A Fowl Fight

Fossil finds recharge debate about birds and dinosaurs

By RICHARD MONASTERSKY

Although the rules of decorum forbid well-mannered folk from playing with their food, the 19th-century naturalist Thomas Henry Huxley happened on an important clue about bird evolution while picking apart the drumstick of a chicken.

After dismantling the leg of a Dorking fowl, a breed of English chicken, Huxley realized that the bones he was holding bore an uncanny resemblance to the ankles of fossilized dinosaurs, which were starting to grab scientists' attention at that time.

The Dorking fowl's anatomy so closely matched the dinosaurs' that if the bird bones "were found in a fossil state, I know not by what test they could be distinguished from the bones of a dinosaurian," Huxley told his peers at the Geological Society in London in an 1869 address. Faced with these and other similarities of the pelvis and hind limbs, he theorized that dinosaurs were the closest known relatives of birds. They were "the Animals which are most nearly intermediate between Birds and Reptiles."

For Huxley, this discovery dovetailed with the new theory of evolution proposed by his friend Charles Darwin. The dinosaurs represented a transitional form, helping to explain how birds could have evolved from reptiles.

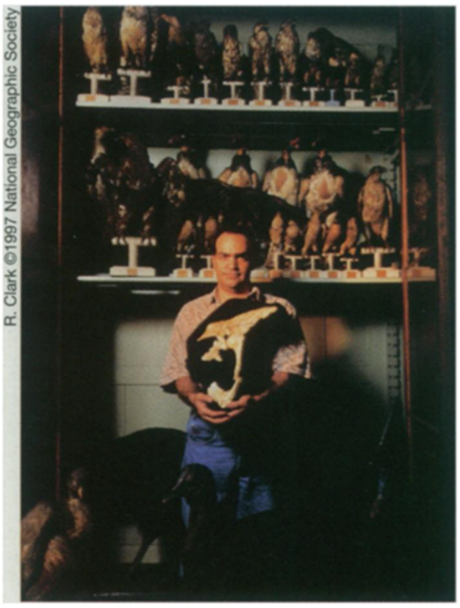
Today, a new clutch of fossil finds is bolstering Huxley's venerable theory. Discoveries around the world are filling in missing pieces of the evolutionary line connecting dinosaurs and birds, according to the scientists who have unearthed these fossils.

Critics of the dinosaur-bird link have launched a counterattack, trying to pull apart the evidence that has amassed since Huxley's day. "The dinosaurian origin of birds is, in my opinion, a delusional fantasy," says Alan Feduccia, an ornithologist at the University of North Carolina at Chapel Hill.

The issue of bird origins continues to occupy center stage among scientists because these animals differ in so many ways from their flightless antecedents, making avian evolution a critical problem to solve. "The leap from some kind of reptile to birds was enormous. Birds are the most unique group of vertebrates from just about every standpoint. They are strange," says Ned K. Johnson, an ornithologist at the University of California, Berkeley.

Contrary to popular wisdom, the dinosaurs never went extinct, according to most paleontologists. We see dinosaurs all the time, flocking in trees and fouling cars with their droppings. In the currently accepted interpretation, birds rank as a specialized subcategory of dinosaur.

The classification seems ridiculous if one imagines a modern swallow perched on the giant skeleton of *Tyrannosaurus rex*. Back in the Jurassic period, however, birds bore a closer resemblance to dinosaurs. The oldest known bird, *Archaeopteryx*, had long reptilian tailbones, a mouthful of teeth, sharp claws on its forelimbs, and the long legs of a runner. Modern birds lack most of these features.



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Fernando Novas shows off the pelvic bones of Unenlagia, *which he claims is the most birdlike dinosaur known.*

Paleontologists have noted some 200 anatomical features shared by birds and dinosaurs—far more than the number of similarities linking birds to any other type of reptile, ancient or living. For that reason, they categorize *Archaeopteryx* and all later birds as feathered dinosaurs.

When scientists draw the dinosaur family tree, they perch birds on a big branch belonging to the theropods—the group that includes *T. rex* and other predators that walk upright on two feet. On a more detailed level, birds reside among a specialized group of theropods, known as maniraptorans, which includes *Velociraptor*—one of the stars of *Jurassic Park* and *The Lost World*.

Paleontologists who subscribe to the bird-dinosaur theory view *Archaeopteryx* as a missing link that provides a critical glimpse into the process of bird evolution. Yet the fossil species represents only one step in what must have been a long journey from ground-dwelling maniraptorans to wrens, ravens, and roadrunners.

