



FAUNA FLOURISH UNDER

Scientists taking part in the Amery Ice Shelf Ocean Research (AMISOR) project were surprised recently by the discovery of rich and diverse marine life deep beneath the ice shelf.

Video cameras lowered into three (of four) boreholes, drilled across the 550 km-long ice shelf to depths of 750-1300 m below sea level, revealed flourishing life forms existing some 100-250 km distant from the open ocean.

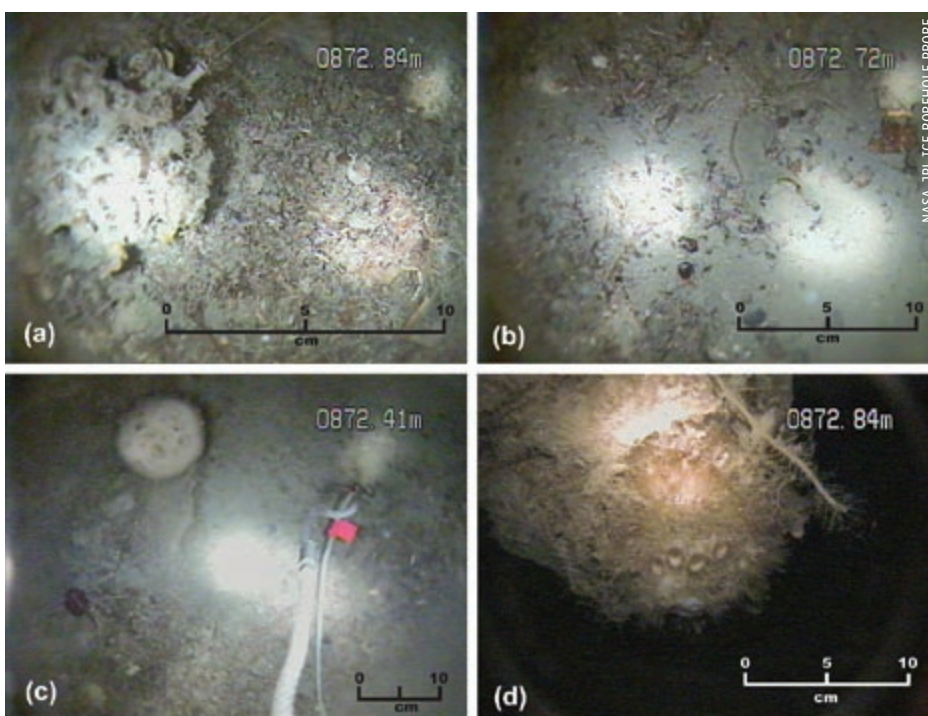
Initially the blackness was punctuated by swarms of tiny particles being carried along in the currents beneath the shelf. However, an attentive eye soon realised that a small percentage of these were actually moving haphazardly across the field of view, often against the current. Biologists were quick to recognise the presence of amphipods (tiny mobile crustaceans) in the water column.

Evidently a suitable percentage of the current-swept particle swarm was edible detritus, rather than merely crushed rock debris, ground from the bedrock of Antarctica by the ice sheet.

The next sighting was a major surprise: a krill auditioned for the camera with a looping dance in the spotlights at a depth of some 750 m beneath the drill site at AM01 (see map). This was most likely an 'ice krill' (*Euphausia crystallophorias*), and it was the first report of these lively crustaceans at such great depth. We have since witnessed them beneath the shelf at AM03 and AM04, which are both deeper and further from open water.

The sea floor at AM01 was also home to a complex benthic (sea floor) assemblage, dominated by suspension-feeding invertebrates including sponges, molluscs, sea urchins and sea fans, unlike anything previously reported so far beneath an ice shelf (see figure).

Global climate change studies focus attention on the seabed under ice shelves, or in areas previously covered by them (such as parts of the Larsen Ice Shelf – see story page 6), for evidence of prior ice shelf advance or retreat preserved as fossils in seabed sediments. The AMISOR findings are important because the community beneath AM01 is indistinguishable from that commonly found on the Antarctic continental shelf in open water. Before now, if palaeontologists had found the fossil remains of such a complex community of organisms, they would probably assume that the site was free of the ice shelf when these



The seabed at AM01 contained a richly diverse benthic community with: (a) – bryozoan species (large structure at left) and calcareous tubes; (b) – mucous net filter feeders (right of centre); (c) – white sponge (top left) and urchin (lower left); and (d) – sponge (centre) and hyoids (top right).



