

The Paleontograph

**A newsletter for those interested in all aspects of Paleontology
Volume 3 Issue 3 August, 2014**

From Your Editor

Hello All, I hope you've enjoyed your summer. It has been humid but not too warm here in the Northeast.

I've just returned from Morocco, where it was very warm. My wife and I spent about a week touring the country and some of its fossil sites. This was a trip I've been dreaming about for years and I am very glad I made it. We did not make it to the Trilobite areas but we saw the Phosphate and Orthoceras areas. We met with diggers at their homes and toured factories where the black Orthoceras plates and other items are produced. We also visited some of the normal tourist areas including Marrakech and Casablanca.

I'm about to head out to the Denver Show. I will be set up in the Coliseum so if any of you are at the show, please stop by my Lost World Fossils booth on the main floor and say hello.



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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Tyrannosaurine from Alaska's North Slope

Bob Sheridan, March 30, 2014

Tyrannosaurus is probably the most beloved of the classic dinosaurs: A giant theropod (~40ft long) from the last part of the Cretaceous, with spike-like teeth, a very robust jaw and tiny arms with two-fingered hands. About three dozen genera are assigned to the group of theropods to which Tyrannosaurus belongs, and the ancestry of this group of theropods goes back to the Jurassic (Guanlong being the most famous early ancestor). Interestingly, Dryptosaurus, a partially known New Jersey theropod described in 1866 by Edward Drinker Cope, is now thought to be a tyrannosaur.

I will now introduce two bits of nomenclature that will be important later. "Tyrannosaurids" are those genera that include the later, larger theropods like: Tyrannosaurus, Tarbosaurus, Daspletosaurus, Albertosaurus, Gorgosaurus, etc. "Tyrannosaurines" will include the immediate relatives of Tyrannosaurus: Tyrannosaurus, Tarbosaurus, Dapletosaurus (and perhaps Alioramus). Most students of theropods realize that there is always a tension between "lumping" and "splitting". It has long been a controversy whether Tarbosaurus is a separate genus, or just the Asian version of Tyrannosaurus. Similarly, some argue whether Gorgosaurus and Albertosaurus are the same genus.

A recent paper by Fiorillo and Tykoski (2014) reports remains of a new tyrannosaurine specimen from the Kikak-Tegoseak Quarry at the North Slope of Alaska. The best date for that strata would be 69 Myr. A number of dinosaur tracks and bones have been found in the North Slope, but these are usually hadrosaurs or nodosaurs. Tyrannosaurine specimens have not been found north of southern Canada.

The specimen has been given the name *Nanuqsaurus hoglundi* (from the Inupiaq word for polar bear, plus geologist Forrest Hoglund). It consists of only three fragments from the skull:

1. A part of the ascending ramus of the right maxilla.
2. A part of the skull roof including the frontals, parietals, and laterosphenoid bones,
3. A section of the left jaw near the front of the mouth.

The expected length of the skull would be about 700 millimeters, less than half that of Tyrannosaurus.

Even with these tiny fragments, there are enough characters that assign *Nanuqsaurus* to being a tyrannosaurine:

1. The maxilla fragment has ridges consistent with a peg-in-socket articulation of the maxilla and nasal. This is seen only in adult (but not juvenile) Tyrannosaurus, Tarbosaurus, and Daspletosaurus.
2. The skull roof fragment has facets for articulation with the lacrimal and sagittal crest. The shape of these is similar to that in Tyrannosaurus and Tarbosaurus.
3. The size of the teeth in the jaw fragment is informative. There are reduced mesial dentary teeth. This is seen in some juvenile specimens of Tarbosaurus.

Phylogenetic analysis, given only the characters of the fragments puts *Nanuqsaurus* as a sister group to Tyrannosaurus/Tarbosaurus.

The authors suggest the small body size of *Nanuqsaurus* compared to most tyrannosaurines reflects the difficulty of finding enough food in the arctic, which may have been fairly warm in the Cretaceous, but also dark half of the year. By this mode of thinking it would have been an offshoot of the Tyrannosaurus/Tarbosaurus stem adapted to the arctic region.

Sources:

Fiorillo, A.R.; Tykoski, R.S.

