“Molecular evidence of keratin and melanosomes in feathers of the Early Cretaceous bird Eoconfusiornis.”
Proc. Natl. Acad. Sci. USA 2016, 113, E7900-E7907.

Hyoliths: Another Problematica Identified

Bob Sheridan January 23, 2017

Many of the animals from the Paleozoic, in particular from the Cambrian, remain "problematica." That is, they are so strange it is not obvious if they are members of familiar groups of animals. Some may represent phyla that went extinct early in the history of multicellular life. On the other hand, we see that with additional fossil finds, aided by phylogenetic analysis, we can recognize commonality between some problematica and modern phyla. For example, Hallucinogenia is reinterpreted as a velvet worm, conodonts are shown to be chordates, etc. However, it is not uncommon for the assignment to be revised several times. Today's story is about a recent (Moysiuk et al., 2016) association of the problematical hyoliths with lophophorates.

First a little background on hyoliths. These animals, at best a centimeter or two long, appear in the Cambrian and exist throughout the Paelozoic. They have a conical bilaterally-symmetric shell (the “conch”), covered by a hinged convex lid (“operculum”) at the wide part of the cone, plus two curve spines about one-third the length of the (“helens”). The helens appear to originate at the top of the cone. Given the bilateral symmetry of the cone, it is assumed that there is a right and left helens. Most fossil hyoliths, which are preserved as two-dimensional films, appear with the operculum fully open, such that the fossil looks like a cone with a scoop of ice cream on top. From the shelly appearance and conical shape, it has been usually assumed that hyoliths are mollusks, the group that contains modern bivalves (e.g. clams), snails squids, and chitons.



Second, we need to talk about lophophorates. This is a group of organisms (brachiopods, bryozoans, and phoronid “worms”) that filter feed using a tentacled lobe (“lophophore”) surrounding the mouth. The most common fossil lophophorates are brachiopods. These superficially resemble bivalves (clams, oysters, etc.), in that they are entirely enclosed by two shells attached by a hinge, but are not mollusks. Given that almost always only the shells are preserved in fossils, the best way to distinguish bivalves from brachiopods is the plane of symmetry. Consider the plane separating the two shells. Bivalves are bilaterally symmetric around this plane. In contrast, brachiopods are bilaterally symmetric around a plane perpendicular to the plane separating two shells. Brachiopods have a U-shaped gut with the mouth inside the lophophore and the anus outside the lophophore. We know a lot about the soft anatomy of brachiopods because some still exist today. Most living brachiopods attach themselves to rocks by means of a stalk called a pedicle.

Moysiuk et al. examined ~1500 specimens of hyoliths from the Burgess Shale. Given the number of specimens, and state of preservation in the Shale, it is now possible to get a good picture of the softer parts of hyoliths. Hyoliths clearly have a fan-shaped tentacled lobe at the top of what appears to be a gut, and the gut, when visible, appears to be U-shaped. Mollusks have a muscular foot and an anus far from the mouth. Clearly, then, the soft parts of hyoliths are more consistent with brachiopods than bivalves. However, the features are not entirely like modern brachiopods, and it is not clear which exact branch of lophophorates hyoliths belong.

Nothing like the helens exist in modern lophophorates. However, the authors suggest these could be used to lift the mouth of the hyolith cone above the sea floor. A few films on the internet show hyoids moving forward by pushing the helens against the sand.

Sources:

Moysiuk, J.; Smith, M.R.; Caron, J.-B. “Hyoliths are Paleozoic lophophorates.” Nature, 2017, 394, 394-397.

How Long Did Dinosaur Eggs Incubate?

