PALEONTOLOGY

Utah's Fossil Trove Beckons, And Tests, Researchers

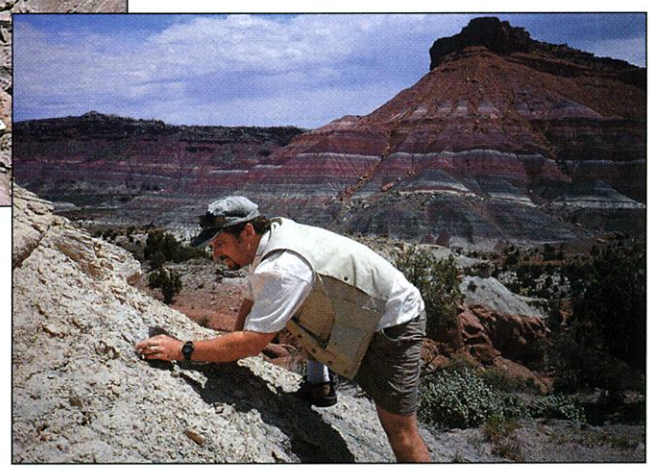
At Grand Staircase–Escalante National Monument, patience and muscle power pay off in paleontological riches

GRAND STAIRCASE–ESCALANTE NATIONAL MONUMENT, UTAH—Alan Titus parks his four-wheel-drive field vehicle on a dirt road that cuts across a remote plateau here, hops out, and strides into a scrubby forest. Just minutes later, the Bureau of Land Management (BLM) paleontologist spots fragments of bone under a juniper tree and crouches to investigate. Quickly brushing away the surrounding shale, he identifies it as the broken end of a femur, probably from a duck-billed dinosaur.

There are few better places in North America to scout for dinosaurs and other large Mesozoic vertebrates. All over the plateau pieces of bone litter the surface. The badlands are so rich that Titus sometimes scouts for fossils with binoculars, searching the hills for piles of orange-stained bone. "This place has enough fossils to keep an army of paleontologists happy for the rest of their careers," he says. Yet most of the plateau has never been thoroughly prospected by paleontologists.

That's about to change. Three teams of vertebrate paleontologists have started to survey the fossil diversity of parts of the monument. Despite frustrations with a lengthy permitting process and restricted access to field sites, they're finding relatively complete skeletons of new horned dinosaurs and other creatures. Graduate students are already working in the area, and Yale University is planning to set up a research program. "It's a high," says Dave Gillette of the Museum of Northern Arizona in Flagstaff, one of the team leaders. "Everything we've touched has turned to gold."

The monument was created in 1996 with its vast trove of fossils in mind. The 760,000 hectares boast what could be the world's best record of Late Cretaceous terrestrial life—creatures that lived during most of the 20 million to 30 million years before the demise of the dinosaurs. And because the region is so remote, few large skeletons have been excavated. "I consider this to be the promised land of vertebrate paleontology in the U.S.," says Scott Sampson of the Utah Museum of Natural History in Salt Lake City, who heads another of the survey teams.



Rich pickings. Finds at the monument, including rare impressions of hadrosaur skin (*above*), are abundant enough to satisfy "an army of paleontologists," says Alan Titus (*right*).

CREDITS: (TOP TO BOTTOM) MUSEUM OF NORTHERN ARIZONA; E. STOKSTAD

Revolutionary rocks

Rocks in the monument date back to the middle Permian period, about 280 million years ago, but most of the excitement centers on the unique terrestrial record of the Late Cretaceous period. During this period, a doomed group of rodentlike mammals called the multituberculates was wildly diversifying, as were marsupials. At the same time, new types of dinosaurs—hadrosaurs, ceratopsians, and tyrannosaurs—were rising to prominence. "We see a whole revolution going on; the biota is changing dramatically," says Richard Cifelli, a paleontologist at the University of Oklahoma, Norman.

