The Paleontograph

A newsletter for those interested in all aspects of Paleontology

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From Your Editor

So how many of you forgot about me and my newsletter? The last issue was February. I retired from my day job March 15th. I always felt I did not have enough time in my life to do all of the things I wanted to do. So I craved retirement for years thinking I would finally have enough time. Well I was wrong about that! It seems I have even less time now. I thought about outing out an issue many times but it always got pushed aside. Bob Sheridan, to his credit, just kept writing, so I have a nice little pile of articles built up. I also have some from a few others. I finally got around to transferring my files from my work computer to my home computer so I'm back. I am sorry for the long break and hope you enjoy the return of The Paleontograph.

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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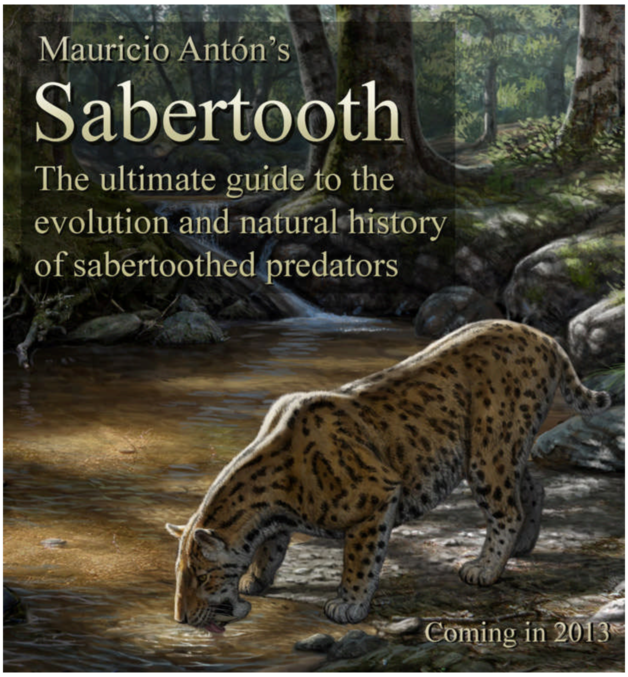
Sabertooth--A Review

Bob Sheridan, November 29, 2013

The "Life of the Past" series from Indiana University Press seldom disappoints. The latest is "Sabertooth" by Mauricio Anton. I have been a big fan of Anton's paleoart since I saw his illustrations in "The Big Cats and Their Fossil Relatives" from 1997. I really admire Anton's ability to illustrate extinct animals from bones, to musculature, to the fully restored creature. I especially enjoy the way he can illustration small distinctions between related species. Anton has illustrated many paleontology books written for a general audience, some of which I have reviewed for the Paleontograph, but is the first solo effort I have come across. As far I as can find out, Anton has no formal training in paleontology, but he seems to have a deep knowledge of the subject and can explain things very well. It is certainly precedented to have artists become famous non-credentialed paleontologists and write their own books. Stephen and Silvia Czerkas (sculptors rather than illustrators) filled that role circa 1990.



For knowledgeable amateurs such as myself (and presumably for long-time readers of the Paleontograph), there is a sweet spot in paleontological writing where there is enough technical detail that I am learning a lot of new things, but the author does not assume I already know obscure anatomical and taxonomical terms. "Sabertooth" hits the sweet spot. It covers a variety of topics: the diversity of sabertooths (with a discussion about each species), where sabertooth fossils are found, how sabertooths differ from their nearest non-saber relatives, how the living appearance of sabertooths is restored (Anton can be considered an expert on this), how sabertooths made a living, and how they went extinct.

