AUSTRALIAN ANTARCTIC MAGAZINE

ISSUE 20 2011

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The Australian Antarctic Division, a division of the Department for Sustainability, Environment, Water, Population and Communities, leads Australia's Antarctic program and seeks to advance Australia's Antarctic interests in pursuit of its vision of having 'Antarctica valued, protected and understood'. It does this by managing Australian government activity in Antarctica, providing transport and logistic support to Australia's Antarctic research program, maintaining four permanent Australian research stations, and conducting scientific research programs both on land and in the Southern Ocean.

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- To maintain the Antarctic Treaty System and enhance Australia's influence in it;
- To protect the Antarctic environment;
- To understand the role of Antarctica in the global climate system; and
- To undertake scientific work of practical, economic and national significance.

Australian Antarctic Magazine seeks to inform the Australian and international Antarctic community about the activities of the Australian Antarctic program. Opinions expressed in *Australian Antarctic Magazine* do not necessarily represent the position of the Australian Government.

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Australian Antarctic Division

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JIM MILNE

ABOUT THE COVER

Glenn Jacobson took this photograph of Antarctic sea ice during a voyage to Mawson station in February this year. Glenn works in the Australian Antarctic Division's multimedia section as a production coordinator, where he produces video and still images for the Antarctic Division's website, various publications and news media. The photograph was taken on a cloudy afternoon from the wheel house deck of the *Aurora Australis* (ISO 250, F13, 1/640).

MERTZ GLACIER CALVING PROVIDES SCIENTIFIC OPPORTUNITIES

When a gigantic iceberg collided with the Mertz Glacier ice tongue in February 2010, it exposed a part of the sea floor that had been hidden from view for decades. The calving of the 2500 km² ice tongue also changed the geography of the region, with unknown consequences for the global ocean overturning circulation and climate. But within a year of the calving the Australian Antarctic Division assembled a team of scientists to make the first observations of the new environment.

Scientists have been studying the Mertz Glacier region and its associated 'polynya' since the early 1990s. A polynya is an area within the sea ice pack that remains free of ice even in the depths of winter. Because there is no ice to insulate the ocean from the cold atmosphere, the ocean loses huge amounts of heat. The rapid cooling causes sea ice to form, but strong winds coming off the Antarctic continent blow the ice offshore as rapidly as it forms. This makes polynyas important sea ice 'factories', constantly forming and exporting sea ice. The Mertz polynya, for example, covers only 0.001% of the Antarctic sea ice zone at its maximum winter extent, but is responsible for one per cent of the total sea ice production in the Southern Ocean.

According to CSIRO oceanographer Dr Steve Rintoul, the salt that is left behind when new sea ice forms creates cold, dense water that sinks to the ocean bottom and forms 'Antarctic Bottom Water'. This bottom water forms one branch of the global overturning circulation, which influences global climate patterns by transporting heat, carbon dioxide and fresh water around the world's oceans.

'The Mertz polynya contributes about 15 to 25 per cent of Antarctic Bottom Water and we think it may have been the presence of the glacier tongue that made it such an active polynya,' Dr Rintoul says.

'The loss of the ice tongue may mean that the area is less effective in forming dense, salty Antarctic Bottom Water, which could have flow-on effects on ocean currents.'

1. *Ice cliffs in the Mertz Glacier region.* (ESMEE VAN WIJK)
2. *Above: ABC journalist Karen Barlow travelled on the Mertz Glacier voyage and reported on the science in her blog* Breaking the Ice. *She and her cameraman Michael 'Chook' Brooks also filmed pieces for ABC News and the Lateline program. See an online ABC special about the voyage at www.abc.net.au/news/events/antarctic-summer/* (ESMEE VAN WIJK)

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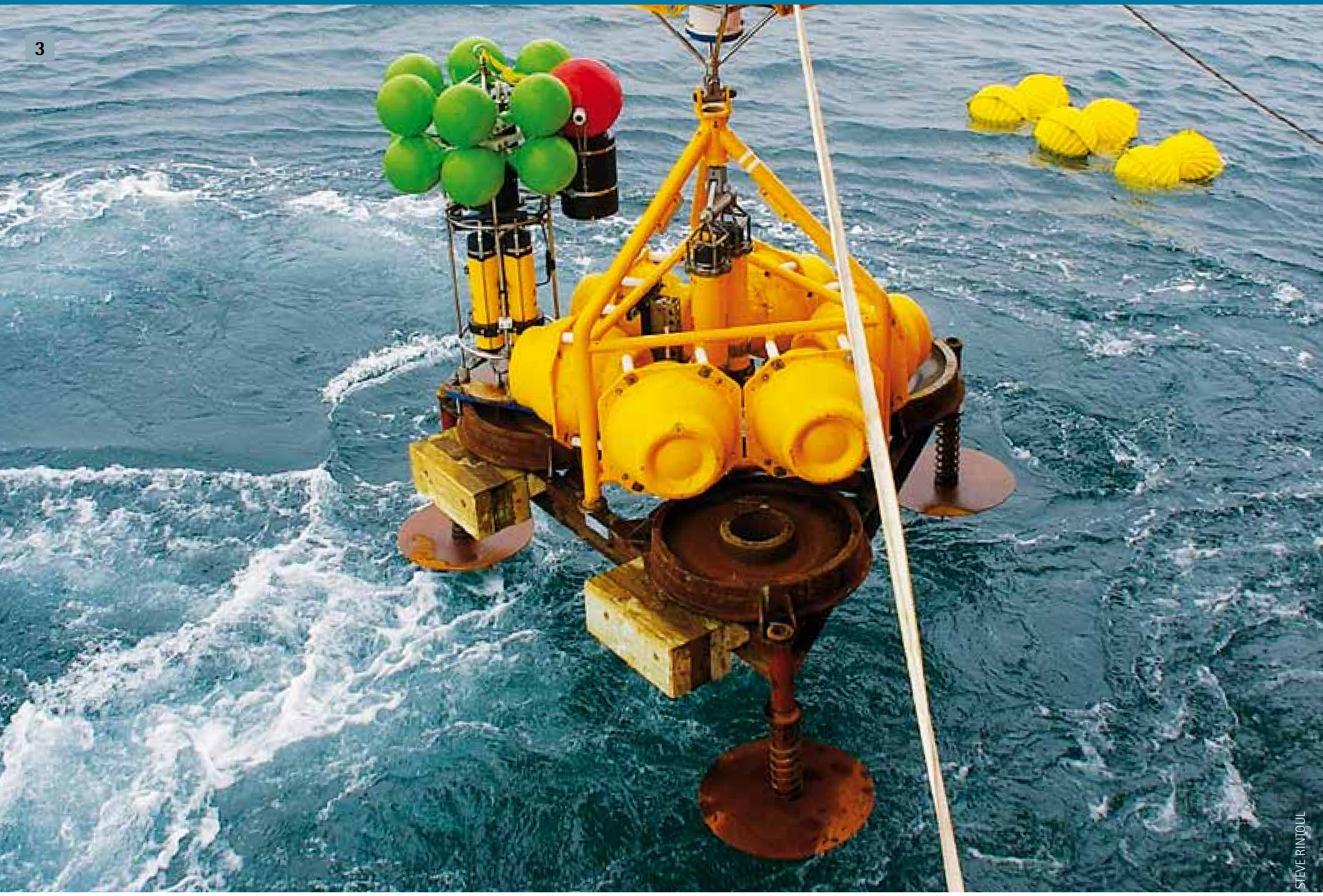


STEVE RINTOUL

To find out, scientists participating in the Mertz Glacier voyage between January and February this year, set out to measure the changes in temperature, salinity, oxygen, carbon and nutrients, from the sea surface to the sea floor. On previous voyages to the region Dr Rintoul and his oceanographic team have shown that Antarctic Bottom Water has become less salty and less dense since the early 1970s, probably as a result of an inflow of glacial melt water.

