The Paleontograph

A newsletter for those interested in all aspects of Paleontology
Volume 2 Issue 4 May, 2013

From Your Editor

Welcome to our latest issue. I continue to be very busy but it is not all work. I just became a grandfather and I'm heading out to see her. With some luck, I'll squeeze in a day of collecting in New Mexico. I have several other trips planned and I'll be happy to get into the field.

The New Jersey show turned out very well. There was a lot to see and large crowds. I enjoy going to shows. You don't have to buy anything and there is usually something interesting to see. There were also many nice displays so it was not all commercial. A couple of you stopped by and that was nice.

I have not much come in from anyone other than Bob although I do have another article from Alan. I think some of you should write us an article or even send a couple of pictures.
PS: I've been so busy that this issue was delayed several weeks. Hope you did not forget me.

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

Holes in Gastropod Shells: Predation or Abrasion?

Bob Sheridan March 16, 2013

Small round holes in the fossil shells of bivalves, brachiopods, and gastropods are usually assumed to be the product of predation. The predator is presumed to be some kind of mollusk with a rasping tongue called a radula that can bore through thick shell. This perfectly reasonable; there are many examples of such predation among living mollusks. The frequency of holes in a fossil marine fauna is sometimes taken as a metric for predator-prey relationships.

However, is the assumption true? If there were other ways to create small round holes in shells, most of "predator-prey" work done with this type of trace fossil would be in doubt. There are some published criteria to distinguish predator drill holes from other types of holes, but it is not really known whether these are adequate.

Gorzelak (2013) examine the types of holes produced in modern shells by a completely abiotic source, abrasion. The experiment is simple. Take isolated shells from modern bivalves, gastropods, and brachiopods, and tumble them for a few hours with gravel and salt water. Presumably this would be equivalent to the shells being moved by surf. One would intuitively expect that the tumbled shells would be damaged and, if they did show holes, these would be large, irregular, and at random locations. However, this is not what happens. Generally there is little obvious damage, but sometimes there appears a single round or oval hole penetrating the shell. The majority of such holes have smooth margins. For gastropods, there is a correlation between the size of the shell and the size of the hole (roughly 10 to 1). There is also a correlation between the inner and outer diameters of the hole (roughly 3 to 4). Also, for gastropods the holes almost always appear near the aperture.

Gorzelak note that their abrasion holes resemble holes in fossil shells in almost every aspect, including the correlation between inner and outer diameter. This does not mean every hole in a fossil shell is a taphonomic artifact, but it does mean it might be hard to tell abrasion holes from predation holes, and some new way must be found to distinguish them.

Sources:

Gorzelak, P.; Salamon, M.A.; Trzesiok, D.; Niedzwiedzki, R.
"Drill holes and predation traces versus abrasion-induced artifacts revealed by tumbling experiments." PLoS ONE 2013, 8, 358528.

Hind Wings in Basal Birds

Bob Sheridan March 16, 2013

In 2002 the first description of Microraptor was published. This is a crow-sized dromaeosaur with flight feathers (i.e. with asymmetrical vanes) on both its arms and legs. Supposedly this represents a "four-wing" stage in the development of birds. Microraptor allowed the "trees down" hypothesis for flight to be linked with the dinosaurian origin of birds, because clearly microraptor had to be a tree-dwelling gliding animal. (It was certainly not running and dragging its leg feathers on the ground!) How exactly Microraptor positioned the leg feathers during flight was a big topic circa 2005, and it is not really settled now, but one idea is that microraptor mimicked a biplane with both arm and leg feathers sticking out to the side, legs feathers below the arm feathers.

If Microraptor represented a four-wing stage in the evolution of birds, then early true birds should retain some evidence of flight feathers on their legs. Zheng et al. (2013) examine this by looking at 11 specimens of basal birds from the Early Cretaceous of China: Sapeornis, birds similar to Confusciusornis, Cathayornis, and Yanornis.

Before we continue, I should point out that birds, like most mammals but unlike humans, walk on their toes, so the foot includes not only the part that touches the ground, but the metarsals (equivalent to the sole of the foot in humans), which are held off the ground. A bird's ankle joint appears to be a backward knee. In birds, the tibia (shin) and tarsals (ankle) are fused as a single bone called the tibiatarsus.

