PALEONTOLOGY

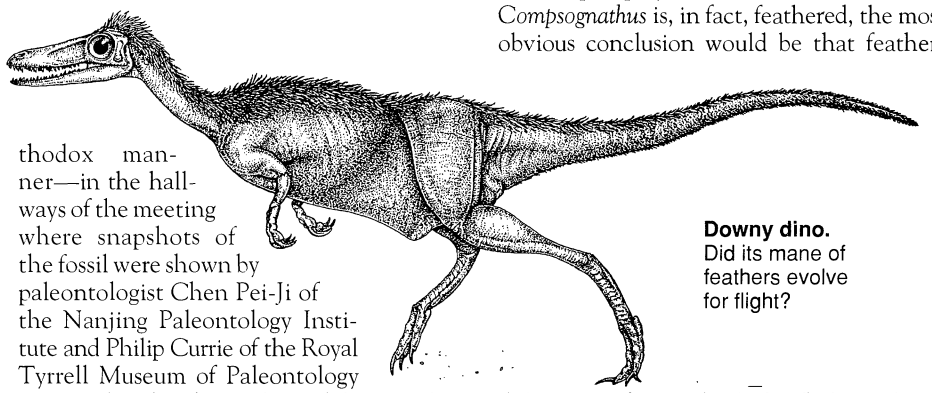
New Feathered Fossil Brings Dinosaurs and Birds Closer

NEW YORK—When Yale University paleontologist John H. Ostrom proposed in *Nature* in 1973 that dinosaurs gave rise to birds, his view got a cool reception. He wrote that his study of the bones of *Archaeopteryx*, the oldest widely accepted bird, had convinced him it had inherited many features directly from a small carnivorous dinosaur. Although the theory of a dinosaurian origin for birds was not new—British biologist Thomas Henry Huxley had first proposed it in 1868—it had been dismissed in favor of the idea that birds evolved from reptiles that preceded dinosaurs.

So, when Ostrom saw photos last month of a newly discovered fossil dinosaur from China that looked like an important missing link between birds and dinosaurs, he felt vindicated. Along its neck, back, and tail, the small, 121-million-year-old dinosaur appears to have a mane of downy feathers—a feature until then seen only in birds. "I never expected to see such compelling evidence that birds derived from dinosaurs," says Ostrom, who saw the photos at the Society for Vertebrate Paleontology meeting here.*

The Chinese find is one of a series of new fossils from the Cretaceous period that is tightening the link between dinosaurs and birds. Though the feathered dinosaur may turn out to be too good to be true—there are questions about whether it really did have feathers, and it has yet to be formally described in a scientific journal or even a lecture—a flock of other new fossils reported at the meeting, from Madagascar, Spain, and Argentina, provides further evidence that dinosaurs were at the root of the avian family tree. This gallery of missing links, which includes birds with dinosaurian claws and skulls and featherweight dinosaurs with bird-like pelvises and shoulders, also holds clues about how early birds got off the ground and perfected flight. "This has been a good year for finding fossils that tell us about the origin of birds," exulted Luis Chiappe, a paleontologist at the American Museum of Natural History.

Most paleontologists now embrace the theory that birds evolved from dinosaurs, but a vocal minority still questions it. And unfortunately, the fossil that could provide the strongest support is the one for which details are most sketchy—the Chinese dinosaur. Its discovery was revealed in an unorthodox manner—in the hallways of the meeting where snapshots of the fossil were shown by paleontologist Chen Pei-Ji of the Nanjing Paleontology Institute and Philip Currie of the Royal Tyrrell Museum of Paleontology in Canada. The photos showed the complete skeleton of a dinosaur splayed out on a mudstone slab, with a dark line running down its neck and backbone. On close inspection, the line shows the impression of feather-like features about a half-centimeter long, says Currie. "You could see at the nape of the neck something that looks like downy feathers with a central stem, or rachis."



Downy dino. Did its mane of feathers evolve for flight?

MICHAEL WILLIAM SKREPNICK

But confirming whether the impressions are feathers, scales, or something else may prove to be difficult. The fossil was discovered last summer in the Yixian Formation in China's rural Liaoning Province. The farmer who found it sold it in two parts to rival institutes—the Nanjing Paleontology Institute and the Chinese Geology Museum in Beijing. Although it has been named *Sinosauropteryx prima* by Ji Qiang, director of the Chinese Geology Museum in Beijing, as yet, neither group has published or presented a formal description of the fossil.

