The Paleontograph

A newsletter for those interested in all aspects of Paleontology
Volume 10 Issue 2 June, 2021

From Your Editor

Welcome to our June edition. I hope this issue finds you healthy and safe. It seems like life is getting back to our new normal. I think many of the changes we saw from the pandemic will stay around in one form or another. I, for one, am very happy to have my mind on paleo instead of sickness.

I've been out collecting a couple of times and have some more trips planned. I've also been busy trying get some fossils to sell. The pandemic changed a few things in the fossil world also. Some wholesale suppliers have started selling direct to the public, making it harder for a guy like me to get inventory.

Bob has been very busy writing these last few months. I have a large backlog of articles for the next issue. I hope you enjoy the articles presented here for your reading pleasure.

I hope to see some of you at the show in Edison NJ coming in August.

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

Did Juveniles of Large Theropods Displace Mid-Size Theropod Species?

Bob Sheridan March 2, 2021

In most communities of modern fauna (mostly mammals), species come in a range of sizes. Typically there are more genera of small size, fewer genera of medium size, and few genera of large size. One can think of a size range as a type of niche or "job". Generally speaking, only a very limited number of animals fill the same niche because they would compete with each other. This is especially true of carnivores; generally larger carnivores specialize in larger prey.

Dinosaurs appear to be different from mammals in that there are more species that are large than are small. This could be an artifact of fossilization, i.e. larger bones are more likely to be preserved and discovered. However, in some cases there also appear to be fewer medium-sized species than small or large ones, which would not be expected from such an artifact.

Schroeder et al. (2021), using data from the Paleobiology Database, examine the mass distribution of 550 dinosaur species divided into 43 fossil localities (Hell Creek, Cedar Mountain, Judith River, etc.). Presumably all the animals at each locality lived at the same time as a "community". Localities span the Mesozoic, from the Middle Triassic to the Late Cretaceous. Masses of adult dinosaurs vary from 0.1 kilogram to 100,000 kilograms. Species are divided into carnivores and herbivores for the purpose of analysis.

This study confirms previous observations that, within any one community, the masses of the adult herbivores are skewed to the right (i.e. more larger species). On the other hand, the masses of adult carnivores (almost always theropods) in most communities appear bimodal in distribution (i.e. there are many small and large species, but few medium-sized species). That is, there is a "size gap" regardless of the time period or continent. "Medium-sized" in this case is the range 100 to 1000 kilograms. The bimodal nature appears more strongly in the Cretaceous than the Jurassic or Triassic.

The hypothesis under investigation in this paper is whether juveniles of theropod species that have very large adults (i.e. "megatheropods") act like medium-size carnivores, thus creating a size gap by potentially crowding out species of medium-size adult carnivores. Since those juveniles start very small when they hatch, they can potentially occupy a very broad range of sizes as they grow up. Thus, juveniles of different sizes could be considered "morphospecies." For the hypothesis to be true, the juveniles of megatheropods would have to be as numerous as real species and most of them would have to fill the size gap. The authors feel this hypothesis is supported by the data because, on the average, the juveniles appear to fill the size gap.

However, the trends should be observed in individual localities as well. It is indisputable that in some localities (e.g. Bayan Shireh and Cedar Mountain—Late Cretaceous Mongolia and Early Cretaceous Utah, respectively) juveniles are medium-sized but not numerous, and in other localities (e.g. Horseshoe Mountain—Late Cretaceous Canada) they are numerous but large rather than medium-sized. However, in no formation displayed in the paper are juveniles both numerous and medium-sized, such that the size gap is filled. My feeling is that, while the "juvenile morphospecies" hypothesis could be plausible from the available data, some skepticism is warranted.

Sources:
Schroeder, K.; Lyons, S.K.; Smith, F.A.
"The influence of juvenile dinosaurs on community structure and diversity."
Science 2021, 371, 941-944.

Vogel, G.
"Hungry teen dinosaurs crowded out competitors."
Science 2021, 371, 871-872.

Weird Earth--A Review

Bob Sheridan, March 11, 2021

Normally I wouldn't review a book for the Paleontograph that didn't have a strict paleontological theme. In 2013 I am made an exception for "Abominable Science!," a book by Daniel Loxdon and Donald Prothero debunking cryptozoology. Cryptozoology is the study of animals that are unknown to science, but that many believe exist. Recently there is another book by Donald Prothero "Weird Earth: Debunking Strange Ideas About Our Planet" by Donald Prothero. **Cont'd**

Donald Prothero is a paleontologist at the Department of Vertebrate Paleontology at the Los Angelos County Natural History Museum. He has written many books, most of them aimed at correcting misconceptions about paleontology.

