PALAEONTOLOGY

Rival species recast significance of 'first bird'

Archaeopteryx's *status is changing, but the animal is still key to the dinosaur–bird transition.*

BY EWEN CALLAWAY

The iconic status of *Archaeopteryx*, the first animal discovered with both bird and dinosaur features, is under attack. More-recently discovered rival species show a similar mix of traits. But *Archaeopteryx* still hogged the opening symposium at the 2014 Society of Vertebrate Paleontology meeting in Berlin last month, and even festooned the official conference beer glasses.

As the simplistic idea of a 'first' bird gives way to a messy evolutionary transition, newly discovered fossils and improved analysis techniques put *Archaeopteryx* in prime position to unravel the details. "Research on *Archaeopteryx* is really catching a new breath," says palaeobiologist Martin Kundrat of Uppsala University in Sweden, who co-organized the symposium at the November meeting.

The first *Archaeopteryx* fossil specimens turned up in limestone quarries in Bavaria, southern Germany, in the early 1860s. Until recently, they were the only fossil specimens found to mix bird- and dinosaur-like features. On the one hand, they are small — the fossils show juvenile creatures about the size of a magpie, which as adults may have been raven-sized — and have broad feathered wings that look good for gliding; on the other, they have a jaw with sharp teeth, dinosaur-like claws and a bony tail. These features led to the idea of the first bird, and generations of scientists have treated the 145-million-year-old animal as a 'transitional species' — the key piece of evidence linking birds and dinosaurs (*Archaeopteryx* is Greek for 'ancient feather', whereas its German name, *Urvogel*, means 'first bird').

But starting in the 1990s, the unique status of *Archaeopteryx* faced a challenge from the discovery in China of other potential transitional species. Fossils of *Anchiornis huxleyi* and *Microraptor gui* reveal small-bodied creatures like *Archaeopteryx*, and they may have used their four wings to glide. Another, *Aurornis xui*, has legs, claws and a tail similar to those of *Archaeopteryx*, yet lived about 10 million years earlier, leading some to propose it as a better candidate for first bird (see 'The fight for first bird).

Many scientists now believe that *Archaeopteryx* is just another dinosaur. Others find this hard to swallow. "To some ornithologists this is a really big deal — *Archaeopteryx* is the first bird," says Gareth Dyke, a vertebrate palaeontologist at the University of Southampton, UK. "They'd rather cut off one of their legs than admit it has nothing to do with bird origins."

New specimens of *Archaeopteryx* are also reinvigorating research. There are now 12 known fossils of the creature, and at the symposium Kundrat unveiled the first scientific description of the eighth to be discovered. Researchers lost track of the 'phantom' after it was found in Germany in the early 1990s, until a collector purchased it in 2009. It is now on loan to a Bavarian museum with an agreement that it will always be available for research.

Kundrat reported that the phantom lived more recently than other *Archaeopteryx* fossils, bolstering suggestions that there may been more than one *Archaeopteryx* species. And in July, an analysis[1] of the eleventh fossil showed that the animals boasted feather-covered legs, suggesting that the feathers evolved for purposes other than flight, such as display or insulation. Kundrat says that the twelfth specimen might soon emerge from a private collection.

Scientists are also developing techniques to analyse *Archaeopteryx*. Kundrat presented a three-dimensional (3D) scan of the rock-embedded bones of the phantom, which he made with help from scientists at the European Synchrotron Radiation Facility in Grenoble, France. "Now we have the first very detailed picture of the *Archaeopteryx* skull," he says.

"Archaeopteryx is becoming one more fossil in this really diverse family tree."

Palaeontologist Ryan Carney of Brown University in Providence, Rhode Island, presented a 3D X-ray-tomography body scan of an *Archaeopteryx* fossil known as Thermopolis and a surface scan of another fossil. (Carney sports a black feather tattoo as a nod to his part in the discovery[2] of pigment structures in *Archaeopteryx*'s feathers that suggest the bird was black.) Both analyses will help to model whether and how *Archaeopteryx* flew and to determine its place in the transition from dinosaurs to birds.

