

Scientists reveal origin for kinetic skulls in early Cretaceous paraves

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This is *Sapeornis chaoyangensis* specimen IVPP V19058. Credit: Zhonghe Zhou

A team of scientists led by Dr. HU Han from University of New

England, Australia and Dr. ZHOU Zhonghe from the Institute of Vertebrate Paleontology and Paleoanthropology (IVPP) of the Chinese Academy of Sciences reported a new quantitative analysis of early Cretaceous paraves. This research was published in the latest issue of *PNAS*, in a paper titled "Evolution of the vomer and its implications for cranial kinesis in Paraves."

Birds are the only group of dinosaurs surviving through the end Cretaceous mass extinction. Their [evolutionary success](#) has been attributed to many biological adaptations, including cranial kinesis, a special ability to move the rostrum independent of the braincase, which is believed to be associated with feeding mechanisms. The reduced lateral and flexible palatal structures made cranial kinesis possible by transferring force from the quadrate to elevate the upper bill. Thus, mobility of the palate is extremely important.

The closest dinosaurian relatives of [birds](#) are thought to have rigid skulls with no cranial kinesis. Although this feature has been the subject of great interest since first described, its origin and [early evolution](#) remains poorly understood in previous studies, largely due to the extremely rare preservation of the palate among early birds.

The researchers made 3-D reconstructions of the vomers (one of the palatal elements) of an Early Cretaceous bird *Sapeornis*, and a troodontid *Sinovenator*, a non-avian dinosaur close to the dinosaur-bird transition. They provided new morphological information for the palate of these two early Paraves and enabled a preliminary reconstruction of the palate of *Sapeornis*, the first available for an Early Cretaceous bird.

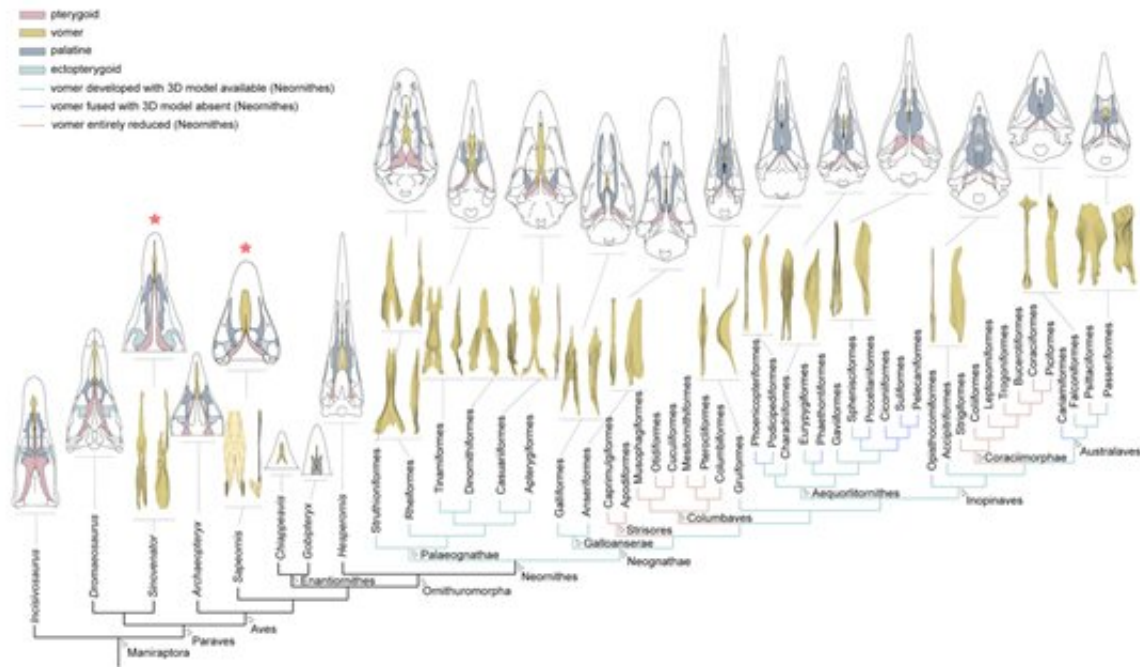


Fig. 2. Palatal evolution from non-avian dinosaurs to crown birds. Credit: Dr. HU Han