I am making another exception because:
1. People interested in paleontology probably have an interest in geology and planetary sciences (I know I do).
2. Anything by Donald Prothero is worth reading.
3. Belief in conspiracy theories, and other demonstrably false ideas, has reached a fever pitch lately, and a book meant to counter this trend should be applauded.

There are 18 chapters in "Weird Earth" covering a large number of claims. We can divide these into several categories:
1. Resurgence of ideas that were held in pre-scientific times, but now cannot be supported. Examples are: the flat earth, earth-centered universe, various versions of the idea that the earth is hollow (and perhaps inhabited).
2. Some ideas are proposed by biblical literalists: that all geology can be explained by Noah's flood, that the earth is six thousand years old, the idea that dinosaurs are faked.
3. Some are misinterpretations or over interpretations of known findings: since the earth's magnetic poles reverse, there will soon be a time when we will be exposed to dangerous radiation. "Ley lines" connect archaeological sites in England. The earth is expanding with time.
4. A few are about the lack of knowledge in geology. Currently, no one can predict when earthquakes occur, but some people claim they can, and this has caused some confusion for non-geologists. You might remember the case from 2009 where geologists were criminally charged for not predicting the earthquake near Abruzzo, Italy.
5. There are various New Age ideas: Atlantis existed, crystals have magical healing powers, divining rods work, aliens live within Mt. Shasta, California.
6. There is one obvious conspiracy theory: The moon landings were faked. However, all of the ideas are partly "conspiracy theories" because many current proponents of these ideas claim that all of Science is conspiring to silence them. (Of course, the truth is more like: Science is ignoring their ideas because they are obviously wrong.)

For each one of these beliefs, Prothero does a good job of presenting the facts that debunk them. Sometimes there is more than one approach. For example, we know the size of the Earth (both from the ground and observations from space) and the mass of the Earth (based on the periods of orbiting bodies including the moon). The overall density of the Earth is deduced as between that of solid rock and iron. This rules out any version of a hollow Earth (i.e. with significant pockets of air). Also, temperature increases by 25C for every kilometer under the earth. Near the center of the Earth, it is 7000C, much too hot for the underground environment to be habitable.

Some paths to debunking are not so obvious except by resorting to statistics. For instance, consider the idea that archeological sites in England fall along straight lines, the so called "Ley lines." This is mostly a mathematical artifact. Archaeological sites are so common in England that one can always draw a straight line that passes near many of them, even if the sites are arranged completely randomly. Statistical arguments can also be used against the "faked moon landing" conspiracy. In the 1960s, hundreds of thousands of people worked on the Apollo program, and not one has confessed to faking anything, even fifty years later. In contrast, real conspiracies consisting of just a few people are usually revealed in a short time.

Going over all these topics, my first thought is "How can anyone believe any of this nonsense?" The issue is, of course, is that most people do not form their beliefs based on evidence, while Science is all about evidence. The first chapter summarizes the basic tools of scientific thought and critical thinking, such as "burden of proof", "extraordinary claims require extraordinary evidence", "anecdotes do not make science", "look at all the data, not just the parts you like", etc.. The final chapter is "Why People Believe Weird Things." Of course, people have a number of cognitive biases that encourages the formation of beliefs without evidence. Unfortunately, explaining the facts alone cannot overcome these. The most important bias right now appears to be tribalism: I believe things because others in a group that I identify with hold that belief. Also the "internet echo chamber" can spread false ideas very easily and not allow for alternative views.

This book is not paleontology, but I think you would like it.

Sources:

Prothero, D.R.
"Weird Earth: Debunking Strange Ideas About Our Planet"
Red Lighting Books, Bloomington IN, 2020, 293 pages. $20 (hardcover).

