Dinosaurs in the Dark

Recent fossil finds in Alaska and Australia are raising questions about how the dinosaurs could have survived winters near the North and South Poles

By RICHARD MONASTERSKY

Picture a dinosaur in your mind. Then take a look at the surrounding landscape. What do you see?

The images that come to mind are probably reminiscent of horror movies with either "lagoon" or "swamp" in the title. Clouds of fog blanket the still surface of some tropical waterway. Overhead, some mushy growth, the consistency of cooked spinach, hangs off lush, drooping leaves.

Snow just doesn't seem to fit into the picture.

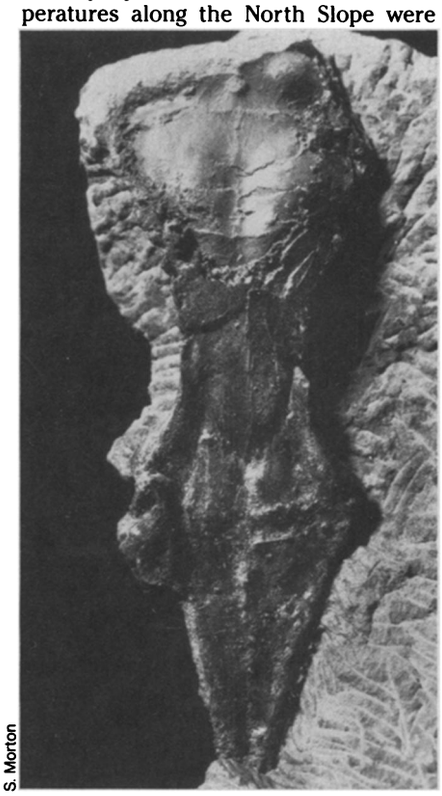
But recent fossil finds may be changing this tropical image. In the last four years, paleontologists have discovered dinosaur bones along the Colville River in northern Alaska, in a remote area called the North Slope. At the other end of the world, dinosaur remnants are turning up in the far southern latitudes of Argentina and Australia, in areas that would have been below the Antarctic Circle during Cretaceous times, a period that lasted from 144 million to 65 million years ago.

"The latitudinal range of the late Cretaceous dinosaurs is creeping north and south," says vertebrate paleontologist J. Michael Parrish from the University of Colorado in Boulder. Researchers are now learning that dinosaurs roamed to the very ends of the continents, toward both poles, into lands where the cold night of winter would have lasted several months and temperatures would sometimes have hovered around the bottom of the thermometer.

Although reports of the finds in the Southern Hemisphere have not yet appeared in the scientific journals, researchers from Australia will be announcing their discoveries next month in National Geographic Research. Meanwhile, in the last few months, detailed news from Alaska has started to circulate through the paleontologic world. Mulling over the meaning of the polar finds, scientists in the field are trying to decipher what the fossils are telling them about the lifestyle of the dinosaurs. In particular, many are wondering how it is possible that the dinosaurs survived winters in such a forbidding environment.

When the sun sets over the Colville River in late October, night takes hold of the land and doesn't loosen its grip for another three months. At times, temperatures in this section of northern Alaska drop to −25°C. Throughout the dark days, the only animals to be seen on the snow-masked tundra are the musk-ox, reindeer and caribou.

During the late Cretaceous period, the last heyday of the dinosaurs, winter temperatures along the North Slope were much warmer. In fact, a primeval forest covered the now-treeless land. Large hardwood trees — long extinct but somewhat like cedars — created the high canopy of the Alaskan forest. Underneath were the flowering shrubs, along with mushrooms, horsetails and ferns, according to Judith Totman Parrish of the University of Arizona at Tucson.



S. Morton

Fossilized skull of a chicken-sized hypsolophodontid dinosaur from Dinosaur Cove, Australia. As the animal was decaying and sediments filled in the brain cavity, a cast of the brain was formed. On the basis of the cast, scientists believe this animal may have had a relatively oversized brain, which, along with its large eyes, may have helped this species survive through the long, dark polar night.

She and Robert Spicer of the University of London have studied the fossilized wood and leaves of the ancient forests that grew along the North Slope. Using these remains, they can estimate how warm and humid the North Slope was during the Cretaceous period.

Although the forest may have been bountiful, it would not have passed for a tropical paradise, says Totman Parrish. Seventy million years ago, it would have resembled the woods that today surround Anchorage, Alaska. Winter temperatures would drop below the freezing level, with an annual average between 2°C and 6°C during the last several million years of the Cretaceous, she and Spicer report in the January Geology. At their coldest, the temperatures on the North Slope may even have been as low as −11°C, says Totman Parrish.