When we hear "sabertooth" we usually think "cat". This is because Smilodon, which is known from thousands of specimens from the La Brea tarpits and thus is the most famous and complete sabertooth, is a member of Felidae. This is the family that includes all our modern cats, big and small. (The classical division of sabertooths into "dirk-tooth" and "scimitar-tooth" varieties was developed from the Felidae.) However, one of the most interesting things about saber-teeth is that they evolved independently many times in unrelated carnivores. There is a sister group to the Felidae called the Barbourofelidae, which includes the sabertooth Sansanosmilus. There is a sister group to the branch of Carnivora containing cats, hyenas, meerkats, etc. called the Nimravidae. Nimravids superficially resemble cats, but aren't. Dinictis is an example of a nimravid sabertooth. Creodonts are an extinct branch of mammals that included many carnivores, although they are not related to the modern order Carnivora. This included the small sabertooth Machaeroides. Thylacosmilus was a marsupial sabertooth, which is about as unrelated to the other sabertooths as one can get and still be a mammal. It is often compared to Smilodon as an extreme example of convergent evolution. Finally, a number of gorgonopsids, large mammal-like reptiles that lived in the Permian, had very enlarged saber-teeth.

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Saber teeth cont'd

The obvious difference between sabertooths and close non-saber relatives is that the upper canines are much longer and tend to be blade-like instead of conical. However, there are a lot of other more subtle differences that are seen again and again in unrelated animals. Here is a partial list (applying mostly to the mammals, but some are seen even in the gorgonopsids):

1. The lower canines are smaller than expected.
2. The front of the mandible develops a grooved flange to cover the inner side of the saber-tooth. (Interestingly, Smilodon has a very elongated saber, but has a very with the small flange in the mandible.)
3. The incisors get larger.
4. There are fewer cheek teeth. The meat-shearing carnassial teeth (where they are present, i.e. in Carnivora) get larger.
5. The cranium gets shallower from top to bottom.
6. The mastoid process gets larger. This anchors the muscle that pulls the head down.
7. The coronoid process on the mandible gets smaller. This is the attachment point of mandible to the temporalis jaw muscle. This is possibly an adaptation to allow a big gape.
8. The neck is longer, but the back shorter.
9. The front legs are more robust.
10. The hind feet are more nearly plantigrade (the foot angled more parallel to the ground), as opposed to digitigrade (walking only on the toes so that the foot is vertical).

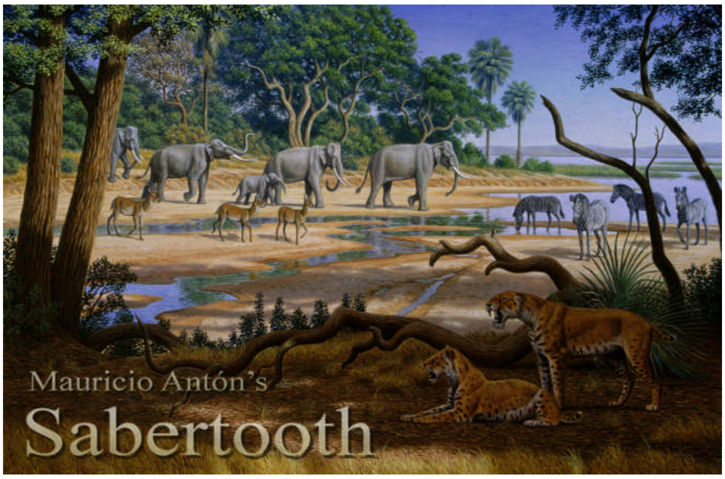
The presumption is that saber-teeth must have some useful function since they and a constellation of associated features evolved several times independently. However since no modern animal has them, we can only speculate how they were used. A lot of the speculation is based on the observations in the previous paragraph. The current best guess is that they were used to quickly kill very large prey by severing arteries in the neck, as opposed to the way modern big cats kill by crushing the windpipe. This required sabertooths to immobilize their prey using the front limbs before biting, and this in turn required a lot of power as opposed to speed. Most of the penetrating power behind the saber-teeth would have come from the neck instead of the jaw muscles.

So this is a very comprehensive treatment of the topic of sabertooths. As you might expect from Anton, the illustrations are plentiful, clear, meticulously accurate, and esthetically pleasing. The only possible thing I would wish for is more detailed information on the gorgonopsids, the only non-mammal sabertooths. However, the fact that they are mentioned at all is a big plus compared to most works on sabertooths.

