Scientists find the first bird beak, right under their noses

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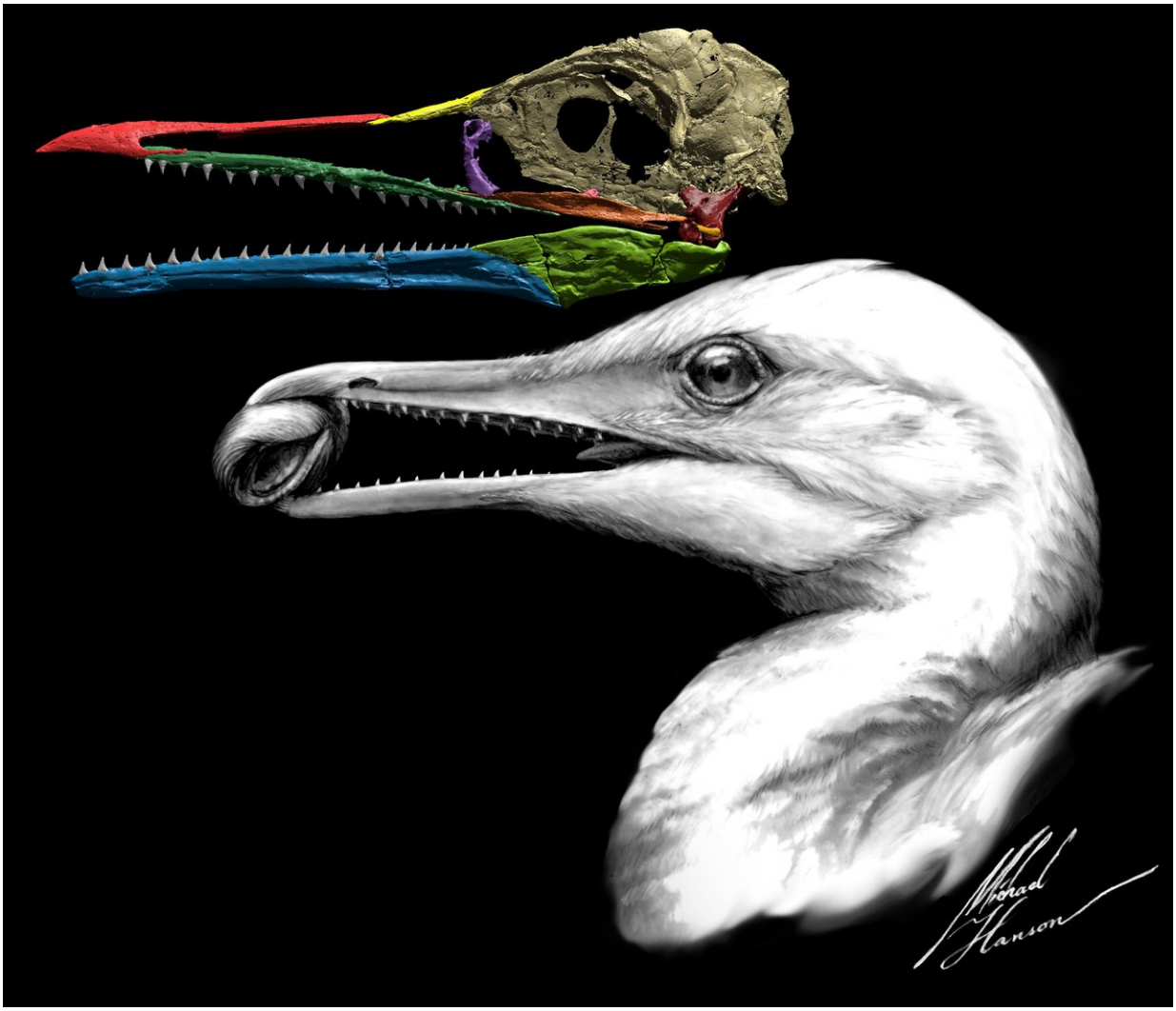

Fossil reconstruction and illustration of *Ichthyornis dispar*. Credit: Michael Hanson/Yale University

Researchers have pieced together the three-dimensional skull of an iconic, toothed bird that represents a pivotal moment in the transition from dinosaurs to modern-day birds.

