PALEONTOLOGY

# Dinosaur Fossils, in Fine Feather, Show Link to Birds

Paleontologists seeking to trace the evolution of reptiles into birds have long been hunting a strange beast: a feathered dinosaur. Such a creature, they say, would prove once and for all what many researchers already believe: that the dinosaurs didn't die out completely but instead took wing and evolved into what we now call birds. Two years ago a chicken-sized dinosaur with featherlike filaments bristling along its back raised hopes, but researchers couldn't agree that the bristles were really feathers, and the debate simmered on (*Science*, 1 November 1996, p. 720, and 14 November 1997, pp. 1229 and 1267).

Now, a team of Chinese, Canadian, and American paleontologists claims that in rich fossil beds in China they have discovered the real thing—dinosaurs with feathers. In reports in this week's issue of *Nature* and the July issue of *National Geographic*, they describe two species of turkey-sized theropod (meat-eating) dinosaurs that have unmistakable feathers fanning out from their forearms and tails. "You can't get around the fact that these are feathers on dinosaurs," says Philip J. Currie, a paleontologist at the Royal Tyrrell Museum of Palaeontology in Drumheller, Alberta, a co-author of the papers. These fossils "provide the best evidence to date that birds were derived from theropod dinosaurs," says Peter Wellnhofer, a paleontologist at the Bavarian State Collection of Paleontology and Historical Geology in Munich. The plumage on these flightless creatures also suggests that feathers did not evolve for flight but were first used for insulation, display, or some other purpose.

Such claims ruffle the feathers of a small band of doubters, who believe the ancestors of birds branched off from the reptiles before dinosaurs appeared. The feathers are real enough, says Larry D. Martin, a paleontologist at the University of Kansas, Lawrence—but they just show that the creatures are birds, not dinosaurs. "I think they've found a group of flightless birds," he says.

The new finds come from a site in rural Liaoning Province of northeast China—a place being called a paleo-Pompeii, where millions of birds, dinosaurs, fish, insects, and plants died suddenly, sometime between 120 million and 135 million years ago (*Science*, 13 March, p. 1626). Over the past year and a half, local collectors brought three new specimens with distinct feathers to paleontologist Ji Qiang, director of China's National Geological Museum in Beijing and lead author of the *Nature* report. At first, says Ji, he and co-author Ji Shu-an, also of the National Geological Museum, were struck by the resemblance of the fossils to *Archaeopteryx*, the 150-million-year-old Bavarian fossil long considered the first bird. They thought all of the fossils were a single new species, *Protoarchaeopteryx*. But as they examined the specimens with Currie last fall, they realized that two of the fossils had much shorter arms and longer, sharper teeth with deeper roots than the others. They named this second creature *Caudipteryx zoui*: *Caudipteryx*, or "tail feather," for its long tail plumes, and *zoui* after Zou Jiahua, vice premier of China, an avid research supporter.

PHOTOS: O. L. MAZZATENTA / NATIONAL GEOGRAPHIC SOCIETY

**True feathers.** Fossils of *Caudipteryx (above)* and *Protoarchaeopteryx (right)* show modern feathers, linking them to birds.

Unlike the first purported dinosaur with feathers—a species called *Sinosauropteryx* from the same beds—both new species have "unambiguous" feathers, says Mark Norell, a paleontologist at the American Museum of Natural History and another co-author. "These are just like feathers in modern birds," he says. The fossils clearly reveal both downy feathers and more advanced modern feathers, with visible internal structures, including the vane or web-like portion of the feather, with barbs and barbules on either side of the shaft.

Although the feathers link these creatures to birds, their bodies tie them to theropods, the researchers say. *Caudipteryx*, in particular, resembles the vicious *Velociraptor* of *Jurassic Park* fame. Norell rattles off several features that make the link—short arms, serrated teeth, a theropodlike pelvis, a bony bar behind the eye. The researchers scored the new fossils for 90 characters, he says, and found that *Caudipteryx* and *Protoarchaeopteryx* are most closely related to theropod dinosaurs, sitting on a branch of the dinosaur family tree between *Velociraptor* and *Archaeopteryx*.

Most paleontologists who have seen photos of the fossils agree with that ancestry. "There's no doubt that they are more primitive than *Archaeopteryx*," says Wellnhofer, an *Archaeopteryx* expert who has seen a fossil of *Protoarchaeopteryx*. "Now, we have a fundamental problem of how can we tell a bird apart from a dinosaur?" Feathers are no longer a defining trait of birds, points out Kevin Padian, a paleobiologist at the University of California, Berkeley, who wrote a commentary on the fossils for *Nature*.

The dinosaurian origin of feathers is "the most amazing thing about the discovery," says Padian. "Now we can chart the evolution of feathers and how the flight apparatus was assembled and refined." Because the feathered arms of these animals were too short to work as wings, it seems that feathers did not evolve for flight. "The first feathers were used for warmth, balance, or courtship display," Ji suggests. "The ability for flight came later."

But Martin and other skeptics still think that where there are feathers, there are birds. Martin cites features such as a shortened tail and an ossified sternum to argue that both new species are more birdlike and advanced than *Archaeopteryx*. In his avian family tree, the Chinese fossils are the flightless descendants of earlier birds that could fly—the same ancestral birds that also gave rise to *Archaeopteryx* and modern birds. He notes that the timing is right for this, as the new fossils are some tens of millions years younger than *Archaeopteryx*.

Norell and Currie counter that it's not unusual for a more primitive animal to survive as a sort of "living fossil" for many millions of years. And an overwhelming number of characters place these specimens with theropods, not birds, they say. In fact, similar analyses had already convinced most paleontologists that dinosaurs gave rise to birds. "The question was settled for me a while ago," says Wellnhofer. "But it's always nice to have another piece of evidence."

–Ann Gibbons