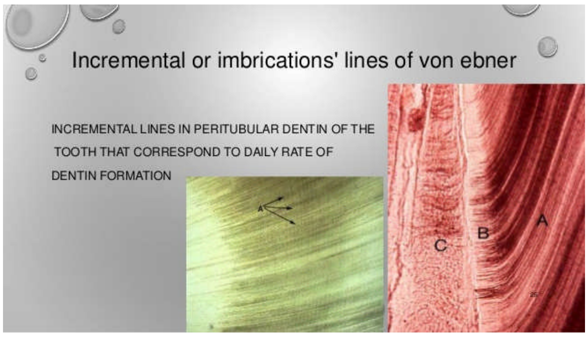
Bob Sheridan January 31, 2017

Most dinosaurs are thought to have growth rates faster than modern reptiles and nearly as fast as that of modern mammals. The growth rate for a dinosaur species is determined by collecting a number of specimens of various sizes and plotting the estimated weight of each animal as a function of age. The age of a specimen in years, in turn, is estimated by the number of LAGS (lines of arrested growth) in its long bones. Compared to reptiles, dinosaurs, and mammals, birds have a very high growth rate, and reach full size within a single year.

Modern bird eggs incubate fairly quickly (11-85 days), with larger eggs taking longer. In contrast, reptile eggs, like those of crocodilians, take much longer to incubate compared to bird eggs of the same size. The relationship of incubation time with mass in bird and reptiles eggs is good enough that we can extrapolate how long dinosaur eggs (which tend to be bigger than either bird or reptile eggs) would incubate, assuming they had a bird-like or reptile-like growth rate. A new paper by Erickson et al. (2017) tries to directly measure the incubation time of dinosaur eggs to determine whether they were more like birds or reptiles.

Fortunately, there is a “clock” analogous to LAGS available for some eggs: von Ebner lines. These are microscopic lines that are formed in the dentin in teeth; supposedly there is one line per day of formation. von Ebner lines have been used in the past to estimate the lifetime of dinosaur teeth before replacement. Since dinosaur embryos have teeth, it should be possible to determine how long their teeth have been forming while in the egg. Note, this will be an underestimate of the total time of incubation: teeth do not start forming until well after embryonic development starts (the jaws have to be present), and the embryo is not yet hatched.

All that needs to be done in theory is find embryos in dinosaur eggs, measure the volume of the egg, section the embryo teeth, and count the von Ebner lines.



In practice it is very hard to find near-term embryos preserved in dinosaur eggs. Also counting von Ebner lines in dinosaur embryos and relating them to total days of tooth formation is not straightforward. Even in the egg, dinosaurs eggs go through rounds of wear and replacement, and one must identify the oldest teeth and take into account how often the teeth are replaced. Two techniques for studying the histology of the teeth mentioned in this paper are high-resolution CT scan and physical sectioning of the teeth. Also, it is somewhat hard to estimate the volume of dinosaur eggs, since in many cases they are incomplete or crushed.

In this paper the authors examine embryonic teeth of two dinosaurs Protoceratops andrewsi (a ceratopsian from Mongolia) and Hypacrosaurus sebingeri (a crested hadrosaur from Alberta, Canada). As an interesting aside, the first identified dinosaur eggs, discovered in Mongolia in the 1920’s, were assigned to Protoceratops, which was the most common dinosaur in the region. It wasn’t until the 1990’s that the eggs were found to belong to Oviraptor. It is only very recently that the real Protoceratops eggs were discovered. Ironically, they look similar to Oviraptor eggs.

Despite all the uncertainties involved, it does seem like the total days of tooth formation in these dinosaur embryos is at least twice as long as the total incubation time expected for a bird egg of the same size, and much more consistent with the incubation time of modern reptile eggs. Also, remember the tooth formation time is an underestimate of the total incubation time. This implies that the short incubation of bird eggs is probably a recent development, not shared by dinosaurs in general.

Cont'd

von Ebner Cont'd

Note that the comparison in this paper is between von Ebner lines in dinosaurs and observed incubation times in birds and reptiles. While bird embryos do not have teeth that persist long enough to study, it should be possible to examine the teeth of reptile embryos to see if von Ebner lines are consistent with the observed incubation times.

It should also be pointed out that the dinosaurs examined in this paper are not in the branch of dinosaurs (theropods) that is ancestral to birds. There is therefore incentive to look for embryos of theropods and perhaps the embryos of toothed birds.