The AMISOR hot water drill camp.

What is AMISOR?

The Amery Ice Shelf Ocean Research (AMISOR) project is part of a broad umbrella study of the entire Lambert Glacier Basin, Amery Ice Shelf system (located between Mawson and Davis in East Antarctica), to understand both the climatic history of the region, and its probable response to global warming.

The project is part of the Australian Antarctic Division's Ice, Ocean, Atmosphere and Climate programme and the Sea Level Rise programme within the Antarctic Climate and Ecosystems Cooperative Research Centre.

The project, which has been running since 2000, brings together glaciological and seismological fieldwork, marine science and oceanographic surveys, sedimentation history and sea floor biology, airborne and satellite remote sensing, and numerical modelling of the past and future behaviour of the ice-ocean system.

The central pillar of AMISOR has been fieldwork involving hot water drilling of four boreholes through the ice shelf. Closely linked with this, and often working in tandem in the field, have been two other projects: a systematic seismic survey of the north-central shelf region (run by Macquarie University); and monitoring of the 'Loose Tooth' – a series of developing rifts at the front of the shelf that will lead to an iceberg calving event (run by the University of Tasmania and the Scripps Institution of Oceanography in California). These activities feed data into 'coupled' ice shelf-ocean models that predict the patterns of melting and freezing at the base of the shelf, the modifications to water masses circulating below the shelf, and examine the way iceberg-forming rifts propagate into the body of the shelf.

Measurements and sampling activities at the borehole sites have provided information on such things as ice shelf elevation, ice thickness, surface weather, ice shelf temperature profiles, and annual variability in salinity and temperature in the water cavity below the ice shelf.

HONEYCOMB ICE

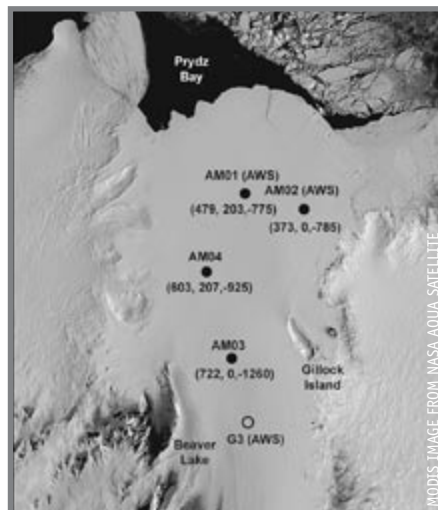
animals were living there. Although a reasonable assumption, it turns out to be incorrect. Thus, these new observations provide a better context for sediment core interpretation of the history of the ice shelf in the region.

Seabed borehole video and sediment core samples were recently obtained from beneath AM03 and AM04. At first glance there appears to be less species diversity and abundance than below AM01, but investigations are continuing. It is exciting that these sites, with increasing distance from open water, could provide insight to the colonisation processes in such extreme environments.

Another intriguing discovery of the AMISOR project has been the porous nature of the marine ice toward the base of the ice shelf at sites AM01 and AM04. This feature manifested itself during the drilling process when a pressure sensor in the well indicated that hydraulic connection with the ocean cavity had been achieved whilst the drill head was still many tens of metres above the true base of the shelf.

Borehole video footage showed that the lower 70-100 m of the marine ice was honeycomb in nature with ice platelets (large ice crystals) welded together, and interstitial sea water filling progressively larger and larger cavities. The ability of sea water to move relatively freely through this honeycomb ice makes these parts of the shelf vulnerable to any increases in sea water temperatures.

The next phase of the AMISOR project is likely to focus on the uniqueness of the honeycomb nature of the marine ice, and its susceptibility to temperature and ocean circulation pattern changes beneath the shelf. We will also examine the gradation of benthic communities as we progress further beneath the shelf.



Location map showing the four borehole sites and the automatic weather station at G3. The distance between AM01 and AM02 is approximately 50 km. Numbers in parenthesis beneath each site are total ice thickness, marine ice thickness, and depth of sea floor below mean sea level.

To complete the story that the Amery Ice Shelf and environs have to tell us though, we need to launch other major deep field projects, for example, a full seismic survey for the true bathymetry (depth) of the southern half of the shelf. Ultimately, we hope to unleash a fully instrumented autonomous underwater vehicle to roam the depths of the ocean cavity and unlock more of its fascinating secrets.

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