"A diminutive new tyrannosaur from the top of the world."

[PLoS ONE 2014, 9, e91287](https://doi.org/10.1371/journal.pone.0212877)



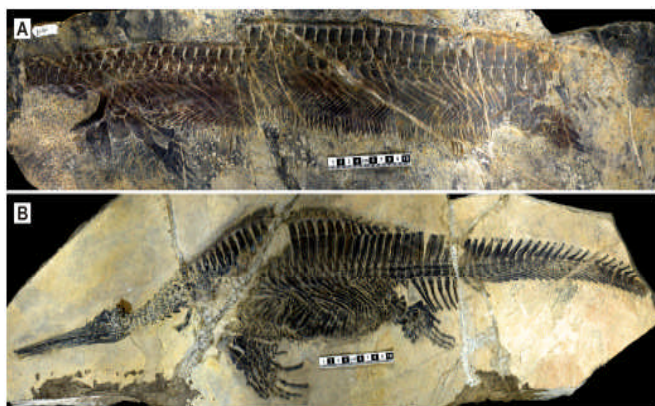
Parahupehsuchus: an Armored Marine Reptile

Bob Sheridan, April 17, 2014

Advanced ichthyosaurs, say from the Jurassic or later, are very fish- or dolphin-like in appearance: deep (from top to bottom) streamlined bodies, a dorsal fin, tuna-like tail, and long flippers in the front but very reduced or absent hind limbs. Very basal ichthyosaurs from the Early Triassic are more elongated in the body, have longer tails, etc., which would be expected in an intermediate between a land reptile and an obligate marine swimmer.

Utatsaurus is probably the most widely known example. There are other Early Triassic marine reptiles like Hupehsuchus and Nanchangosaurus which have more land animals characteristics: robust hind feet, separate clawed fingers, etc. It is not clear whether they are ichthyosaur ancestors or are a separate group.

Today's story involves a new Early Triassic marine reptile called Parahupehsuchus ("like Hupehsuchus") as described by Chen et al. (2014). It was excavated in Hubei Province, China. Phylogenetic analysis shows that it is in the same general group as Nanchangosaurus, Hupehsuchus, and an unnamed poorly preserved specimen named IVPP, V4070. Parahupehsuchus is about 73 centimeters long.



Parahupehsuchus has an elongated snout with no teeth (being toothless is unusual for this type of animal), an elongated tail much like that of a crocodile, and separate fingers and toes.

The most unusual features of Parahupehsuchus are in its torso. Each dorsal rib has a flange pointing forward and backward such that each rib significantly overlaps its neighbors. There is no room for intercostal muscles. Similarly the gastralia (belly ribs) are very wide and touch each other. There are also bony ossicles at the top of the spine. The authors refer to this completely covered condition as a "body tube." It is not clear whether this means the abdomen was complete rigid, but it would have been severely restricted at least. It is not unheard of for reptiles to develop overlapping ribs, or a body covering (as in turtles) although not exactly in the same configuration as Parahupehsuchus.

Much of the discussion in Chen et al. has to do with the physiological consequences of the "body tube", i.e. how was Parahupehsuchus able to breath or swim with such a rigid torso, and why the animal would need such unusual armor. One obvious suggestion for the second made by the authors is that the body tube is to prevent predation. That would suppose there was a marine predator large enough to try to eat Parahupehsuchus; although such animals are rare in the Early Triassic, the authors say there is at least one such (as yet unnamed) animal. I am not sure I buy the "anti-predation" idea because the longish neck and head of Parahupehsuchus would still be exposed. However, perhaps the idea is that Parahupehsuchus wouldn't be worth eating.

Sources:

Chen, X.-H.; Motani, R.; Cheng, L.; Jiang, D.-A.; Rieppel, O.

"A carapace-like bony 'body tube' in an early marine reptile and the onset of marine tetrapod predation." [PLoS ONE](https://doi.org/10.1371/journal.pone.0194396) 2014, 9, e94396.

