

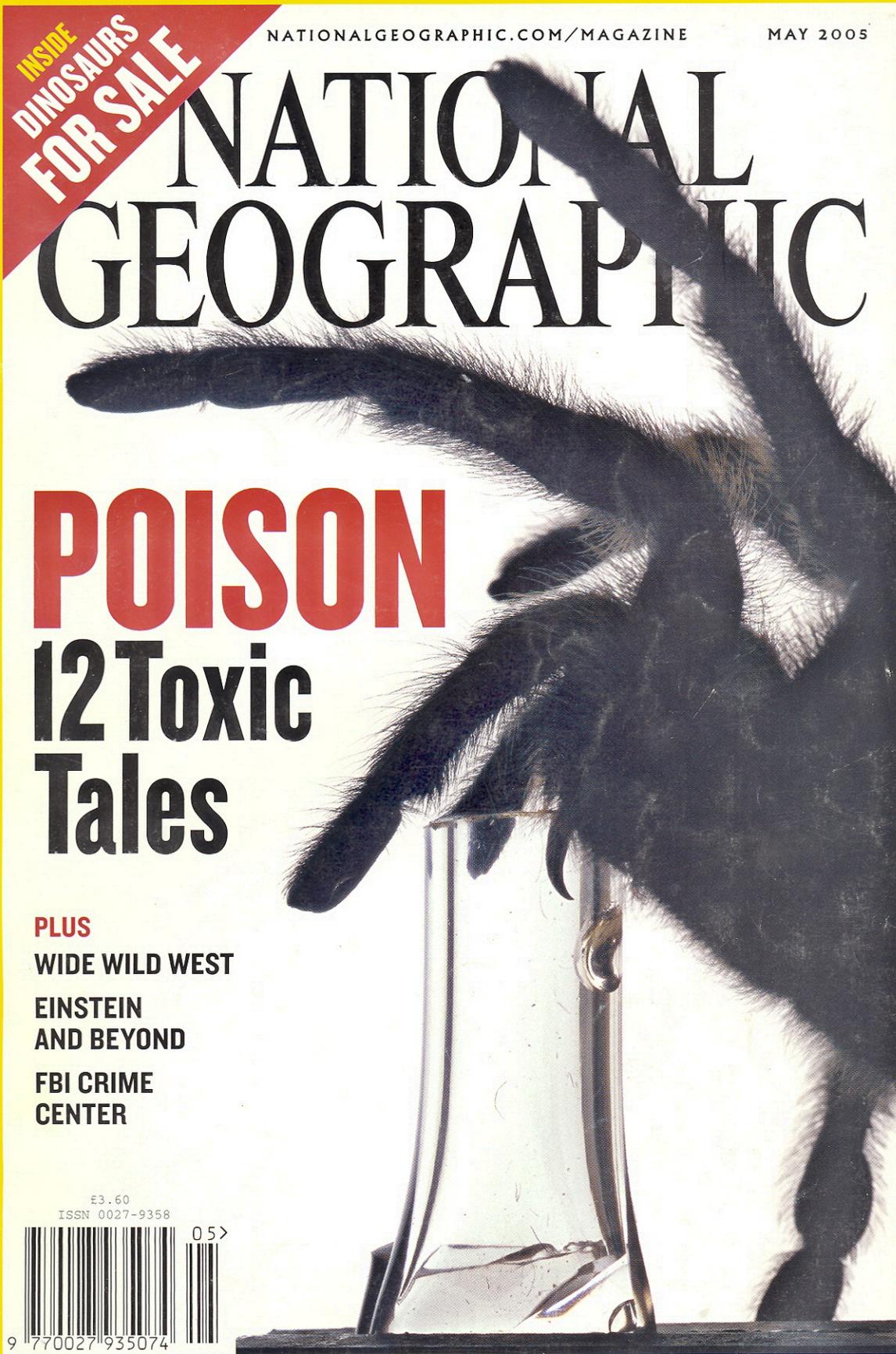
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# GEOGR

THE PEOPLE, PLACES, AND

★  
North Pole

Present

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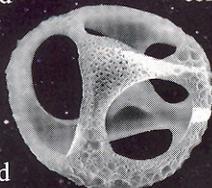
18,000 years ago

CLIMATE

## Great Green North

*Was the icy Arctic once a warm soup of life?*

Under a microscope they look like greenish brown globs—run-of-the-mill pond scum would look about the same. But these globs are actually clumps of spores from an aquatic fern, and they're revolutionizing our understanding of the Arctic Ocean. Fifty million years ago the now ice-locked northern ocean may have resembled a giant freshwater pond, choked with waterweed and teeming with microscopic life.



