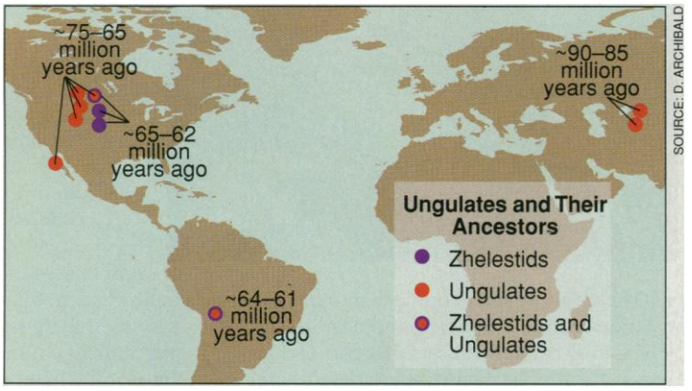
PALEONTOLOGY

Mammal Diversity Takes a 20-Million-Year Leap Backwards

Elephants would seem hard animals to miss, but tracking them back in time hasn't been easy. Paleontologists have zealously followed the fossil trail of elephants and their kin—the ungulates, which include whales and deer and are one of the largest mammal groups—back to the Cretaceous-Tertiary (K-T) boundary, when the dinosaurs went extinct 65 million years ago. "But when you reach the Cretaceous period, you just hit a stone wall," says Rich Cifelli, a vertebrate paleontologist at the Oklahoma Museum of Natural History. There were no older ungulates to be seen. Yet the 65-million-year-old ungulates look different enough from other mammals around at the time to raise suspicions that they must have branched from other lineages well before the K-T boundary.

Now there's more than suspicion—there's hard evidence. On page 1150, David Archibald, a paleontologist at San Diego State University, reports that some fossil teeth and jaws—recovered over the past decade from a wind-swept desert in the southwestern former Soviet Union by a now-deceased Russian paleontologist—look enough like ungulate teeth to push their ancestry back another 20 million years. And because these 85-million-year-old "zhelestids," as the rat-sized ungulate forebears are called, were found in Asia, it opens up the possibility that ungulates first appeared there.



Earliest ungulates? 85-million-year-old fossils—called "zhelestids"—from Asia could be ancestors of this major mammal group.

Although other researchers caution that more fossils are needed to firm up the ungulates-zhelestid connection, they are hailing this crack in the K-T boundary as a genuine breakthrough. The fossils, they say, indicate that there was growing mammalian diversity even under the thundering feet of the dinosaurs, whose dominance of many ecological niches was thought to have kept mammals from branching into many new forms. The notion of early diversity is bolstered by another type of evidence: recent work on a "molecular clock" showing that the DNA of several living mammals, including ungulates, first diverged about 100 million years ago. Asia may have been the cradle of this diversification. Hans Thewissen, a paleontologist who teaches at Northeastern Ohio Universities College of Medicine, says Archibald's research "suggests that Asia is the place to take a very close look at for research into the Cretaceous period" and mammalian origins.

Prior to recent finds, the honor of oldest ungulate ancestor belonged to a 65-million-year-old species called *Protungulatum*, dug up from Montana's Bug Creek Anthills; related creatures of similar antiquity were unearthed in Utah; Alberta, Canada; and Baja California. Yet other mammal fossils, thought to be the ancestors of modern rodents and rabbits, dated as far back as 75 million years, and still older bones seem to belong to a more general mammalian root.

Then in 1991, Archibald got an invitation from the late Lev Nessov, a paleontologist at St. Petersburg University, to visit his site in the Kyzyl-Kum desert of Uzbekistan: a towering cliff called the Bissekty Formation, rife with Cretaceous fossils. Nessov had found fossilized teeth that looked generally mammalian, but with a difference. Carnivorous and insectivorous small mammals from that period have sharp teeth, good for slicing, but Nessov's finds were flatter and squared off. They looked like grinders similar to those of *Protungulatum*—and like faint vestiges of those found in modern deer and cows. Nessov coined the name zhelestid ("wind thief" in Greek and Kazakh) for the tooth owners, but he wanted Archibald's help in classifying them. The two researchers joined in excavating more fossils until Nessov died in October 1995. Archibald kept working on the analysis.

He was intrigued by the apparent age of the fossils. The 70 fossils were sandwiched between two layers of ancient marine rocks preserving extinct species of oysters and bony fish. From dating at other sites, researchers knew that some of these marine species died by 85 million years ago, implying that Nessov's fossils were at least that old. Says Archibald: "Everything about the site argues for late, but not the latest, Cretaceous."

All in all, Archibald identified five different species of zhelestids. And their teeth are the first signs of placental mammals that were adapting to a herbivorous lifestyle, diversifying into different niches even while dinosaurs ran rampant over the planet, he says. (Ungulate trackers had focused their efforts on the Americas, he notes, and so missed the Asian material.)

This notion of Cretaceous diversity also gets some support from molecular data. In last week's issue of *Nature*, Pennsylvania State University biologist Blair Hedges reported that he and his colleagues charted the differences among a variety of nuclear genes from three orders of living mammals—including one ungulate, a cow. Hedges's team found that some of the genes mutate at distinct but regular rates, so the average number of genetic differences between mammals in two orders serves as a "clock," letting researchers count back in time to when these animals last shared a common ancestor. The answer: 100 million years ago. And this, Hedges says, ties in to Archibald's results: "The existence of the early ungulates really demonstrates that the evolutionary radiation of the modern orders of placental mammals was well under way at the time."

Many paleontologists find Hedges's work intriguing, but advise caution. "There's good reason to think the modern orders of mammals are older than what the fossil record tells us," says Michael Novacek of the American Museum of Natural History in New York. But he notes the notion that the molecular clock ticks at a constant rate has been contested (*Science*, 31 March 1995, p. 1907).

Likewise, Thewissen would like to see some crania and limbs from Archibald's zhelestids to solidify the link to ungulates. More fossils would also help confirm if ungulates migrated from origins in Asia to Europe and North America, says Novacek. "It's a pretty good case that several of the major mammalian groups evolved in Asia," he says, and ungulates could be one of them. But Archibald will have to demonstrate this with fossils dotting the migratory routes.

That's fine with the researcher himself. The research, Archibald says, presents a "testable idea," and he's going to start looking for younger fossil beds, hoping to trace the evolution of ungulates forward through the end of the Cretaceous period—breaking through the wall once and for all.

–Kim Peterson