Beach Fossils of the New York Bight

Bruce Edward Litton

Rockaway Beach, Queens, New York, is a slice of sand where routines of the everyday Big City meet the open Atlantic. Who would think this crowded beach is a great place to pick fossils after a storm? Between November and March, Nor'easters produce opportunity few care about, but those who seek fossils find tokens of deep time. A group of about three dozen of us from the New York Paleontological Society kicked our way across the sand towards the drift lines, having been informed that the treasure to seek is a blue crab fossil from the Pleistocene Epoch more than 11,700 years ago. We were assured that plenty of fossil shells would be found, but that the crabs, locked into place by clay having become rock, are uncommon.

We could do better. Fossil lobster claws, gastropods, sponges, and other very rare specimens have been found on the Rockaway and Long Island beaches. But no one seems to expect them.

We walked and picked shells that appeared ancient near the throat of the New York Bight, the indentation or oceanic pocket between Long Island and Queens, and the northern New Jersey beaches, cleaved by the Hudson Canyon. Ocean currents erode the coastline freeing fossils from sediment and sand; storms wash them onto the beaches. To some degree the canyon, 7217 feet deep at the continental shelf's base, routes current in the direction of Rockaway Beach. At any rate, when the wind is strong from the southeast, fossils tend to grace drift lines. You could bet that collectors walked the beaches after Hurricane Sandy, and in fact a blog account confirms they did.

We surely found Holocene Epoch specimens only a few thousand years old and none of our collection seemed to be of the rare Lower Pleistocene exceptions two million years old that are reported. Most seem to come from the Pleistocene Ice Age, although interglacial periods warmed ocean temperature averages 3.6 to 19.8 degrees F beyond what they are now. That was news to my concern for global warming. It made me feel that we are less alone and unique than I had thought. On the other hand, the Wisconsin Glacier was the last of three ice masses, and ocean levels fell 400 feet lower than at present with ocean temperatures averaging 5.4 to 12.6 degrees F colder than they are now. Thus, the

Hudson River carved what remains as the Hudson Canyon cutting through the continental shelf. Almost all of the fossil shells are of species alive and well in the Bight today such as surf clams, ocean quahogs, whelks, and moon snails. However, the Ponderous Ark and the periwinkle turn up while living specimens today are from North Carolina southward. This is clear evidence of those warmer waters of startling climatic shifts between glaciers.

On our beach trek, I had been finding fossil shells that would have excited me as a boy, had I known this is what they are. North Carolina's Outer Banks had yielded many finds at dawn before other beachcombers took their picks. Fossil shells may be available on any beach, although barrier beaches subject to erosion reveal the most. But how does one know how to identify them?

They tend to be gray. Once a fossil shell was pointed out to me by an experienced collector, I knew them all. Discoloration can vary from gray, to off-white, to tan or rusty. They have no periostracum, the outer shell layer, nor ligament that holds together the bivalves, although there is more to being a fossil than these lacks of characteristics. On occasion, a blackened shell may be found that is not a fossil. The black shell particularly of clams and scallops is the result of years being buried in bay mud, which may be anoxic as is sometimes claimed to be the case. Sulphides stain the shell. However, black shell stain may not require much lack of oxygen. As a clammer in New Jersey's Barnegat and associated bays many years ago, I found black mud had permanently blackened shells, as opposed to the whitish shells of those from sand. But these live organisms were not without oxygen, although sulphides were abundant. The smell left no doubt.



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Beach Fossils Cont'd

As paleontology enthusiasts, we New Yorkers knew that what is essential to making a fossil shell is not the lack of a ligament—which is also usually not present in fairly recent, non-fossil bivalve shells—nor the absence of periostracum, but the mineralization of the fossil substance, whether of shell or crab remains in gray clay concretion. Taphonomy determines specifically how and why fossils are preserved. In common parlance, a fossil is the remains of an organism turned to stone, but fossil shells are not exactly stones and don't seem to be so at all, although they may be embedded in stone concretion such as common gray clay. Furthermore, shells are mineralized upon formation by organic processes—they're made of calcium. So are bones, and fossil bones are classics. But the quality of mineralization is not the same in fresh shells or bones as those that have fossilized. The scientific term for the process is perimineralization, which implies the added ingredients from ground water penetrating the pores of bone over great expanse of time, or of brine transforming the mineral content of shells—porous enough—and hardening them to some degree.