Special strategies are required for survival in such frigid temperatures. Modern cold-climate animals that remain active during the winter often grow thick pelts to insulate their bodies. Others crawl into a tree hollow or a snow cave and hibernate for the winter.

But scientists know that the dinosaurs found so far in Alaska — the horned ceratopsian varieties and the thin-skinned hadrosaurs — could not have cloaked themselves with either fur or feather. Nor would hibernation have been an answer, says Parrish. There would have been no place on the coastal plain to park a hadrosaur body that reached a length of 9 meters (almost 30 feet) and weighed more than 3 tons.

One of the easiest ways to explain how the dinosaurs coped with the Alaskan winters would be to say that they didn't

even try. The Colville River was probably no farther than 2,100 kilometers away from the Arctic Circle, where winter temperatures would have been warmer, and at least some daylight would have appeared every day. Over a period of several months, the animals could have migrated south at a relatively leisurely rate, write Parrish, Totman Parrish, Spicer and Howard Hutchison of the University of California at Berkeley in a recent issue of the scientific journal PALAIOS.

The idea of migrating dinosaurs does have some support in the fossil record. The hadrosaur bones on the North Slope are found in the stratified layers of sedimentary rock in the bluffs overlooking the Colville River. Within the bone-bearing layers, scientists are uncovering clues about the habits of these herbivorous dinosaurs.

"What they're finding up there is a big bone bed, which certainly suggests a relatively large herd," says John Horner of the Museum of the Rockies in Bozeman, Mont. Horner is one of the many paleontologists who believe that the large dinosaurs lived in herds and migrated, in search of new forage. These herds would have tramped north and south along the coasts of inland seas that then covered the central parts of North America and Asia.

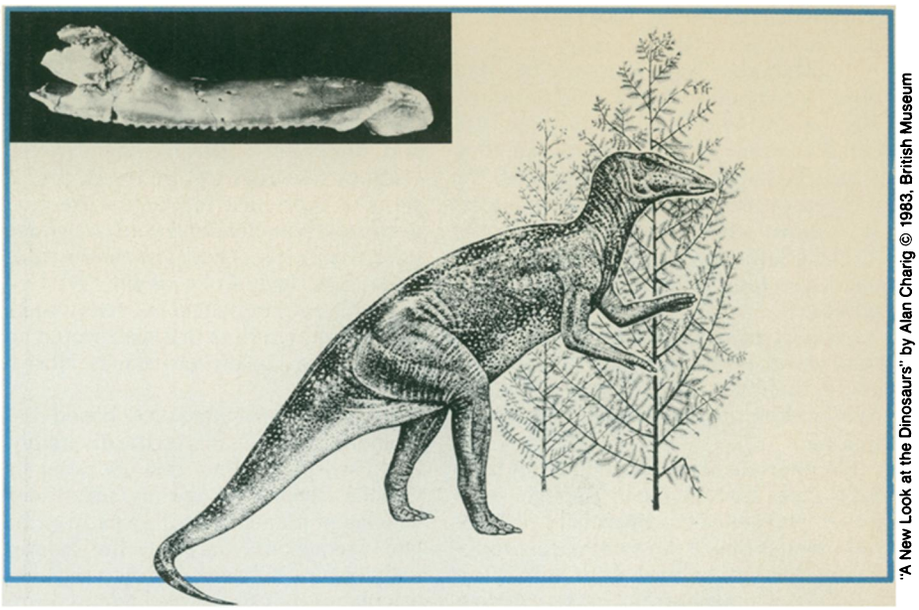
As a modern analog to the large herbivorous dinosaurs of the Cretaceous, Horner points to elephants, which naturally migrate in groups looking for food and water. "They have to," he says, "or they eat themselves out of house and home."

Lending support to this herd theory, Horner has found one fossil site in Montana that contains the bones of some 10,000 dinosaurs, a huge community of animals living together at the same time. Because they are found in volcanic ash, Horner surmises that an eruption killed these animals *en masse* about 80 million years ago.

For Horner, the Alaskan finds represent a potential solution to questions about the origin of certain dinosaur species. Similar hadrosaur bones are found in Asia and western North America, which presumably were joined by a land bridge during the late Cretaceous. The hadrosaurs may have evolved in Asia and then migrated to America — or, conversely, they might have started in America and headed westward.

In either case, the migrating dinosaurs must have passed through Alaska. Therefore, by comparing the species found in Alaska with their cousins in Asia and North America, says Horner, "we might be able to figure out which way they were going."

Other evidence on the North Slope, however, suggests that the Alaskan dinosaurs may not have migrated far from their final resting place. Berkeley paleontologist William A. Clemens, along with Elisabeth Brouwers of the U.S. Geological Survey in Denver and several colleagues, are working the hadrosaur fossil site along the Colville River. So far, they have discovered many juvenile hadrosaurs buried along with the adults.