'One of the main goals of this voyage was to see if this trend is continuing and to test the idea that increased melting of Antarctic ice is contributing to the fresh water signal we see in the ocean,' he says.

The team deployed three moorings (see photos) within the region to measure the outflow of Antarctic Bottom Water from the Mertz polynya. These moorings will collect data on current speed and direction, temperature, salinity and oxygen, before they are retrieved in two years time.

The team also measured water properties using a CTD (conductivity, temperature and depth) profiler instrument (see *CTD Explained* on page 4). The CTD profiler was lowered at 149 stations during the month-long expedition and almost 100 profiles were collected over the continental shelf and slope in the Mertz polynya region.

'A preliminary analysis of the CTD results suggests that the calving of the glacier tongue has had an impact on the salinity of dense water on the continental shelf,' Dr Rintoul says.

'The dense waters sampled this summer were much fresher and less dense than samples taken at the same locations three years earlier. The surface waters were also much fresher than in 2008.

Dr Rintoul says the fresh surface layer probably reflects the melting of thick multi-year sea ice floes present over much of the shelf. This thick sea ice used to be trapped on the eastern side of the Mertz Glacier tongue, but when the ice tongue broke free, the sea ice started to move out of the area.

Sampling the line

CTD measurements were also made along a defined line between Hobart and the Antarctic continental shelf, with the ship stopping every 30 nautical miles to lower the CTD profiler to the sea floor, to depths of up to 4700 m. This 'SR3 transect' has been studied since 1991, providing a long time series for tracking climate change in the oceans.

'The only way we can detect and understand changes throughout the full depth of the oceans is to carry out repeat transects like this one,' Dr Rintoul says.

'We collected 55 CTD profiles from the sea surface to the sea floor, with the CTD package travelling about 400 km through the water column. More than 1000 water samples were collected for various chemical analyses, including oxygen, nutrients, salinity and carbon dioxide.'

Biologists also deployed nets to capture zooplankton along the SR3 transect; in particular marine snails known as pteropds. These organisms are an important food source for marine predators in the Antarctic food web and are at risk from ocean acidification, caused by increased atmospheric carbon dioxide dissolving in the ocean.

'When carbon dioxide dissolves in sea water it forms a weak carbonic acid, which is capable of dissolving shells,' says marine biologist Dr Will Howard of the Antarctic Climate and Ecosystems Cooperative Research Centre.

As the ocean becomes more acidic, scientists expect to see changes in the number and type of shell-forming zooplankton in sampling areas, and decreases in the thickness and integrity of their shells (*Australian Antarctic Magazine* 18: 4-5, 2010).

Phytoplankton bloom

One surprise of the voyage was the discovery of large phytoplankton blooms in the Mertz Glacier region.

'Pretty much everywhere we went in the shallow waters of the continental shelf, we encountered intense phytoplankton blooms,' Dr Rintoul says.

'The sea looked greyish-green, like coastal waters, rather than the intense blue more typical of offshore Southern Ocean waters. In some places there was so much organic material raining down through the water column that we could measure chlorophyll (a photosynthetic pigment) down to depths of more than 200 m. Usually we only find chlorophyll in the upper 50 to 75 m.'

As a result, CSIRO chemical oceanographer Dr Bronte Tilbrook recorded some of the lowest carbon dioxide values ever measured in the Southern Ocean.

'Our measurements indicated that the phytoplankton were growing rapidly, taking up lots of carbon as they photosynthesised and making that part of the ocean a strong "sink" for atmospheric carbon dioxide,' he says.

'It may be that the melt of all the old ice released by the calving of the Mertz Glacier was supporting the bloom. We estimated that about one million tonnes of carbon had been taken out of the water. We normally don't see that in the Mertz region.'

Biodiversity mapping

The geographic change in the Mertz Glacier region, as well as the iceberg scouring and exposure of the sea floor caused by the tongue calving, will have an impact on the organisms that live on the sea floor (known collectively as the 'benthos'). On previous voyages to the region scientists discovered diverse and dense communities of corals and other creatures at depths of 400 to 800 m on the continental slope. Two areas, each about 400 km^2, were later protected by the Commission for the Conservation of Antarctic Marine Living Resources, which declared them 'Vulnerable Marine Ecosystems' (*Australian Antarctic Magazine* 15: 19, 2008).

On this latest voyage, the scientific team deployed cameras on the CTD equipment to take photos of the benthos (see story on page 8), to map the location of coral gardens and to see how this location relates to ocean currents.

'So far the evidence seems to support our hypothesis that the corals grow where dense water, produced in winter polynyas, cascades off the shelf and into the deep sea,' Dr Rintoul says.

'These dense waters transport small particles of food that are scavenged by filter feeders. When we shone a light beam through the water and

3. A mooring is deployed from the trawl deck of the *Aurora Australis*. The mooring consists of an anchor (metal tripod) and an acoustic release, yellow glass floats for buoyancy, an acoustic doppler current profiler to measure ocean currents (top of mooring), a fibre optic gyro (attached to red float) to measure current direction and a number of small CTDs to measure water properties.
4. The CTD rosette of Niskin bottles used to collect water samples at different depths.
5. *Aurora Australis* crew prepare to capture the fibre optic gyro after its release from a mooring. The gyro was deployed on each mooring and left underwater for a couple of hours to determine the orientation of the instrument package on the sea floor, before the acoustic release was triggered to allow the gyro to float to the surface. Once the red float attached to the gyro was spotted, the crew launched a grappling hook using an air gun (pictured) to haul the gyro back to the boat. A lot of planning was required to ensure the gyro didn't get stuck under an ice floe or iceberg.

ESMEE VAN WIJK

Above: Sea ice algae.

measured how much light was transmitted and how much was blocked by particles, we found that the dense water was often full of particles.'

The observations from the voyage will provide a useful benchmark for tracking future changes resulting from the Mertz Glacier tongue calving event. If the calving results in less dense water flowing off the shelf, this may affect the food supply to these benthic communities.

Autonomous science

Along with the CTD measurements and oceanographic moorings, scientists deployed four Argo floats, which will join some 3000 others throughout the world's oceans measuring temperature, salinity and ocean current speeds. These free-drifting floats rise up and down between the ocean surface and two kilometres depth every 10 days, and beam their information to ground stations via satellites. Two of the Argo floats deployed were ice floats that are able to sample under the winter sea ice, providing valuable data from the seasonal ice zone which, historically, has been poorly sampled.

'The data we've collected from this voyage and from the instruments that will remain in the ocean for some years to come will give us a better understanding of the role of the Southern Ocean in the climate system and the sensitivity of the region to future change,' Dr Rintoul says.

'This information in turn will allow us to anticipate and respond more effectively to climate change.'