Aquilolamna

Bob Sheridan, March 19, 2021

We normally think of sharks as apex predators, but there are many peaceful types that strain plankton for a living. The whale shark, basking shark, and megamouth shark are examples. All have very wide mouths and reduced teeth, plus some kind of "raker" structure on the gills to catch the plankton. There are also shark relatives such as manta rays and devil rays that are filter feeders. The contrast in anatomy between the planktivorous sharks and rays needs to be detailed. The sharks mentioned above have torpedo-shaped bodies, short pectoral fins, prominent pelvic fins, a large dorsal fin, and a vertical tail with the dorsal lobe being longer. In contrast, the rays are flat from top-to-bottom, have very large triangular wings (presumably analogous to the pectoral fins) that make them wider than long, and have a long whip-like tail. Any other fins are reduced.

Since sharks and their relatives have cartilaginous skeletons, finding anything but jaws and teeth as fossils is fairly rare. One needs special conditions that preserved the outline of the entire body to say anything definitive about their anatomy. Torpedo-shaped sharks go back to the Devonian, but the fossil record of rays goes back no further than the Tertiary.

A new shark described by Vullo et al. (2021) is from the Late Cretaceous of Mexico. This is given the name *Aquilolamna milarcae* ("eagle shark"). Its body is generally torpedo-shaped with a very wide head but no obvious teeth. It has a typical shark tail. However, it appears not to have pelvic and dorsal fins. The most interesting aspect is the pectoral fins, which are very long but narrow from front to back. In this, Aquilolamna is a chimera between sharks and rays. Whether Aquilolamna is a ray ancestor or just convergent on their body plan is not clear, since prehistoric sharks are very diverse in body-plan.

The lifestyle of Aquilolamna is presumably a slow swimmer that filter-feeds.

Scrappy shark fossils from the Late Cretaceous that might suggest filter feeding are known. For instance, there are tooth fossils called Cretomanta and Pseudomegachasma. These are distinct, but both types of teeth are small and hooked. There is also specimen called Platylithophycus that consists only of gill rakers. The authors speculate that some of these fossils might represent parts of Aquilolamna.

Sources:

Vullo, R.; Frey, E.; Ifrim, C.; Gonzalez, M.A.G.; Stinnesbeck, E.S.; Stinnesbeck, W.
"Manta-like plantivorous skarks in Late Cretaceous oceans."
Science 2021, 371, 1253-1256.

Ectoparasites in Burmese Amber?

Bob Sheridan March 21, 2021

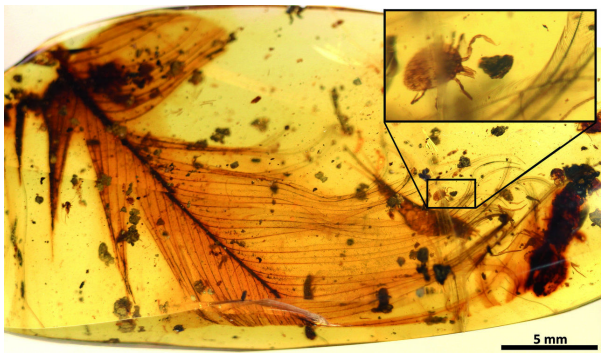
Ectoparasites live on the skin of their host but not inside the body. The two most common blood-sucking ectoparasites are fleas (which are insects) and ticks (which are arachnids). Both of these are of medical importance because they transmit disease between hosts. Fleas prey mostly on mammals, and ticks prey on mammals, reptiles and birds. These parasites get around by hanging onto the host's hair or feathers, when available.

Fossil fleas and ticks are known from amber. There has long been speculation that ticks preyed on dinosaurs, since they were the most common large animal in the Cretaceous with feathers. Burmese amber (~100 Myr in age) is a good place to test this idea since amber often contains both feather fragments and attached arthropods. **Cont'd**

Parasites Cont'd

One cannot necessarily tell an isolated dinosaur feather from the feather of a true bird, however.

Penalvar et al. (2017) report on two specimens of Burmese amber containing ticks. The first specimen contains a previously described tick species *Cornupalpatum burnanicum*. It is less than a millimeter long and appears to be immature because it does not show sexual characteristics. The most interesting thing about the specimen is that it appears to be grasping an isolated pennaceous feather. The feather appears to be of a very advanced type, asymmetric, with barbs and hooklets. The authors also feel the tick was holding the feather before being engulfed in amber, and if that is true, this would be the first direct evidence that ticks might prey upon dinosaurs (or early birds). The second specimen of amber contains two individual ticks of the same new species, which is named *Deinocroton draculi*. A very interesting aspect of these specimens is that they seem to be covered in long hairs from dermestid beetle larvae. Since some modern dermestid beetles occupy bird's nests, the implication is that the newly named ticks also could be found in the nests of birds or feathered dinosaurs.