The revolution was absent from most parts of North America, which were covered by seas. But the monument belonged to land that stretched from Mexico to Canada. Because the climate was humid, sediment from mountains near the Utah-Nevada border was washed into lowlands, preserving the remains of plants and animals. The narrow continent was covered with thick stacks of these sediments; in the monument, they are an impressive 2000 meters thick. Elsewhere in the Western United States, the terrestrial rocks either are still buried by younger sediments or have been eroded away. In the monument, however, a large-scale gentle fold called a monocline has left more than 5000 square kilometers of fossil-rich Late Cretaceous rocks exposed.

Not much work has been done on the large fossils. Partly that's because the area is so rugged and remote; the Escalante River, for example, was the last major river to be discovered in the continental United States, around 1872. Vertebrate paleontologists have focused on other fossil-rich areas, such as the badlands of South Dakota and Montana. It wasn't clear how many fossils, if any, were in this part of Utah. In fact, Herbert Gregory of the U.S. Geological Survey, who published the first geological map of the area in 1931, declared it practically devoid of fossils. "There's this myth that it's barren," Titus says.

The myth first began to fade, for a few paleontologists, in the 1980s. Screen-washing of sediment revealed sites that produced tens of thousands of tiny teeth and other so-called vertebrate microfossils, including many fish, crocodiles, frogs, and lizards. "The exposures are obscene. They drip with fossils," says Jeff Eaton of Weber State University in Ogden, Utah. He started working in the area that is now the monument in 1982 and 9 years later bought a house nearby to be able to spend more time in the field. "I knew I would spend the rest of my life here," Eaton says. "And I've barely scratched it."

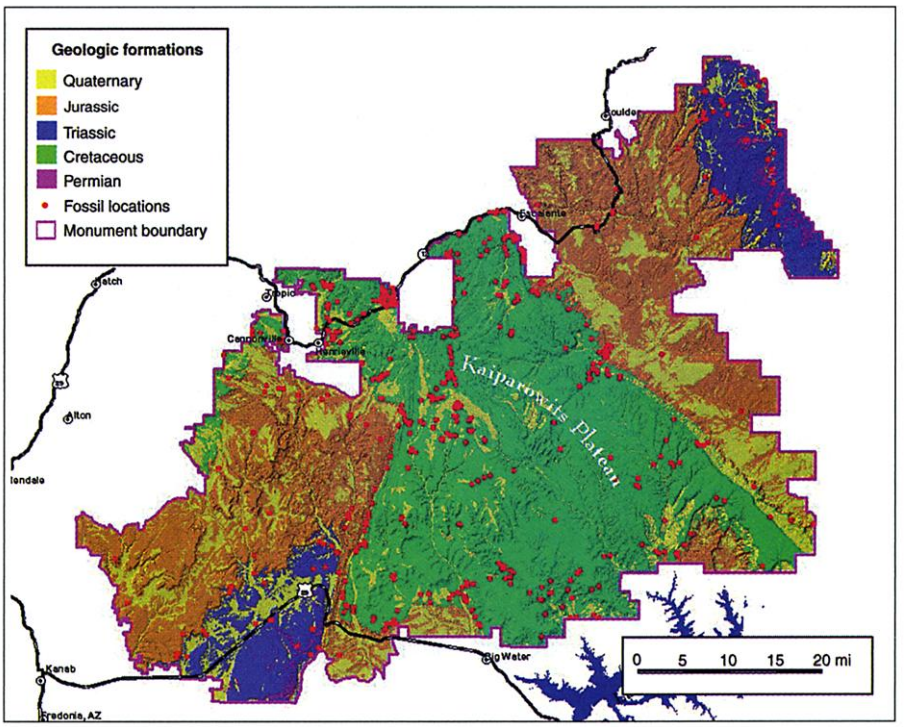
This early work—much of it done with Cifelli—established the ages of the rocks, an important step because there are no volcanic ash beds for geologists to date. Fossils from the area also pushed back the marsupial record by 10 million years and helped reveal the geographic distribution of early

mammals across North America.