WENDY PYPER[1], STEVE RINTOUL[2,3], BRONTE TILBROOK[2,3] and ESMEE VAN WIJK[3]

[1] Australian Antarctic Division, [2] Antarctic Climate and Ecosystems Cooperative Research Centre, [3] CSIRO

STEVE RINTOUL

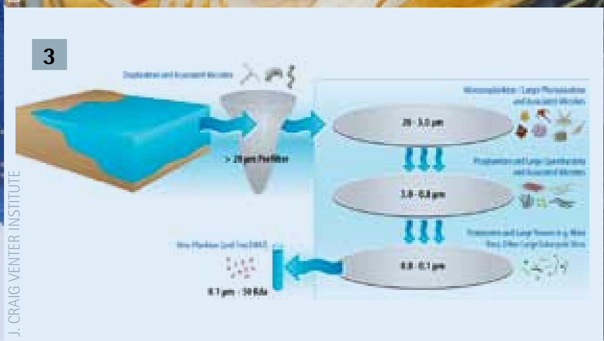
CTD EXPLAINED

The Conductivity-Temperature- Depth (CTD) instrument is the workhorse of oceanography. Almost all the samples analysed on the voyage were collected by the CTD system. A CTD is made up of two parts: sensors that continuously measure temperature, oxygen and conductivity (salinity is calculated from the temperature and conductivity measurements) as the instrument descends, and a carousel of 24 plastic cylinders (Niskin bottles) that are used to collect water samples at different depths. The CTD is lowered on a 6.4 mm diameter wire that contains an electrical cable. The electrical connection provided by the cable supplies power to the instrument and allows two-way communications: profiler data is sent to the ship, and signals sent from the ship tell the instrument when it is time to collect a water sample. Different Niskin bottles are closed at different depths, trapping water samples that are analysed back on board the ship for oxygen, pH, carbon, alkalinity, fluorescence and nutrient concentrations. The first CTD was invented by an Australian, Neil Brown. Before his invention, oceanographers could only collect discrete samples at a small number of depths.

Capturing the ocean's microbial diversity

MATTHEW Z. DEMAERE, UNSW

DAVID WILKINS, UNSW



J. CRAIG VENTER INSTITUTE

LAURA SMITH, UTAS

1. A Google Earth map showing the location of the microbial sample sites
2. The filtration apparatus used to separate different sized microbes in seawater.
3. A schematic showing which organisms the different filters collect.
4. Tim Williams (left) and David Wilkins in the *Aurora Australis* laboratory preparing to filter water samples.

During the Mertz Glacier voyage a team of microbiologists from the University of New South Wales collected water samples to learn more about microbes (bacteria, archaea* and viruses) and their role in Southern Ocean ecosystems.

The ocean is the largest microbial environment on Earth, yet until very recently we have lacked the technology needed to study more than a tiny fraction of its enormous diversity. Our microbiology group at the University of New South Wales is working to develop an inventory of the microbial ecosystems of the Southern Ocean, including which microorganisms are present and the metabolic and ecological processes they perform. Our study also aims to establish a baseline against which environmental changes, such as the temperature and ocean acidification effects of climate change on microbial ecosystems, can be measured. This baseline will help refine predictive models for these changes.

We collected 24 x 400-litre seawater samples during the marine science voyage of the *Aurora Australis* in January and February this year. The ship made a 1500 km transect of the Southern Ocean from Tasmania to the Antarctic coast, allowing us to sample the full breadth of Southern Ocean environments, from warmer waters to the cooler subantarctic and frigid Antarctic zones.

Our seawater samples were collected from both the surface and the deeper layers where maximal chlorophyll concentrations exist in the water column (chlorophyll is a photosynthetic pigment present in algae and other phytoplankton). This is typically where the highest density of marine microbes is found. The seawater was pumped through a fine 20 µm mesh (1 µm = 0.001 mm) to remove non-microbial organisms, then through three consecutive filters of increasing fineness (3.0 µm, 0.8 µm, 0.1 µm) to collect the microbial component (biomass). The different filters capture microbes of different size ranges.

Back in the lab in Sydney, the microbial biomass will be removed from the filters for metagenomic, metatranscriptomic and metaproteomic analysis. Metagenomics is a recently developed technique which allows DNA from an entire microbial community to be sequenced in a single process. This gives researchers a wealth of crucial data on what kinds of microbes and genes have been selected in that community, letting us answer questions about how the microorganisms are adapted to the environment and what ecosystem roles they play.

Metatranscriptomics and metaproteomics involve similar analyses of the total RNA and protein components of the community, respectively. While metagenomics can tell us what genes the microorganisms possess, not all genes are 'expressed' (transcribed into RNA, which is then translated into functional proteins) at the same levels, or at all times.

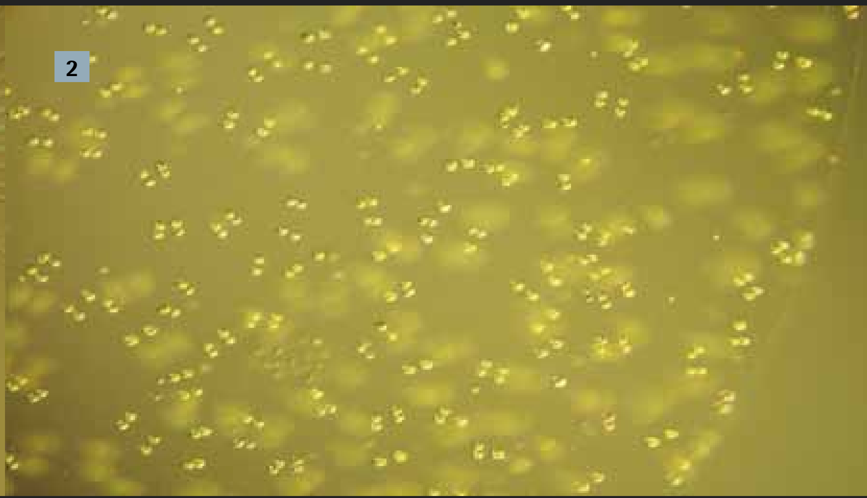
Identification of the RNA and proteins will tell us what particular genes are actually being expressed by the microbes, giving a more complete picture of community processes. Proteins, such as enzymes, will tell us what metabolic processes are occurring, such as the conversion of atmospheric gases into biomass.

This work contributes to the Australian Southern Ocean Genome-Based Microbial Observatory (ASOMO), established in 2008, which aims to understand the genomic and functional differences that occur in microbial populations. Related research was previously published in the *Australian Antarctic Magazine* 14: 8, 2008.