Gao et al. (2019) describe a piece of Burmese amber with what looks like a pennaceous feather a little over 1 centimeter long, plus 10 specimens of an insect that they name *Mesophthirus engeli*. These specimens appear to be nymphs rather than adults; they fall into two different age categories. Since they are nymphs, according to the authors, they cannot be easily assigned to a modern insect group. The nymphs have oval-shaped wingless bodies, without constrictions between head and thorax or between thorax and abdomen, short antennae, and robust chewing parts. The body length would be only 0.14 millimeters long. The authors suggest that, since the nymphs have chewing mouth parts, and the feathers show some damage, the lifestyle of these insects is to eat feathers (as opposed to sucking blood).

Grimaldi and Vea (2021) reexamine the same specimens from Gao et al. They suggest that "Mesophthirus" is anatomically very like early nymphs of scale insects (which include aphids). Certain ages of modern scale insect nymphs are called "coccoid crawlers". Crawlers of this type are common in Baltic amber. Grimaldi and Vea feel that the "chewing mouth parts" sketched by Gao et al. are actually the clypeus and crumena. The crumena is the coiled configuration of mouthparts of coccoids that are used to siphon fluids from plants.

If these amber-trapped insects are coccoids, they could not be ectoparasites, in the sense of feeding on feathers, since their mouthparts are useful only for sucking plant juices. The feather damage seen in the amber could be from a number of causes other than the presence of the nymphs. Since coccoids clamber over all sorts of surfaces, it would not be surprising if they coincidently were associated with a feather.

This leaves only the ticks in the first section as the only unambiguous Cretaceous ectoparasites.

Sources:

Gao, T.; Yin, X.; Shih, C.; Rasnitsyn, A.P.; Xu, X.; Chen, S.; Wang, C.; Ren, D.
"New insects feeding on dinosaur feathers in mid-Cretaceous amber.
Nature Commun. 2019, 10: 5424.

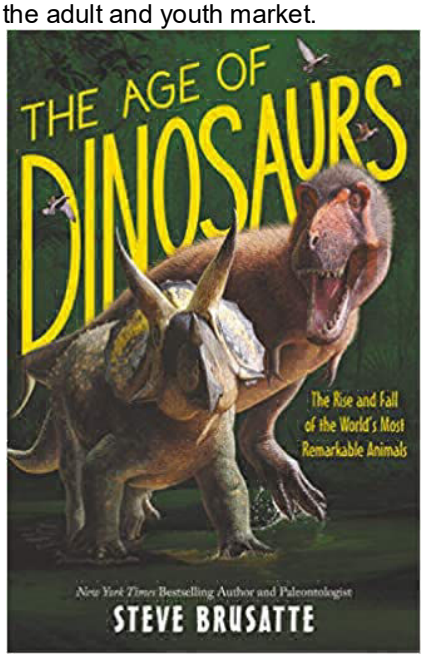
Grimaldi, D.A.; Vea, I.M.
"Insects with 100 million-year-old dinosaur feathers are not ectoparasites."
Nature Commun. 2021, 12: 1469.

Penalvar, E.; Arillo, A.; Delclos, X.; Peris, D.; Grimaldi, D.A.; Anderson, S.R.; Nascimbene, P.C.; Perez-de la Fuente, R.
"Parasitized feathered dinosaurs as revealed by Cretaceous amber assemblages."
Nature Comm. 2017, 8: 1924.

The Age of Dinosaurs--A Review

Bob Sheridan March 20, 2021

I try to keep up on the popular books on paleontological subjects. Today's review is for a very recent book "The Age of Dinosaurs" by Steve Brusatte. The author Steve Brusatte is a paleontologist at the University of Edinburgh. He has written many popular accounts of paleontology for the adult and youth market.



"The Age of Dinosaurs" is clearly a shortened and simplified "youth" version (the book jacket itself says "Age 8-12") of Brusatte's 2018 book "The Rise and Fall of the Dinosaurs". Some of the 14 chapter headings are very similar. Look up my review of TRAFOTD in the Paleontograph from that time, if you are interested. If you've already read TRAFOTD, you don't need to see "The Age of Dinosaurs," unless you are checking it out as a gift.