Cont'd

Wings Cont'd

Sapeornis has long pennaceous feathers on its tibiatarsus and metatarsals. The confusciusornids have long feathers on the tibiatarsus and the proximal part of the metatarsals. Cathayornis (an enantiornithine) has large feathers on the tibiatarsus, but not on the metatarsal. Yanornis has short feathers on the tibiatarsus. A number of dinosaurs like Sinornithosaurus have short filamentous feathers on the tibia. Modern birds have only short soft feathers on their legs. The authors feel that these long feathers on the legs of basal birds must affect the aerodynamic properties of the legs; however exactly what they would be used for (lift, drag, steering, etc.) cannot be specified.

One of the reconstructions of Microraptor

The authors have an evolutionary model of feathers developing in the history of dinobirds and the development reversing in later birds: Basal coelurosaurs have filamentous feathers, some dromaeosaurs have long feathers extending all the way down the shin and foot. Later birds have shorter pennaceous on the legs, and even later birds have pennaceous feathers only on the shin. Modern birds have no pennaceous feathers on the legs.

Sources:

Balter, M.
"Dramatic fossils suggest early birds were biplanes."
Science 2013, 339, pg. 1261.

Zheng, X.; Zhou, Z.; Wang, X.; Zhang, F.; Zhang, X.; Wang, Y.; Wei, G.; Wang, S.; Xu, X.
"Hind wings in basal birds and the evolution of leg feathers."
Science 2013, 339, 1309-1312.

Late Cretaceous Bird Nesting Site

Bob Sheridan April 26, 2013

Dinosaur nesting sites are now quite common. Bird nests from the Mesozoic, on the other hand, are quite rare. Fernández et al. (2013) describe a fossil nesting site in the Bajo de la Carpa Formation of Argentina. Interesting, the site is on the campus of the National University of Comahue, near Neuquen City. (However, none of the authors is from this university.) The stratum in question is Late Cretaceous in age and contains the skeletal remains of a number of crocodilians (suggesting a river environment), plus a few birds and dinosaurs. The egg site is 55 square meters in area and contains 65 eggs. Overall the eggs form a long band pointing north/south, consistent with having been laid along a shoreline. The matrix holding the eggs appears to be the remains of river-deposited sand dunes. There is no sign of nesting materials.

The eggs themselves are about 4 centimeters in length and 3 centimeters in diameter and have a classic egg shape with a big and little end, as is characteristic of birds. The shell thickness averages about 180 micrometers. Inside some of these eggs are tiny strut-like coracoids bones, which confirms the embryos as true birds. Assignment to a specific bird is difficult, but the authors suggest Neuqueornis, an enantiornithine found in the same formation, as a likely candidate.

Cont'd

Nests Cont'd

Most of the eggs are oriented vertically, and partly buried with the small end down. A few eggs have fallen on their sides. The eggs almost always occur singly and are equally spaced only a few lengths apart. There is one case of a pair of eggs together and one case of three together. The spacing is typical for dense colonies of birds nesting at the same time. However, laying single eggs and propping them vertically in sand is not known among modern birds. The closest analogs are modern birds that prop their eggs vertically, but bury them in vegetation, and birds that lay their eggs in shallow unlined depressions in the ground called scrapes. Some troodont dinosaurs are known to orient their eggs vertically.

The authors make much of the low permeability of the eggs to gas and water compared to most modern bird eggs. The permeability is estimated from the size and density of pores in the shell and the area of the egg. Low permeability suggests an arid environment.

Sources:

Fernández, M.S.; Garc¹a, R.A.;Fiorelli, L.; Scolaro, A.; Salvador, R.B.; Cotaro, C.N.; Kaiser, G.W.; Dyke, G.J. "A Large Accumulation of Avian Eggs from the Late Cretaceous of Patagonia (Argentina) Reveals a Novel Nesting Strategy in Mesozoic Birds" PLoS ONE 2013, e61030

Cooking Melanosomes

Bob Sheridan April 7, 2012

Melanosomes are micrometer-size, ovoid-shaped bodies in feathers that carry pigment. In modern birds, the shape and the size of the melanosomes are correlated with pigments of certain colors. Remarkably, melanosomes in some fossil feathers, or at least the cavities that used to enclose them, are visible by scanning electron microscopy. For the past few years there has been a growing body of literature where one tries to guess the color of the pigments in feathered dinosaurs and early birds from the shape and size of fossil melanosomes.