TIM WILLIAMS, DAVID WILKINS, MATTHEW DeMAERE, FEDERICO LAURO and RICK CAVICCHIOLI
University of New South Wales

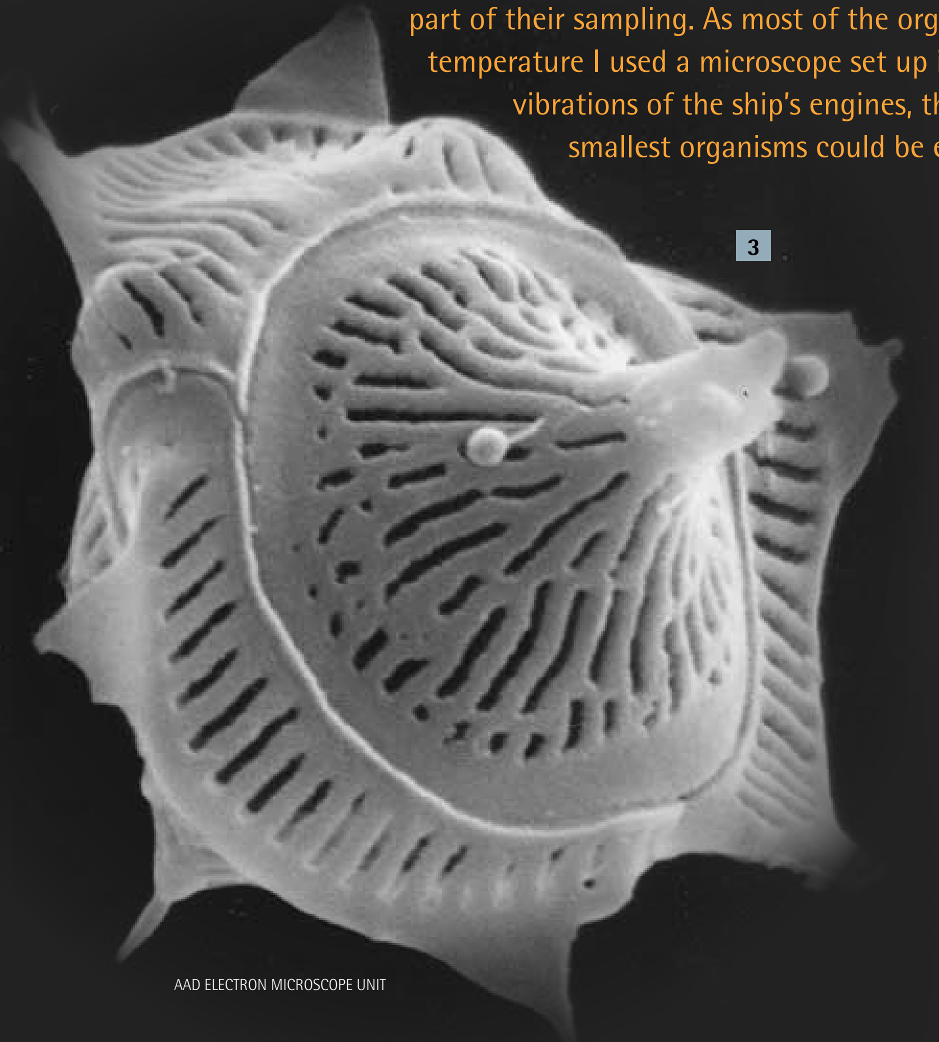
* Archaea are an ancient group of microorganisms distinct from bacteria and eucarya. R. Cavicchioli. Archaea – timeline of the third domain. 2011. *Nature Reviews Microbiology* 9: 51-61.

MICROBIAL MENAGERIE UNDER THE MICROSCOPE



IMAGES: HARVEY MARCHANT

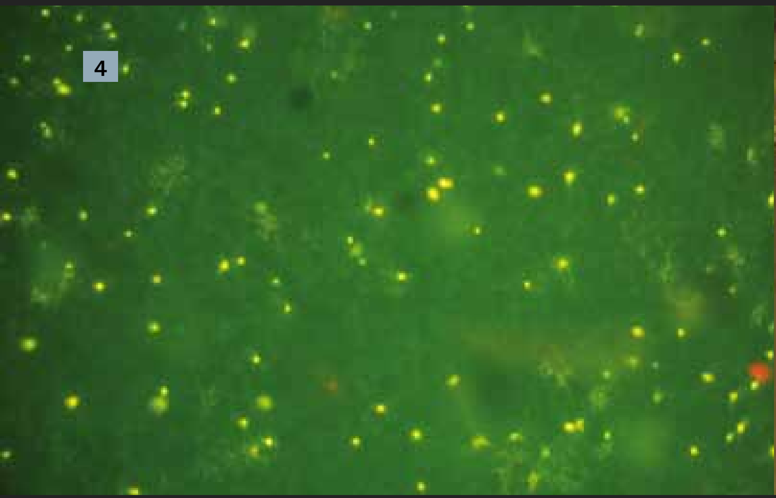
The marine science voyage to the Mertz Glacier region brought together researchers with a diversity of interests in marine microbial processes, including the distribution, abundance, biodiversity and activity of phytoplankton and the effects of ocean acidification on organisms. My particular tasks were to ascertain the change in the concentration of cyanobacteria (blue-green algae) with temperature; to collect samples of a group of phytoplankton called Parmales; and to identify protists (see box story) that others collected as part of their sampling. As most of the organisms are very sensitive to elevated temperature I used a microscope set up in a 3°C cold room. To damp out the vibrations of the ship's engines, the microscope was shock-mounted so the smallest organisms could be examined, counted and photographed.



AAD ELECTRON MICROSCOPE UNIT

In tropical and temperate oceanic waters some of the most abundant organisms are photosynthetic cyanobacteria, which occur at concentrations of 10–100 million cells per litre. These tiny organisms carry out most of the photosynthesis and play a critical role at the base of the food web. However their abundance declines dramatically with decreasing temperature across the Southern Ocean. Near the Antarctic coast where the water temperature is less than 2°C, their concentration drops to only about 1000 per litre. Their virtual absence in polar waters represents one of the fundamental differences in biodiversity between polar, temperate and tropical oceans. We discovered the quantitative relationship between water temperature and cyanobacterial concentration 20 years ago. On this voyage I repeated the counts to see if the relationship had changed, perhaps by different strains of cyanobacteria. It hadn't.

Parmales are a group of minute phytoplankton, less than 5 µm in diameter, covered with patterned scales made from silica. They are especially abundant in polar and sub-polar



waters but only poorly represented elsewhere in the global ocean. They are commonly found in the faecal material of grazers, which suggests they are heavily grazed and therefore important in polar food webs. Their high abundance is also indicated by their silica scales composing more than 30% of the biogenic silica in some sediments close to the Antarctic coast.

Although Beatrice Booth, from the University of Washington, and I formally described them as a new species of algae 25 years ago, they have only recently been characterised using molecular biological methods and their photosynthetic pigments. On this voyage I collected Parmales to study their life cycle, which has yet to be fully ascertained. These studies are continuing on cultures of living Parmales at the Australian Antarctic Division.

Perhaps the greatest surprise on the voyage was finding a massive phytoplankton bloom where the Mertz Glacier tongue was before it was dislodged by iceberg B09B. The bloom was apparently stimulated by iron being released into the sea by the melting of multi-year sea ice that had been dammed up by the glacier tongue. There was a huge drawdown of carbon dioxide in the vicinity of the bloom. Cameras deployed from the ship to see what organisms were living on the seafloor where the Mertz Glacier tongue used to be, revealed that phytoplankton from the bloom were dropping out and covering the bottom with a green fluff. Microscopy of the bloom revealed that the bloom was composed of the large diatoms *Corethron, Rhizosolenia* and *Chaetoceros*. These same organisms were found in samples of the fluff from the bottom. Interestingly, most of these diatoms still had their cellular contents, indicating that they had only recently fallen from the surface waters. So as well as providing the food for grazers at the surface, the phytoplankton were providing a fresh food supply for the bottom dwellers.