We all know fossils are special. We sensed this as children. Their stoniness is something I sensed as a five year old having to do with a special process of some sort, and I was aware of immense time. It is a natural transformation that results in preservation, as if impermanence in nature is not the whole story. As a child, I found fossils in my Indianapolis, Indiana, backyard and contemplated them as symbols of something absolute within existence of which I am part. They suggested to me that I have something deep within myself that can weather the flux of life.

True, the earth, the oceans, ourselves—none of this lasts forever. Yet the oceans and the entire planet are part of existence that cannot have come from nothing, nor become nothing. Everything transforms, as a fossil is a transformation of organic matter, given that it is not a fossil footprint or the like. A fossil suggests immortality in the way a work of art is a re-creation or transformation of experiential meaning which lasts for millennia. But nothing lasting would mean anything without particular search here and now, quite limited in time as we were by the few hours of our outing.

For the time being, we clambered along the beach. We must have walked 15 or 20 blocks and I never expected to find one of those blue crabs, not that any evidence of the original coloration would be

present if I did. We all seemed to search with sincere persistence. No one on the beach appeared to be there on a social lark. My son, Matt, had gained a fossilized lightning whelk in perfect condition. What's the likelihood of this? I saw it first, standing out on the flat, wet sand as the wash receded, like a live creature crawling out of the primordial sea in full view to anyone who would look from the City of New York. I called out to my son. I pointed and he ran immediately to it. We celebrated and soon moved on, my suspecting that this would be our best find and perhaps it was, but everyone had the crab in mind.

And then it appeared very simply at my feet. I saw the ribbed pattern underside, picked it up, and beheld what everyone else up and down the beach was looking for. I felt more odd than fortunate. This proved to be the only blue crab fossil found. The outing's expert guide gave my son a blue crab piece he had found on earlier occasion as if to complement his father's fortune. I was more grateful to the guide than for my own find. I don't find myself truly avid about paleontology these recent years. But I was so as a young boy; it was important that my son take home a special token. What I remember best is Matt's triumphant lifting of the whelk above the surf as if he could blow a clarion call through it.



Paluxy River Tracks Digitally Reconstructed

Bob Sheridan, April 4, 2014

In 1940 Roland T. Bird, a collector of fossils for the American Museum of Natural History, discovered a 9 meter long dinosaur trackway, containing many dozens of individual footprints, on the bed of the Paluxy River near Glen Rose, Texas. This is probably the most famous and often interpreted dinosaur trackway. Most paleontologists believe it records an incident where a theropod is following a sauropod. In some interpretations, this records the theropod chasing and attacking the sauropod. However, since the pace never seems to exceed a slow walk, a duller interpretation seems plausible: A sauropod walked by and then, several hours later, a theropod walked by. This trackway was excavated by Bird and parts were distributed to various museums. You can still see part of it under the Apatosaurus skeleton at the AMNH. Bird made several sketches of the trackway before he excavated it. Two of these are called the "Rye chart" and the "Austin chart." Nowadays, it would be common for a trackway to be laser-scanned so 3D digital model of the original surface could be stored and examined virtually. However, 70 years ago this was not possible.

A new paper by Falkingham et al. (2014) shows that it is possible to generate a 3D digital model of the tracks using photogrammetry, which is the field of generating 3D models from 2D photographs. (The authors of this paper have been studying and publishing on this trackway for many years. The link under Sources points to a very exhaustive monograph on Paluxy River tracks.) The authors used the original photographs that Bird took during the excavation process in 1940. In order to get three dimensional information one has to photograph the same object from two different angles. 12 out of 19 photographs could be matched in this way. There are additional difficulties: people, tools, sandbags, etc. can obscure part of the trackway in one photograph. However, it is apparently possible to reconstruct the entire trackway using all the photographs. The new digital model has some drawbacks: The far end of the trackway (farthest from the camera) lacks detail and there are some linear artifacts due to the fact that the vantage point from which the photographs were taken did not change much. Also, the scale of the digital trackway had to be set by using some of Bird's original measurements.

