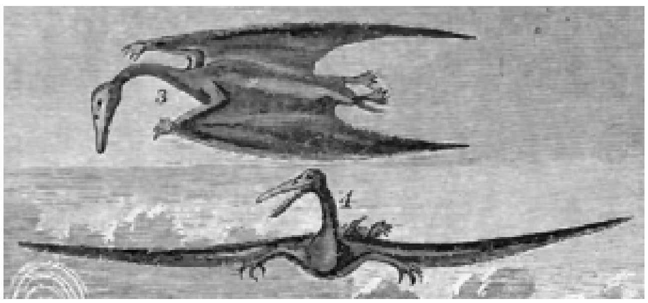
Pteranodon osteohistology! Or, bizarrely bacon-esque pteranodon bones

October 30 2015, by Taormina Lepore



Early interpretation of Pteranodon. Credit: E.D. Cope. Public Domain.

In the Mesozoic Era, the time of dinosaurs, the skies were filled with monsters.

Leathery wings, long beaks, bizarre forelimbs modified for flight. Think of Disney's Fantasia or Don Bluth's The Land Before Time. Like demon reptile bats, they ruled the air while birds were just getting their start on the evolutionary stage, and long before bats were a twinkle in Earth's eye.

But those monsters were not, in fact, dinosaurs.

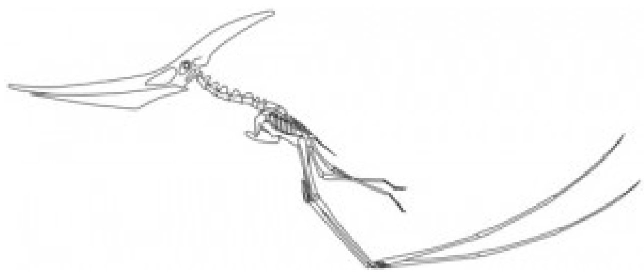
The pterosaur clade encompasses a broad diversity of flying reptiles, all in their own distinct group, distant cousins of dinosaurs. The name, aptly, translates to "winged reptile".

One of the most famous pterosaurs, one that has featured in numerous films and has been turned into many plastic toys, is Pteranodon. This is the creature that many people think of when they think of pterosaurs: a long, pointed, toothless snout, with a long crest at the back of its head. Tailless, and probably a little awkward; that is, until it flies. I like to think of them as fairly graceful, once they were airborne.

There have been several studies on just how Pteranodon flew, how it grew, and how it lived, but relatively little on its osteohistology – the inner structure of its bone. Starting with early discoveries by paleontology rivals Othniel Charles Marsh and Edward Drinker Cope in the late 19th Century, Pteranodon catapulted to stardom as the first pterosaur found outside of Europe, with its strange toothless skull and large size. The wingspan of Pteranodon longiceps, one of two currently valid species, was over 20 feet (6 meters). Can you imagine something like that swooping through the skies today? It's definitely unusual, and there Pteranodon really inspires the imagination.

The second valid species as of this article's writing is Pteranodon (=Geosternbergia) sternbergi, named for George Sternberg, its collector and one of the namesakes of the Sternberg Museum of Natural History at Fort Hays State University, in Hays, Kansas.

It is only fitting that the Sternberg Museum of Natural History is the place where further studies on the osteohistology of Pteranodon are being undertaken. The museum's chief curator and Fort Hays assistant professor Laura E. Wilson is at the forefront of Pteranodon histology, a topic that is in need of a more robust set of data. Wilson has one of the largest collections of Pteranodon bones in North America at her disposal, and was able to present her preliminary findings on how Pteranodon limb bones can be linked to bone growth.



Pteranodon longiceps, about to launch into the air. Credit: Witton and Habib 2010.

At the 75th annual meeting of the Society of Vertebrate Paleontology, Wilson explained how she had taken delicate thin sections of Pteranodon bone and analyzed the patterns of growth within those sections.