As with TRAFOTD, illustrations in this book are black and white photographs of specimens, of paleontologists, and of paleontologists next to specimens. Each chapter header has a very realistic drawing of a restored dinosaur, representative of the topic under discussion. The text is an easy-to-read combination of history, personal anecdotes, established facts, and some speculation. For most young audiences interested in science, this is a perfect combination. Also, you should be aware that this book, as with TRAFOTD, does not try to be a comprehensive treatise on dinosaurs, but concentrates on those topics the author has worked or has an interest.

Sources:

Brusatte, S.
"The Age of Dinosaurs. The Rise and Fall of the World's Most Remarkable Animals"
Quill Tree Books, NY 2021, 249 pages $18 (hardcover).

The History of Plants in Fifty Fossils--A Review

Bob Sheridan, March 12, 2021

Recently, there has been a rash of books with titles like: The History/Story of X in N Fossils/Discoveries. These tend to be "picture books" in that there is about of page of text and a color picture of a fossil opposite. I can across a new one recently: "The History of Plants in Fifty Fossils." This book seems to have been published first by the Natural History Museum in London, and now by Smithsonian Books. The author Paul Kenrick is a researcher at the Natural History Museum, London specializing in fossil plants. Most of us amateur paleontologists know something about the large glamorous vertebrate fossils or the common invertebrate fossils, but are not too conversant with plant fossils. Thus I wanted to check this book out.

The format of the book is pretty much as anticipated. Fifty sections of text, plus photograph, covering specific topics, varying in scope from the general (e.g. beginning of photosynthesis, fossil fruits, etc.) to specific species (e.g. *Montesechia vidalii*—the first flowering plant) in roughly chronological order. The scope of time is from 2.6 billion years ago to historical times.

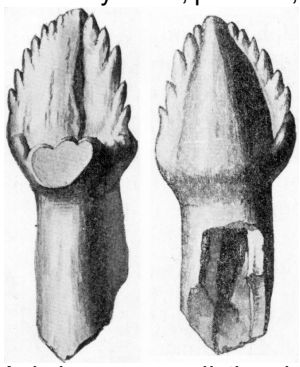
The text is informative and the fossils very beautiful. One complaint I have is that the photographs need more information; I cannot tell how big the fossil is, where it comes from, how old it is, etc. just by looking at the photograph. That type of information is at the back of the book. Since that information is just a dozen lines or so per photograph, it could have easily been put in the main text.
Sources:

Kenrick, P.
"A History of Plants in Fifty Fossils".
Smithsonian Books, Washington, DC, 2020 160 pages, $25 (hardcover)

Digging Ankylosaurs?

Bob Sheridan March 25, 2021

Nodosaurs and ankylosaurs, of which there are many known genera from the Late Cretaceous, are related “armored dinosaurs.” These are fairly large (~1 ton in weight), wide and low animals covered with rounded bony plates on the top and spike-like projections on the side. The plates on the head are almost always completely fused onto the skull. Both have very small, primitive, leaf-shaped teeth.



Ankylosaurs are distinguishable from nodosaurs in that they have bony clubs at the end of their tails. Usually nodosaurs have narrower muzzles; this is usually interpreted to mean nodosaurs were browsers while ankylosaurs were grazers. Ankylosaurs are also typically wider than they are high. There are other, less visible, differences. For example ankylosaurs have more complex nasal passages.

Most ankylosaur skeletons have been found in North America, but less complete specimens have been found in Asia. Park et al. (2021) describe a partial ankylosaurus specimen from Mongolia. This specimen (MPC-D 100/1359) was first discovered in the 1970’s but was abandoned when the original expedition ran out of funds. It was collected in 2008. The specimen consists of the trunk, arms, and parts of the legs, and scutes. The body lies in a “resting posture” with the limbs folded under the torso. The parts are mostly articulated. It is fairly unusual to find articulated ankylosaurs or nodosaurs, especially in regard to the bony plates and spines. These bits of armor are embedded in the skin and easily fall away from the skeleton, so their original placement is unclear. The nodosaur Borealopelta is the only previous specimen where the plates and spines have been found in place. This specimen has not yet been given a species name.