The authors compare the photogrammetric digital model with a laser-scanned digital models of parts of the trackway currently accessible at the AMNH and Texas Memorial Museum and also with the Rye chart and the Austin chart. The Rye chart appears more accurate in terms of the overall curving of the trackways (they curve to the left, whereas the Austin chart shows a straight trackway). Also there are a few tracks in the laser-scanned models that are not in the charts. The placement of the sauropod vs. theropod tracks are not quite the same in the photogrammetric model as in the charts, possibly indicating the two trackways were measured independently by Bird.

The fact that lost trace fossils can be resurrected from historical photographs is quite amazing, even if the results are not perfect.

Sources:

Falkingham, P.L.; Bates, K.T.; Farlow, J.O. "Historical photogrammetry: Bird's Paluxy River chase sequence digitally reconstructed as it was prior to excavation 70 years ago." *PLoS ONE* 2014, 9, e93247.

Convex Hulls as a Way to Estimate the Mass of Fossil Animals

Bob Sheridan, April 1, 2014

In December I reported about a very good method to estimate the mass of fossil birds as described by Field et al. (2013). To repeat the introduction from that article: There are basically two ways of estimating the mass of fossil animals. One way is to find a measurement X from the skeleton that correlates highly with mass M in extant animals, and then use the equation that links M to X to estimate the mass of fossil animals. The difficulty here is that the equation one derives from the extant animals may not apply to the fossil animals. The second way is to build a scale model (real, say out of clay, or virtual on the computer) of the restored animal, measure the volume of the model, scale up to the volume of the model to that of the real animal, then use an estimate of the density of living animals to get the mass. The limit of this is that most fossil animals are not known completely enough to build an accurate model. Even if the animal is known completely, one can build a skinny or fat model, so there is a large variation in the estimated mass.

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Hulls Cont'd

A new article (Brassey et al., 2014) attempts to take the subjectivity out of the second method by using an automatic method of estimating the volume of an animal, and it does this by generating a convex hull around the parts of a skeleton, once that skeleton is scanned into a computer. First, what is a convex hull? It is easier to explain this in two dimensions. Imagine that you have driven a set of nails into a board. You wrap a very small rubber band around the nails. The rubber band forms a shape (hull) comprised of straight lines just surrounding the outermost nails. There are no concavities in this shape (it is convex). In three dimensions one forms a surface made of planar polygons around the outermost points. There are off-the-shelf algorithms for generating convex hulls and estimating the volume. For this to work for the stated purpose, the skeleton must be laser-scanned and then divided on the computer into functional units: trunk, pelvis, head, neck, left femur, left shin, left foot, etc. A convex hull is calculated for each unit, and the volumes added. In some cases, the individual parts must be further subdivided to get a good estimate, for example the very curved neck of a camel.

Note that we do not have to get a good estimate of the true volume of any particular animal. In fact, the volume is likely to be severely underestimated since the animal is effectively a "shrink-wrapped" skeleton. One need only show that the convex volume calculated from the skeleton of living animals correlates very well with the mass of those animals. Brassey et al. did this for 33 extant animals including birds, non-primate mammals, and primates. Within each group the correlation of $\log(\text{mass})$ with $\log(\text{convex hull volume})$, the correlation is very high ($r^2=0.97$ to 0.99). This means the mass is very predictable from the convex hull volume.

The slope of the linear relationship, i.e. the number which is used to transform the convex hull volume to a body mass, is slightly different for the three groups. Interestingly, the slope for birds is not much different than that of the mammals; this is unexpected since we think of birds as being light-weight. The authors treat the slope as a kind of "density": how much mass is effectively packed into the convex hull volume. Since the convex hull volume underestimates the true volume of animals, we would expect the densities to be greater than 1000 kg per cubic meter (roughly the density of water or of flesh). Indeed this is true. The densities are in the range 1200 to 1400.

In birds, there is a slight negative correlation between density and body mass, that is, the mass does not rise quite as fast as the convex hull volume. Interestingly, the same negative correlation is found in studies where the volume of entire carcasses are measured. One interesting note is that for density studies of birds, it helps to use plucked carcasses, since the feathers of birds makes the apparent volume of their bodies 50% too large.



The convex hull method sidesteps the issues associated with trying to construct a model of an extinct animal as a living creature. However, one still needs a complete skeleton, and there are still judgments that need to be made about how to properly subdivide the skeleton into functional units.

