Deep impact. Experts debate how well Arctic benthic communities will weather warming.

Thriving Arctic Bottom Dwellers Could Get Strangled by Warming

Ten years ago, biologists skirting Canada's mainland Arctic coast on an icebreaker lowered a video camera to the bottom and got a surprise. Instead of the desolation they expected below ice-covered waters, there was a crowd. Slender brittle stars elbowed each other; fish glided by; anemones writhed under the camera's bright light. This wonderland could be jeopardized by climate change. "We don't know until it happens, but if you have no ice, you probably have no typical Arctic fauna," says Julian Gutt, a marine ecologist at the Alfred Wegener Institute for Polar and Marine Research in Bremerhaven, Germany.

The Arctic bottom fauna, or benthos, is surprisingly rich in species, abundance, and ecological significance. Of the northern ocean's 5000 known marine invertebrates, 90% live on the bottom. In shallow waters, they form the basic diet of many topside creatures including seabirds, walruses, bearded seals, and bowhead whales. Although many of the tiny creatures are migrants from North Atlantic waters, up to 20% are Arctic endemics.

The bounty exists because of the cold, not in spite of it. During the brief summer warmth, ice algae and cold-water plankton explode into life. In warmer waters, such simple organisms are devoured by zooplankton, which are devoured by predators, and so on up the food chain; thus nutrients stay in the water column. But in icy Arctic water, zooplankton do not grow fast enough to consume the sudden rushes of plant life. As a result, much of the plant life sinks to the bottom, where creatures there get it. For this reason, the benthos "can have production that is actually greater than in the tropics," says Bodil Bluhm, a benthic ecologist at the University of Alaska, Fairbanks (UAF).

Many biologists hypothesize that climate change could hurt the Arctic benthos and the large creatures that live off it by wiping out ice (and hence ice algae), lengthening growing seasons for zooplankton, and giving warm-water species a foothold. "The way the system works now is very much in favor of the benthos," says UAF polar ecologist Rolf Gradinger. "If the system changes, things could go downhill fast."

A preview might come from the Bering Sea, between Russia and Alaska. There, higher water temperatures and pullbacks in seasonal ice have progressed fast in recent decades. Oxygen uptake in sediments (an indicator of carbon supply to living things) has dropped by two-thirds, and populations of benthic creatures such as mussels have declined by half. Diving ducks, walruses, and gray whales are moving away, while pollock and other southern pelagic fish are streaming in (*Science*, 10 March 2006, p. 1461).

Preliminary evidence suggests that higher temperatures may be starting to have similar effects in the more northerly Barents and Laptev seas, off Scandinavia and Siberia, says Dieter Piepenburg, a marine biologist at the University of Kiel in Germany. Piepenburg, who wrote a 2005 review on Arctic benthos in *Polar Biology*, says it remains to be seen whether this would spell the end. He says that Arctic benthic organisms have probably already weathered not only warm cycles but also cold ones so extreme that deep ice sheets repeatedly scoured bottoms clean of life far out to sea. Piepenburg thinks the organisms may have migrated to deep waters and then recolonized when the coast was clear.

Those deep waters may also contain more life than previously believed. In 2001, U.S. researchers over the remote Gakkel spreading ridge detected chemical plumes indicating hydrothermal vents—which feed biological hot spots in other parts of the world—but were unable to locate a source. Indeed, no vents have yet been found anywhere in the Arctic, but as part of the International Polar Year (IPY), U.S. researchers in July will return to the Gakkel and deploy new under-ice autonomous vehicles to hunt down and sample the chemical plumes. If they find vents and vent creatures, the organisms may well be unique, because the narrow straits connecting the Arctic to other oceans are too shallow to allow movement of deep-sea creatures and thus mingling of genes.

Researchers are bound to discover many polar organisms, especially in deep places like this, says Gradinger, who is leading the Arctic Ocean inventory for the worldwide Census of Marine Life. The deep basins are mostly unexplored, he says, and many small creatures that live buried in sediments even in shallow areas have yet to be glimpsed. IPY may help change this; within its framework, Gradinger counts 20 biological collecting projects slated so far.

–K.K.

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periods occurred, but the timing, amplitudes, causes, and possible interactions of warm-cold cycles are perplexing. Most other cores gathered so far go back only a few hundred thousand years. Even IODP's cores are missing a giant chunk of time—sediments from 43 million to 18 million years before present—because they were apparently uplifted and eroded away in some as-yet-unidentified event.

Efforts are under way to beef up the records. Last year, the *Healy* and the Swedish icebreaker *Oden* teamed up in the central Arctic Ocean to pull sea-floor cores that researchers hope will cover the last million years. Leonid Polyak, a marine geologist at Ohio State University in Columbus who participated, says some cores exhibit up to 80 cycles of apparent glacial melting, indicated by alternating bands of different-colored grains. Polyak says it appears that the bands come at intervals of 20,000 years, suggesting that they represent fluctuations in Earth's orbit; however, he is unsure, because the cores have not yet been well dated. His colleague Dennis Darby, a paleoclimatologist at Old Dominion University in Norfolk, Virginia, says one core from 1300 kilometers north of