

reforms,” Zheltikov says. “Among all three candidates,” Khokhlov adds, “Fortov has formulated the clearest program that emphasizes the necessity for changes in the Russian Academy of Sciences.”

Fortov faces an uphill struggle to persuade Livanov to grant him time to reform RAS from within. “During the election campaign, Fortov repeatedly emphasized that relations with the ministry have to be normalized,” Khokhlov says. Livanov, like his predecessors in the administrations of Vladimir Putin and Dmitry Medvedev, dislikes the academy’s independence and emphasis on basic

research; he wants more research that is relevant to industry. To an extent, Fortov agrees. In his electoral program he states: “the Academy must actively and in various ways participate in the creation and implementation of large-scale targeted programs for the benefit of the state, education, and business.”

During the campaign, Fortov suggested that young scientists should be offered contracts of 3 to 5 years—instead of the current RAS system guaranteeing lifetime employment—“to create a competitive environment and raise the mobility” of researchers. Fortov says he will ensure that

scientists get paid as much as twice the average salary of all workers in the region in which an institute is based, and provide emeritus scientists with “decent conditions for life and work.” To shake up the ossified management, Fortov has proposed limiting senior RAS officials, including the president, to two 5-year terms in office.

“By any measure,” Zheltikov says, Fortov “is the right person at the right time to do the job—to find the right tone, lead a dialogue, and work out the right solutions.”

—VLADIMIR POKROVSKY AND DANIEL CLERY
Vladimir Pokrovsky is a writer in Moscow.

PALEONTOLOGY

Authenticity of China’s Fabulous Fossils Gets New Scrutiny

Last week, when paleontologists unveiled a fossil purporting to be the earliest known bird, media outlets rapidly spread the news. Most relayed the team’s contention, published in *Nature*, that the 160-million-year-old fossil from China dubbed *Aurornis* “resolves” long-standing controversies about the early evolutionary history of birds, which nearly all researchers now believe descended from feathered dinosaurs.

But the picture is murkier. Few media reports noted that *Aurornis*, or “dawn bird,” had not been found during the team’s excavations in China, but had been acquired from a fossil dealer. This key information was not in the main body of the *Nature* paper, but rather in online supplementary information (SI) that accompanied it. The authors acknowledge the possibility that the specimen may be 35 million years younger than reported; they are conducting additional tests to verify its provenance.

Suspicious dog any specimens from the fabulous fossil fields in northeast China’s Liaoning province, where *Aurornis* and dozens of other new species of feathered dinosaurs and early birds have been found over the past 15 years. Some of the country’s leading paleontologists have been outspoken about a growing number of fake and composite specimens from Liaoning and other fossil-rich areas of China (*Science*, 24 December 2010, p. 1740). “This is a big concern,” says Zhou Zhonghe, director of the Institute of Vertebrate Paleontology and Paleoanthropology (IVPP) in Beijing. “Illegal and unscientific collecting and commercial trading,” he says, have flooded the market with fake fossils and caused an “irretrievable loss” of crucial information, such as where authentic fossils came from

and how old they really are.

Many scientists in Western countries have been slow to express concern about the provenance of Chinese fossils, possibly to avoid antagonizing Chinese colleagues. But the publication of *Aurornis*, the latest of a flurry of recent papers in *Science* and *Nature* describing fossils purchased from Chinese commercial dealers or acquired from collectors, has emboldened several leading Western paleontologists to speak their minds.

“We usually think of guns and drugs when we think of the black market, but there is a black market for fossils, too, and China is an epicenter,” says Stephen Brusatte, a paleontologist at the University of Edinburgh in the United Kingdom. “Some of these fakes are masterful.” Kevin Padian, a paleontologist at the University of California (UC), Berkeley, says that researchers should be prepared to

subject any fossil of uncertain provenance to extra tests, such as computed tomography (CT) scanning, to prove that specimens are genuine. “We have experienced scientists squawking when the integrity of their specimens has been impugned, but sometimes the suspicions have been vindicated,” he says.

An infamous case is “Archaeoraptor,” billed in *National Geographic* in 1999 as a “missing link” between dinosaurs and birds. “Archaeoraptor was a clumsy fake,” says Timothy Rowe, a paleontologist at the University of Texas, Austin, who led the team that cracked the case. But that conclusion came only after extensive forensic examination. High-resolution x-ray CT revealed that what at first appeared to be a complete skeleton was a mosaic of 88 separate pieces mounted onto a shale slab and glued into place with builder’s grout.



True or false? A Beijing-based paleontologist checks a fossil in a dealer’s shop in Liaoning province.

CREDIT: R. STONE/SCIENCE

“Authentication is not easy,” says Lawrence Witmer, a paleontologist at Ohio University in Athens. “High-quality fossil forgeries can fool paleontologists just as easily as forgeries in the art community.” Luis Chiappe, an early bird expert at the Natural History Museum of Los Angeles County in California, says that he will “always be skeptical of any specimen that is so neatly arranged, so well preserved in a single slab with little bone missing.” *Aurornis*’s exquisite preservation should raise eyebrows, Chiappe asserts, although he stresses that he has no evidence to suggest that it is not authentic. The fossil trade in China “is not a black-and-white story,” he adds, because “we’ve benefited enormously from specimens acquired in this way,” even if important information about where the fossils came from is lost.

The economy of Liaoning province has also significantly benefited, Chinese and Western scientists point out, because local farmers—who vastly outnumber paleontologists—have become better and better at finding fossils and working with intermediaries and dealers to create composites that can be sold for higher prices. “We can’t blame the farmers for this,” Padian says. “It’s money.”