Borealopelta

Because this is the most complete postcranium of an Asian ankylosaur so, the authors make a comparison to the North American ankylosaurs. The following features are thought to be important:

1. The angle of the ileum. In some ankylosaurs they flair outward. In some they are parallel to the axis of the body.
2. The number of dorsal vertebrae contacting the sacrum. MPC-D 100/1359 has 9 while most ankylosaurs have 5 or less. The implication is that Asian ankylosaurs had more rigid trunks.
3. The shape of the osteoderms that extend outward from the flank.
4. How many phalanges there are in the middle three fingers. Some Asian ankylosaurs, including MPC-D 100/1359, have three instead of four. The toes of MPC-D 100/1359 seem especially short. This could be interpreted as the extra stiffness leading to a better weight-supporting hand, or it could be considered an adaptation for digging (see below).

Since most ankylosaurs are incomplete, these characters are not known for most, so any comparison has to be regarded as provisional at this point.

Most of the discussion in this paper is whether ankylosaurs could dig. It is often noted that the arms of ankylosaurs are especially strong. In the sense of an anteater or ground sloth digging to find food, this is plausible. On the other hand, they had no claws, so any digging would have to be in something soft like sand.

Cont’d.

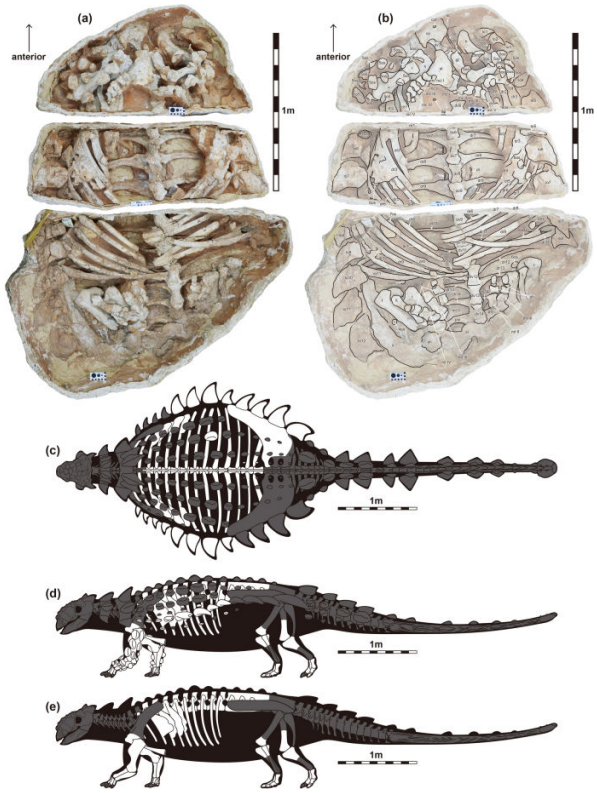


Figure from the Nature paper

Another sense of digging has to do with the animal partially burying itself. It is this aspect that has attracted most attention in the popular press, but the evidence is very weak. Many ankylosaurus specimens are found in a "resting position." This is usually interpreted as being the result of being buried by in dust storm, since they lived in an environment with sand dunes. It has also been noted that the resting position is a suitable way of an ankylosaur to protect its soft underside from predators. The idea under discussion here is whether ankylosaurs actually dug shallow pits to better cover up their underside. The analogy is with modern horned lizards, which live in sandy soil, and dig burrows to lay eggs or hide themselves completely under the sand. One has to admit horned lizards superficially resemble ankylosaurs quite a bit in their shape and spiny covering, but I think this analogy is misleading. The most important thing to realize is that the lizards are less than six inches long. It seems less plausible that an animal the size of a car could dig itself a shallow pit, even in sandy soil, in a time frame that would be useful. Also, it is not clear that being in a shallow pit would help protect an ankylosaur much more than its armor would.

Sources:

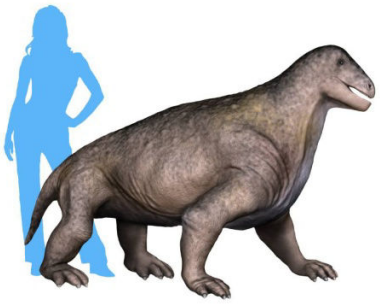
Park, J.-Y.; Lee, Y.-N.; Currie, P.J.; Ryan, M.J.; Bell, P.; Sissons, R.; Koppelhus, E.B.; Barsbold, R.; Lee, S.; Kim, S.-H.
"A new ankylosaurid skeleton from the Upper Cretaceous Baruungoyot Formation of Mongolia: its implications for ankylosauric postcranial evolution."
Scientific Reports 2021, 11: 4101.