HARVEY MARCHANT

Australian National University

Single cell diversity

Phytoplankton are the organisms at the base of the marine food chain. Similar to land plants, phytoplankton use the energy of sunlight in the process of photosynthesis to convert carbon dioxide and water into organic compounds. Also, just as there is an enormous diversity of land plants, so there is a great diversity of phytoplankton in the sea. Some are tiny photosynthetic bacteria about 1µm (0.001 mm) in size, others are about 0.25 mm; so you can see individual cells with the naked eye – just.

At the level of the single cell, what is a plant and what is an animal becomes blurred. Some phytoplankton graze on bacteria and other phytoplankton while some protozoa (animals) harbour and nurture chloroplasts (the photosynthetic organelles) from phytoplankton that they have consumed, and use the photosynthetic products themselves. These days it's usual to lump marine phytoplankton and protozoa together and call them protists. In 2005 Fiona Scott and I published the book *Antarctic Marine Protists* in which we describe more than 550 different species. These different species of microscopic organisms are as distinctive as the different species of plants and animals that you can see with the naked eye.

1. *Corethron*, a diatom that was blooming in vast numbers where the Mertz Glacier tongue used to be. The largest cell is about 0.1 mm long.
2. Colonies of the alga *Phaeocystis* are common in Antarctic waters. The colonies can be several centimetres in diameter and contain thousands of individual cells which are about 5 µm in diameter.
3. Scanning electron micrograph of a species of Parmales. These organisms are covered in distinctively patterned silica scales. They are about 4 µm in diameter.
4. A fluorescence microscope image of cyanobacteria. Each cell is about 1 µm (0.001 mm) in diameter.
5. Foraminifera are not abundant in Antarctic surface waters. They have a huge surface area, because of their spines, on which to trap food particles. This specimen is about 0.1 mm across.

Life beneath a glacier tongue

The calving of the Mertz Glacier tongue in February 2010 exposed a large section of the sea floor, about 80 km long and over 30 km wide, enabling access to an area where no information existed. Using an underwater camera, a team of scientists and technicians from Geoscience Australia and the Australian Antarctic Division collected the first images of the sea floor and the marine animals that live there.

Ecosystems under ice shelves or glacier tongues are unique. Any marine life living on the sea floor in these areas does not have the same opportunity for food as in the open ocean, where there is a regular supply of phytoplankton from the surface waters. There are very few opportunities to study ecosystems existing in such situations (because they are usually covered in ice), so we had little idea of what to expect.

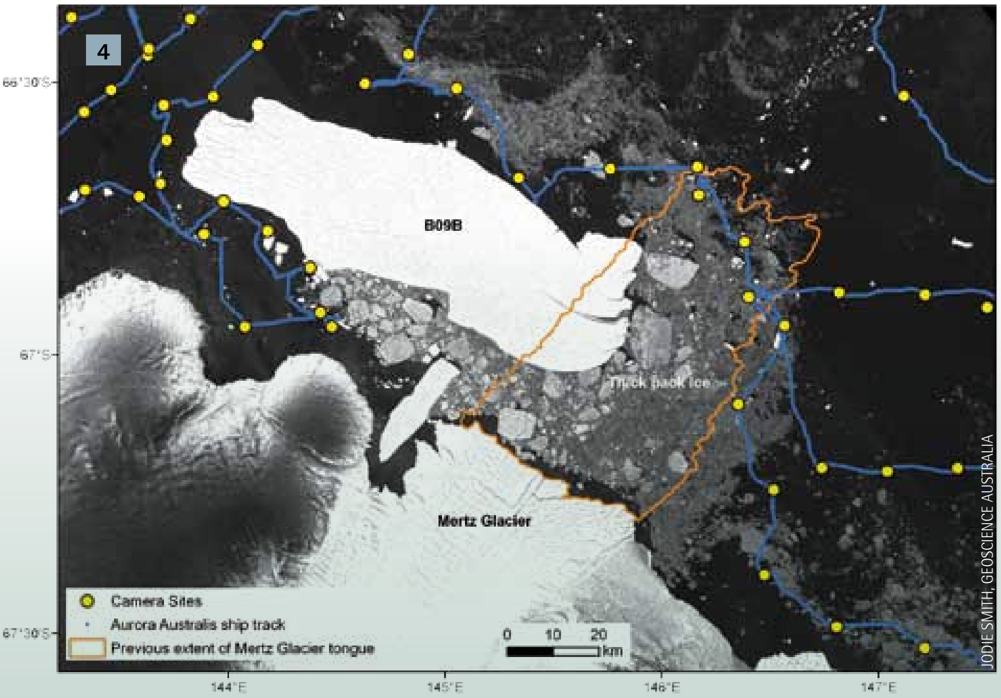
AUSTRALIAN ANTARCTIC DIVISION

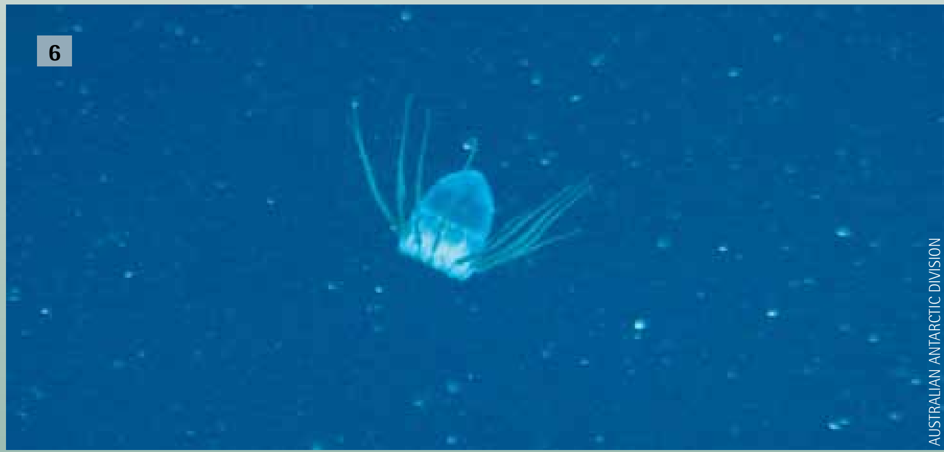
A digital SLR camera inside a waterproof casing was attached to a frame and lowered to just above the sea floor. We collected more than 1800 still images of the sea floor at depths ranging from 170 to 2300 m. At these depths there is little or no light reaching the sea floor so we used two strobe lights to illuminate it as we took photos. Parallel laser pointers set 50 cm apart were used to provide a scale for the images.

There was much anticipation onboard as the camera was lowered, with speculation about what might (or might not) live on a sea floor previously covered by a glacier tongue. It typically took about an hour from the time the camera was attached to the frame and lowered into the water until it was retrieved again. We then had to remove the camera from its waterproof casing and download the images in the photo lab. This lab was a popular destination for expeditioners and crew on board, curious to know what lay below.

We found that life under the Mertz Glacier tongue is similar to life in the adjacent areas, although more sparse. A diversity of marine animals was observed, including sea pens, bryozoans, anemones, gorgonians, holothurians, urchins, brittlestars, crinoids, sponges and even a sea star that measured more than 50 cm across.