Sources:
Erickson, G.M.; Zelenitsky, D.K.; Kay, D.I.; Norell, M.A.
"Dinosaur incubation periods directly determined from growth-line counts in embryonic teeth show reptilian-grad development."
Proc. Nat. Acad. Sci. USA. 2017, 114, 540-545.

Calvapilosa:

An Ancestral Crown-Group Mollusc?

Bob Sheridan February 10, 2017

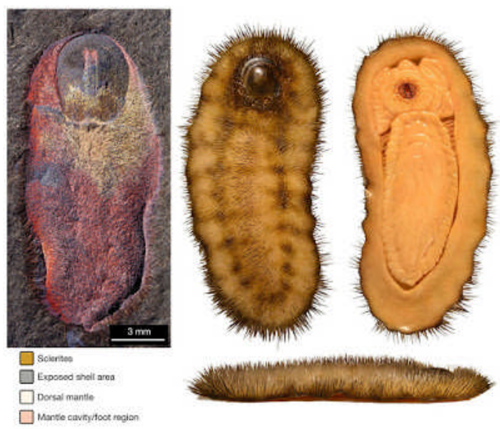
Molluscs (or mollusks) is a large, very diverse group of invertebrate animals. Almost all have some kind of "mantle," a muscular "foot", and a "radula" (a rasping tongue). Almost all have some kind of hard calcium carbonate shell, whether internal or external. Once can divide living molluscs into gastropods (e.g. snails), cephalopods (e.g. octopus), bivalves (e.g. clams), aplacophorans, monoplacophorans, and polyplacophorans (e.g. chitons). There is also a possible grouping called "aculiferans" which combines aplacophorans, monoplacophorans, and polyplacophorans.

A number of Cambrian animals are assigned to a group called the sachitida. Among the most familiar from the Burgess Shale are Halkieria and Wiwaxia, which are a few centimeters long. Halkiera appears to be a flattened slug covered in some kind of chain mail. At the front and back of the animal on the dorsal surface are small shelly, bilaterally symmetric "caps" that appear superficially similar to the shells of brachiopods. Wiwaxia is a dome-shaped animal covered with overlapping chitinous scales (sclerites) parallel to the surface of the animal. It also has long curved, flat spines that appear to stick out from the animal. It has long been debated what modern animals the sachitida are related to: annelid worms, brachiopods, or molluscs.

Vinther et al. describe a new animal from the Ordovician of Morocco, which they call Calvapilosa kroegi ("spiny scalp of Bjorn Kroger"). This animal somewhat resembles Halkieria with the following differences:

1. The body is covered with tiny short hollow spines (or "hairs") instead of sclerites.
2. There is only one shelly dorsal cap (at the front).

Calvapilosa clearly has a cylindrical radula, with small teeth, below the cap. (It has been suggested that Halkieria had a radula also, but that has not been as clear.)



Given that it has a radula a mantle, and a "foot", Calvapilosa is clearly a mollusc, and this tends to confirm the assignment of sachitida as molluscs. Phylogenetic analysis puts Calvapilosa and other sachitida specifically in the aculiferan branch. Since Calvapilosa is among the most primitive type of aculiferan, the authors suggest an evolutionary path where the first molluscs started with a single small shell, gained a second shell (as in Halkieria), and then gained up to eight shells as in modern chitons. In this model, modern aplacophorans, which are aculiferan molluscs with no shells, lost theirs secondarily.

Sources:
Vinther, J.; Parry, L.; Briggs, D.E.G.; Van Roy, P.
"Ancestral morphology of crown-group molluscs revealed by a new Ordovician stem aculiferan."
Nature 2017, 542, 471-474.