Volume is roughly proportional to the cube of an animal's length. Thus, it is conceivable that a much simpler measurement, such as using the length of the femur, or the sum of femur, humerus, and spine might also be almost as accurate as the convex hull volume at estimating mass. A comparison to that simpler method, however, was not done.

Sources:

Brassey, C.A.; Sellers, W.I.
"Scaling of convex hull volume to body mass in modern primates, non-primates mammals and birds."

PLoS ONE, 2014, 9, e91691.

Field, D.J.; Lynner, C.; Brown, C.; Darroch, S.A.F.
"Skeletal correlates for body mass estimation in modern and fossil flying birds."

PLoS ONE, 2013 8, e82000.

Where Do Ratites Come From?

Bob Sheridan, May 24, 2014

Ratites are flightless birds that live or once lived in the southern continents.

1. Ostrich (Africa)--extant.
 2. Elephant bird (Madagascar)--extinct
 3. Rhea (South America)--extant
 4. Tinamou (South America)--extant
 5. Cassowary (New Guinea)--extant
 6. Emu (Australia)--extant
 7. Moa (New Zealand)--extinct
7. Kiwi (New Zealand)--extant

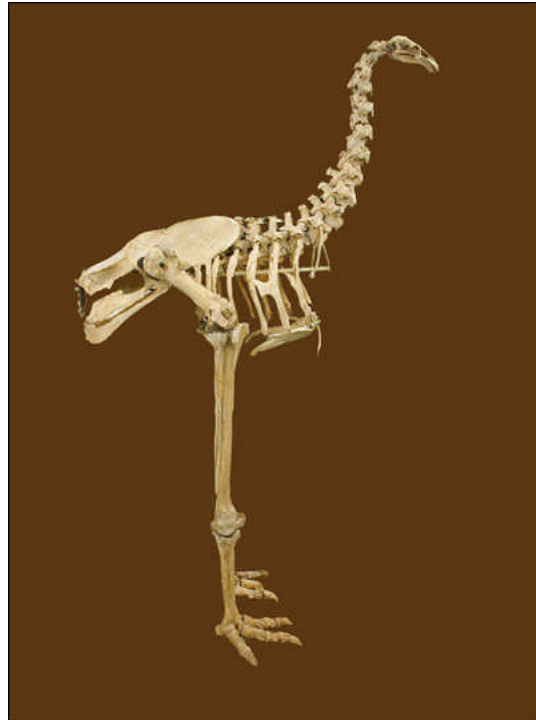
The tinamou and kiwi are chicken-size; the others are very large, up to 9 feet tall. These birds seem to be linked by common anatomical features. For example, ratites are referred to as paleognaths: they have a fairly primitive palate structure. Assuming all these birds are really related, how did they get where they are in terms of geography? One can imagine two extreme scenarios:

1. Ratites had their current flightless form in Early Cretaceous Gondwana. As the continent split into Africa, South America, etc., the ratites were carried along with them. This is called "continental vicariance."
2. The ancestral ratite could fly. It crossed the ocean and settled down on different continents. Ratite descendants independently became large and flightless.



The first scenario is simpler and makes a very simple prediction: ratite phylogeny should reflect the time the continents split off: Madagascar from Africa (160 Myr), Africa from the other southern continents (120 Myr), and New Zealand from Australia (80 Myr), and Australia and South America from Africa (50 Myr). That is, the kiwi should be most closely related to the moa, the rhea should be most closely related to the tinamou.

The elephant bird should be the most different from the other birds. The second scenario would also make a prediction: ratites could be in different stages of flightlessness. In fact, the tinamou is not completely flightless and has a keeled sternum, which implies its recent ancestors might have been strong fliers.



Moa Skeleton

Many anatomical comparisons seem to support the first scenario. However, anatomical comparisons have their limits, the most important of which has to do with convergence: different animals can have similar features just because they have the same "jobs", not because they are closely related. An alternative approach to deriving phylogenies is to use molecular information, i.e. comparing the DNA of the animals. Until recently we could do this only with extant animals. However, nowadays it is quite routine to sequence the DNA from the bones of extinct animals if they have been extinct less than tens of thousands of years, especially for mitochondrial DNA (which is more chemically robust and exists in many copies per cell).