Scientists got their first glimpse of the fern spores aboard an ice-breaker last summer. "I was absolutely shocked," says Ted Moore, a scientist on the Arctic Coring Expedition, an audacious attempt

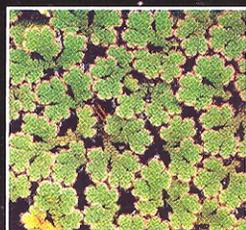
to bore into the ocean floor. The 15-foot-long cylinders of rock and mud the expedition pulled up may help solve one of Earth's great mysteries: How did the far north, which once enjoyed a balmy climate, become the cold white place it is today?

While other oceans have long been well mapped, the Arctic has remained largely a blank. As recently as 1996 a ship plowing through pack ice near the North Pole found that existing charts had misplaced a giant underwater ridge by 120 miles, and an ocean-floor abyss, shown as featureless, was actually a welter of mountains and canyons. More mysterious than the

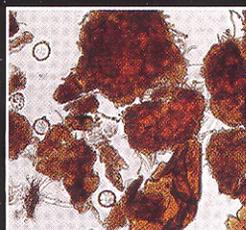
14 million years ago

# APHICA

C R E A T U R E S   O F   O U R   U N I V E R S E



MODERN AZOLLA FERN



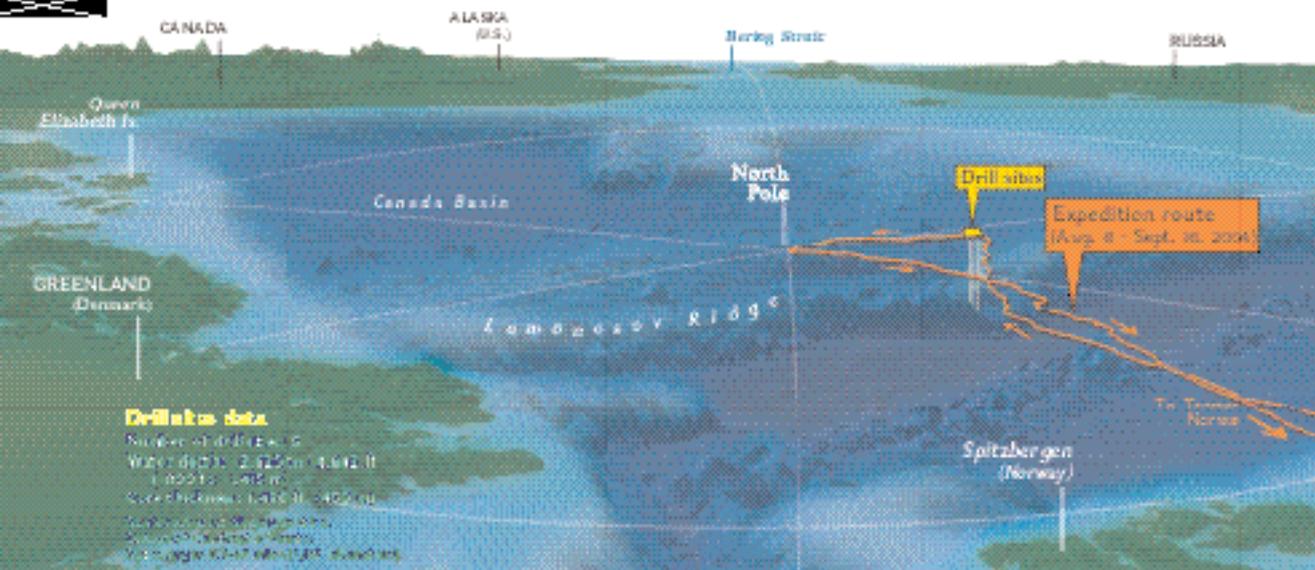
ANCIENT AZOLLA SPORES

**An evolving Arctic:** The ice-free northern ocean of 50 million years ago (below) teemed with microscopic organisms called ebridians (facing page) and the spores of floating ferns (above). By 14 million years ago ice was taking over, peaking 18,000 years ago in the last Ice age.

★  
North Pole

★  
North Pole

50 million years ago



NATIONAL GEOGRAPHIC MAPS, SOURCE: MARTIN JACOBSON, UNIVERSITY OF STOCKHOLM, CREW FOR NEEMO 03

Arctic's topography was its history. To read it required drilling deep into seafloor sediment layers that record past conditions like the pages of a book. But controlling a drill that is plunging through thousands of feet of water on board a ship buffeted by pack ice was a daunting prospect.

"You have to protect the drill ship from the ice," says Kate Moran. An oceanographer at the University of Rhode Island, Moran served as co-leader—along with Jan Backman of the University of Stockholm—of the three-ship, European-funded Arctic Coring Expedition. One ship, a Russian nuclear-powered behemoth (below, background) smashed the biggest floes, some a quarter mile wide or more and eight to ten feet thick, while another, a diesel icebreaker from Sweden, middle, fended off smaller bits.