The nominal price for this book seems high at $50, but I got it for $31 at Amazon. Well worth it.

Sources:

Anton, A.
"Sabertooth."
Indiana University Press, Indiana, 2013, 243 pages.
$50 (hardcover).



Suction-Feeding Ichthyosaurs Disputed

Bob Sheridan December 16, 2013

Two and a half years ago, I reported on an article by Sander et al. (2011) that described three specimens of a new species of Late Triassic Shastasaurus, *Shastasaurus liangae*. Shastasaurus is one of the largest ichthyosaurs, with a length >6 meters. Whereas most ichthyosaurs had long snouts filled with a large number of small pointed teeth, consistent with their roles as marine predators, the new Shastasaurus specimens had a short toothless snout. Whereas most ichthyosaurs have long front flippers, Shastasaurus seems to have short flippers. Whereas most ichthyosaurs have a body that is deep from top to bottom, Shastasaurus has a slender body. Sander et al. speculated that, since Shastasaurus resembles beaked whales in a number of characteristics (short toothless snout, small flippers), it might have also used suction feeding like beaked whales.


© N. Tamura, 2011

Here we will need two digressions. First, "suction feeding" vs. "ram feeding". In suction feeding, the predator draws back its tongue or otherwise rapidly increases the volume of its mouth cavity so that water rushes in, carrying along one or more prey items. This works only in water and at very close range, so generally the predator has to get close to its prey without the prey realizing it, or else the prey is very slow and cannot escape when it senses the predator approaching, or the prey occurs in dense groups. In ram feeding, the predator simply overtakes the prey such that the prey ends up in the predator's mouth. Both methods require the prey be small enough to be swallowed whole.

Second, the hyobranchial rod. This is a calcification, one on each side, of the connective tissue that supports the tongue and larynx in tetrapods. The human equivalent is the hyoid bone. Since suction feeders make very strong motions with their tongues, the hyobranchial rod is usually relatively thick.

Motani et al. (2013) attempt to determine whether Shastasaurus is likely to be a suction feeder by comparing the skull and hyobranchial anatomy of suction vs. ram feeding turtles, sharks, and cetaceans. They also include 18 ichthyosaur specimens where hyobranchial rod is present. Characteristics measured for these are: mandibular length (MW), mandibular width (MW), width of the mandible at the end of the tooth row (TW), hyobranchial width (HW), hyobranchial length (HL), and mandibular bluntness (MW/ML).

In one graph the authors plot log(TW) vs. log(MW). This is an indirect measure of the suction that could be produced by the mouth. Suction feeders and ram feeders fall on two separate lines, with suction feeders having a smaller TW per MW. The ichthyosaurs, with the exception of Eurhinosaurus, fall more toward the ram feeder line. Eurhinosaurus is an exception, not because it is a likely suction feeder, but because it has an unusual "overbite": the upper snout is very long and the mandible is dwarfed. In another graph the authors plot log(HW) vs. log(HL). Again suction feeders and ram feeders fall on two separate lines. As expected, suction feeders have a larger HW for a given HL, i.e. the hyobranchial rod is thicker per length. All the ichthyosaurs including Shastasaurus fall on the ram feeder line. Mandibular bluntness (i.e. whether the animal has a short or long snout) is more complicated. Within sharks and cetaceans, the suction feeders have a shorter snout than the ram feeders. However, the absolute bluntness varies between those classes of animals. Ichthyosaurs generally have extremely long snouts compared to other animals; even the shortest-snouted ichthyosaur has a long snout compared to the beaked whales, for instance.

The authors conclude that ichthyosaurs, including Shastasaurus were ram feeders. The lack of teeth of Shastasaurus is not necessarily an indication of suction feeding, and it might be a consequence of having a shorter than usual jaw for an ichthyosaur.