Revelations about *Archaeopteryx*'s brain are already informing its place in the evolutionary tree. Last year, evolutionary biologist Amy Balanoff of Stony Brook University in New York and her colleagues reported[3] in *Nature* that the brains of *Archaeopteryx* and a variety of dinosaurs related to it were, like modern birds, all relatively large for their body sizes. Because earlier dinosaurs did not fly as well as modern birds, if they flew at all, the finding suggests that the brain expansion occurred well before flight emerged. It is yet another clue that *Archaeopteryx* may not have been any more bird-like than other suggested transitional species. "It's another piece of data that has taken away from the specialness of *Archaeopteryx*," says Balanoff.

Balanoff is now investigating whether the *Archaeopteryx* brain shares finer anatomical details — inferred from skull shape and small impressions on it — with theropod dinosaurs, the lineage that gave rise to birds. Her team also reported[3] the discovery of a structure called a wulst in the *Archaeopteryx* brain, which was previously found only in living birds. The wulst, involved in perception, might have helped the creature to process visual information during flight. But the question is whether it, too, is present in *Archaeopteryx*'s dinosaur kin.

Taken together, the findings suggest that there was no neat transition from dinosaur to bird, making the idea of a first bird seem increasingly arbitrary and prone to the caprices of an incomplete fossil record. "I love *Archaeopteryx*. I did a thesis on the animal," says Nicholas Longrich, a palaeontologist at the University of Bath, UK. "But in some ways, we're moving beyond *Archaeopteryx*. It's becoming one more fossil in this really diverse family tree."

Some think the debate over the transition will one day be moot. "The boundary between dinosaurs and birds in the future will completely disappear," says Ulysse Lefevre, a palaeontologist at the University of Liège in Belgium, who discussed new fossils from China at the Berlin meeting that might further blur the line.

What is clear is that *Archaeopteryx* research is still key to understanding the dinosaur–bird family tree. "There are some controversies over whether *Archaeopteryx* is the first bird or not. I don't think it matters at the moment."says Kundrat. "We are bringing *Archaeopteryx* back to life through new quantifiable analysis." ■

1. Foth, C., Tischlinger, H. & Rauhut, O. W. M. *Nature* **511,** 79–82 (2014).
2. Carney, R. M. *et al. Nature Commun.* **3,** 637 (2012).
3. Balanoff, A. M., Bever, G. S., Rowe, T. B. & Norell, M. A. *Nature* **501,** 93–96 (2013).

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The fight for first bird

For more than a century, scientists looked to *Archaeopteryx* to understand the transition from dinosaurs to birds. But more-recently discovered fossils are threatening to strip *Archaeopteryx* of its 'first bird' title. One by one, the features that once made *Archaeopteryx* stand out as a transitional species are falling away.

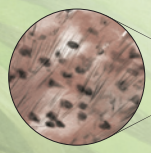
Zanabazar junior

Archaeopteryx

Woodpecker

Bird brains for everyone

Despite their reputation, bird brains are big relative to the size of their bodies owing to an expanded cerebrum (red). *Archaeopteryx's* brain was also large, but so were those of other theropod dinosaurs, such as *Zanabazar junior*, suggesting that this trait is not unique to birds.



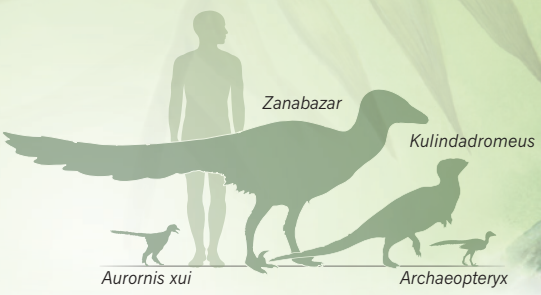
Fossil of forelimb plates and bristles

Fall of feathers

Feathers were once the sign of a bird. Things changed when feathered theropod dinosaurs — from the lineage that gave rise to modern birds — showed up in the 1990s. Now many researchers believe that all dinosaurs had feathers, thanks to *Kulindadromeus zabaikalicus*, which is from a completely different lineage. Its feathers — fossilized as structures that resemble ribbons, plates and bristles — may have been used for warmth or signalling.

Anatomy argument

Aurornis xui is the latest creature to challenge *Archaeopteryx*'s spot as first bird. As well as being of similar size, it has limbs, claws and a tail like *Archaeopteryx*, and it pre-dates its rival by about 10 million years.



Family tree

Birds are the dinosaurs that didn't go extinct. An incomplete fossil record for the transition means that each new fossil discovery can reshuffle the evolutionary order. Watch this space.