Currie got lucky: He was in China studying other dinosaur fossils when a Chinese colleague invited him to see the Nanjing half of the feathered fossil on 25 September. But other paleontologists have had to satisfy their curiosity by examining Pei-Ji's and Currie's photos. What they have seen suggests that it is a close relative of *Compsognathus*, a chicken-sized dinosaur belonging to the group of carnivorous dinosaurs known as coelurosaurian theropods—the same group that Ostrom argued in 1973 gave rise to birds. According to new dates on the Yixian sediments reported by University of Toronto scientists at the meeting, the Chinese fossil is too recent—121 million years old—for the dinosaur to have given rise to the 150-million-year-old Jurassic bird, *Archaeopteryx*. But if it does have feathers, it could be a descendant of the dinosaur that gave rise to birds, says Ostrom.

Peter Wellnhofer, an expert on *Archaeopteryx* from the Paleontological Museum in Munich, concurs. It is unlikely that a feature as unusual as feathers evolved twice, he says.

The confirmation of feathers on a dinosaur would also shed new light on a long-standing debate among paleontologists over whether feathers evolved for flight, warmth, courtship display, or some other reason. If the *Compsognathus* is, in fact, feathered, the most obvious conclusion would be that feathers didn't arise first in birds for flight. Paleontologist Robert Bakker of Casper College in Wyoming has proposed that dinosaurs were warm-blooded and that downy feathers first appeared in some of them to trap body heat. Others such as Wellnhofer caution, however, that even if the feathers are real, they didn't necessarily evolve for warmth. They also might have been part of the animal's adornment for attracting mates.

But these ideas on the evolution of feathers are, well, for the birds, according to University of North Carolina ornithologist Alan Feduccia, the best-known critic of the theory that dinosaurs gave rise to birds. He sees no proof that the dinosaur had feathers and doubts that any will be forthcoming. Feathered wings were "the most complex appendage produced by vertebrates," he says; it's implausible that an animal would have developed feathers if it did not fly.

But even if the feathered dinosaur turns out to be a chimera, the bird-dinosaur link is getting other support. A 75-million-year-old bird from Madagascar sports a distinctive foot with a "wicked looking claw" like that of a dromeosaur dinosaur such as *Velociraptor*, say vertebrate paleontologists Catherine Forster and David Krause of the State University of New York, Stony Brook, who discovered the turkey-sized bird. Although it lived more recently than *Archaeopteryx*, it shares so many features with *Archaeopteryx*, such as a reversed first toe, that it must be closely related.

And paleontologist Fernando Novas of the Argentine Museum of Natural Sciences has found a dinosaur with a remarkably bird-like shoulder and upper arm. Novas reported that a late Cretaceous (about 90 million years old) dromeosaurid in Patagonia has a shoulder and upper-arm bone that could have been tucked into the body like a wing. Forster adds that the shape of its pelvis also looks like that of the bird from Madagascar.

The skeletal similarities of these birds and

*Fifty-sixth Annual Meeting of the Society of Vertebrate Paleontology, American Museum of Natural History in New York City, 16–19 October.

dinosaurs offer clues to another paleontological mystery—how the first birds got off the ground. Perhaps, says Chiappe, what started as predatory movements of the arms of a dinosaur like the one in Patagonia eventually evolved into flapping that was rapidly refined into modern flight.

Yet another fossil described at the meeting, a fledgling bird the size of a sparrow that lived briefly in Sierra del Montsec, Spain, about 130 million years ago, is offering a glimpse of how flight was perfected. Like *Archaeopteryx*, this sparrow-sized creature had a primitive, dinosaurian skull, with a depression between its eye socket and brain case, reported Chiappe, who has studied the bird with a team from the University Autonoma of Madrid. But unlike *Archaeopteryx*, which had a short, primitive wing, this small, Spanish bird and its closest cousins probably had a longer, more sophisticated wing with the beginnings of a "slot"—the set of quill-like feathers that allows modern birds to maneuver better at slower speeds (*Nature*, 1 August, p. 442). "This is exciting because you see that in the early evolution of birds, the flight apparatus was a priority," says Chiappe.

The new findings haven't swayed Feduccia or University of Kansas paleontologist Larry Martin, another skeptic of the bird-dinosaur link. Says Feduccia: "It's biophysically impossible to evolve flight from such large bipeds with foreshortened forelimbs and heavy, balancing tails"—exactly the wrong anatomy for flight. And as for the suite of other strange-looking characters that link dinosaurs and birds, Martin says that they could have been inherited from an ancient reptilian ancestor that gave rise to both dinosaurs and birds. "In my opinion, the theropod origin of birds will be the greatest embarrassment of paleontology in the 20th century," says Feduccia.

But to Ostrom, who 23 years ago breathed new life into the theory that dinosaurs gave rise to birds, the wealth of new fossils speaks for itself: "I'm satisfied I know where birds have come from."

