tions, and controversies involving, among other things, fossils that have disappeared from its collections. But it has formidable assets: Some 57 fossil skeletons—including a prized 70-million-year-old, $10 million *Saurolophus angustirostris*—are each valued at $100,000 or more. These specimens are an important source of revenue for an institute where scientists earn only about $100 a month. For example, a recent Russian dinosaur exposition—featuring unique Permian fossils such as the only known *Estemmenosuchus uralensis* and the species-describing type specimen of *Scutosaurus karpinskii*—generated $105,000 for PIN during a 7-month show ending last May at the new City Museum in St. Louis.

Similar support came from a 4-year-long Great Russian Dinosaurs exhibition, organized in August 1993 by PIN, the Monash Science Centre in Clayton, Australia, and the Queen Victorian Museum in Tasmania. The exhibition, featured on the cover of *Time* magazine's Australia edition, "was put together by scientists, and the funds all flowed back into research and education in one way or another," says paleontologist Patricia Vickers-Rich, science-centre director. The activities, she says, have "definitely helped PIN survive."

Nauka will now get a share of such proceeds. A 21 October draft "framework" agreement calls for PIN and Nauka to develop "commercial usage of museum exhibits, objects from collections, from archives, and other unique materials," as well as to make for sale "reconstructions, copies, and casts" of "original paleontological samples," with Nauka taking a 15% cut. But the percentage in the final agreement—signed last December by PIN director Alexei Rozanov, Parin, RAS vice president Rem Petrov, and Pleiades president Alex Shustorovich—was not revealed, leading to speculation that it may be higher. "Rozanov called it a commercial secret," complains Masha Hekker, a PIN paleontologist and outspoken Rozanov critic who was dismissed last December and is now fighting her dismissal in court. Seven PIN scientists, including Hekker, wrote to the All-Russian Paleontological Society, saying that the Nauka deal "looks like the beginning of the privatization of collections and other property of the institute."

And one U.S. collaborator with PIN shares such misgivings. Charles Dean Pruitt, a self-employed mathematician who hooked up with PIN serendipitously in 1993 during a visit to Moscow, organized the St. Louis exhibit and is now negotiating with Nauka to organize shows early next year at the Kansas City Children's Museum and afterward at the Florida International Museum. Pruitt questions the need for Nauka to be involved: "It's unfortunate that the efforts of the existing team of specialists and experts at PIN are being duplicated." Income from the show, Pruitt says, "goes a long way to keep these people in science instead of selling pencils in a kiosk."

R. STONE

Showtime. Acting PIN director Igor Novikov (posing with *E. uralensis*) says Nauka deal will be "fruitful."

A subsequent agreement has fueled fears that institutes may get little revenue from some activities. As part of a joint program, PIN staff members earlier this year made two casts of a fossil of an ancient flightless bird called *Diatryma steini*. The casts were then sold for $5000 each to two German museums. Igor Novikov, who is acting director of PIN while Rozanov recovers from heart problems, says PIN's share was "almost 50%." Parin defends the figure, saying that PIN staff who made the casts "earned much more than their regular income" and that the money has helped the institute purchase materials to make its own cast. "No casts would have been made at all if it was not for the Nauka effort," says Parin.

PIN's top staff members seem to agree. "We have to follow the order of the presidium," Novikov says. "But the agreement also will be fruitful for our institute." Other key staff members have accepted Nauka as well. "We have to organize these exhibitions to support our research," says paleontologist Alexander Karhu, PIN's exhibitions supervisor.

Besides the Zoological Institute, Nauka has approached three other institutions. They are the Kunstkamera—a world-renowned collection of pathological specimens and medical oddities in St. Petersburg that was started by Peter the Great—and two Moscow outfits, the Botanical Garden and the Archaeological Institute. Kunstkamera director Chuner Taksami says he too opposes the deal on the table from Nauka.

Staff at these institutes are anxiously watching the showdown between ZIN and Nauka. But, with most Russian scientists and officials spending large chunks of the summer at their dachas, or summer homes, Potapov says the dispute won't be resolved until September at the earliest. That means Dima and other Russian scientific icons must wait a bit longer to find out who'll be profiting from their next public appearance.

–RICHARD STONE

MEETING MAMMALIAN EVOLUTION

New Views of the Origins of Mammals

HAYAMA, JAPAN—Paleontologists and molecular biologists take different approaches to questions of evolution and often come to different conclusions. Fifty mammalian researchers from both sides of the fence tried to find common ground here at the International Symposium on the Origin of Mammalian Orders from 21 to 25 July.

Rallying Round the Tertiary Radiation

In recent years, researchers who determine how long species have been diverging based on differences in their DNA have pushed back the dates of emergence of modern mammals—the predecessors of everything from whales to tree shrews—to as much as 100 million years ago. That's far earlier than fossils suggest, but the DNA researchers blame the discrepancy on the notoriously incomplete fossil record. At the meeting, however, two paleontologists went on the offensive, claiming that a close look at the fossil record shows that it is complete enough to date the origin of the modern mammalian orders. If the DNA "clocks" can't agree with the fossils, says the author of one study, paleontologist J. David Archibald of San Diego State University, then "the problem is with the molecular clock."

Paleontologists have long held that the modern mammalian orders emerged and differentiated into families, genera, and species after the Cretaceous-Tertiary (K-T) extinction 65 million years ago. That event wiped out the dinosaurs and presumably gave mammals more evolutionary breathing room. But many in the molecular camp have argued that several orders of mammals, including primates and rodents, arose more than 35 million years

before the K-T boundary. Divergence within a few if not many of the modern orders was well under way during the Cretaceous, they say (*Science*, 1 May, p. 675).