The assumption of such studies is that the fossil melanosomes are the same size and shape they would be in the living animal. A paper by McNamara et al. (2013) seeks to test that by treating modern feathers with heat and pressure. The feathers in question, from different types of birds, different parts of the body, and different colors, are from dried bird specimens at the Peabody Museum at Yale. Some feathers were left untreated, while some were wrapped in aluminum foil and autoclaved at 200 Celsius or 250 Celsius and ~250 atmospheres pressure for 24 hours. Both treated and untreated feathers were examined by electron scanning microscopy.

All the treated feathers lost their original color, and the feathers shrank by a significant degree, but this depended on temperature. At 200 Celsius, some color was retained and the individual melanosomes shrank by ~8% and ~13% along their long and short axis. At 250 Celsius all feathers turned black and the melanosomes shrank by 19% and 20%. The matrix surrounding the melanosomes may shrink more or less than the individual melanosomes. In some cases the shrinking matrix at the surface of a feather my obscure the presence of melanosomes. Different parts of a monochromatic feather may look different after treatment.

Certainly the fossil feathers were compressed by great pressure over millions of years, but it is not clear what temperatures they are exposed to, and fossils from some locations would be more distorted than others. The authors suggest, for instance, that the Jehol Formation was exposed to more heat than other feather-bearing formations. At the moment it is not possible to estimate how much melanosomes may have shrunk in any given fossil.

So in a general way, this paper suggests one must be very cautious about interpreting fossil melanosomes. However, some other scientists feel that this paper is not very much of a threat, with some saying that they already took shrinkage into account, others saying that the degree of shrinkage would not change their conclusions.

Sources:

McNamara, M.E.; Briggs, D.E.G.; Orr, P.J.; Field, D.J.; Wang, Z.
"Experimental maturation of feathers: implications for reconstructions of fossil feather colour." Biology Letters 2013, 9, 20130184.

Some Thoughts on Fossil Collecting

Alan Russo

There are many “styles” of fossil collecting. Another way to put it is there are many ways and reasons that people collect Fossils. Some collect for the Science, the amateur paleontologist if you will. Some collect to decorate their living rooms. Some have never stepped one foot out in the field, but have incredible collections of bought fossils. Some do it as a business to make money, and some, just for the excitement of the “Hunt”.

Personally I consider myself an experiential Fossil collector. What I mean is, I love the whole experience of the act of collecting. For me, the experience is such an important part of collecting that I don’t buy, trade, or acquire Fossils in any other way other than collecting them myself. I have a story and an experience that goes along with each fossil in my collection. Don’t get me wrong, I love the science of it, there are many times I find myself interested in the name etc. of the Fossils I find, and I am certainly am not putting down others for the way they collect, but it is not a nearly as important to me as the experience of it all.

For me the experience is a multi-leveled affair. First there is the collecting trip itself and all the levels of excitement and experience it brings. There is the anticipation of visiting a new part of the country, and visiting new ecosystems. Then there is the camaraderie of spending time with likeminded friends that perhaps you haven’t seen since the last major expedition you had partaken. Then of course there is the anticipation of what new and incredible Fossils you might find. I sometimes feel like an explorer setting off for new lands and sometimes I fell like Indiana Jones on the adventure of a lifetime.

Next, there is the getting down and dirty part of it. It is just so cool, that after spending the whole rest of your life fitting in to the norms of society, you don’t have to worry about rolling around in the dirt as an adult and being ostracized for it. Dirty, muddy ,wet, boots and pants full of dirt and rock dust and loving it, now that’s living!

My imagination and wonderment are also an important part of the experience. Almost every time I discover a new find, at some point in time while holding that Fossil, I wonder what the Earth was like at the time and the circumstances of the life and death of the animal or plant I have found. When I taught Earth Science programs I did a program on Plate Tectonics, and part of that program was showing the students maps of the Earth at different intervals of the geologic timeline. I try to envision what the earth looked like when that particular Animal or Plant (fossil) was alive and try to imagine what the place that I found the Fossil looked like at the time it was alive. This is all sheer speculation of course, but in my head, a fun thing to do none the less.