Big beasts are there, too. After President Bill Clinton created the national monument in 1996, the BLM commissioned a survey of the fossil resources, including the larger bones that Eaton and his colleagues hadn't focused on. The final report, published this year by the Utah Geological Survey, lists more than 800 localities with fossils—a number that Gillette estimates is just 1% of the potential. Evidence from teeth and scraps of bone suggests that skeletons of as many as 50 genera of dinosaurs may be waiting to be found.

Dinosaur paleontology at the site is now getting in gear. The BLM plans to spend about $200,000 a year on paleontology there—about 20% of the monument's science budget. The money is supporting three teams on 5-year contracts to survey the fossil resources, plus a few additional excavations. Dinosaur workers say the monument fills in a geographic gap for Late Cretaceous dinosaurs, which are well known from rocks north to Alaska and south to Mexico. Because dinosaurs are believed to have migrated less than was previously thought, Sampson says, southern Utah may reveal unique facts about their ranges, ecologies, and evolutionary relationships.

Already there are finds, although none of the discoveries has been published yet. So far, the cast of characters includes the back half of a hadrosaur with skin impressions and an articulated tail, found by Titus in 1998. Working last summer in rocks the same age just outside the monument, Gillette and his colleague Barry Albright excavated a 75% complete therizinosaur, a strange plant-eating dinosaur—one of only two such specimens discovered outside Asia. The team also dug up two marine reptiles called pliosaurs, including the most complete specimen known from Utah. A team led by Sampson has found a hadrosaur of its own, plus armor from a new giant crocodilian and what appears to be a new genus of horned dinosaur. To top it off, just last month they discovered remains of what could be a new species of tyrannosaur. The skull of another new ceratopsid genus was found in 1998 by a crew working for the Utah Geological Survey.



Fossil trove. The monument abounds in traces of ancient life, particularly Cretaceous.

Obstacle course

The work poses special challenges—the first of which is getting permission. Each application for an excavation permit has to be reviewed by a BLM archaeologist and botanist and by other specialists to make sure no other resources are threatened by the dig. That takes 3 to 6 months on average. "Some people may be discouraged by the hoops and hurdles you have to go through to get a permit," says Sid Ash, a paleobotanist affiliated with the University of New Mexico in Albuquerque. The wait can complicate grant writing, Gillette notes, as some funders require a permit with an application. "It's a big balancing act," he says.

An even bigger problem is access to fossil sites. About half of the monument is wilderness study area—land that Congress may declare wilderness. Combined with other BLM restrictions, the designation puts more than 65% of the monument off limits to motor vehicles, including half of the existing roads. "We do not make exceptions lightly," says monument manager Kate Cannon. One of the few was the excavation of the hadrosaur tail, for which Gillette and other researchers were allowed two trips to drive along a closed road to carry tools in and remove the bones.

Eaton says that almost all of the hundreds of sites he's worked are now inaccessible by vehicles—which are needed to remove heavy samples of sediment. "I'd like other people to test my findings," he says. "That's difficult when they can't get to the site." For his own research, Eaton has had to pack out a 1500-kilogram sample of rock in 20-kg bags loaded into a frame backpack.

Members of the Utah team also had to resort to muscle power last year while digging up their ceratopsian skull. To haul it away, they put each of three 360-kg blocks of sandstone on an old car hood and spent 5 days dragging them half a kilometer to a dirt road. "It was comic," says Utah's state paleontologist, Jim Kirkland. "If we'd driven in, we could have swept out the tracks."

Despite the hurdles, Kirkland and others are glad to be working in the monument. "It really is going to explode in the next few years," Sampson says. "I plan on working there the rest of my career." Others clearly feel the same way about the possibilities. This summer, a crew from Yale University examined some of the monument's Triassic rocks—strata from the early days of the dinosaurs—to beef up their collections and begin a field program for up to a dozen graduate students. Titus has high hopes for all the researchers: "It boggles my mind to think of what they'll find when they really get going."

–ERIK STOKSTAD

No wheels. Vehicle restrictions forced Utah paleontologists to drag heavy fossils through the desert.

CREDITS: (TOP TO BOTTOM) MAP: A. TITUS/GSENM; M. HAYDEN/UTAH GEOLOGICAL SURVEY