MARINE BIODIVERSITY

Assessing biodiversity on the Antarctic sea floor

Vonda Cummings

Scientists are only now getting a good picture of the remarkable diversity of seafloor fauna below the sea ice of the Ross Sea.

For explanations of terms in **bold**, see glossary on page 23.

Vonda Cummings is based at NIWA in Hamilton.

Think of Antarctica, and you probably conjure up images of inhospitable vast white expanses of ice and snow, glaciers, mountain ranges and, apart from the penguins, very little obvious life. However, below the sea ice of the Ross Sea, the seafloor is teeming with a diverse and colourful array of fauna. Scallops, urchins, brittlestars, seastars, nemertean worms, nudibranchs (sea slugs) and giant isopods are just some of the animals living on the seafloor, and many different kinds of worms, shellfish and crustaceans live in the seafloor sediments. In places, the diversity and abundance of coastal marine organisms in the Ross Sea is amongst the highest in the world. But this environment is coming under increasing pressure from fishing, tourism and climate change. How might these changes affect this unique ecosystem?

To answer this question we first need to understand more about these seafloor communities and their habitats. How do the animals interact with their surroundings? How are they linked to each other? (For example, who is eating what?) What would happen if there were large-scale changes such as a reduction in sea-ice cover or a change in the rate of plant growth in the area? All these questions, and more, are being tackled in a series of associated research programmes, collectively known as ICECUBE (see panel opposite and pages 13–14). The project aims to improve our ability to link the information gathered in surveys of the flora and fauna and their habitats with the sea-ice related processes that influence biodiversity.

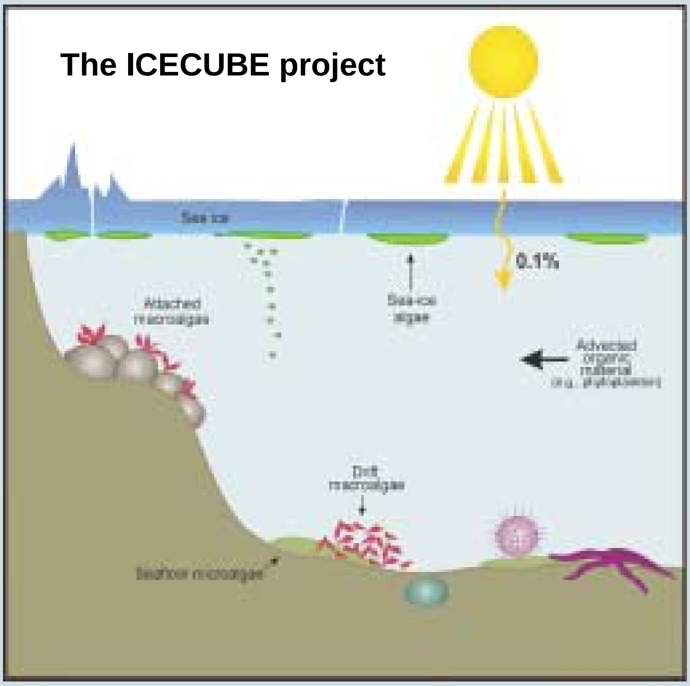
Natural gradient

Antarctica has very marked seasonal differences. There is total darkness in winter and 24-hour daylight in summer, accompanied by huge changes in the extent of sea-ice cover. All this has a major influence on **primary production** sources (see pages 13–14) and, consequently, the supply of food to the seafloor fauna.

As you move from high to low latitudes in the Ross Sea, from McMurdo Sound to Cape Adare (see map opposite), there is a natural gradient in environmental conditions and productivity. NIWA's research in the Ross Sea includes investigations along this natural gradient of the seafloor fauna and their habitats, and how they interact with the physical environment: temperature, light, sea-ice and water movement. We are looking for the key factors – such as food sources, or physical conditions – that affect which animals live where on the seafloor. For example, we expect to find that because sea-ice cover is so important for primary producers it will affect the diversity of the whole community.

Seastars (*Odontaster validus*) and nemertean worms (*Parborlasia corrugatus*) on a boulder covered with attached macroalgae (*Phyllophora antarctica*). (Photo: Rod Budd)

Diver collecting large animals from along a video transect in New Harbour. (Photo: Rod Budd)



The ICECUBE (**C**oastal **U**nderwater **B**enthic **E**cosystems) project is investigating the processes underlying the observed broad- and local-scale biodiversity patterns in seafloor communities along the Ross Sea coast. The biodiversity of Antarctic coastal marine communities is affected by physical and biological factors, such as substrate type and food. The strong seasonality in environmental conditions (particularly sea-ice cover and light) strongly influences **primary production** and the subsequent supply of food to the animals on the sea floor.