W. Clemens

"A New Look at the Dinosaurs" by Alan Charig © 1983, British Museum

Paleontologists have not yet determined the species of the hadrosaurid dinosaurs found on the North Slope of Alaska. But they may have resembled either the Anatosaurus *(shown) or another genus called* Edmontosaurus. *Inset shows fossilized lower jawbone of a North Slope hadrosaur (seen from above).*

With their shorter legs, these youngsters may have been slower than the elders, says Clemens. "Having a lot of small forms there suggests the possibility that the population as a whole didn't migrate over long distances," he says. If so, the dinosaurs must have remained in Alaska all year long.

Down under, in Australia, paleontologists may have an even stronger case against migration. Patricia V. Rich, Thomas H.V. Rich and their colleagues have been digging at Dinosaur Cove and other points along the southwestern coast of the continent. In the early Cretaceous period, about 110 million years ago, this area was in the process of breaking away from Antarctica and would have been well below the Antarctic Circle.

While researchers first started finding bones in and near Dinosaur Cove in 1979, it is only within the last four summers that the flow of fossils from this area has really started to accelerate. Yet the researchers have noticed that all the dinosaurs they are finding are small, measuring less than 2 meters in length. One individual, from the family Hypsolophodontidae, was about the size of a chicken.

"Animals that size don't migrate thousands of miles," Thomas Rich told SCIENCE NEWS in a telephone interview from Australia. He works at the Museum of Victoria in Melbourne; Patricia Rich is with Melbourne's Monash University.

"For these animals to get into an area where there would be at least some daylight every day of the year, they would have to migrate about 1,000 kilometers due north," he says. "I think that they must have somehow coped with the environment that they were in."

Indeed, the animals from Dinosaur Cove show signs that they could have dealt with the polar night. Hypsolophodontids, found in Australia and elsewhere in the world, had relatively large eyes. And the chicken-size specimen from Dinosaur Cove also had what may have been an unusually large brain, perhaps reflecting a well-developed visual cortex, says Thomas Rich. Such features may have helped the animal maneuver in the moonlight.

"They're a group that may have been preadapted for a high-latitude environment in which there would have been three months or more of annual darkness," he says.

Moreover, because the animals were small, they could have crawled into a hole and hibernated for the winter, which would have been cold, with temperatures possibly dipping below freezing, says Patricia Rich.

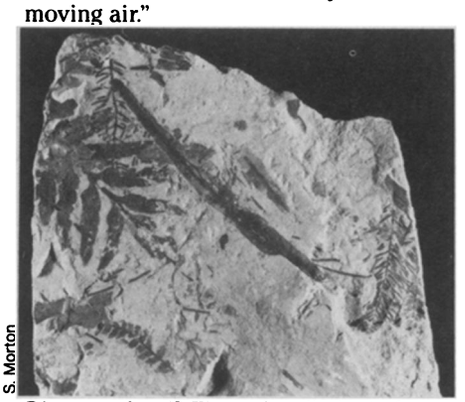
The thought that the dinosaurs overwintered in northern Alaska and southern Australia has stoked the fires of a central controversy in the paleontologic field — the debate over "warm-blooded" versus "cold-blooded" dinosaurs. In the early days of the field, scientists had assumed without much thought that dinosaurs, being reptiles, must have been cold-blooded as are all modern reptiles. But in the last decade

and a half, researchers have realized that the answer is not that simple.

Cold-blooded, a term usually taken to be synonymous with the word ectothermic, describes creatures that do not create their own body heat; instead, they rely on the sun to warm their insides. For that reason, lizards and other ectotherms slow down when outside temperatures drop. Endothermic animals, on the other hand, use food as a fuel to warm their bodies.

Supporters of the endothermic dinosaur camp have said that if dinosaurs could survive the winters of North Alaska, then they must have been endothermic.

Ectothermic dinosaurs could not have kept their bodies warm enough, says Robert Bakker of the University of Colorado, who is one of the most vocal proponents of warm-blooded dinosaurs. "The still air temperatures," says Bakker, "would have gotten down near freezing frequently during the four months of winter Cretaceous night. And, of course, the still air is not what kills you; it's the moving air."



S. Morton

Dinosaur food? These fossil plants from southern Australia are found in the same rocks as the dinosaurs.

"The wind chill certainly would have dropped the effective skin temperature well below freezing. And there's no big cold-blood today on land, anywhere, that could survive that kind of temperature." At such low temperatures, the cold-blooded animals would suffer "massive tissue death," says Bakker.

Yet Parrish, Totman Parrish, Spicer and Hutchison counter that argument: "We do not feel that the presence of dinosaurs on the North Slope, where even summer temperatures were cool, is *a priori* evidence that the dinosaurs were endothermic."