–Ann Gibbons

MAD COW DISEASE

Protein Test Favors BSE-CJD Link

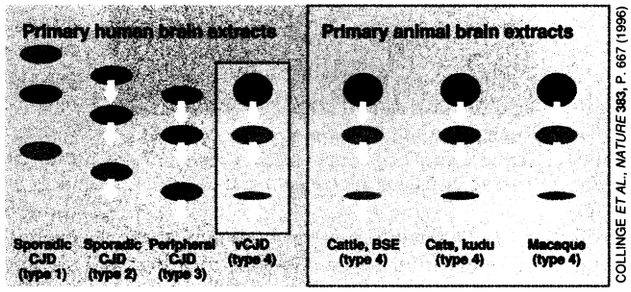
LONDON—"Beef blamed for CJD deaths" ran the front-page headline in the London *Times* on 24 October, after British scientists published the first evidence of biochemical similarities between recent anomalous cases of Creutzfeldt-Jakob disease (CJD) in humans and bovine spongiform encephalopathy (BSE) in cows, mice, and other animals. By analyzing the proteins thought to transmit these degenerative diseases of the brain, researchers had shown that the new variant of the human disease, known as vCJD—which has now struck 14 young people since 1994—resembles BSE more closely than classical CJD.

The new work, which appeared in last week's *Nature*, strengthens the case that beef infected with BSE, or "mad cow disease," is the cause of vCJD, but scientists do not think the link has yet been proved. They see the British team's success at chemically characterizing BSE and four strains of CJD as a milestone of a different kind. "The important result is that [vCJD] can be diagnosed" by applying this technique, says neurovirologist Corinne Lasmézas of France's Atomic Energy Commission (CEA) in Fontenay-aux-Roses.

Suspicions of a BSE-CJD link first surfaced last March, when British government scientists who monitor CJD spotted 10 cases of the disease in people under the age of 45. CJD normally afflicts only the elderly, and in all 10 of the new cases the pattern of brain damage, or neuropathology, was different from the usual CJD pattern (*Science*, 29 March 1996, p. 1798). The search was on for further evidence that the new vCJD might in fact be a human BSE infection.

The test, developed by John Collinge's team at Imperial College Medical School at St. Mary's Hospital, London, provides what virologist Clarence Gibbs of the U.S. National Institutes of Health (NIH) in Bethesda calls "the second piece of evidence suggesting a link." It does so by giving biochemists a way to differentiate chemically between different strains of CJD, BSE, scrapie in sheep, and related diseases—something that has been impossible until now.

The infectious particle responsible for these diseases seems to be an abnormal form of a naturally occurring protein, dubbed a prion (*Science*, 12 July 1996, p. 184). Prions apparently lack DNA or RNA, which can be decoded to indicate the strain of infection if the agent is a virus or a bacterium. What's more, the basic chemical makeup of prions causing different strains of the same disease is identical. Prion researchers have proposed instead that the different strains reflect differences in the protein's shape, which current techniques cannot distinguish.



COLLINGE *ET AL.*, *NATURE* **383**, P. 667 (1996)

Spot check. Collinge's test shows clearly that the pattern of prion masses in new variant CJD mirrors that of BSE.

Collinge's team, extending a method that had previously shown a distinction between two "normal" CJD strains, examined how many sugar groups are attached to the prion proteins. They extracted prion proteins from infected brains and separated them by mass on a gel. Classical CJD material produces a characteristic pattern of three bands, corresponding to prions with no attached sugar groups, with one, or with two. The researchers identified three variations on this three-band pattern, but in each case prions with one attached sugar group predominated.

The team then analyzed samples from the first 10 vCJD cases and found a fourth pattern in which prions with two sugars were the most common. When the scientists later ran samples of brain from BSE-infected cattle, mouse, cat, and monkey, they displayed an almost identical two-sugar pattern. "It's the most suggestive evidence so far" of a link between the animal and human diseases, says biochemist Byron Caughey of the NIH Rocky Mountain Laboratory in Montana.

But the welcome for the new test has not been unanimous. "It's a very interesting suggestion that the [sugar] pattern is common, but I don't know how strong that evidence is," says Pierluigi Gambetti at Case Western Reserve University in Cleveland, Ohio. Vindication of Collinge's results will have to wait until the only other method of identifying strains yields results. It involves injecting infected brain material into mice, then comparing the incubation time and neuropathology when the animals come down with the disease. This experiment, now under way at the Neuropathogenesis Unit of the Institute of Animal Health in Edinburgh, "will furnish a much more persuasive view" of BSE-vCJD similarities, says Paul Brown of the NIH Laboratory of Central Nervous System Studies in Bethesda. Gibbs agrees: "We're all awaiting the outcome."

Collinge is now looking at whether the test could be applied to tissues other than brain, such as the tonsils and lymph nodes, making it easier to acquire samples while the patient is alive. If the work leads to a test able to detect the disease early on, he says, "we should think seriously about developing therapeutics."

–Claire O'Brien

Claire O'Brien is a writer in Cambridge, U.K.