Cont’d

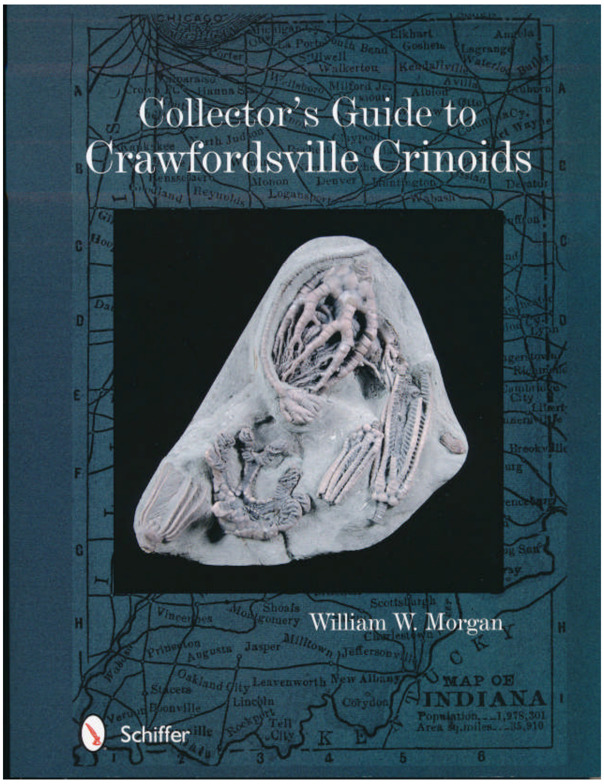
Suction Feeding Cont'd

Sources:

Motani; R.; Ji, C.; Tomita, T.; Kelley, N.; Maxwell, E.; Jiang, D.-Y. Paul Sander, P.M.
"Absence of suction feeding ichthyosaurs and its implications for Triassic mesopelagic paleoecology."
PLoS ONE 2013, 8, e66075

Sander, P.M.; Chen, X.; Cheng, L.; Wang, X.
"Short-snouted toothless ichthyosaur from China suggests Late Triassic diversification of suction feeding ichthyosaurs."
PLoS ONE 2011, 6, e19480

Ed. Note:
One of our readers, Bill Morgan, recently published a book that I am sure many of you will be interested in. I know, I will be ordering a copy.



A new book "Collector's Guide to Crawfordsville Crinoids", written by William W. Morgan, and published by Schiffer Publishing, Ltd., provides an up to date description of Mississippian Age crinoids from localities near Crawfordsville, Indiana. The book is available from several on line book sellers, including Amazon, or from the publisher. The completeness, abundance, and especially the exceptional aesthetic appeal of these fossils make them widely sought after by both professional and amateur paleontologists from all over the world. The quality is such that it is generally believed that this is the only location in North America at which invertebrate fossils have been extensively quarried commercially for several periods during the past 150 years. The initial section of the book describes the geology of the region and discusses the factors most likely responsible for the extraordinary preservation. Emphasis is placed on the exceptional value of the site from both a scientific and a lay perspective. The book next surveys the recent literature to offer a detailed description of the morphology, geologic history and classification of Paleozoic crinoids. New terms are bolded and defined when they first appear in the text and in a separate glossary. Relatively simple diagrams and photographs are used to facilitate understanding. The last and most extensive part of the book uses descriptive text in combination with high quality photographs of actual specimens to enable the reader to differentiate and identify the common as well as many of the more rare species of crinoids found at the Crawfordsville localities.

The Correlation Between Melanosome Size and Pigment Color with Phylogeny

Bob Sheridan March 15, 2014

The past few years have seen many papers that estimate the feather color of extinct birds and dinosaurs by examining the shapes and sizes of melanosomes in the preserved feathers. Melanosomes are ovoid bodies, less than a few micrometers long (smaller than a red blood cell), that contain the pigment melanin, which comes in several types. In modern birds, the shape of melanosomes is correlated with the color of the pigment (black and brown with sausage shapes, and red with more spherical shapes), and workers have assumed that the same correlation holds for extinct birds, feathered dinosaurs, etc..