The Inner Ears of Dinocephalians

Bob Sheridan March 27, 2021

Dinocephalians ("terrible heads") are large (cow-sized or larger, up to 2 tons) early synapsids that lived in the Middle Permian. These can be herbivores (with peg-shaped teeth) or carnivores (with enlarged canines). They are all quadrupeds and generally have a very robust build. Many have thickened skulls and may have knobs or projections on their heads.

CT-scanning is now routine for fossils and can nondestructively reveal very small structures. The details that are of most interest are the structure of the brain cavity and the inner ear. Today's story deals with the inner ear. 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 semicircular canals (three perpendicular loops) at the top. The semicircular canals detect rotation around three axes. One application to fossil animals comes from the expectation that the lateral semi-circular canal should be horizontal; given that expectation, one can guess the habitual orientation of the head of a fossil vertebrate. As will be discussed below, things may be more complicated than this.



Moschops

Dinocephalians Cont'd

Based on a CT-scan of Anteosaurus, Benoit et al. (2021) compare the semicircular canals of several dinocephalians: Anteosaurus (carnivore), Jonkeria (carnivore), Moschognathus (also known as "Moschops", herbivore), and Struthiocephalus (herbivore). They also note the depth of a lobe of the cerebellum called the floccular fossa. There are three observations of note:

1. The floccular fossa in Anteosaurus is deeper than in Moschognathus.
2. The semicircular canals in Anteosaurus are larger than in Moschognathus even though the skulls are about the same size.

3. The angle of the lateral semi-circular canal relative to the axis of the skull is smaller in the carnivores than in the herbivores (25 degrees vs. 65 degrees).

From 1and 2 the authors deduce that Anteosaurus was an "agile" predator. This is what seems to be most interesting to the popular press. The idea that a very chunky animal would be running after prey seems appealing. From 3 the authors deduce that the herbivores held their heads lower so they could more easily butt heads. This is consistent with the top of the skull being thicker.

There is reason to doubt some of these conclusions. The idea that a larger floccular fossa is correlated with greater agility is debunked by Ferreira-Cardosa et al. (2017) using data from extant animals. The correlation of larger semicircular canals with greater agility comes from Spoor et al. (2007), but that applies only to primates, and even then, the trends are not very strong. Remember also, that the argument that cetaceans (whales, dolphins, etc.) are more "agile" than land animals is used to explain why cetaceans have smaller semicircular canals—opposite of the argument here. Finally, the expectation that the lateral semicircular canals will indicate the "neutral position of the head" has been studied in living ungulate mammals by Benoit et al. (2020)—yes, the same first author as the Andeosaurus paper. Those authors find that:

1. On the average animals hold their head 30-40 degrees lower than indicated by the lateral semicircular canal, but there is a great variation among animals.
2. Grazers hold their heads lower than browsers, but only for some classes of ungulates.

3. Ungulates that butt heads have a greater angle between the axis of the skull and the lateral semicircular canal compared to ungulates that do not, but on the average those two types of animals hold their heads at a similar angle most of the time.

So the correlation of angle with head butting could be plausible for dinocephalians since it holds for a large group of mammals, but the conclusions about "agility" are dubious.

Sources:

Benoit, J.; Kruger, A.; Jirah, S.; Fernandez, V.; Rubidge, B.S.
"Palaeoneurology and palaeobiology of the dinocephalian therapsin Anteosaurus magnificus."
Acta Palaeontol. Pol. 2021, 66, 29-39.

Benoit, J.; Legendre, L.J.; Farke, A.A.; Neenan, J.M.; Mennecart, B.; Costeur, L.; Merigeaud, S.; Manger, P.R.
"A test of the lateral semicircular canal correlation to head posture, diet, and other biological traits in 'ungulate' mammals."
Scientific Reports 2020, 20:19602.