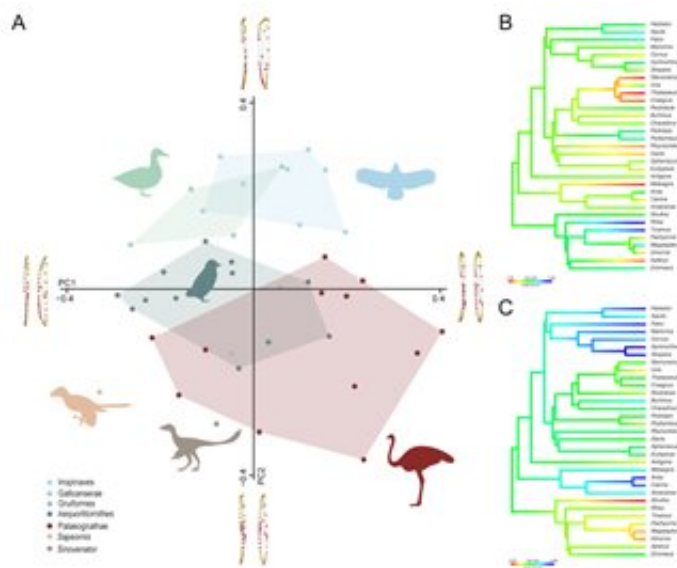


Fig. 3. Principal components analysis result of vomer shape in Paraves (PC1 & PC2). Credit: Dr. HU Han

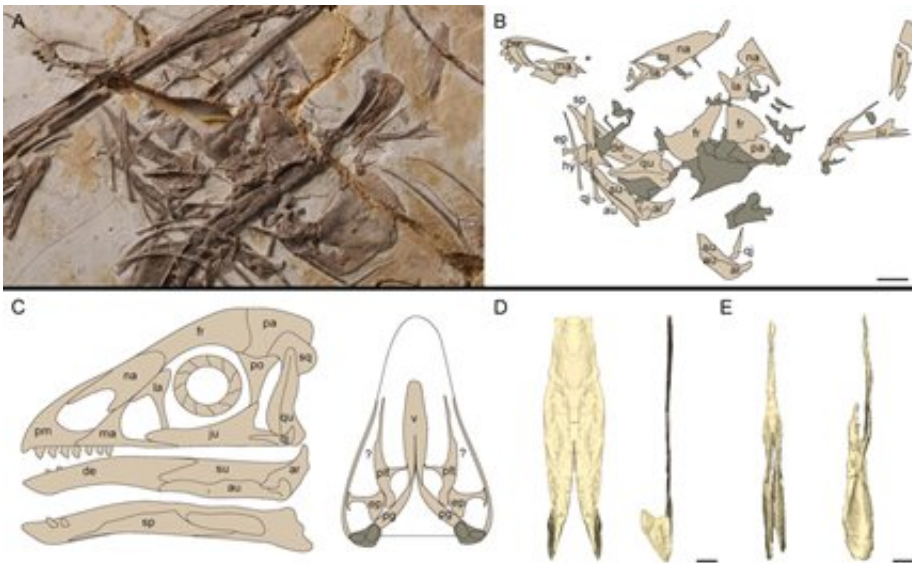


Fig.1. Photograph and camera lucida drawing of the skull of *Sapeornis* IVPP V19058; Cranial reconstructions of *Sapeornis*; 3D reconstructed vomers of *Sapeornis* IVPP V19058 and *Sinovenator* IVPP V12615. Credit: Dr. HU Han

Based on the new 3-D data from these two extinct lineages and representatives of modern birds, they conducted a comprehensive morphological study of the palate of birds, and a 3-D geometric morphometric analysis focusing on the vomer.

The results indicate that the Palaeognathae retained the plesiomorphic morphology of the palate inherited from non-avian dinosaurs. In contrast, the neognathous palate was much more modified with the vomer playing a prominent role in this evolutionary transition.

Basal birds, like palaeognaths, had limited cranial kinesis, a conclusion also supported by the identification of an ectopterygoid in *Sapeornis*. This suggests that the remarkably flexible avian skull is likely to be an

innovation of the Neognathae, which evolved after its divergence from the Palaeognathae in the Late Cretaceous.

The greater efficiency and evolutionary plasticity of the neognathous feeding mechanism afforded by the evolution of cranial kinesis may have increased the adaptability of this clade, allowing them to diversify into a wider array of ecological niches compared to the palaeognaths, and thus ultimately contribute to the current success of the neognathous radiation.

More information: Han Hu et al. Evolution of the vomer and its implications for cranial kinesis in Paraves, *Proceedings of the National Academy of Sciences* (2019). [DOI: 10.1073/pnas.1907754116](https://doi.org/10.1073/pnas.1907754116)

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