

Antarctic life hung by a thread during ice ages

Frozen in time... frozen in place... frozen solid... All of these phrases have been used to describe Antarctica, and yet they all belie the truth about this southerly point on the globe. Although the area is covered in ice and bears witness to some of the most extreme cold on the planet, this ecosystem is dynamic, not static, and change here has always been dramatic and intense.

A report published in the March issue of *Ecology* argues that the extreme cold and environmental conditions of past Ice Ages have been even more severe than seen today and changed life at the Antarctic, forcing the migration of many animals such as penguins, whales and seals. Understanding the changes of the past may help scientists to determine how the anticipated temperature increases of the future will work to further transform this continent.

Extreme cold and lasting darkness have always worked to limit the productivity of the microscopic algae in Antarctica. The availability of such algae drives the entire region's food web, from one-celled organisms to top predators such as whales and seals, making life in this region challenging for all kinds of animals.

But during the Ice Ages, animals in Antarctica faced conditions even more life-threatening. Massively thick and permanent ice covered most of the land, and sea-ice coverage around the continent was permanent. The Antarctic continental shelf was glaciated and most seafloor animals dodged extinction by emigrating into deeper waters.

Sven Thatje from the University of Southampton's School of Ocean and Earth Science (UK) has been studying geological records of the area for such insights. He and his team from the British Antarctic Survey in Cambridge and the German Alfred Wegener Institute have found that penguins, whales and seals were very dependant upon areas of open water known as polynyas. The polynyas, the team contends, must have existed far south of the present winter sea-ice boundaries, and far north of the Antarctic shelf.

Polynyas have been important both in the past and today because they cause upswells of warmer water, and thereby help establish local food webs for many animals.

Thatje's team analyzed geologic and genetic records and found that during glacial periods the permanent sea-ice belt advanced much further to the North than it is now. In parts of the Southern Ocean, the summer sea-ice boundary was located where the winter sea-ice limit is today, and ice coverage was complete and a magnitude thicker than seen today. These boundaries would have forced a complete shut down of food supplies for most life, both from the sea and land.

Only species that are champions of cold weather adaptation in the present day, such as Emperor Penguins and Snow Petrels, were likely able to survive in locally restricted areas of biological productivity. Those animals, it seems likely, may have stayed in Antarctica during the Ice Ages.

But the polynyas were too isolated to support larger top predators, such as seals and whales, which had to move north to escape starvation. Many other penguin species lost access to traditional feeding grounds and ice-free breeding areas on land, which are crucial for their survival. Some of those animals may have thus been forced to emigrate as far north as the Patagonian shelf off the coast of what is now Argentina.

"Science is only now beginning to ponder what happened here during the Ice Ages," says Thatje. "This research is leading to a radical reconsideration of those time periods. Antarctic species are champions in adaptations to extreme cold and the harshest environmental conditions. Understanding how the stunning

Antarctic fauna has evolved and coped with glacial-interglacial periods will help us to assess their sensitivity to current climate warming.”

Thatje also notes that the animals of Antarctica are extremely vulnerable to warming temperatures. Their ability to survive in extreme cold is unique and has taken tens of millions of years to evolve.

Shifts in the distribution of animals over glacial cycles have likely been a very common phenomenon in region, he says. But given the fact that sub-Antarctic organisms are invading the area as temperatures rise, Thatje says it is time to assess how and if the Antarctic ecosystems will be able to cope with the new invaders.

Source: Ecological Society of America

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