The Necks of Azhdarchid Pterosaurs

Bob Sheridan February 3, 2017

Pterosaurs come in a number of families. The one under discussion today is the azhdarchids (named for the genus Azhdarco from Uzbekistan). Azhdarchids come from the Latest Cretaceous of North America, Europe, and Western Asia, and include some pterosaurs of astounding size. The most recognized example is Quetzalcoatlus (from Texas). Although no one specimen is complete enough to get a firm estimate, some azhdarchids had a wingspans of over 30 feet and would be almost 20 feet tall when standing on the ground. The largest known skull is about 9 feet long. Estimated weight for these animals is surprisingly low, perhaps 500 pounds. Practically all azhdarchids have toothless beaks. In some genera, the beaks are long and pointed, in others more blunt. It is not clear what kind of lifestyle these animals led. Suggestions range from opportunistic land scavengers (like giant storks), to skimming fishers, to wading predators (like herons).

Where the neck of azhdarchids are preserved, these are very long (about half as long as the entire animal), and consist of 9 cervical vertebrae. Each individual vertebra is a long cylinder, which can be up to 2-6 times as long as wide. Given that neural spines restrict the movement of vertebra against each other, azhdarchid necks were not particularly flexible. It is generally assumed that all azhdarchids would have long, thin necks. However, recent work by Naish and Witton (2017) suggests that this might not be true.

These authors discuss a specific specimen EME 315, which is an isolated pterosaur cervical vertebra excavated from the Latest Cretaceous sediment of Romania. Given the large size of EME 315 (~11 inches long), the authors infer that it is from the azhdarchid Hatzegopteryx, since no other giant pterosaurs are known from Romania. The authors feel EME 315 is most analogous in features to the seventh or eighth cervical vertebra of other azhdarchids (i.e. close to the base of the neck). The most unusual thing about EME 315 is that, instead of being a long and thin cylinder, it is very short, about as wide as long. It also has relatively much larger neural spines for the attachment of muscles. Pterosaur bones, including the cervical vertebrae, are mostly hollow to reduce weight. The walls of EME 315 are proportionately much thicker than the walls of other known cervical vertebrae from azhdarchids.

Clearly, Hatzegopteryx had a shorter, more heavily muscled, more stress-resistant, neck than other azhdarchids of similar size like Quetzalcoatlus. This is consistent with the fact that the (partial) skull of Hatzegopteryx seems more heavily-built than that of other azhdarchids of the same size. The robust skull and neck allows the possibility of Hatzegopteryx being a more aggressive a predator, perhaps able to kill animals bigger than can be swallowed whole.

Sources:

Naish, D.; Witton, M.P.
"Neck biomechanics indicate that giant Transylvanian azhdarchid pterosaurs were short-necked arch predators."
PeerJ 2017, DOI 10.7717.2908

Ovatiovermis: Another Cambrian Lobopodian

Bob Sheridan February 5, 2017

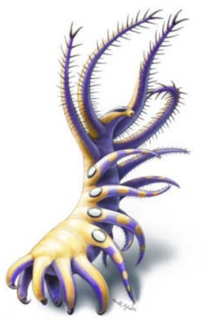
Lobopodia is an informal grouping of "worm-like" animals with stubby legs. Some living representatives are onychophorans (velvet worms) and tardigrades (waterbears). Tardigrades, onychophorans, and arthropods are sometimes grouped into a larger category called panarthropods, with the (still controversial) idea that arthropods (insects, crustaceans, spiders, etc.) descendants of lobopodians that acquired an exoskeleton.

Cont'd

Lobopodians Cont"d

In the Early Cambrian, lobopodians were much more diverse, being represented by over a dozen genera. The most famous example from the Burgess Shale (~520 Myr) is Hallucigenia. Its body appears to be a long tube (~15 mm long) with seven pairs of flexible "tentacles" on one side and seven pairs of somewhat longer rigid "spikes" on the other. Hallucigenia has undergone a few reinterpretations. At one time, it was considered an extremely weird animal unrelated to any living group, until the “tentacles” were interpreted as legs, and Hallucigenia thereby a relative of the velvet worms. Hallucigenia was incompletely known until very recently, when Smith and Caron (2015) were able to describe what the "head" and "tail" look like.