1. Life under the Mertz Glacier tongue includes sea pens, bryozoans, gorgonians, brittle stars, anemones, holothurians, sponges, urchins, crinoids and sea stars. The sea floor is scattered with dropstones which have fallen from the glacier above.
2. Jodie checks the underwater camera.
3. The underwater camera (and strobe lights attached to the bottom of the frame) being lowered into the water from the trawl deck of the *Aurora Australis.*





These animal communities must source their food from particles carried many tens of kilometres by currents that flow beneath the Mertz Glacier tongue. The animals live on a sea floor comprised mostly of mud with pebbles and cobbles scattered across the surface. These are known as 'dropstones' because they fall from the glacier tongue above.

The *Aurora Australis* was prevented from getting into most of the area previously covered by the glacier tongue by the massive iceberg (B09B) that collided with the glacier tongue almost a year ago. Just before our journey south the iceberg started to move west, across the front of the remaining glacier tongue. We regularly downloaded the latest satellite images to check the position of B09B and hoped that it would move out of the way by the time we got there. Unfortunately it stopped just to the west of the glacier tongue and, due to its size (nearly 100 km long and over 20 km wide) and a large amount of sea ice accumulated behind it, we could not gain access to the area where we wanted to take photos. The ice was too thick for the ship to move through and, as a result, limited the sites where photos could be collected to the northern tip of where the glacier tongue once sat. Such is the way things go when doing research in Antarctica!

While we were in the Mertz region we were able to explore the area along the continental shelf, where deep sea corals have previously been found. These corals are so unique and fragile that they have been protected as 'Vulnerable Marine Ecosystems' by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) (*Australian Antarctic Magazine* 15: 19, 2008).

We found further evidence of deep-water coral communities at several sites along the shelf break. The photos collected at these sites show a spectacular display of vulnerable marine life. This new information will be used to support the application to CCAMMLR for a Marine Protected Area (see story page 25) in the Mertz region.

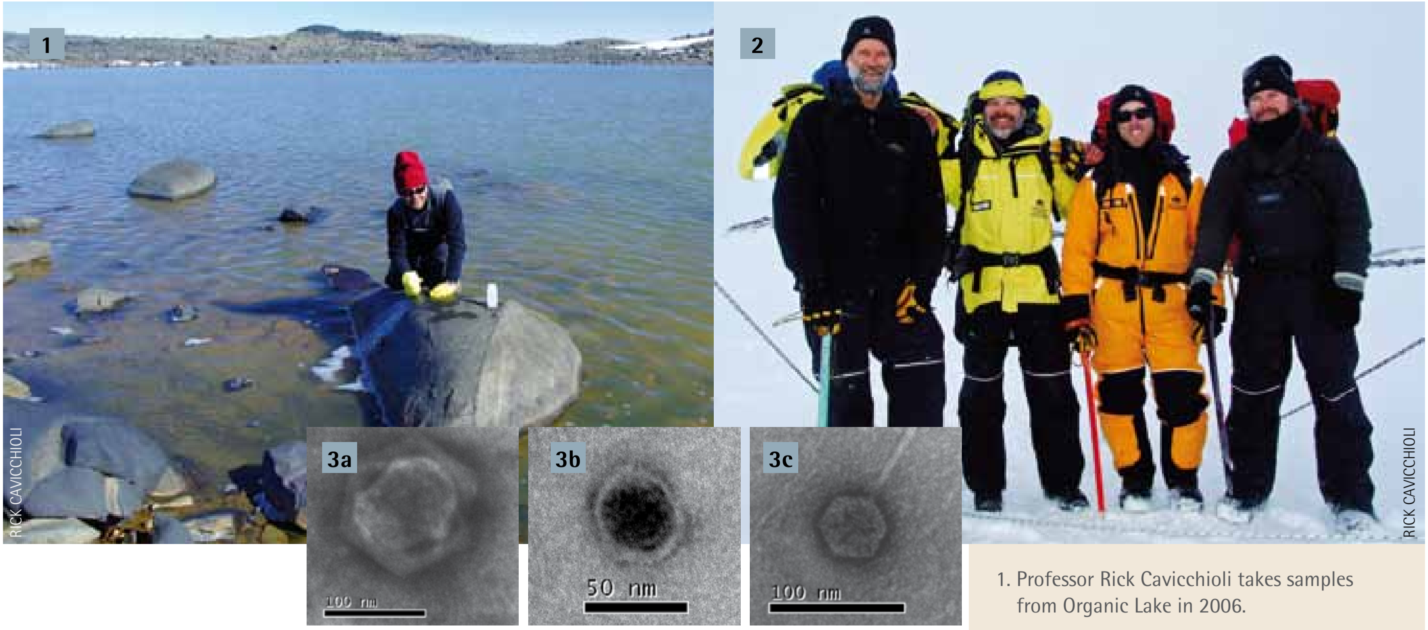
The images from the voyage will be analysed to identify the organisms and communities at each site and their relationship to the physical and chemical environment. This information will be used to help answer some key research questions outlined in the Australian Antarctic Science Strategic Plan relating to ocean acidification and change in marine ecosystems, as well as protecting marine biodiversity.

JODIE SMITH[1] and MARTIN RIDDLE[2]

[1] *Geoscience Australia,* [2]*Australian Antarctic Division*

4. Ice conditions, ship track and sampling sites around the Mertz Glacier tongue during the Mertz Glacier voyage in January 2011. The Envisat high-resolution radar image from 12 January 2011 (www.polarview.aq) shows the position of iceberg B09B and the thick pack ice backed up behind it in the area covering the former Mertz Glacier tongue. The blue line shows the ship track and yellow dots show the location of underwater camera sites. The previous extent of the Mertz Glacier tongue prior to calving in February 2010 is outlined in orange.
5. This giant sea star measures about 50 cm across.
6. A jellyfish.

VIRUS KILLER LURKS IN ANTARCTIC LAKE



1. Professor Rick Cavicchioli takes samples from Organic Lake in 2006.
2. Part of the research team in Antarctica in 2008. L-R: John Rich, Rick Cavicchioli, Federico Lauro and Mark Brown.
3. Transmission electron micrographs of negatively stained virus-like particles from Organic Lake which resemble (a) a phycodnavirus or PV, (b) the Sputnik virophage, and (c) a bacteriophage – a virus that infects bacteria.

A virus that attacks other viruses has been discovered in a hypersaline lake near Davis station in Antarctica.

The virus is only the third 'virophage' discovered. The first one, called Sputnik, was discovered in 2008 and the second one, Mavirus, was discovered earlier this year.

The new virophage, called Organic Lake Virophage or OLV, after the lake in which it was found, was discovered by a team of scientists led by Professor Rick Cavicchioli of the University of New South Wales.

In 2006 and 2008 the team travelled to Antarctica's Vestfold Hills with the Australian Antarctic Division to collect water samples from a number of hypersaline lakes that dot the landscape. The samples were filtered through different sized filters (3.0 µm, 0.8 µm and 0.1 µm; where 1 µm = 0.001 mm) to separate different microbial components, including viruses, bacteria and algae.

Back in their laboratory the team used 'metagenomics' and 'metaproteomics' to identify the DNA sequences and protein components, respectively, in the entire microbial communities captured in each filtered sample (see related story on page 5).

In the 0.1 µm sample the team found a previously unknown DNA sequence which they were eventually able to reconstruct to reveal a complete circular genome with similarities to the Sputnik genome. Using transmission electron microscopy, they identified virus particles in their sample which also resembled Sputnik in size and appearance.

