PALEONTOLOGY

Teeth and Bones Tell Their Stories at Chicago Meeting

CHICAGO—About 900 fossil lovers gathered here from 8 to 11 October for the annual meeting of the Society of Vertebrate Paleontology. Highlights ranged in time from the dawn of land vertebrates more than 300 million years ago to the extinction of the dinosaurs and other creatures 65 million years ago.

Shark and Ray Extinctions

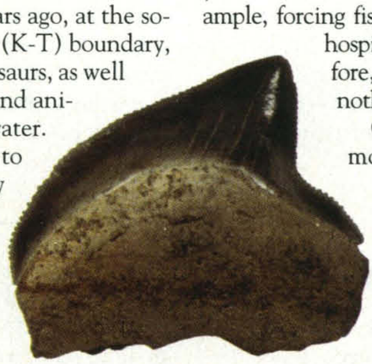
During the disastrous extinction that occurred about 65 million years ago, at the so-called Cretaceous-Tertiary (K-T) boundary, the world lost all of its dinosaurs, as well as many of its land plants and animals dwelling in shallow water. Now add sharks and rays to the list of casualties, say John Hoganson of the North Dakota Geological Survey in Bismarck and his colleagues.

Smaller life-forms in the sea, such as plankton and the shellfish called ammonites, are known to have gone extinct in droves at the K-T boundary, when an asteroid is believed to have struck Earth. But extinctions of large marine animals have been tough to document, in part because the sedimentary rocks that may record them are mainly underwater and inaccessible. Now, by combining separate rock records, one dating from before the extinction and the other from after it, Hoganson and his colleagues say they can demonstrate large-scale extinctions of sharks and rays in the seaway that covered much of central North America before and after the K-T boundary.

Because sharks and rays have skeletons of cartilage, which have long since decomposed, the researchers classified fossilized teeth from marine rocks in two areas, the Fox Hills and Cannonball Formations of North Dakota. They found 22 shark and ray species at the Fox Hills site, dated to the late Cretaceous by the presence of other fossils, and 15 at the Cannonball site, which belongs to the early Tertiary. None of the Cretaceous species at Fox Hills were present at Cannonball, indicating that they had all gone extinct, although other species belonging to some of the same families as the sharks and rays did survive from one era to the next.

Not everyone is convinced that the fish went extinct, however. Says paleontologist David Archibald of San Diego State University, "They don't have the [complete] geological section; they're missing at least 1 million years, at the K-T boundary." A change in the environment, such as receding seas, could have yielded the same fossil evidence by, for example, forcing fish to move to distant, more hospitable environments. Therefore, he says, "their work says nothing about K-T extinctions."

Others find the evidence more persuasive, noting that many extinctions are known only from isolated data points. "There are very few places in the world that have marine rock that span the boundary," says paleobotanist Kirk Johnson of the Denver Natural History Museum. But he adds, "Hoganson has stratigraphic units that come close." For his part, Hoganson suggests that confirmatory evidence might be found in rocks along the Gulf Coast in Texas and Alabama, which have late Cretaceous and early Tertiary marine sediments that can be studied.



Long gone? *Squalicorax pristodontus* teeth were absent in a Tertiary sample.

J. HOGANSON/NORTH DAKOTA GEOLOGICAL SURVEY

Famous Dinos Misidentified

Back in 1979, field paleontologist John Horner of the Museum of the Rockies in Bozeman and his colleagues found a rare deposit of 75-million-year-old dinosaur eggs in Montana. Because the egg clutches were surrounded by bones of the herbivorous dinosaur *Orodromeus malekei*, Horner and other paleontologists originally thought that *Orodromeus* had laid the eggs. But last year, he made a discovery that not only negates that conclusion but also has implications for understanding dino behavior: The eggs belonged not to *Orodromeus*, but to the carnivorous *Troodon*, Horner now says.

This reversal implies that the *Orodromeus* bones are the remains of food brought back to the nest for the young by the parent *Troodons*. If so, dinosaurs may have been more nurturing than thought, lending further support to the still-controversial idea that today's birds are descendants of the dinosaurs. "There is increasing evidence that the behavioral features we associate today with birds were found also in dinosaurs," says Horner.

Horner's reanalysis was triggered by the discovery of another nest just 80 kilometers away, where the presence of *Troodon* bones on the eggs left little doubt that the carnivore was brooding its eggs. So Horner decided to reanalyze the supposed *Orodromeus* eggs and embryos. After removing more rock from the specimens to get a better look at the embryos, Horner discovered that all the eggs belong to *Troodon*. He found, for example, that the crests of the embryonic humoral bones were identical to those of *Troodons* studied elsewhere. Horner noted the error in a brief "Scientific Correspondence" in the 5 September 1996 issue of *Nature*. But, he says, not many paleontological researchers noticed, and at the meeting he offered a public mea culpa, telling everyone "we're correcting a mistake."

Dinosaur curator Mark Norell of the American Museum of Natural History in New York City is not surprised by the misidentification. Indeed, he notes that a fabled dino hunter from his own institution, Roy Chapman Andrews, made a similar error in 1923, classifying eggs from a Mongolian site as the herbivorous *Protoceratops*. In 1993, Norell found eggs that, based on both their gross appearance and chemical composition, were identical to those that Andrews had found. But the embryos at the new site turned out to be a carnivore called *Oviraptor* (*Science*, 4 November 1994, p. 779).

Oviraptor (so named because it was originally thought to be an egg predator) is now thought to have brooded its eggs, but *Troodon* may have displayed even more advanced behavior. The *Orodromeus* remnants found around the clutches were not fragments of dead juveniles, Horner says, but were instead the remains of animals delivered to the nest by a *Troodon* parent to feed its young. While such advanced social behavior is common in birds, it is not often associated with dinosaurs. In addition, Horner says, *Troodon* shows other birdlike behaviors, including nesting in colonies, laying eggs at regular intervals in neat clutches, and producing oblong eggs.

