Antarctic icebergs teem with diverse life

by Scott_LaFee

Fractured from the ancient ice sheets that encrust Antarctica, the bergs of the Weddell Sea may appear at first glance to be cold and sterile places, as lifeless as ice cubes bobbing in a glass of water.

MELTDOWN - Scientists are assessing the impact of global warming on the Earth's southernmost continent. CNS Illustration. But like their proverbial tips, they have much more below the surface. New research - perhaps the first of its kind - suggests that at least some free-floating Antarctic icebergs are biological hot spots featuring everything from microscopic plankton and diatoms to krill, fish, seabirds and seals.

"It was the scale that was substantial and surprising," said Ken Smith, an oceanographer at the Monterey Bay (Calif.) Aquarium Research Institute and lead author of the study, which was published in the journal Science. "There was more abundance and variety than we expected."

That's significant news, because icebergs are proliferating off the coast of Antarctica, the result of global warming. But before this new research, there was scant scientific data to indicate drifting icebergs might be important environmental factors.

"There was some anecdotal information from people who had dived around grounded icebergs that fish densities were greater, but a grounded iceberg is a completely different beast from one free-floating in the ocean," said Ronald Kaufmann, an associate professor of marine science and environmental studies at the University of San Diego and part of the research team.

Indeed, what little information existed about seagoing icebergs was often conflicting. Some observers had suggested icebergs enriched their surroundings; others argued that they depleted them.

Smith and colleagues decided to find out, starting with the null hypothesis that drifting icebergs imparted no significant chemical or biological characteristics to the surrounding ecosystem.

The hypothesis was wrong.

FREEZE FRAMED

The first task was to choose subjects suitable for study - hardly a slam dunk. Most icebergs spend their limited life spans - whether months or years - beyond easy observation, in an environment that is hostile to humans.

At last count, there were an estimated 200,000 icebergs in the Southern Ocean. Smith and colleagues counted 11,000 large enough to be seen with satellite imagery in just one part of the Weddell Sea, an arm of the south Atlantic Ocean that slices into the Antarctic continent southeast of Cape Horn.

The size and shape of icebergs varies greatly. The largest range from tens and hundreds of feet long to several miles. When a portion of the Larsen B ice shelf collapsed into the Weddell Sea in 2002, for example, it was 1 1/2 times the size of Rhode Island and contained an estimated 720 billion tons of frozen water - enough ice cubes to fill more than 12 trillion 20-pound plastic bags. The collapsed shelf produced thousands of icebergs.

Icebergs invariably begin as tabular forms: broad, flat fields of floating ice. Over time, wind, water and warmth can remold them into weird and wild shapes with names like dome, pinnacle, drydock, wedge and blocky.

The scientists narrowed their focus to two particular icebergs in the austral spring (June through August) of 2005. The first, called A-52, was chosen in part because it was big enough to be seen and chosen ahead of time from satellite imagery.

Tabular and oblong, A-52 stretched roughly 13 miles in length, with a width of just over 3 miles. It towered 82 to 105 feet above the ocean's surface, with an estimated submerged depth of 750 feet.

The second iceberg was selected by scientists cruising aboard the research vessel Laurence M. Gould. W-86 was considerably smaller: 1.2 miles long, one-third of a mile wide and 135 feet tall. Its submerged portion was estimated to be almost 1,000 feet deep.

Both icebergs were free-floating, clear of the continent and of pack ice that could complicate and confuse observations, data and conclusions.

Over several days in December 2005, the scientists followed the two bergs as they meandered through the Weddell Sea. The journey of an oceangoing iceberg is typically erratic, its path influenced by many things.

Since most of their bulk is below the surface, they are pushed by currents. But if they extend deep into the water, currents at various depths can simultaneously push them in different directions.

"Then there's wind blowing against the exposed portion of the berg," said Kaufmann, "plus the changing effects caused by melting, parts of the iceberg breaking off. As a result, icebergs tend to spin and spiral, like giant swizzle sticks."