Many scientists believe that the dinosaurs, with their massive bodies, cannot be compared with modern cold-blooded reptiles. The dinosaurs would probably have retained far more internal heat than do today's reptiles. And in the PALAIOS paper, the researchers suggest that even ectothermic dinosaurs may have been able to live through the winters. If the temperatures did not drop below freezing too frequently, large ectotherms could survive by lowering their internal temperature and slowing down their lifestyle.

The researchers also propose that vegetable matter, stewing in the stomachs of the dinosaurs, would most likely ferment and produce considerable heat.

Other scientists feel that such discussions of overwintering tactics are moot because it is unclear how cold the winters actually were. For instance, paleobotanist Jack Wolfe of the U.S. Geological Survey in Denver believes that the winter temperatures in Alaska would not have dropped below zero or even close to that mark.

Totman Parrish and Spicer based their temperature estimates on the diversity of the fossil plants they dug up along the Colville River. Finding only seven to 10 species of plants in sediments from the late Cretaceous, they set the average temperature between 2°C and 6°C, and calculated that the winter temperatures would drop several degrees below the yearly average.

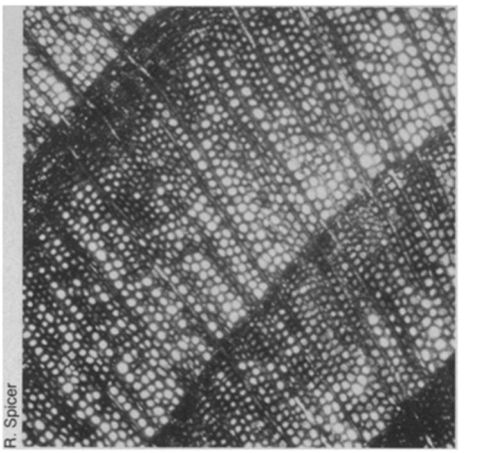
But Wolfe thinks Parrish and Spicer's estimates are too cold. The problem, he says, is that these researchers are not seeing the entire forest through the trees. Other scientists looking at fossilized pollen from the same period have found several species of plants that are not represented in the fossil record of leaves and wood collected by Parrish and Spicer. In that case, the researchers would be underestimating both diversity and temperatures.

In his work in Alaska, Wolfe has found that pollen can serve as a clue to ancient plants that are missing from the record. "In my early collecting in the Cook Inlet basin," he says, "I was getting very low diversity in a lot of parts of the section. Yet I was doing the pollen at the same time and I realized that diversity had to be higher." After several years of hunting, Wolfe found the missing species in another fossil bed.

It is not yet possible, he says, to determine the climate from the fossil plants. Less direct methods, however, indicate that temperatures during the coldest month of the year would have dropped only to 4°C (about 40°F).

As is usual with paleontologic discoveries, the recent dinosaur finds in Alaska and Australia are raising more questions than they are answering. The debates about migration and overwintering tactics will no doubt continue for many years as new evidence develops. And at the same time, the paleobotanists will be trying to develop an accurate picture of the polar environments.

Many scientists are wondering what the dinosaurs would have eaten if they had remained near the poles over the winter. Photosynthesis would probably have ceased during the long winter night.



R. Spicer

A section of fossilized wood from the North Slope of Alaska helps researchers who are studying the climate of the area during the late Cretaceous. The border between light- and dark-colored cells marks the winter cessation of growth. Large light-colored cells grew during spring. During the summer, the tree grew smaller cells with thicker walls that appear dark. This pattern suggests that summers in the area were cool.

And it appears that most of the leaves would drop during autumn, which means there would be no food on the trees for several months of the year.

Others are debating the speed of the young hadrosaurs found along the Colville River and are considering the style of dinosaur migration. If the animals ate while they ambled south for the winter, then the youngsters may have had no trouble keeping up with the pack.

Almost inevitably, the new finds have also stimulated more skirmishes in what has become the most publicized debate within paleontology and perhaps within the whole scientific world — that is, the impact-extinction debate.

Did a comet or meteorite strike the blow that wiped the dinosaurs of the earth forever by blocking out sunlight and cooling off the globe? Clemens and his colleagues suggest that if several dinosaur species were adapted to living through winters near the poles, then such effects from an impact could not account for the disappearance of the polar dinosaurs.

Yet these statements have drawn the criticism of many researchers who have argued vehemently against relating the new finds to any theories about the extinction of the dinosaurs, until more work is done.

In the long run, however, such questions and controversies do not dim the scientific enthusiasm over the Alaskan and Australian discoveries. "Everyone who works on dinosaurs is excited by it," says Horner. "It extends the range of the dinosaurs and it also brings up a few problems.

"And we love to answer problems," he says. "It's our business." □