Two Argentinean paleontologists now claim to have identified another key stage in this evolutionary sequence. In January 1996, Fernando E. Novas of the Museo Argentino de Ciencias Naturales Bernardino Rivadavia in Buenos Aires and Pablo F. Puerta of the Museo Paleontológico Egidio Feruglio in Trelew unearthed a new type of dinosaur from 90-million-year-old rocks.

Novas and Puerta, who reported their discovery in the May 22 NATURE, have found only fragments of the animal, mainly pelvis, leg, and shoulder bones. Even with such meager pieces, the dinosaur skeleton looks remarkably birdlike, say the scientists. They named it *Unenlagia camahuensis*, which means "half-bird from northwest Patagonia."

Unenlagia was a small maniraptoran predator about 2.3 meters long. Unlike other dinosaurs, it had a shoulder joint that pointed outward, which enabled the animal to fold its arms like a bird, says Novas. It could also have raised its arms in a manner similar to the flight stroke of a bird's wings. Other maniraptorans had forward-pointing shoulder joints, which made their arms hang down in front in an unbirdlike manner.

With its big body and small arms, *Unenlagia* could not have flown, says Novas. He speculates that the animal may have held its arms out for balance while running. "Skaters and surfers use their arms to keep their equilibrium. Probably this is how the animal used its forearms."

Although *Unenlagia* remained firmly on the ground, its peculiar anatomy indicates that some maniraptoran dinosaurs evolved a birdlike shoulder joint long before it became useful for flight. Paleontologists consider this feature a preadaptation—a specialization that would later permit relatives of *Unenlagia* to evolve the full range of motion of a bird's wings.

The avian similarities extend to *Unenlagia*'s hindquarters, where it has a prominent bump on the ischium, one of the bones of the pelvis. These characteristics, combined with others, make *Unenlagia* the most birdlike dinosaur yet discovered, says Novas.

The find has impressed other paleontologists as well. "Fernando is filling in a little more of the gap, getting a little closer to *Archaeopteryx*. This thing is closer to birds than anything we've seen before," says Jacques Gauthier of Yale University.

Unenlagia may not hold that position for long. A fossil from Madagascar appears to lie closer to the origin of birds than any other animal found thus far, save *Archaeopteryx*. Data on the fossil have not yet been published.

During an expedition to Madagascar in 1995, Catherine A. Forster of the State University of New York at Stony Brook and her colleagues unearthed the bones of a raven-size creature that lived at the end of the Cretaceous period, roughly 75 million years ago. They identify the animal as a bird because one of its arm bones has characteristic knobs where flight feathers would have been attached. It also has a reversed first toe, a characteristic of birds unknown in any other type of theropod dinosaur, says Forster.

In other respects, the Madagascan bird looks remarkably like a typical maniraptoran dinosaur, from its long bony tail to the arrangement of its lower leg and foot bones. The animal's most striking feature appears on its second toe, which has a retractable, sickle-shaped claw three to five times the length of its other claws. This formidable weapon looks like a miniature version of the claw on the second toe of *Velociraptor* and some other maniraptorans.

The slashing claw, which does not appear on any other bird, provides a key clue to avian origins, says Forster. "This is a remnant which shows exactly where birds came from. It shows the link really clearly between birds and theropods."

Forster and her colleagues rank the recent find as a primitive bird, evolutionarily closer to *Archaeopteryx* than to any other known dinosaur or bird.

The list of fossils at the transition between dinosaurs and birds will grow even longer with the addition of recent finds in China. Last year, scientists there announced the discovery of a dinosaur with strange, downlike structures on its back that may be the precursors of feathers (SN: 5/3/97, p. 271). The same site in northeast China has yielded a rock slab holding a different dinosaur next to some feathers, raising questions about whether the two go together. Although scientists have not yet published studies of these new finds, supporters of the bird-dinosaur theory are touting them as evidence in their corner.

The claims made for all these new fossils don't fly with critics of the bird-dinosaur hypothesis. Larry D. Martin, for instance, argues that the Madagascan creature is actually a typical dinosaur. The arm bones, with their evidence of feathers, may well belong to indisputable bird fossils that were found near the new creature. Moreover, he saw no evidence that the first toe was reversed when he viewed the specimen for a short time last year.

"I thought it was a dinosaur. It did not strike me that there were any avian features," says Martin, a paleontologist at the University of Kansas in Lawrence.