Let me give you an example if I may. On a trip to Texas, part of a long journey of discovery I was on at the time, I decided to go to Guadalupe Mountains National Park after seeing it on a map. Fossils were not really on my mind, though I am always on the lookout for fossil bearing rock, I just wanted to discover a new place I had never been before. It was early afternoon when I got to the park and decided to go for a hike after setting up camp. The route I had chosen was a hike to the top of Guadalupe Mountain. It was a beautiful but somewhat strenuous climb with an altitude gain of 3000 feet. When I got to the top I came around a bend in the trail and to my surprise and utter amazement, standing in front of me was a fossilized Coral Reef! Needless to say I was blown away. Of course, I have since learned that those mountains are world famous for having the best preserved Fossil Coral Reefs in the world.

When you are hiking you have a lot of time to think and on my trip down from the mountain the Coral Reef I had just “discovered” was in the forefront of my thoughts. I began to think about what I had just seen; A CORAL REEF, AT THE TOP OF THE HIGHEST MOUNTAIN IN TEXAS, IN THE MIDDLE OF A DESERT!

The Semicircular Canals of Dinosaurs

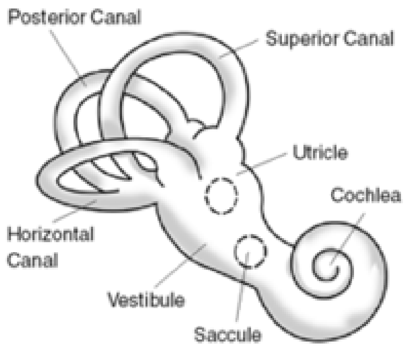
Bob Sheridan April 14, 2013

All vertebrates have three loop-like semicircular canals as part of their inner ear. The canals contain fluid, which by inertia tends to stay in place as the animal turns, and the motion of the fluid relative to the canals bends hair-like extensions of nerve cells. In this way the canals monitor rotational acceleration. The canals are more or less right angles to each other. The "lateral" or "horizontal" canal (LSC) is more or less parallel to the ground and monitors left and right turns, i.e. "yaw". The "superior" or "anterior" canal (ASC) monitors "roll". The "posterior" canal (PSC) monitors "pitch."

Among mammals there is a general rule that animals that undertake agile/violent motions have larger semicircular canals than expected for their size. For mammals, the "expected" size is usually based on the cube-root mass of the animal, which is generally proportional to the length of the animal, which is also proportional to the size of its head. The idea of agility being interpreted from the size of the semicircular canals is often applied to classes of extinct animals such as dinosaurs. However, since we do not know how to calculate the "expected" size of the semicircular canals in dinosaurs, this can be problematical. A particular issue is that in dinosaurs the size of the head relative to the body can vary a lot; imagine the large head of a ceratopsian and the tiny head of a sauropod.

Georgi et al. (2013) analyze the size of semicircular canals in 27 specimens of diverse dinosaurs. A CT scan is made of the dinosaur's skull, and the semicircular canals are located. A computer program automatically identifies the plane of the canal. Not all canals could be measured for all dinosaurs, which is a shame since Triceratops has the largest head of all the dinosaurs studied.

One metric for size is the cross-sectional area of the interior of the canal, assuming it were a full circle. This should be more or less proportional to the volume of fluid that would move. The radius of the canal would be proportional to the square-root of this area. The authors examine three metrics for the size of the animal: the cube-root of its mass, the cube-root of the mass of the head, and the length of the skull. Obviously, the last is easy to measure, but estimating the mass of extinct animals involves a lot of uncertainty, and estimating the mass of the head is even worse. One should be able to plot the radius of the canal vs. these three metrics and get more or less a straight line. The metric with the highest correlation with the radius is presumably the most appropriate.



Your classic Semi Circular Canal

Interestingly, which measure is best depends on which semicircular canal one looks at and whether the dinosaur is a biped or quadruped. Bipedal dinosaurs have a larger ACS than that of quadrupedal dinosaurs of the same size. In quadrupedal dinosaurs, the radius of the PSC and LSC correlates better with skull length than the other two measures. For the ASC, the cube-root of the head mass seems better correlated. There is practically no correlation of the PSC and LSC with the cube-root of the body mass. For the bipedal dinosaurs, all measures correlate about equally and fairly well for all semicircular canals. The difference between quadrupedal and bipedal dinosaurs is easily explained: in the bipeds the relative size of the head vs. the body is fairly constant. In contrast, in the quadrupeds there is a big range: sauropods have relatively tiny heads, but ceratopsians have large heads. Any differences between semicircular canals is explainable by different functions. For example, the LSC is concerned mostly with locomotion while the other two have more relationship with balance.

