

## ScienceWatch - Bird-Dinosaur Link Questioned by a Breath of Fresh Air

The hypothesis that birds evolved from small, fast-running dinosaurs known as theropods, has received another blow. Writing in the November 14, 1997 issue of *Science*, John A. Ruben and coworkers conclude that the respiratory system of theropods was so different from modern birds as to preclude the possibility that birds evolved from them. In their report, Ruben et al. compared the lung structure and ventilation systems of modern birds and crocodiles with fossil evidence from dinosaurs. Both birds and reptiles possess lungs that are analogous to a single alveolus. (Alveoli are thin, blind sacs where efficient gaseous exchange occurs). In contrast, highly active mammals evolved a bronchial tree that ends in millions of alveoli. Furthermore, even though the lungs of birds and reptiles are septate, i.e. subdivided into pockets or “septae”, they are not as efficient as the mammalian alveoli in maintaining the high rates of oxygen consumption necessary during periods of intense activity.

With respect to their ventilation system, mammals, crocodiles and birds all differ. In mammals the diaphragm, a dome-shaped muscle separating thoracic and abdominal cavities, expands the chest cavity when it contracts (pulls down), allowing the lungs to fill with air. Unlike in mammals, the crocodilian diaphragm is non-muscular connective tissue that attaches via muscles to parts of the liver and pubic bones, forming a “hepatic-piston” which pulls the diaphragm toward the tail in order to ventilate the lungs. A sturdy pubis accommodates muscle attachments. Birds lack a diaphragm. Instead they rely on a well-developed rib cage and sternum (costal system) to efficiently ventilate their lungs, permitting high energy expenditures, especially during flight.

What was the respiratory system of theropods like? Soft-tissue impressions in the chest cavity of well-preserved theropod fossils (*Sinosauroptryx*) from the early Cretaceous period show that the shape and placement of the diaphragm closely resembled that found in the crocodiles. Moreover, the pubis in theropods, like crocodiles, was well-developed. From these observations the authors conclude that theropod lungs were also septate, but unlike modern bird lungs, were ventilated by a hepatic-piston diaphragm. Furthermore, they argue that the costal ventilation system, which lacks a diaphragm, could not have evolved from the hepatic-piston system because any intermediate form with a less than fully functional diaphragm would have been too debilitated to effectively compete for survival. They conclude by saying that the presence of the hepatic-piston diaphragm system in theropods “poses fundamental problems” for “the conventional wisdom that birds are direct descendants of theropod dinosaurs”.

Another study reviewed in *Chickadee Chatter* last month, concluded that even though both birds and theropods lost two fingers of the five-fingered basic vertebrate plan, birds could not have evolved from theropods because the dinosaurs lost digits 4 and 5, while birds lost 1 and 5. The current study comparing lung structure and ventilation supports that conclusion and focuses renewed attention on the theory, which predominated until the 1970's, that birds evolved from thecodonts, a more primitive dinosaur group.

However, many paleontologists still find good reasons to endorse the theropod origin of birds and are critical of these new findings. For example, theropod dinosaurs walked on two feet and had an immobile pubic bone, while crocodiles walk on four feet and have a moveable pubic bone. Given these differences in pelvic structure, critics say, it is difficult to interpret the significance of the large pubis found in both. They have also questioned the hand study, saying it uses the developmental patterns of modern vertebrates to explain the pattern seen in dinosaurs.

No one doubts that a relationship exists between birds and dinosaurs, but the exact nature of the connection is under renewed scrutiny. The battle lines have been drawn and the controversy is likely to continue for some time. Hopefully, we will learn a lot more about birds and dinosaurs along the way.

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