Cambrian lobopodians are still being described. For example, Yang et al. (2015) described Collinsium cilosium ("hairy [monster] of [Desmond] Collins") from the Early Cambrian Xiaoshiba Lagerstatte, which is the Chinese equivalent to the Burgess Shale. Collinsium is larger than Hallucigenia and has 15 pairs of legs that differ in length. The 9 rearmost pairs appear to walking legs with a terminal claw. The front most pairs are long, tendril-like, and are covered in some kind of long bristles (hence "hairy" in the name). The head seems to have some kind of short antennae (like modern velvet worms). Having bristles might imply a lifestyle of filter-feeding. Whereas Hallucigenia has 7 pairs of spines, Collinsium has 15 sets of three spines each, with the center spine being the longest. This gives Collinsium a very spiky appearance.



Recently, Caron et al. (2017) described a new lobopodium, which they named *Ovatiovermis cribratis* (“clapping worm with sieving”). Specimens of Ovatiovermis are found in the Burgess Shale. The trunk of Ovatiovermis is about 18 mm long. It has 9 pairs of legs, the first two pairs are very long and are covered with long bristles. The last three pairs of legs are short and thick and end in a terminal claw. The “head” is a short tube in front of the first pairs of legs. The authors discern two dark structures at the dorsal surface of the head (perhaps eyes) and a proboscis with teeth. There are no spines. One plausible suggestion for a lifestyle is that Ovatiovermis sat on the sea floor or some other substrate using its thicker rear legs, and used its front bristled legs to filter plankton out of the water. (This, of course, implies that there was plankton in the Cambrian.) The suggest lifestyle of Ovatiovermis is therefore similar to Collinsium, except that Ovatiovermis is naked, while Collinsium had spines, presumably to protect it against predators.

Phylogenetic analysis of 38 panarthropods places Ovatiovermis, Collinsium, and Luolishania in the same group. Hallucinogenia, Cardiodictyon, and Carotubulus fall into another group. These are fairly distinct from modern onychophorans. However, the exact relationship of these groups to each other and other panarthropods depends on the method the authors used to construct the phylogenetic tree, which probably means there is not enough data to decide such questions.

Sources:

Caron, J.-B.; Aria, C.
“Cambrian suspension-feeding lobopodians and and the early radiation of panarthropods.”
BMC Evolutionary Biology 2017, 17:29

Smith, M.R.; Caron, J.-B.
"Hallucigenia's head and the pharyngeal armature of early ecdysozoans."
Nature 2015, 523, 75-79.

Yang, J.; Ortega-Henrandez; Gerber, S.; Butterfield, N.J.; Hou. J.-B.; Lan, T.; Zhang, X.-G.
"A superarmored lobopodian from the Cambrian of China and early disparity in the evolution of onychophora."
Proc. Natl. Acad. Sci. USA. 2015, 112, 8678-8683.

Saurischians vs. Ornithischians: No Longer Valid?

Bob Sheridan March 24, 2017

Any children's book on dinosaurs will tell you dinosaurs are divided into two types based on the disposition of the hip bones: saurischians ("lizard hips") have the pubis pointing forward and ornithischians ("bird hips") have the pubis pointing backward. There are certain subgroups of dinosaurs where the pubic bone is differently disposed than the rest of their group members. For example, therizinosaurs, which are theropods that became herbivores, and maniraptors, the subclass of theropods closest to birds, have the pubis pointing backward, although theropods in general are saurischians. However, by and large, the "two types of hips" model is considered a strong paradigm.

It is useful to review the idea of cladistic analysis, since today's story depends on it. The aim of such analysis is, given a matrix of animals and their characters, to build an "tree" (or "cladogram") such that animals are grouped by "shared derived" characters. Convergent characters (ones that arise in separate lineages) add noise, but one usually assumes that these are not very common. By Occams Razor, the tree where there are the fewest reversals of characters is presumably the best hypothesis for the true evolutionary relationship. Since the number of possible trees goes up exponentially with the number of animals, not all trees can be scored even on the fastest computers, so there are clever algorithms to search through the "space" efficiently, but one ends up with a number of "good" trees, and no guarantee that the "best" tree has been found.