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Melanosomes Cont'd

This assumption probably needs to be examined. Also, we have a very limited idea about the correlation of melanosome color and shape in animals other than birds.

A paper by Li et al. (2014) examines melanosomes by scanning electron microscopy in a variety of living animals: 44 species of mammals, 36 species of lizard, turtle, and crocodile. The authors also examine 13 fossil species of birds, feathered dinosaurs, and pterosaurs. Since the width of melanosomes does not vary much, the authors monitor "shape" by measuring the length. In the animals studied melanosomes can be anywhere from 0.1 micrometers to a little over 2 micrometers. In all cases the melanosomes examined are from feathers, scales, or hair, but not skin.

In the living animals we know what the color of the hair/feather/scale really is and can make a correlation with melanosome length. The colors studied here are black, brown, and grey. Additional colors allowed for feathers are "iridescent" (colors due to the diffraction of light in the feather rather than by pigment) and "Penguin-like".

In the scales of living lizards, turtles, and crocodiles, all melanosomes are small (on the average ~0.5 micrometers) regardless of the color of the pigment, so there is no way to distinguish color by melanosome shape. In mammalian hair, black-containing melanosomes are long (averaging ~1.0 micrometer), but brown and grey melanosomes are shorter (averaging ~0.75 micrometers). Thus the colors are distinguished by shape. The authors note that grey hairs in mammals may not be due to specific pigments. In feathers of extant birds, the range of melanosome is is large. Brown melanosomes are the shortest (~0.4 micrometers), grey melanosomes are the longest (~1.2 micrometers) and have the most variation in length. Black, iridescent, and penguin-like are intermediate in length. Again, the colors are distinguished by shape.

In the extinct animals, we can monitor only the variation in shape of the melanosomes. Not surprisingly, this depends on the group being studied. In the pterosaur and earlier dinosaurs, melanosomes tend to be short and do not vary much in length, much as in the modern lizards, turtles, and crocodiles. It is not until maniraptor theropod dinosaurs (the branch from which birds ultimately arose) that we see variation in length among melanosomes. And, of course, birds retain the great variation of melanosome length that we see in maniraptorans. Mammals also have a large variation in melanosome length, but they probably gained it independently.

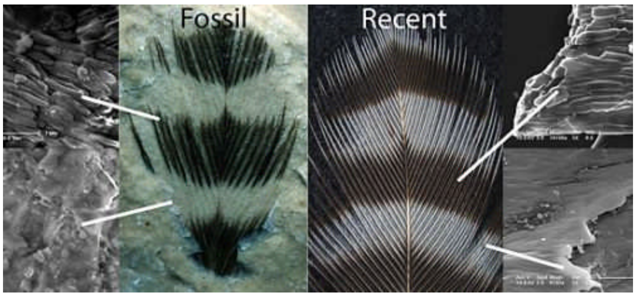
So the use of melanosomes to estimate the colors of extinct animals can be justified, but only for feathered dinosaurs and birds, as has been done. The same may be possible for mammals, although I am not aware of any publication on that topic.

Note that the authors base their colors on the visible appearance of feathers, hair, etc.. There are some confounding effects there because visible colors can be produced by the physical structure of the integument and not just the pigment in the melanosomes. It would be interesting to repeat this exercise for living animals by monitoring the chemistry of the pigment. Also, the color choices are different from previous efforts where melanosomes were divided into black/brown vs. red.

Sources:

Li, Q.; Clarke, J.A.; Gao, K.-Q.; Zhou, C.-F.; Meng, Q.; Li, D.; Alba, L.D.; Shawkey, M.D.
"Melanosome evolution indicates a key physiological shift with feathered dinosaurs."
Nature 2014, 507, 350-353.