Clambering atop icebergs - or even getting very close - is usually too dangerous. Large waterfalls, for

example, tumbled off the sides of A-52, evidence of rapid melting. Consequently, researchers gathered their data from shipboard devices, towed instruments and a remotely operated vehicle (ROV) able to film the bergs' underwater surfaces.

From water samples taken at various depths and distances from the icebergs, scientists measured the presence of biological activity, such as chlorophyll (the green pigment in plant life that facilitates photosynthesis), phytoplankton (microscopic floating plants like algae that form the base of the marine food chain), zooplankton (tiny marine animals) and micronekton (free-swimming animals bigger than plankton but smaller than 4 inches in length).

Like all Antarctic icebergs, A-52 and W-86 weren't lumps of pure frozen water. As former bits of glacier, the icebergs contain countless bits of soil and rock scraped off the Antarctic continent. It is this terrestrial material that appears to be the fuel and foundation for a whole web of organisms living on and around the icebergs.

As the icebergs melt, scientists say, they enrich surrounding waters with minerals and nutrients, such as iron, that spur the growth of phytoplankton, microscopic floating plants like algae that form the base of the marine food chain.

On the submerged undersides of the icebergs themselves, researchers found diatoms, a class of phytoplankton with rigid cell walls composed of silica, attached to tiny fragments of volcanic rock embedded in the ice.

The abundance of phytoplankton and associated microorganisms attracts predators: shrimplike Antarctic krill (Euphasia superba), tiny jellies and arrow worms. These, in turn, were prey to larger species: various species of fish, pelagic (open oceangoing) seabirds like Cape Petrels (Daption capense) and Antarctic Fulmars (Fulmarus glacialoides), and occasionally Weddell seals (Leptonychotes weddellii). In effect, the icebergs behave like giant floating fertilizer pellets, enriching the immediate waters and boosting biological abundance and diversity. The resulting "halo effect" extends about two miles beyond the icebergs. After that, scientists said, chemical and biological measurements tend to fall back to normal, open-sea levels.

"It's not that you won't sometimes come across a denser patch of krill in the open ocean, without anything else in sight," said Kaufmann, "but this study suggests that you're far more likely to find higher densities of life in association with icebergs."

CARBON CAPTURED

The surprisingly robust life around Antarctic icebergs - researchers estimated that they boosted overall biological productivity in the Weddell Sea by 40 percent - may have other, greater implications.

"One important consequence of the increased biological productivity is that free-floating icebergs can serve as a route for carbon dioxide drawdown and sequestration of particulate carbon as it sinks into the deep sea," said Smith at the Monterey Bay Aquarium.

In other words, the increased abundance of phytoplankton means more carbon dioxide is pulled out of the atmosphere through ordinary biological processes. This carbon is then converted by organisms into fecal matter and deposited on the bottom of the ocean, where it becomes sequestered or trapped.

"While the melting of Antarctic ice shelves is contributing to rising sea levels and other climate-change dynamics in complex ways," said Smith, "this additional role of removing carbon from the atmosphere may have implications for global climate models that needs to be further studied."

Smith emphasized that this first expedition was intended only to prove that further research was not only necessary, but possible. The findings, however limited, have attracted new funding for additional expeditions.

Maria Vernet, an oceanographer at Scripps Institution of Oceanography who participated in the study, said subsequent expeditions will expand and refine the initial experiments and observations.

"Our results were based on one cruise. We wanted to know if a more detailed study was worth doing. The answer to that is now a yes.

"We will go back in June 2008 and March 2009 to test how consistent the signal is between several icebergs. We will test the importance of micronutrients to the surrounding waters by studying icebergs in micronutrient-depleted waters. We will sample around several more icebergs of different sizes.

"At this point, we expect to see a signal. We just don't know how different it will be."

Not everyone expects Antarctic icebergs to prove to be major environmental players. Kevin Arrigo, a biological oceanographer at Stanford University who has studied icebergs in Antarctica's Ross Sea, says they aren't calving or melting as prolifically as those in the Weddell Sea. And he notes that biological production in the seas around Antarctica amounts to less than 10 percent of the worldwide total of marine life.

But for the moment, until more expeditions are launched and more data published, the environmental role of Antarctic icebergs is likely to remain a hot topic.

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