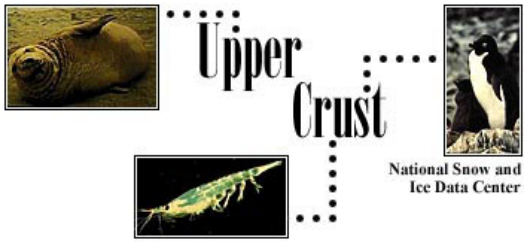

by Rachel Hauser
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Sea ice provides sanctuary for krill, a credit card-sized crustacean that is the cornerstone of the Antarctic food chain. In a 1997 *Nature* article, scientists reported a possible relation between krill abundance and the presence of sea ice. They say years of limited sea ice coincide with reduced krill population and increased numbers of *Salpa thompsoni* or salps, a competitor of krill. What might happen to the Antarctic food web if temperatures increase in the polar regions?

Krill (*Euphausia superba*) form an essential part of the diets of whales, penguins, squid, seals, seabirds and fish. However, elevated numbers of salp, which do not figure on the menus of most krill-dependent predators, inhibit adult krill reproduction and vitality. Climate warming resulting in less sea ice favors higher numbers of salps and thus fewer krill, said Roger Hewitt, one of the authors of the *Nature* article.

"We think that sea ice provides a refugia for the krill population," said Hewitt, a biologist with NOAA's Antarctic Marine Living Resources Program at the Southwest Fisheries Science Center, La Jolla, California. "It allows the krill a place to overwinter, protects them from predators and also provides a food source in the form of ice algae that grows in small cracks on the underside of sea ice. So, the more sea ice, the better for the krill."

Hewitt and colleagues, working in support of the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR), have been studying the abundance and distribution of krill near the tip of the Antarctic Peninsula in the Weddell Sea since 1987. Their research has prompted CCAMLR to call for a re-evaluation of the current krill management model.

Sustainable krill harvest is estimated at 150 million tons, 1.5 times greater than the total number of fish and shellfish harvested annually from the world's oceans, according to the Australian Antarctic Division. CCAMLR set a precautionary limit of 1.5 million tons for krill harvest in the southwest Atlantic sector of the Southern Ocean, although recent catches currently average 100,000 tons per year.

Hewitt believes Antarctic warming is likely to cause significant changes to both the physical environment and the resident species. Disintegration of portions of the ice shelves and a decrease in the frequency of strong recruitment of young krill from seasonal spawning may be the first evidence, he said.

Using satellite data available from the National Snow and Ice Data Center, scientists analyzed seasonal sea ice cover off the northwestern side of the Antarctic

Krill fight for survival as sea ice melts.

Close-up photograph of krill. (Image courtesy of NASA's Passport to Knowledge: Live from Antarctica 2.)

For more information, visit:

- National Snow and Ice Data Center DAAC
- NASA's Live from Antarctica 2 (A Passport to Knowledge Project)
- Ocean Planet (A Smithsonian traveling exhibition)

Images in title graphic courtesy of NASA's Passport to Knowledge: Live from Antarctica 2.

Peninsula from 1979 through 1996, the length of the passive microwave data record. To correlate daily sea ice concentration data with annual population dynamics of immature and adult krill, they created an annual index that combines the temporal and spatial extent of sea ice.

Relating air temperatures to sea ice extent to estimate sea ice cover, the researchers inferred krill numbers prior to satellite coverage.

"Initially our research was based on the premise that the krill population was regulated by predator consumption so we looked for ways to control the krill fishery to minimize the impact on their natural predators. We soon realized that the krill population is sustained by occasional strong year classes and that this has more to do with environmental conditions, namely extensive sea ice development in the winter months and absence of salp population blooms in the spring and summer months," said Hewitt.

Salps prefer an open ocean environment and flourish in years with warmer temperatures and less sea ice. They obtain food by filtering water and extracting edible resources through the cylindrical gelatinous tubes that are their bodies. Early spring determines the impact of salp population on krill. In October or November, during periods of limited sea ice cover, salps rapidly increase their numbers by asexually budding little clones, creating long chains of salps. They efficiently consume the meager quantities of available phytoplankton, decreasing amounts available to krill.

Insufficient quantities of food during the early spring inhibit krill reproductive development and spawning. During years of extensive ice cover krill seem to spawn early. According to research published by the Australian Antarctic Division female krill can lay up to ten thousand eggs, sometimes several times a season, that sink to a depth of two thousand meters before hatching.

"Krill larvae metamorphose through several stages as they move up the water column appearing about two or three weeks later in the ocean surface plankton. At this time, they are vulnerable to predation by salps," said Hewitt.

Scientists believe that spring phytoplankton is the key in the salp and krill equation. During the summer months, salp consumption of phytoplankton accounts for only 20 percent of total available phytoplankton. In years of limited sea ice cover when the Antarctic ocean waters open early encouraging early phytoplankton blooms, Hewitt said, the salp population explodes while the krill population declines.

Combining passive microwave sea ice data with annual salp and krill densities, Hewitt and his colleagues correlated strength of krill population with sea ice extent. During years of poor sea ice development, open water conditions favor salps and krill do not seem to spawn nearly as aggressively nor do their young survive as well.

The connection between krill, salps, sea ice and long-term warming has not been concretely proven, but the evidence suggests a dependency. "There are some obvious changes occurring in the Antarctic marine ecosystem, but whether it's a regime shift, a trend, or the natural variability of the system is unclear. The bottom line is, if our working hypothesis is true and given the documented warming trend in the Antarctic Peninsula, then we can expect some profound changes in the food chain," said Hewitt.

Hewitt, R. P. 1997. Areal and seasonal extent of sea-ice cover off the northwestern side of the Antarctic peninsula: 1979-1996. CCAMLR *Science* 4: 65-73.

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