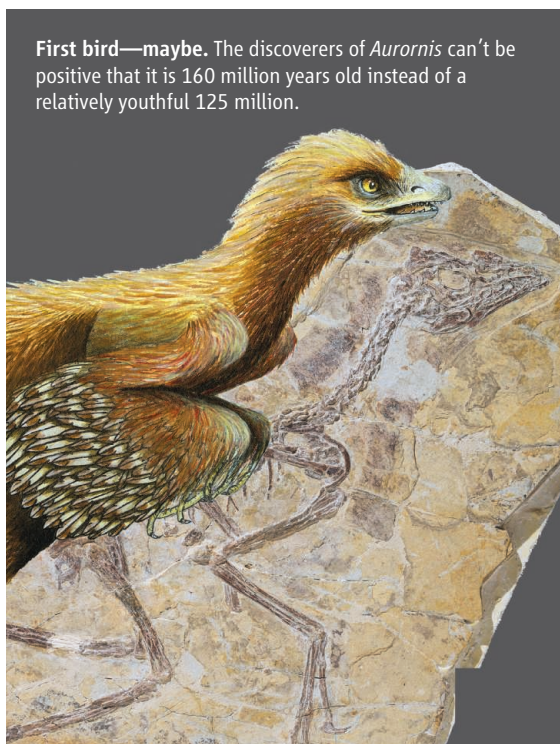
Indeed, says IVPP paleontologist Deng Tao, creating composite fossils has become a small-scale industry in fossil-rich areas of China. “I have personally seen these composite fossils being constructed in workshops or little factories” across several counties in Gansu province, Deng says. “In each workshop, there are bones on shelves like parts in factories.”

Museums and other institutions often get fooled by specimens that turn out to be too good to be true. Or, with genuine fossils, they can’t be sure where the specimens came from. “In China this is especially bad,” says Paul Sereno, a paleontologist at the University of Chicago in Illinois. “There are so many [layers] that are beginning to yield ... fossils across 50 million years of time and a half dozen provinces. There can be as many as 20 specimens of a well-known and named taxon, and yet scientists may be in the dark” about what time period they are from.

For example, the team that reported *Aurornis*, led by paleontologist Pascal Godefroit of the Royal Belgian Institute of Natural Sciences in Brussels, is not entirely

sure whether the fossil came from Liaoning province’s 160-million-year-old Tiaojishan Formation, as the information provided by the fossil dealer indicated, or from the province’s 125-million-year-old Yixian Formation, the mother lode of many other ancient bird fossils. Most other specimens acquired from dealers have similarly uncertain ages, researchers say.

Godefroit and his co-workers acknowledge the possibility that *Aurornis* may have come from Yixian. He says that his team is trying to confirm the specimen’s provenance using botanical and mineralogical tests on the shale slab that it is embedded in and



First bird—maybe. The discoverers of *Aurornis* can’t be positive that it is 160 million years old instead of a relatively youthful 125 million.

that the results of these tests will be published later. Godefroit adds that x-rays and CT scanning reveal no evidence that the fossil was forged, although these data were not included in the *Nature* paper’s SI.

Journals take different approaches to fossil origins. Recent *Nature* reports on feathered dinosaurs and early birds have included at least a minimum of provenance information, as that journal’s rules for authors require, but some papers in *Science* have left it out. For example, the publication earlier this year of 11 specimens of early birds by the IVPP’s Xing Xu, one of China’s most successful dino hunters—a report suggesting that the earliest birds were biplanes that used all four limbs as wings (*Science*, 15 March, p. 1261)—did not include an acknowledgement that the specimens had

come from fossil collectors.

Andrew Sugden, *Science*’s deputy editor for biology, says that the journal’s instructions to authors do not require them to provide information about the provenance of fossils. “We may have to review” those policies, he says, and develop “an internal checklist or something of that kind.”

Xu says that researchers do not have to solely rely on the information that dealers and collectors provide. For example, before publishing a beautifully preserved skeleton of *Anchiornis*—a feathered dinosaur thought to have lived around the time of the dinosaur-bird transition—in *Nature* in 2009, Xu’s team organized a field trip to the site where a farmer claimed to have found it. During that expedition, the team found other specimens of *Anchiornis*, although none as complete as the original.

So what is to be done? Lacking a consensus, some researchers have developed innovative approaches to the problem. For example, Chiappe’s colleague Xiaoming Wang, a mammalian paleontologist at the L.A. County museum, says that the group he leads has worked out an arrangement with dealers “specifically trained to watch out for every specimen they buy and record exactly where it came from.” His team also instructs dealers to pass along the fossils, even if fragmentary, without altering them to enhance their value.

Some researchers say that more drastic steps are required. “Everything that has passed through commercial hands should be CT scanned” before it is published, Rowe insists, adding that the scans should be included in the SI or placed in a public repository. Some paleontologists agree that such a course has become necessary, at least for high-profile specimens on which major evolutionary claims are being based. “In the case of things like *Aurornis*, CT scanning is essential,” Brusatte argues. “Without it, there will always be lingering doubt that the specimen is genuine.”

But others think this is “going too far,” as Sereno puts it, and that it is impractical in many cases. “Most authors do not have access to a CT scanner of appropriate caliber,” says paleontologist Ryoosuke Motani of UC Davis, “and most institutions will be against making 3D data of their specimens available to everyone.” Witmer agrees: “Blanket policies about scanning all fossils probably aren’t workable.”

Until researchers hammer out a solution, controversies like the one over *Aurornis* are likely to become more frequent. The flood of fossil fakes, Wang says, “is going to haunt Chinese vertebrate paleontology for the next 100 years.”

—MICHAEL BALTER