Viruses reproduce by infecting host cells and using the cell's molecular machinery to make multiple copies of their own genome and to package these genomes into protein shells. These new viruses then break out of the cell and are free to infect many more cells.

A virophage is different in that it targets a host cell that is already infected by a 'regular' virus. As the regular virus goes about replicating itself, the virophage hijacks this process by inserting its own genome into the virus. It can then make copies of itself at the expense of the regular virus, whose own replication is significantly reduced.

In each of the three new virophage discoveries, the virophages are associated with giant viruses. Mavirus targets the CroV virus, which infects a plankton species called *Cafeteria roenbergensis*. Sputnik targets a giant virus known as 'mamavirus' which has the world's largest viral genome and infects an amoeba. Professor Cavicchioli's team found OLV associated with a group of giant 'phycodnaviruses', or PVs, that infect algae and consequently help control algal blooms. Like Sputnik and Mavirus, OLV's genome includes genes that it collected from the Organic Lake phycodnaviruses, confirming the predator-prey relationship.

The discovery of a virophage in Organic Lake adds new complexity to the dynamics of the microbial community in the Antarctic system. Professor Cavicchioli's team modelled the impact of OLV as a predator in the marine system.

'By reducing the number of PVs in the community, OLV shortens the time it takes for the host algae population to recover,' he says.

'Modelling shows that the virophage stimulates secondary production through the microbial loop by reducing overall mortality of the host algal cell after a bloom, and by increasing the frequency of blooms during the summer light periods.

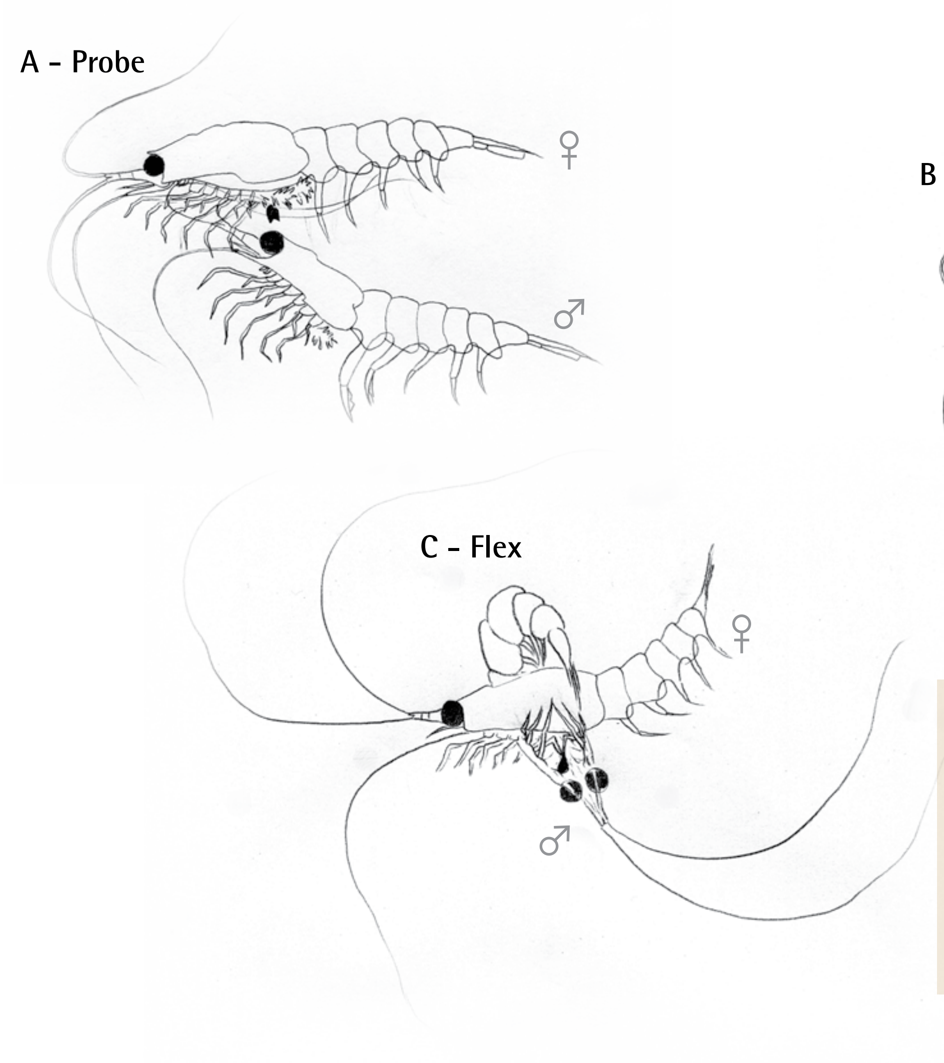
'Antarctic lake systems have evolved mechanisms to cope with long light-dark cycles and a limited food web. In Organic Lake and similar systems, a decrease in PV activity may be instrumental in maintaining the stability of the microbial food web.'

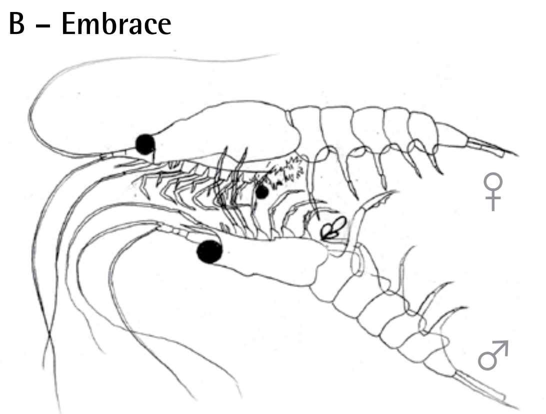
While OLV was the dominant virophage in Organic Lake, the team's analyses suggest that there are other related virophages present. The team has also found genome sequences that match OLV from nearby Ace Lake. And there may be many more virophages waiting to be discovered. Professor Cavicchioli's team has found OLV-type sequences in a saline lagoon in the Galapagos, an estuary in New Jersey and a freshwater lake in Panama.

The research was published in the *Proceedings of the National Academies of Science* in March: Yau S., Lauro F., DeMaere M., et al. Virophage control of antarctic algal host–virus dynamics. www.pnas.org/content/early/2011/03/24/1018221108

WENDY PYPER

Corporate Communications, Australian Antarctic Division





These drawings by Dr Lisa Roberts show three phases of krill mating: A probe; B embrace; C flex. The original underwater footage of this ritual was captured on a digital video and camera system developed at the Australian Antarctic Division. The system was designed to be deployed during commercial fishing operations to assess the nature and extent of the interactions of fishing gear with the sea floor habitat.

KRILL SEX LIFE CAPTURED ON CAMERA

The sexual behaviour of Antarctic krill has been captured on underwater video for the first time. The video footage gives scientists new insights into the crustaceans' brief and frenzied mating ritual and provides the first evidence that mating can take place near the sea floor at depths of 400–700 m.

'Previously scientists thought that krill mate and lay eggs in the surface waters, between zero and 200 metres,' says Australian Antarctic Division krill biologist Dr So Kawaguchi.

'But this video footage shows that mating can take place near the sea floor, reinforcing the importance of the ocean bottom as habitat for krill.'

