

# Air-filled bones helped prehistoric reptiles take first flight

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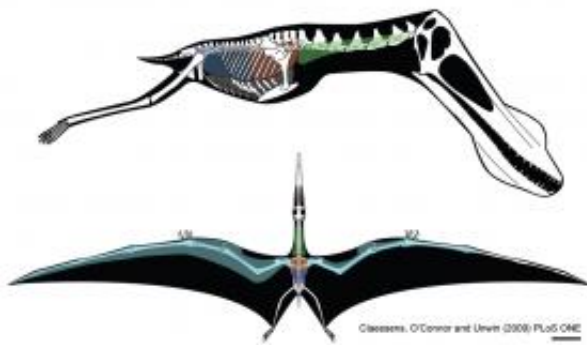


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(PhysOrg.com) -- In the Mesozoic Era, 70 million years before birds first conquered the skies, pterosaurs dominated the air with sparrow- to Cessna-sized wingspans. Researchers suspected that these extinct reptiles sustained flight through flapping, based on fossil evidence from the wings, but had little understanding of how pterosaurs met the energetic demands of active flight.

A new study published today in the journal *PLoS ONE* by researchers from Ohio University, College of the Holy Cross and the University of Leicester explains how balloon-like air sacs, which extended from the lungs to inside the skeleton of pterosaurs, provided an efficient breathing system for the ancient beasts. The system reduced the density of the body in pterosaurs, which in turn allowed for the evolution of the largest flying vertebrates.

"We offer a reconstruction of the breathing system in pterosaurs, one that proposes the existence of a mechanism with the same essential structure to that of modern birds — except 70 million years earlier," said study co-author Leon Claessens, an assistant professor of biology at the College of the Holy Cross.



Courtesy of Claessens, O'Connor, Unwin, 2009

The system would have facilitated the necessary gas exchange to enable sustained activity, added co-author Patrick O'Connor, an assistant professor of biomedical sciences at the Ohio University College of Osteopathic Medicine.

Claessens and O'Connor were inspired to conduct the study after David Unwin of the University of Leicester, then curator at the Natural History Museum in Berlin, showed them an extraordinarily preserved pterosaur in 2003. The scientists thought the specimen might finally shed light on how the animals powered sustained flight.

"The shape and size of the rib segments that articulate with the sternum indicate that the ribcage was mobile, contrary to previous ideas," Claessens said.

Unique and previously unrecognized projections on the ribs provided important leverage for the muscles that power lung ventilation, he added.

Because fossils rarely preserve soft tissues, the research team conducted a comparative study that included pterosaurs, birds and crocodilians in order to get a better understanding of the relationships among air sacs, lung structure and the skeleton. By using X-ray movies and CT scans, the group characterized how the skeleton works to move air through the lungs in living animals, and also how to identify the signature traces left on bones that have been invaded by air sacs.

Not only do the extinct pterosaurs show evidence that their bones that were invaded by air sacs, but patterns of pneumaticity throughout the entire skeleton of different pterosaur species parallel trends identified in many living bird groups. For example, there is a direct relationship between the proportion of the skeleton invaded by air sacs and the absolute body size of an animal.

"Whereas small-bodied pterosaurs and birds typically pneumatize only a restricted part of the backbone, larger-bodied species routinely pneumatize most bones of the body, including the wing skeleton out to the ends of the fingers," O'Connor said.

Such modifications of the skeleton would have reduced bone density and resolved a major problem with sustaining flight in large-bodied pterosaurs: the energetic cost of keeping a heavy body up in the air. Density reduction of the skeleton in pterosaurs may have been beneficial, particularly so in the aerial giants—just as it appears to be in the largest flying birds today.

Air sacs in birds also serve other purposes, such as for visual displays and the production of sound, the researchers said. The existence of an analogous air-sac system in pterosaurs highlights new areas of research

in which paleobiologists can explore aspects of pterosaurian biology.

Provided by Ohio University

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