Melanosomes in fossil and recent feathers



Filter-feeding Anomalocarid

Bob Sheridan, March 27, 2014

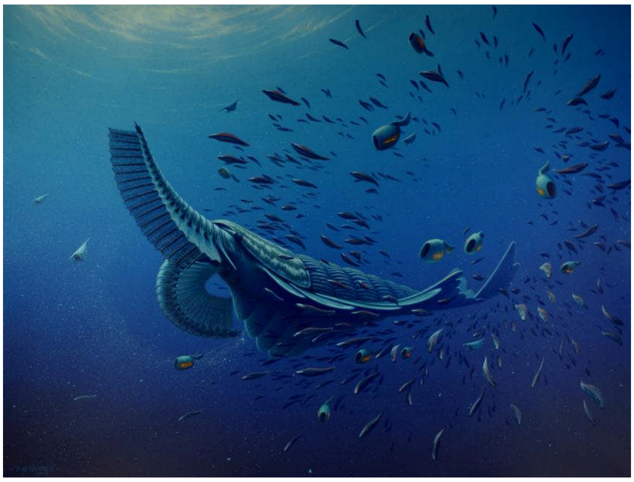
Anomalocarids are unusually large (up to 2 meters long) arthropods from Early Cambrian seas. They had elongated bodies with a large head and a tail fan. To each side they project long lobes that interlock to produce an undulating swimming surface. Large compound eyes projected on stalks from the sides of their head. Underneath their heads, on either side and in front of the circular mouth, were two curved “great appendages,” which superficially resemble shrimp tails. This will be important later: On each segment of the appendage is a spine; the length of the spine relative to the thickness of the appendage varies between species. These appendages were presumably very flexible and could be extended straight or curled tightly, making them something like a grasping arm.

One interesting story about the anomalocarids is that the appendages and mouth parts were discovered separately and given separate names. They were assigned as part of a crustacean and a jellyfish, respectively. It was only later that the two were discovered to be parts of a larger animal. In retrospect, this is not surprising since the appendages and the mouth are the parts that are most often preserved.

It is generally thought that anomalocarids were predators which grabbed prey with their appendages and brought them close to the mouth to be chewed up. In restorations of anomalocarids, the prey item is usually a trilobite. There is some suggestive evidence for trilobites being the main prey, but nothing indisputable. For example, some have linked the shapes of breaks in trilobite carapaces with the shape of the anomalocarid mouth. Some large coprolites have been found with bits of trilobite shells, and it is assumed that at the time only anomalocarids were large enough to produce the coprolite.

Here is the main part of today's story:
One particular anomalocarid, *Tamisiocaris boreali,* was previously known from the Sirius Passet Fauna of Greenland. It is known from disarticulated appendages, or the appendages with part of the head shield. A new paper (Vinther et al., 2014) describes especially well-preserved specimens of the Tamisiocaris appendages. These are about 120 millimeters long and are divided into 18 segments. Each segment bears a pair of very long spines. One can build a phylogeny based only on the characteristics of the appendages. When this is done, Tamisocaris comes out most closely related to *Anomalocaris biggsi*, which also has long spines. The unique aspect about the spines of Tamisiocaris, however, is that these spines bear long, fine bristles. The authors feel the function of these appendages is for filter-feeding.

A number of modern animals specialize in filter feeding plankton, either marine or fresh water. The largest are baleen whales and whale sharks. In the middle we have the flamingo. The smallest filter-feeders are crustaceans. One can predict the size of the organisms that are meant to be scooped up based on the “mesh size” of the apparatus doing the filtering. In the case of Tamisiocaris, the mesh size is about 5 millimeters, so they would expect to filter organisms a little over 1 millimeter long, about the size of organisms eaten by the modern flamingo.



There are a number of inferences we can make. One is that there must have been good population of suspended organisms, i.e. plankton, in pelagic food webs (i.e. near the surface and far from the shore) during the Early Cambrian. Another is that convergence in lifestyle is a common occurrence, given that mammals, sharks, birds, tiny arthropods, all converged on filter-feeding plankton using a net-like apparatus. Also we see another example where one branch of a family can take up filter-feeding, where the rest prey on large animals.

Sources:

Vinther, J.; Stein, M.; Longrich, N.R.; Harper, D.A.T. “A suspension-feeding anamalocarid from the Early Cambrian.”
Nature 2014, 507, 496-500.