Ferreira-Cardosa, S.; Araujo, R.; Martins, N.E.; Martins, G.G.; Walsh, S.; Martins, R.M.S.; Kardjilov, N.; Manke, I.; Hilger, A.; Catanhinha, R.
"Floccular fossa size is not a reliable proxy of ecology and behaviour in vertebrates."
Scientific Reports 2017, 7: 2005

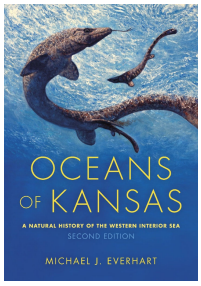
Spoor, F.; Garland, T.Jr.; Krovitz, G.; Ryan, T.M.; Silcox, M.T.; Walker, A.
"The primate semicircular canal system and locomotion."
Proc. Natl. Acad. Sci. 2007, 104, 10808-10812

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

---

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 .

Tom Caggiano personal recommendation.

White River Preparium

Fossil Preparation Lab

Fossil Preparation and Restoration Services.
Proudly serving the Paleontological Community since 1993
Owned and operated by Sandy & Ed Gerken,
P.O.B. 747, Hill City, SD 57745 (605)574-2051
Best way to order, send us an email
wriverprep@aol.com

Tom Caggiano personal recommendation.

https://www.paleoadventures.com/

PALEOADVENTURES

PaleoAdventures is an independent, commercial paleontology company dedicated to helping preserve the important vertebrate fossils (DINOSAURS, MARINE REPTILES, etc.) of the great American west! We are based out of the beautiful, northern Black Hills of South Dakota; a stone's throw away from some of the most important dinosaur dig sites in the world. We are located in the beautiful Black Hills of South Dakota near Devil's Tower, Mt. Rushmore and Deadwood.

Please call 605-210-1275 or email at stein151@comcast.net to schedule a dinosaur dig site tour, purchase a legally and ethically collected fossil specimen or to find out more about our many products and services.

Tom Caggiano personal recommendation.

https://www.fossilsafari.com/

FOSSIL SAFARI®

Warfield Fossils invites you to come on a Fossil Safari® where you can dig your own fossil fish in our private quarry. There are an abundance of fossil fish in the "Green River Formation." Most people find enough fish to satisfy their appetite in the first two hours.
The Fossil Safari is located in Kemmerer, Wyoming.

No Reservations are Needed! There is no need to call before you come, there are no phones at the quarry. There is always someone at the quarry during business hours. Just print a map, show up and we will give you the tools to dig. It's that easy. We will provide you with the proper tools and a basic guided lesson to ensure you a successful fossil hunt! **Kids and Pets are welcome as long as they are kept on a leash.**

Fossil Safari® Season and Hours
7 days a week, 8am to 4pm The Friday of Memorial Day Weekend through September 30th
We accommodate Individuals, Families, and Groups of ALL Sizes!

Tom Caggiano personal recommendation.

PALEO BOND

PaleoBOND offers only top-of-the-line structural adhesive and penetrant stabilizer for fossils, minerals, jewelry, aquariums and more. Meteorites, too!

1067 E. US Highway 24 #191
Woodland Park, CO 80863
651-227-7000
customer.service@paleobond.com

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

AAPS, Association of Applied Paleontological Sciences
96 East 700 South, Logan, UT 84321-5555,
Phone: 435-752-7145

AAPS, The Association of Applied Paleontological Sciences was organized in 1978 to create a professional association of commercial fossil dealers, collectors, enthusiasts, and academic paleontologists for the purpose of promoting ethical collecting practices and cooperative liaisons with researchers, instructors, curators and exhibit managers in the paleontological academic and museum community.

The Paleontograph back issues are archived on the Journal Page of the AAPS website.
https://www.aaps-journal.org/

LostWorldFossils.com

Tom Caggiano personal recommendation.

"The" place for Ammonites!!
Larson Paleontology – LPFossils
https://lpfossils.com/

Larson Paleontology Unlimited (LPFOSSILS). Neal and Luke Larson specialize in; invertebrate & dinosaur fossils, restoration & preparation, collection appraisal.

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

https://www.coliseumshow.com/

EXPO 2021 has been rescheduled to October 22-24, 2021 due to the ongoing pandemic. We are hoping that the arrival of the vaccines in mid 2021 will allow things to return to some sort of normal by the fall. The show will be moved to the Orr Building on the Illinois State Fairgrounds in Springfield, Illinois. This is a newer facility, with more square footage, restrooms, and easy access for the set up and tear down processes.

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