The assumption most workers make is that that the more animals one includes and the more characteristics one includes, the closer the best trees are to the "truth". However, in practice there are difficulties for any finite set of data. Most importantly, in paleontology the original matrix is likely to be incomplete, i.e. one cannot determine all characters for all animals, mostly because skeletons are poorly preserved. The trees always depend on which animals and which characters were included, what algorithm is used to search, and how one determines which trees are better.

Now we get to the meat of the story. The current assumption has been that all ornithischians have a common ancestor and all the saurischians have a common ancestor, and in the past cladistic analysis has supported this. There have been a few observations that did not quite fit, however. For instance some Triassic carnivorous dinosaurs have some characters in common with prosauropods. Also, ornithischians did not diversify until the mid-Jurassic, whereas if they were close to the origin of the dinosaurs you would have expected them diversify earlier. A new cladistic analysis of dinosaurs by Baron et al. (2017) shows an unexpected rearrangement of dinosaurs that may explain some of the anomalies. These authored examined 74 genera of dinosaurs and 457 characters. They included more early carnivorous dinosaurs, like Herrerasaurus, and more early ornithischians like Heterodontosaurus, Lesothosaurus and Pisanosaurus than previous studies. For the purpose of explaining their results, we can consider four groups of dinosaurs:

1. Ornithischians. This includes stegosaurs, heterodontosaurs, ankylosaurs, hadrosaurs, pachycephalosaurs, ceratopsians, etc. Besides the backward pointing pubis, they have a characteristic predentary bone at the front of the lower jaw. Most had some kind of beak and all were herbivores. It has been argued that the backward pointing pubis allows for a bigger gut, which is needed for herbivores, although there are obviously exceptions.
2. Theropods. These are bipedal dinosaurs, almost of which are carnivores. Examples are tyrannosaurs, ornithomimids, dromeosaurs, etc. These have saurischian hips.
3. Sauropodomorphs. This is comprised of two subgroups. Sauropods are the long-necked, longed-tailed large herbivorous dinosaurs (e.g. Apatosaurus). Prosauropods are long-necked herbivores from the Triassic (e.g. Plateosaurus). These have saurischian hips.
4. Triassic carnivorous dinosaurs like Herrerasaurus. These have saurischian hips.

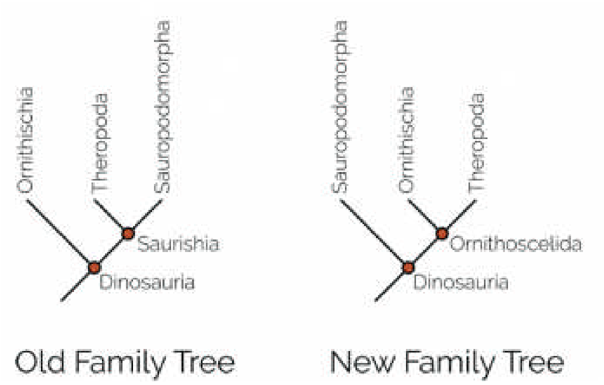
Given a simple saurischian/ornithischian split near the origin of dinosaurs, we would have expected Herrerasaurus to be close to theropods, and sauropods and theropods to be related, but separate from ornithischians. However, in the cladograms produced by Baron et al. Herrerasaurs are grouped with sauropodomorphs, and theropods with ornithischians.