The third icebreaker, foreground, carried the drill rig, which bored into the seafloor 4,000 feet down (map) for nearly three weeks. "I don't think we can quite believe we did it!" Moran said after the ships docked in Norway last summer with a thousand feet of samples spanning 80 million years.

The rotating drill bit had scrambled some of the samples, and about 600 feet below the seafloor, as much as 30 million years of sediments—from 45 to 15 million years ago—were simply gone, perhaps scoured away eons ago by strong currents.

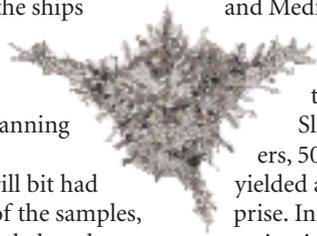
Below that gap, a window opened on a strange world. The very oldest sediments were riddled with the bat-winged fossils of a microscopic, warmth-loving marine alga called *Apectodinium*

(inset). Its presence signaled that the drillers had reached the time 55 million years ago when Earth basked in the warmest spell since the time of the dinosaurs. Crocodiles basked in Greenland then, and Mediterranean warmth apparently reached the very top of the planet.

Slightly younger layers, 50 million years old, yielded an even bigger surprise. In the shipboard lab, a scientist examining the samples was baffled to see "stuff that looks like cow patties." But Henk Brinkhuis, a paleontologist from the University of Utrecht and an expert in tiny marine fossils, knew what it was: spores from *Azolla*—a fern that grows in fresh water.

Brinkhuis had done consulting work for the oil industry, whose crews, drilling in seas bordering the Arctic, had already noticed a mysterious sprinkling of fern spores in 50-million-year-old rock. No one knew the source. Now Brinkhuis and his colleagues think they've found it: a once verdant Arctic Ocean.

Some expedition scientists believe the fern grew in river deltas or coastal lagoons, its



spores drifting into the open ocean. But Brinkhuis argues that the Arctic Ocean itself must have been thick with vegetation. The spores were so plentiful that in the core samples “we have black layers that are virtually made of *Azolla*,” he says. He speculates that geologic forces closed the straits connecting other oceans to the Arctic, so runoff from rivers feeding into it pooled and formed a surface layer of fresh water where the fern could thrive.

Within a million years the fern vanished, maybe because the straits opened up again and flooded the Arctic with salt water, killing the fern. Soon after came the first hint of the frozen northern ocean of today. In samples as old as 47 million years, the scientists found dropstones, pebbles that froze to the bottom of ice floes in shallow water and fell off in midocean. By 15 million years ago, layers of iceborne sand and gravel point to widespread freezing.

That’s earlier than scientists had thought. Many credited later events—rising mountains, shifting ocean currents—with lowering the global thermostat. Ice 15 million years ago, let alone 47 million years



**Aboard ship, roughnecks lug a core sample from the Arctic floor. Back on land, Henk Brinkhuis (bottom, at left) and a colleague study a sample for clues to the ancient ocean floor, such as a fossil diatom (inset).**

ago, calls for another explanation, and a giant freshwater pool could be part of it, says Kate Moran.

Since fresh water is easier to freeze than salt, the ancient Arctic would have been “ripe for freezing,” she says. The ice, in turn, would have reflected sunlight, cooling the climate in a feedback effect that would have resulted in even more ice. The fern may have

been an accomplice. Scientists think a powerful greenhouse effect from atmospheric carbon dioxide ten times higher than today’s fueled the global warm spell 55 million years ago. Before ice could form, the carbon dioxide level had to drop. The fast-growing *Azolla* could have helped by sucking carbon from the air to build leaves and stems. As the ferns died, they would have sunk into deep waters, where scarce oxygen prevented their decay and kept the carbon locked up. “I’m really intrigued by the possibility that it was this little phase that turned the world into an icehouse,” Brinkhuis says.

It will take more study, and probably more drilling, to know exactly what caused the Arctic’s big chill. “After all, we’ve just

stuck one needle hole into this vast ocean,” says expedition scientist Nalân Koç.

These days, as climate warms and the Arctic ice shrinks year by year, we may be undoing the change that began back in that warm, green Arctic 50 million years ago. Says Moran: “Understanding when and why the ice formed is even more important, now that we humans are helping reverse the process.”

—Tim Appenzeller

## Northern Exposure

**The Arctic may not have regained its old lushness, but signs of warming are everywhere.**

**Dwindling sea ice** in the waters north of Alaska and Canada is threatening some sea life—and rekindling the dream of a Northwest Passage.

**Thriving plants** in the warmer climate are turning sparsely vegetated tundra into shrubland.

**Fires and insect outbreaks** fostered by warmer temperatures are assaulting northern forests.



**TAKE TO THE ICE** with other Arctic issues like us from NGM's story "Northern Exposure" at [nationalgeographic.com/magazine/0505/feature\\_6](http://nationalgeographic.com/magazine/0505/feature_6).