To Horner and Norell those findings strengthen the relationship between dinosaurs and birds, although not everyone will be convinced. Just last week, for example, Ann Burke and Alan Feduccia of the University of North Carolina, Chapel Hill, reported in *Science* (24 October, p. 666) an analysis of digit development in the avian hand, which they say supports a different conclusion.

Early Land-Dweller Found

If dinosaurs are the megastars of paleontology, the amphibian-like microsaurs barely rank as bit players. But these 12- to 15-centimeter-long creatures played a crucial behind-the-scenes role: They were among the first four-legged vertebrates to crawl onto land, more than 300 million years ago. As such, microsaurs have ardent fans among paleontologists who want to understand the adaptations that made this epochal change possible. Now these researchers have a new star to follow: a specimen that offers the earliest look yet at the kind of vertebrate that made the leap to land.

At the meeting, paleontologist John Bolt of Chicago's Field Museum of Natural History reported that he and colleague R. Eric Lombard of University of Chicago had identified microsaur remains in a hand-sized sample collected about 10 years ago in Mississippian rocks of southern Illinois by paleontologists from the University of Kansas. Until now, the oldest microsaur fossils had been dated to the early Pennsylvanian period, about 322 million years ago. But finding the new microsaur in Mississippian rock means that it lived roughly 10 million years earlier.

It is "unquestionably the oldest known microsaur," says paleontologist Robert Carroll of McGill University in Montreal. And while 10 million years isn't much on a geological timescale, it has brought microsaurs a big step closer to the critical time, about 360 million years ago, when four-legged vertebrates crept onto land, and is thus giving paleontologists a better view of what those pioneers may have looked like.

JOHN WEINSTEIN/THE FIELD MUSEUM

Relics. The seven microsaurs visible in this sample are the oldest found so far.

This particular fossil shows classic microsaur features, Bolt says. These include uniquely shaped spine bones and a simplified skull, containing just one bone instead of three. But it also has a feature that sets it apart from later microsaurs: the proatlas, a pair of rodlike bones that attach between the first vertebrae and skull and can limit head rotation to up-and-down movements. The large, but more primitive, amphibians that predated microsaurs also had these bones.

Bolt adds, however, that he was disappointed to find that this new form offers few clues to what its immediate predecessors might have been. "We would have liked to see features that were shared only between microsaurs and some other group of early amphibians," he says. Bolt hasn't given up hope of uncovering such links. "We'll find them," he predicts, "but we'll have to dig deeper into the first quarter or half of the Mississippian."

–Anne Simon Moffat

ECOLOGY

El Niño Slows Greenhouse Gas Buildup?

As anyone who tunes in to weather forecasts should know, the periodic warming of the eastern Pacific known as El Niño takes the rap for a lot of bad weather—everything from the hurricane that swept Acapulco earlier this month to the blizzard that dumped up to a meter of snow over the U.S. heartland last week. But El Niño also has an upside that may help researchers better understand global climate change. On page 870, earth scientist Rob Braswell of the University of New Hampshire, Durham, and his colleagues describe new results suggesting that, by warming global climate, an El Niño or any other warm period may help temporarily brake the ongoing rise in atmospheric carbon dioxide due to human activity. The mechanism: a delayed burst in plant growth worldwide that appears to sop up excess levels of the greenhouse gas.


RUTH DEFRIES AND JOHN TOWNSHEND/UNIV. OF MARYLAND

Carbon sink. Two years after a warming, global plant growth seems to suck up excess CO_2.

The findings implicate ecosystem processes—perhaps interactions between soil microbes and plants—as a middleman between warming and plant growth. "These results are a major step forward in providing evidence for mechanisms that explain terrestrial responses to climate change," says ecologist Stuart Chapin of the University of California, Berkeley. Experts say it's unclear, however, whether such plant growth might restrain carbon dioxide buildup over the long haul.

Atmospheric carbon dioxide concentrations have increased more or less steadily over the past 20 years, continuing a trend more than a century old that is attributed largely to rising consumption of fossil fuels and large-scale destruction of forests by slash-and-burn agriculture and logging. Braswell's team analyzed shorter term fluctuations in carbon dioxide levels and—using powerful satellite-based techniques—global temperatures and plant growth after unusual warm spells, some of which are attributable to El Niño events. "We really didn't know what was going to happen, and we weren't confident we'd see anything conclusive," says Braswell.

But to their surprise, they found that the rate of increase of atmospheric carbon dioxide levels slowed significantly about 2 years after each of four warm spells that occurred between 1980 and 1991, including the major El Niño of 1982 to 1983. Global vegetation growth—as measured by light reflected from photosynthetically active leaves—also sped up after a comparable time lag, suggesting that the plants were removing the excess carbon dioxide. "It's a surprise to see such a clear delay given all the variables in global climate and plant growth," he says.

The 2-year gap between the warming events and the changes in vegetation and atmospheric carbon dioxide concentrations indicates that the responses weren't due simply to higher temperatures spurring plant growth. "Ecologists are familiar with lags from field experiments, but such a long delay is surprising," says Braswell. Indeed, adds climate modeler Peter Cox of the Hadley Centre for Climate Research and Prediction at the Meteorological Office in Bracknell, United Kingdom, the lag "is difficult to understand, but is probably associated with processes in the soil involved with the availability of nutrients such as nitrogen." He and others suggest that warming increases the activity of microbes that make fertilizers available in the soil, increasing plant growth after a delay. The hunt is now on for exactly which soil microbes or other factors dictate how ecosystems respond to warming.

–Nigel Williams