Ichthyornis dispar holds a key position in the evolutionary trail that leads from dinosaurian species to today's avians. It lived nearly 100 million years ago in North America, looked something like a toothy seabird, and drew the attention of such famous naturalists as Yale's O.C. Marsh (who first named and described it) and Charles Darwin.

Yet despite the existence of partial specimens of *Ichthyornis dispar*, there has been no significant new skull material beyond the fragmentary remains first found in the 1870s. Now, a Yale-led team reports on new specimens with three-dimensional cranial remains—including one example of a complete skull and two previously overlooked cranial elements that were part of the original specimen at Yale—that reveal new details about one of the most striking transformations in evolutionary history.

"Right under our noses this whole time was an amazing, transitional bird," said Yale paleontologist Bhart-Anjan Bhullar, principal investigator of a study published in the journal *Nature*. "It has a modern-looking brain along with a remarkably dinosaurian jaw muscle configuration."

Perhaps most interesting of all, Bhullar said, is that *Ichthyornis dispar* shows us what the bird beak looked like as it first appeared in nature.

"The first beak was a horn-covered pincer tip at the end of the jaw," said Bhullar, who is an assistant professor and assistant curator in geology and geophysics. "The remainder of the jaw was filled with teeth. At its origin, the beak was a precision grasping mechanism that served as a surrogate hand as the hands transformed into wings."

The research team conducted its analysis using CT-scan technology, combined with specimens from the Yale Peabody Museum of Natural History; the Sternberg Museum of Natural History in Fort Hays, Kan.; the Alabama Museum of Natural History; the University of Kansas Biodiversity Institute; and the Black Hills Institute of Geological Research.

Co-lead authors of the new study are Daniel Field of the Milner Centre for Evolution at the University of Bath and Michael Hanson of Yale. Co-authors are David Burnham of the University of Kansas, Laura Wilson and Kristopher Super of Fort Hays State University, Dana Ehret of the Alabama Museum of Natural History, and Jun Ebersole of the McWane Science Center.

Life reconstruction of the toothed stem bird Ichthyornis dispar showing that the

first form of the avian beak was a precision pincer-tip probably used for fine manipulation. Credit: Michael Hanson and Bhart-Anjan S. Bhullar.

"The fossil record provides our only direct evidence of the evolutionary transformations that have given rise to modern forms," said Field. "This extraordinary new specimen reveals the surprisingly late retention of dinosaur-like features in the skull of *Ichthyornis*—one of the closest-known relatives of modern birds from the Age of Reptiles."

The researchers said their findings offer new insight into how modern birds' skulls eventually formed. Along with its transitional beak, *Ichthyornis dispar* had a brain similar to modern birds but a temporal region of the skull that was strikingly like that of a dinosaur—indicating that during the evolution of birds, the brain transformed first while the remainder of the skull remained more primitive and dinosaur-like.

"*Ichthyornis* would have looked very similar to today's seabirds, probably very much like a gull or tern," said Hanson. "The teeth probably would not have been visible unless the mouth was open but covered with some sort of lip-like, extra-oral tissue."

In recent years Bhullar's lab has produced a large body of research on various aspects of vertebrate skulls, often zeroing in on the origins of the avian beak. "Each new discovery has reinforced our previous conclusions. The skull of *Ichthyornis* even substantiates our molecular finding that the beak and palate are patterned by the same genes," Bhullar said. "The story of the evolution of birds, the most species-rich group of vertebrates on land, is one of the most important in all of history. It is, after all, still the age of dinosaurs."

More information: Complete Ichthyornis skull illuminates mosaic

assembly of the avian head, *Nature* (2018). nature.com/articles/doi:10.1038/s41586-018-0053-y

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