Primary production in coastal systems is strongly driven by sea-ice conditions, which determine the relative importance of the most abundant sources of primary production: (a) sea-ice algae (some of which falls to the ocean floor), (b) phytoplankton carried under the ice from distant open water, (c) seafloor microalgae, and (d) seafloor macroalgae (attached and drift forms of seaweed). Currently, how these different food sources are used by seafloor animals is poorly understood, particularly their response to changes in sea ice cover and hence primary production pathways.

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SCUBA surveys

We began our research in the 2001/02 Antarctic summer with sampling at Cape Evans and New Harbour in McMurdo Sound. Our first aim was to develop the techniques and expertise we needed to undertake a latitudinal-scale comparison of Antarctica's coastal seafloor communities, in a way that was feasible and cost-effective, given the difficulties of working in Antarctica.

We developed a SCUBA-based sampling strategy which includes video transects, seafloor and sea-ice core sampling. This provides information on the diversity of large animals living on the seafloor (for example, urchins, brittlestars and other animals identifiable using video), details of smaller animals living in the sediments, and physical and biochemical habitat characteristics. Thus the sampling regime allows us to assess the results at a number of scales.

Because our time on the ice is limited, we cannot sample as many places as we would like. Therefore, we also use relatively quick remote-sampling techniques (such as "splash cam" and ROV – see *Water & Atmosphere 10(1)*: 6) to observe additional sites, and to help us assess the generality of what we have seen at the intensively SCUBA-sampled sites.

Another aid to unravelling how animal species interact is the use of **stable isotope** techniques.

The Ross Sea region of Antarctica. (Reproduced with permission, from: Waterhouse, E. (2001). Ross Sea Region 2001. A state of the environment report for the Ross Sea region of Antarctica. Antarctica New Zealand)

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These techniques (see *Water & Atmosphere 7(2)*: 22–28), have been little used in the Ross Sea. Stable isotope information can help us interpret the importance of particular species within the system, and therefore help predict the effect of their loss due to environmental change.

In the future we plan to increase the latitudinal extent of our study by sampling at more locations along the Victoria Land coast. For example, in February 2004, NIWA researchers will join Italian, US and German scientists on board RV *Italica*, on a voyage from Terra Nova Bay to Cape Adare (see below).

Once we have information from many locations along this latitudinal gradient, we will conduct a full-scale analysis, the results of which will help us to more accurately predict the consequences of environmental change on the biodiversity of the Ross Sea's marine communities. These predictions are crucial to help preserve this unique ecosystem. ■

Voyage on the *Italica*

Italica, breaking through ice in Terra Nova Bay. (Photo: Simon Thrush)

This summer (2003/04) marine ecologists from NIWA will join researchers from Italy, Spain, Germany and the USA on an expedition on the Italian research vessel *Italica.* Working from Terra Nova Bay to Cape Adare (see map, page 11) the expedition will undertake integrated sampling of the seafloor and water column along transects at depths from 15 to 500 m. This project marks growing international interest in the biodiversity of the Antarctic marine environment and the use of latitudinal gradients.

On this voyage we will visit sites in the coastal Ross Sea that have never been visited or sampled by marine ecologists. We expect to see dramatic changes as we move north along the coast, with increasing productivity, and coastal communities increasingly dominated by seaweeds. But we do not know how this will influence biodiversity; and perhaps we will come across species so far unknown to science. Most importantly, sampling these northern sites on the Victoria Land coast will add new information to our current databases, which are based on sites in McMurdo Sound and Terra Nova Bay. We need the information not only to obtain a more complete picture of the biodiversity of this environment but also to know why it changes.

Collaboration with our Italian colleagues began in 2002 when a team of Italian researchers joined NIWA scientists in studies in McMurdo Sound. Later in the season NIWA ecologists worked with Italian researchers at Terra Nova Bay to develop sampling techniques to support the coming season's work from the *Italica*. This joint work with the Italian team illustrates two aspects of scientific research in Antarctica: its open and collaborative nature, and the large amount of planning and logistic support required. In the end, though, it will be the weather and sea-ice conditions that will dictate how much we can achieve.

Nevertheless, any information gathered will be important. Not only will it add to our fundamental knowledge of this fascinating environment, but it will also help us to make informed decisions about impacts associated with global climate change and the more immediate threats of increased tourism and fishing.

For more information, contact: Simon Thrush, NIWA, PO Box 11 115, Hamilton (ph 07 856 7026, fax 07 856 0151, s.thrush@niwa.co.nz)

The *Italica* voyage and research programme has been organised by Professor Riccardo Cattaneo-Vietti and Dr Mariachiara Chiantore of the Dipartimento per lo Studio del Territorio e delle sue Risorse, Università di Genova.