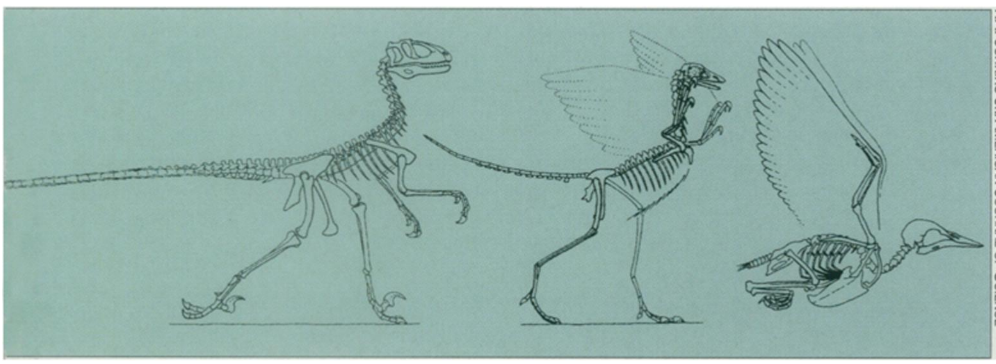
Martin also dismisses the claims made about *Unenlagia*. "It is just a dinosaur, as far as I can see. The forelimbs are not birdlike," he says, although he cautions that he has not seen the actual specimens.

For Feduccia, part of the problem with *Unenlagia* and other so-called birdlike dinosaurs is that they come too late to address avian evolution. He calls this the "time paradox." *Unenlagia* lived almost 60 million years after *Archaeopteryx*; other birdlike maniraptorans lived no closer than 25 million years, he says. Yet the earliest birds must have originated well before the late Jurassic, when *Archaeopteryx* lived.

The absence of maniraptorans in the Triassic and early Jurassic periods argues against their role in bird origins, says Feduccia. He explains away the birdlike characteristics of some dinosaurs as a matter of convergent evolution—when two distinct lines of animals evolve superficially similar features, as dolphins and sharks have done.

His argument about convergence strikes a familiar chord. A critic of Huxley's raised the same point in 1869, wondering whether birds and dinosaurs looked alike because they walked upright on their hind legs.

Instead of searching for avian origins among the dinosaurs, Feduccia argues that birds evolved from much smaller reptiles that lived in trees during the Triassic. These four-footed animals originally jumped between branches and eventually evolved wings that helped in gliding. This tree-down approach makes more sense than the idea of a running dinosaur evolving flight from the ground up, argues Feduccia in his book *The Origin and Evolution of Birds* (1996, New Haven: Yale University Press).



All in the family? Paleontologists see many skeletal similarities between maniraptoran dinosaurs (left), Archaeopteryx *(middle), and a starling (right).*

Many paleontologists accuse Feduccia of sending up a smoke screen with his arguments about the time paradox. First, they note that some researchers have described fragments of birdlike dinosaurs that actually predate *Archaeopteryx*, although these pieces are incomplete. Second, they say that *Unenlagia* and other maniraptorans represent long-surviving vestiges of a transition that took place much earlier. During their day, these dinosaurs were living fossils, much like the modern platypus, says Lawrence M. Witmer, an evolutionary biologist at Ohio University in Athens.

In many ways, the argument boils down to differences in method. Most paleontologists today derive evolutionary relationships through cladistic analyses, which link animals that share many specialized traits not present in other groups. Because birds and dinosaurs have so many similar body parts, cladistic studies paint them as close relatives.

Feduccia, Martin, and others argue that practitioners of cladistics tend to place too much weight on superficial similarities and consequently get befouled by convergences in evolution. A classic example is the moon-shaped bone in the wrists of dinosaurs and birds, says Martin. Although they look alike, the bones develop from completely different wrist bones during the growth of the young animal. Thus, birds and dinosaurs must have evolved this trait separately, and it provides no information about evolutionary relationships, claims Martin.

The argument over similarities and convergences has raged since Huxley stood up to give his lecture, and it gives no evidence of subsiding.

"Most of the scientific community has accepted the fact that birds are related to dinosaurs," says Witmer. "But even though I'm part of the major consensus, I don't think that consensus tells us anything. A very small minority of people may, in fact, be right. We have to look at the evidence."

To that end, paleontologists will keep searching for transitional fossils to help explain how birds first took wing. □