Like rings on a slice of tree, bone can shed a lot of light on how animals grow, when they stop growing, and whether some of the bone is remodeled or undergoes resorption.

Strangely enough, when Pteranodon long bones such as this femur below are sliced in cross-section, they look a lot like bacon – according to Wilson, who is a bacon fan! I pretty much agree with her, it does look enticing.

But there's more here than the appearance of crispy goodness. Histological sections like this one allow Wilson to study different sizes of Pteranodon and determine whether they are all adult specimens – in spite of a wide range of presumably adult, full-grown sizes.

For example, Wilson took three size ranges of Pteranodon from the Late Cretaceous Niobrara chalk deposits of Kansas and made thin sections of single femur bones. If Pteranodon grew like other vertebrates – and that's a big if – then juvenile specimens would be expected to have fast-growing, woven bone, versus the slow-growing parallel fibers along the outer edges, or periosteum, of adult bone. Other juvenile bone features include primary osteons – common structures of newly growing bone – and a wide variety of vascular canal shapes.

In the small, medium, and large femora of the Pteranodon specimens, Wilson noted that Pteranodon may have had abundant resorption of bone in juvenile animals, erasing any early woven features and replacing it with the uniquely thin, parallel periosteal lamellae of adults. That is, if Pteranodon laid down woven bone at all – to date Wilson has no evidence to suggest they did or didn't. But, like thin layers of geologic strata, the hallmark adult-bone lamellae signal one thing: there is a really big variation in adult Pteranodon body sizes.

Pteranodon longiceps. Credit: AMNH

According to Wilson, the "medium and small specimens are not skeletally mature" – and therefore not fully adult. That means they don't have the thin lamellae, either. The smallest appears to be a sub-adult, close to skeletal maturity, which is strange considering its relatively small size. Interestingly, the medium-sized specimen might be the youngest of the three. Primary osteons, abundant vascular canals, and the orientation of these canals – through which blood vessels flow – are, says Wilson, key indicators of the quasi-juvenile state in this mid-sized Pteranodon.

So, the smallest specimen is a sub-adult, the mid-ranger is younger than expected, and the biggest specimen is most definitely adult.

The indication that Pteranodon bones grew to a wide range of adult sizes is intriguing, and there's still no evidence of woven, obviously juvenile bone. "If they did deposit woven bone as fast-growing juveniles," says Wilson, emphasizing the 'if', "then that bone has been resorpted by the time they [were] big or old enough to fly out to sea." That's the Western Interior Seaway, which drowned much of Kansas during the Late Cretaceous, and was home base for Pteranodon.

Pteranodon femur cross-section. Or, bacon! Credit: Laura E. Wilson – Sternberg Museum of Natural History

Wilson found that the smallest specimens were still 60% of the adult body size, and even these specimens appear to be approaching maturity.

The Niobrara specimens were deposited far from shore, and the wings of these ancient creatures would have developed in a way to carry them there. What happened to cause their ultimate demise at sea is something of a mystery, but the way in which they lived and grew is only going to become clearer the more researchers look at the structure of their bones.

What's next for Wilson and the Pteranodon specimens at Sternberg? More bones will need to be cross-sectioned and studied to see if the trend is observed across lots of specimens and body sizes.

Especially enticing is the prospect of one day finding more small juvenile Pteranodon specimens in the field. "One of the big obstacles to my research is that we may never be able to get a full picture of the growth, or ontogeny, of these animals until we find small juveniles – which are missing from our fossil record at this point," says Wilson. "It's very difficult to understand how Pteranodon grew from hatchling to adulthood without the lower half of the body size distribution."

The Western Interior Seaway, where Kansas was seafront property.

More information: Mark P. Witton et al. On the Size and Flight Diversity of Giant Pterosaurs, the Use of Birds as Pterosaur Analogues and Comments on Pterosaur Flightlessness, *PLoS ONE* (2010). DOI: 10.1371/journal.pone.0013982

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