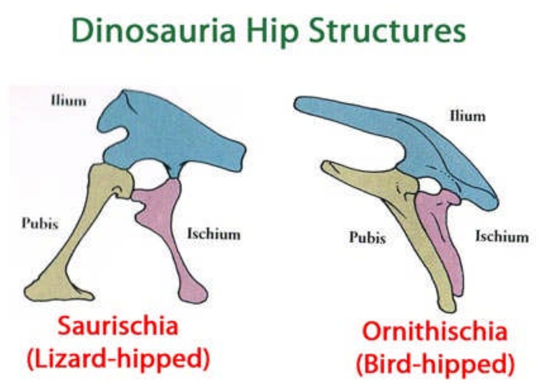
Cont'd

The authors name a new group "Ornithoscelida" that includes the ornithischians and the theropods. "Saurischia" would now include only sauropodomorphs and Herrerasaurus. Instead of a clear single character (like the hip structure), these groupings are due to many subtle characters that would not be obvious to a non-expert. Some examples: a well-developed anterior trochanter that is broad and a least partly separated from the shaft of the femur, fusion of the distal tarsals to the proximal ends of the metatarsals, a fibular crest on the lateral side of the proximal portion of the tibia, a diastema between the premaxillary and maxillary tooth rows of at least one tooth crown's length, etc.

If this new arrangement is true, there are a few obvious consequences. First, the hip structure of dinosaurs is not a fixed characteristic with time. (In retrospect, this is plausible given the unusual theropods noted in the first paragraph.) Another obvious consequence is that Herrerasaurus and later theropods separately converged on the model of a bipedal carnivore. Also, since Herrerasurus was previously considered a primitive dinosaur and it came from South America, it has been argued that dinosaurs originated in the southern hemisphere. However, in the new cladogram some dinosaurs from North America and Europe look more primitive, so an origin in the northern hemisphere is looking more plausible.

This drastic rearrangement of dinosaurs is akin in effect to redefining planets (in a way that does not include Pluto). We can expect a lot of controversy and push-back. As with any branch of science, it takes more than one study to overturn an established paradigm. Cladograms have a lot of dependencies, as noted above, so we need to see if this result stands up to more data and different types of analysis.





Sources:

Baron, M.G.; Norman, D.B.; Barrett, P.M.
"A new hypothesis of dinosaur relationships and early dinosaur evolution."
Nature 2017, 543, 501-506.

Gramling, C.
"Ma, where did they put T. rex?"
Science, 2017, 355, pg. 1249.

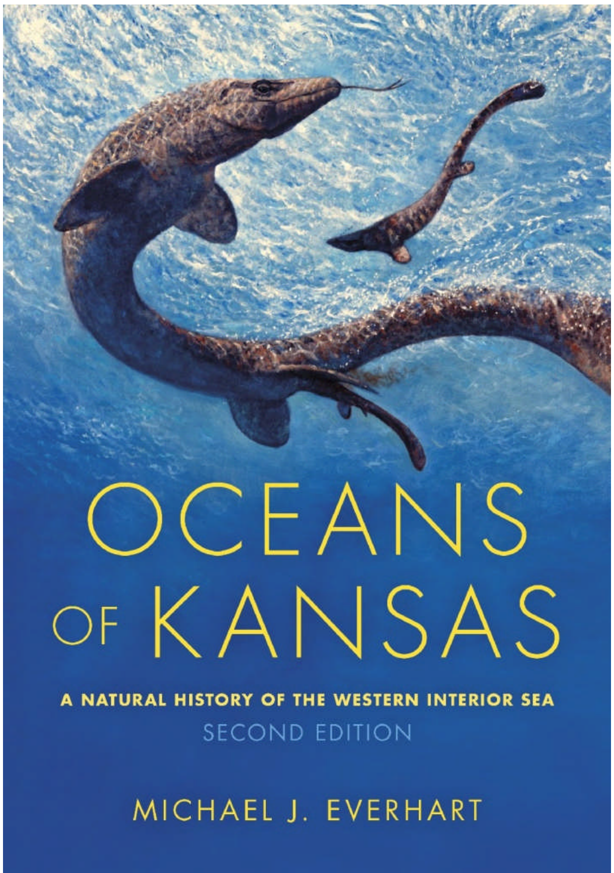
Padian, K.
"Dividing the dinosaurs."
Nature 2017, 543, 494-495.

PALEONTOGRAPH ADVERTISMENT & EVENTS PAGE

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

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."
—Copeia



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.

http://www.coliseumshow.com/

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

http://www.22ndstreetshow.com/

Items are posted free of charge but must be paleo related and will be published at my discretion.