Now Archibald and ecological modeler Douglas Deutschman, also of San Diego State University, have surveyed the fossil record and report renewed support for the traditional paleontological view. Archibald notes that 15 of the 18 extant orders of placental mammals first appear in the fossil record during an evolutionarily short period of 16 million years in the early Tertiary. Statistically, says Archibald, the probability of this clustering occurring randomly due to gaps in the fossil record is "vanishingly small."

What's more, Archibald found no evidence that paleontologists have neglected the period before the K-T, creating a gap in the fossil record that might result in an apparent explosion of diversity later. He found roughly equal numbers of fossil sites and specimens for the 5-million-year periods immediately before and after the K-T boundary. Yet only 11 genera of placental mammals have been found in the fossil record in the period before the boundary, while 139 placental genera have turned up in the 5 million years after it. "Something happened to cause this explosion of speciation," he says.

The reality of the early Tertiary radiation was echoed by John Allroy, a paleontologist at the National Museum of Natural History in Washington, D.C., who did a similar analysis focused just on North American mammals and came to a similar conclusion. If molecular analysts can't find evidence of this explosion in speciation, he says, then they "don't know anything about the evolutionary process." Archibald suggests that something happened at the time to cause molecular clocks to speed up, making the splits among mammals appear earlier than they actually were.

The paleontologists' arguments were "a real eye-opener," says Michael Stanhope, a molecular biologist at Queen's University of Belfast, showing that the fossil record cannot be lightly dismissed. "I think there is a good chance we're missing something about the way DNA sequences evolve."

But not everyone was convinced. Peter Waddell, a phylogeneticist at the Institute of Statistical Mathematics in Tokyo, says that fossil evidence of the ancestors of aardvarks, tree shrews, and rabbits, among others, is missing. "The fossil record is not picking up things we know are there," he says, "so why close the book on [other] missing modern forms in the late Cretaceous?"

Others caution that the molecular evidence may never exactly fit the fossil data. Molecular phylogeneticists can only work with extant species, for example, and so will "never be able to reconstruct all those species which arose but died out," says molecular biologist David Mindell of the University of Michigan, Ann Arbor. There may also be a gap between the moment two DNA sequences begin to differ and the moment a species actually divides into two.

"We are hoping the molecular and morphological data converge," Waddell says, "but molecular people wouldn't necessarily be unhappy if they don't."

Whale-Ungulate Link Strengthens

Judged by its DNA, a whale is just an overgrown hippopotamus with an unusual lifestyle. Researchers who learn how living animals are related by studying their DNA have tended to group the cetaceans—whales, dolphins, and porpoises—with the even-toed ungulates, or artiodactyls, which include cows, pigs, and hippos. By some analyses, hippos are the closest living whale relatives. But to paleontologists, who study fossils, that conclusion has long been anathema. Instead, they contend that cetaceans descended from extinct hyenalike mammals called mesonychians. Now the fossil record may be opening the door to a whale-ungulate connection.

J.G.M. THEWISSEN

Little old whales. Skulls of 50-million-year-old pakicetid whales, with a coyote skull (bottom) for scale.

At the meeting, Hans Thewissen, a paleontologist at Northeastern Ohio Universities College of Medicine in Rootstown and an expert on whale evolution, described analyses of new specimens of early whales and whale ancestors his team collected in Pakistan. The new specimens weaken the link between the whales and the mesonychians, which was primarily based on similarities in the teeth. But they support the idea that whales are cousins of the ungulates, if not actual members of that group, he reported. "I think there is no doubt that they are very closely related to artiodactyls," says Thewissen.

One blow to the mesonychian link came from two specimens of a 50-million-year-old whale, a member of the family Pakicetidae. Analysis by a colleague of Thewissen's, Maureen O'Leary of the State University of New York, Stony Brook, showed that its teeth are not as highly evolved as those of the mesonychians, making it unlikely that whales are the descendants of that group. But on the question of whether the cetaceans are an actual subgroup of the Artiodactyla, as the molecular biologists think, this and other fossil whales don't give a clear answer.

Thewissen says that five morphological features of the early whales, including features of the skull, upper teeth, and feet, are "not inconsistent" with the hippo hypothesis. In particular, the new pakicetid skulls have holes over the eye sockets, known as supraorbital foramina. These features are not known in modern whales but are common to all artiodactyls.

But the last molar on the lower jaw, which has three sections in artiodactyls, has just two in whales. And in artiodactyls, the astragalus, one of the anklebones, has a rounded head and other characteristics that make the ankle much more flexible than it is in any other mammal. Thewissen recently discovered an anklebone from an early whale ancestor that still had legs. It lacks the rounded head, although in other respects it is similar to an artiodactyl astragalus.

Still, Thewissen thinks the morphological evidence, although mixed, opens the door to some kind of relation between the whales and the ungulates. He adds that there is now "considerable doubt" that cetaceans are closely related to mesonychians. That conclusion got a thumbs up from paleontologists at the meeting. For example, John Allroy of the National Museum of Natural History in Washington, D.C., says pulling the mesonychians out of the picture makes a closer cetacean-artiodactyl link plausible. But O'Leary says "it's [still] difficult to connect hippos with whales in the fossil record."

The molecular camp, for its part, viewed Thewissen's conclusion as just a first step toward ultimate vindication. As Norihiro Okada, a molecular biologist at Tokyo Institute of Technology, put it: "I think paleontologists may discover more [features common to early cetaceans and early hippos] in the near future." **–DENNIS NORMILE**