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Ratites Cont'd

The elephant bird and the moa have been extinct only a few hundred years, so this is no problem. Molecular phylogeny also has the advantage in that there is an intrinsic "clock"; we can roughly predict how many base changes will occur in a given time. Molecular phylogenies are usually consistent with anatomical phylogenies, but sometimes there are big surprises, as in today's story.

A recent paper (Mitchell et al., 2014) compares the mitochondrial DNA of the ratites, including the extinct ones. The relatedness of some of the ratites by DNA is completely at odds with their current locations: The elephant bird and the kiwi are very closely related. The tinamou is related to the moa. The rhea and the ostrich are not closely related to any other ratite. The only relationship that does make geographic sense is that of the emu and cassowary (they are both in the south Pacific). Also, by the molecular clock the oldest split (the ostrich from other ratites) occurred only 75 Myr.

If this observation holds up, it completely rules out continental vicariance as an explanation of the origin of ratites, and it better explains why the kiwi and tinamou are small, and the tinamou not quite flightless. A final interesting suggestion from the authors has to do with size. It is a general rule that only smaller animals survive mass extinctions. It seems more likely that ratites would survive the Cretaceous-Tertiary extinction if they were small at the time of the extinction and grew bigger only later.

Sources:

Mitchell, K.J.; Llamas, B.; Soubrier, J.; Rawlence, N.J.; Worthy, T.H.; Wood, J.; Lee, M.S.Y.; Cooper, A.

"Ancient DNA reveals elephant birds and kiwi are sister taxa and clarifies ratite bird evolution."

Science 2014, 344, 898-900.

A New Pterosaur: Mom, Dad, and a 3D Egg

Bob Sheridan, June 14, 2014

Pterosaur bones are hollow and fragile, and are not often preserved. There are only 4 known specimens of pterosaur egg, and these are completely flattened. On the other hand, at this time there are a very large number of pterosaur species identified.

Today's story is about a new pterosaur genus from northwestern China.

Wang et al. (2014) report that an Early Cretaceous site south of the Tian Shan Mountains in Xinjiang has yielded hundreds of pterosaur bones in a small area. The inference is that this must have been a colonial nesting site. The remains of at least 40 separate individuals have been identified so far. The bones are well-preserved, although disarticulated. The species has been named *Hamipterus tianshanensis* ("wing from the Hami region and the Tian Shan Mountains"). *Hamipterus* would have been a fairly large pterosaur (wingspan somewhere between 4 and 9 feet).

Hamipterus has a long skull with a crest running along the top. Skulls seem to come with two different crest shapes, with one lower and thinner, and the other higher, closer to the front of the skull, and thicker. The authors have assigned these as "female" and "male," respectively, while admitting there is not an absolute way to tell which is which.

The bones of *Hamipterus* don't particularly resemble other pterosaurs from that region, but show an affinity to pteranodontoid pterosaurs (which includes the famous *Pteranodon*), except that *Hamipterus* has teeth while most pteranodontoids do not.

The most interesting thing about this pterosaur site is that it includes at least five three-dimensionally preserved eggs (not all from the same location in the formation). Whereas the identification of the other known pterosaur eggs is uncertain (even when they contain embryo bones), we can assign these to *Hamipterus* with some confidence. The eggs are about two inches long and one inch in diameter. If these were contemporary eggs we would say they were severely squashed, but they are certainly more three-dimensional than the completely flat pterosaur eggs we previously knew about. The fact that they are squashed and not shattered implies that the shell was not completely rigid like that of a bird or dinosaur egg, but probably pliable like that of lizard. The shell does show some cracking, though, which might imply a thin outer calcified layer.

Sources:

Wang, X.; Kellner, A.W.A.; Jiang, S.; Wang, Q.; Ma, Y.; Paidoula, Y.; Cheng, X.; Rodrigues, T.; Meng, X.; Zhang, J.; Li, N.; Zhou, Z

"Sexually dimorphic tridimensional preserved pterosaurs and their eggs from China."

Current Biology 2014, 24, 1-8