The authors also note that some unresolved issues with the correlations of canal radius and head size may be explained by considering how stiff the neck of the dinosaur is. If the neck is flexible, only the head constitutes the "moving unit." In contrast, if the neck is stiff, the effective unit size is larger than the head, and might require larger semicircular canals.

Cont'd

Canals Cont'd

Giraffatitan is cited as an example of a dinosaur with an especially stiff neck and larger than expected semicircular canals.

This study demonstrates that body mass is not a good predictor of "expected" semicircular canal size in dinosaurs, and that head size is an empirically better predictor. It makes more physical sense as well: no animal turns their entire body as a rigid unit.
Sources:

Georgi, J.S.; Sipla, J.S.; Forster, C.A.
"Turning Semicircular Canal Function on Its Head: Dinosaurs and a Novel Vestibular Analysis."
PLoS One, 2013, 8, e58517

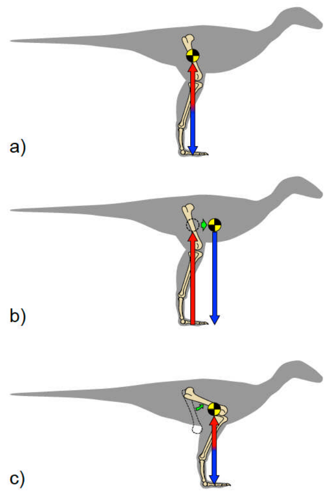
The Center of Gravity of Dinosaurs and Birds

Bob Sheridan April 25, 2013

For a bipedal animal to stand up, the center of gravity, also known as the center of mass (COM), must be directly above its feet. In theropod dinosaurs, the COM is very close to the hip, and thus the legs extend from the hip straight to the ground. Walking is done mostly by moving the femur back and forth, powered by the caudofemoralis (CFL) muscle, which connects the femur to the tail. In modern birds the situation is quite different. The COM is very close to the middle of the chest, and very far forward of the hips. (Presumably so the wings can lift the bird during flight.) The femurs of birds are held in a horizon position pointing forward, such that the feet are brought under the COM. Walking is done by moving the tibia back and forth. It is not clear where along the evolutionary path, from theropod to bird, the COM changed position. Also, although the loss of a tail in birds is the accepted explanation, we do not know the physical cause of the change in the COM.

Allen et al. (2013) examined the expected position of the COM relative to the hip (normalized by the cube-root of the body mass, i.e. the effective length of the animal) for a series of 16 archosaurs along the evolutionary history from crocs to modern birds. Thus includes primitive archosaurs (crocodiles), early saurischian dinosaurs (Plateosaurus), early theropods (Dilophosaurus), advanced theropods (Allosaurus), bird-like dinosaurs (Velociraptor), early birds (Pengonis), and modern birds (Gallus). The studies are done on virtual models of the animals standing in a standard position, with their legs straight down, the spine horizontal, and the arms out to the side. (A real animal might topple over in this position.) The virtual animals include the bones, plus a reasonable amount of flesh covering the bones. The COM is calculated by computer, specifically one monitors how far the COM is in front of the hips. One can also monitor the mass of specific parts such as the tail, head, and arms and see whether the mass of these parts are correlated with the motion of the COM.

Interestingly, while the relative mass of the tail starts falling from early theropods onward (e.g. after Dilophosurus, animal 7), the change in the COM position does not start until maniraptors (Caenagnathus, animal 11). It appears that the transition of COM toward the head has more to do with the increased mass of the head and arms than the decreased mass of the tail.



Ed.Note: this diagram is not from this article, but was as close as I could come to showing center of gravity.

The authors do not say in this paper how they estimated the mass of the CFL. However, the trend in the CFL is to increase in mass until animal 6 and fall thereafter. The fall in CFL mass corresponds to the fall in tail mass. This might imply that the use of the CFL for walking decreased after animal 7, and therefore one can imagine theropods using other muscles to walk, gradually taking on a more "crouched" position of the femur as seen in modern birds..

Sources:

Allen, V.; Bates, K.T.; Zhiheng, L.; Huchinson, J.R.
"Linking the evolution of body shape and locomotor biomechanics in bird-line archosaurs."
Nature 2013, 497, 104-107.