The video footage was captured at 507 m depth and shows three krill – two males and a female – engaged in about five seconds of rapid spinning followed by six seconds of swimming in larger circles with the males pushing against the female.

By breaking the ritual down frame by frame, Dr Kawaguchi and his colleagues were able to define five mating phases: 'chase', 'probe', 'embrace', 'flex 'and 'push'.

During the embrace and/or flex phases the male krill seems to transfer sperm packets to the female, but further study is needed to precisely define the activities occurring in each phase.

Dr Kawaguchi says that while it is possible that mating was induced by the camera light, recent developments in underwater imaging systems has resulted in an expanding body of evidence for the existence of populations of krill near the sea floor, including females carrying developing eggs.

'This research challenges the assumption that most krill live within the top 200 metres of the ocean and suggests that deeper layers are significant habitat for krill. Our observations will have considerable implications for understanding the Antarctic marine ecosystem and for the management of the krill fishery,' Dr Kawaguchi says.

In collaboration with Dr Kawaguchi, arts-based researcher Dr Lisa Roberts has produced an animation of the mating sequence. Dr Roberts digitally traced each video frame and combined these tracings with drawings traced from illustrations of krill anatomy.

The research and animations were published in the *Journal of Plankton Research* in February.

To view the video footage and animation and read the research paper see www.antarctica.gov.au/media/news/2011/krill-do-it-deep-in-the-southern-ocean

WENDY PYPER

Corporate Communications, Australian Antarctic Division

Australia-Japan collaboration addresses climate change questions

1

Australia and Japan have joined forces to assess the impact of climate change on the Antarctic marine system.

The collaboration was established in 2009 in response to a joint Prime Ministers' statement on the importance of enhanced collaboration between the two countries in Antarctic climate science.

The resulting project, 'Establishing a benchmark to assess climate change impact in the eastern Antarctic marine system', is coordinated through the Antarctic Climate and Ecosystems Cooperative Research Centre and Japan's National Institute of Polar Research.

'Australia and Japan both operate permanent research stations in the Indian Sector of the Southern Ocean and have collected vast amounts of pelagic (open ocean) data over the past 30 years during marine science cruises covering more than a quarter of the Antarctic coastline,' says Australian Antarctic Division krill biologist Dr So Kawaguchi, who leads a component of the project.

'The aim of this project is to bring together all this data into a single database so that we can systematically analyse it for changes over the past few decades.

'This will allow us to identify the gaps and limitations in the data, which is important when it comes to interpreting trends in the data or deciding whether we need to collect new data. It will also allow us to identify key geographic areas that are likely to provide answers to the important climate change questions, so that we can plan future observation and monitoring work in these areas.'

Among the questions being investigated are: what is the current state of biology in the Southern Ocean and how does it respond to physical changes; what will happen to Antarctic ecosystems if the polar front (Antarctic Convergence) contracts further south as the Southern Ocean warms and freshens; and are observed changes in biological ecosystems the result of a one-off event (such as the Mertz Glacier calving), part of a decadal cycle or part of a long-term trend?

Two types of data are being combined in the project: 'ecosystems', or biological data relating to such things as krill, phytoplankton and zooplankton; and 'physical oceanography'. The oceanographic data provides a context for the biological data, as changes in ocean properties such as temperature, acidity and sea ice cover, will affect the organisms living in it.

2

AAD

Since the project's inception a number of different groups have expressed interest in contributing new datasets to the original pelagic datasets, including ice core records and Adélie penguin population data. These additions will improve the ability to see climate change links between different components of the Antarctic ecosystem.

The combined data will also be used to understand the habitat requirements of organisms within the system and to model changes in the system over time.

At workshops in Tokyo and Hobart, just prior to the conclusion of the two-year project in March 2011, the team analysed some of the data to look for trends. Significant changes were observed in parts of the sector relating to the timing of annual sea ice advance and retreat and the duration of the annual sea ice season,

CPR (SANDRA ZICUS)

1. Early analysis of data from the Indian and Western Pacific Ocean sectors of the Southern Ocean has detected changes in the timing of annual sea ice advance and retreat and the duration of the annual sea ice season.
2. The group that initiated the Australia-Japan collaboration, at a meeting in Tokyo in 2009.
3. The Continuous Plankton Recorder is towed behind ships and collects plankton in a fine mesh filter.

and further analysis is underway. One long-term study also identified changes in the composition, distribution and diversity of plankton and krill (see box story). But no significant trends were detectable elsewhere.

'Collectively something is happening in many components of the ecosystem, but individually the trends aren't strong,' Dr Kawaguchi said.

'However, there is published data and other information available which may strengthen some observations and help identify the drivers of the trends we did see.'

Further analysis will be undertaken this year and a series of trends papers is planned for a special edition of the *PLoS ONE* journal. The work is expected to feed into the Fifth Assessment Report of the Intergovernmental Panel on Climate Change in 2014.

While the initial two-year project has just ended, Dr Kawaguchi said a long-term collaboration has begun. This collaboration will include the coordinated collection of new data at strategic sites in the Indian sector of the Southern Ocean, development of a biological and physical observation system, the standardisation of existing data in the database and its release to all researchers, and development of a spatial habitat model.

In the future the team hopes to expand the spatial coverage of their database through collaborations with other countries operating in the East Antarctic sector, such as France, South Africa, New Zealand, Italy, the United States and Germany.

WENDY PYPER

Corporate Communications, Australian Antarctic Division

Southern Ocean plankton is changing

A 20-year study of the Southern Ocean has found significant changes in the composition, distribution and diversity of plankton and krill.

The Australian Antarctic Division's Continuous Plankton Recorder project has been mapping and monitoring plankton populations in the Southern Ocean since 1991 (*Australian Antarctic Magazine* 13: 12-13, 2007). The recording equipment is towed behind ships, where it filters and catches the tiny organisms.

Project Leader Dr Graham Hosie said that since the project began in 1991 there have been significant changes in the composition of plankton in the samples.

'We seem to be catching a lot more smaller plankton compared to krill; notably copepods which, like krill, also graze on phytoplankton,' he said.

'We don't know what is causing this or if competition for the same food will affect krill. But any change from krill to smaller zooplankton may force animals that are dependent on krill, such as whales and penguins, to change their diet in order to survive.

'We have also observed sudden very large increases in foraminiferans – a calcareous, single-cell zooplankton. While these blooms are short lived, they suppress other zooplankton numbers. But again, we don't know if this has a flow-on effect to higher animals.'

The project has covered 70% of the Southern Ocean, taken 30 000 samples, identified and mapped 230 species and towed the plankton recorder for more than 278 000 km.

The 20-year study has also resulted in the first *Zooplankton Atlas*, which documents the distribution and abundance of the 50 most common zooplankton species in the Southern Ocean.

The atlas will serve as a reference for other Southern Ocean researchers and monitoring programs such as those run by the Commission for the Conservation of Antarctic Marine Living Resources and the developing Southern Ocean Observing System.

NISHA HARRIS

Corporate Communications

More information

Southern Ocean CPR Survey:
http://data.aad.gov.au/aadc/cpr/index.cfm

Australian CPR Survey:
http://imos.org.au/auscpr.html

UNTANGLING THE ISSUE OF WHALE BYCATCH

Two novel devices designed to prevent toothed whales from stealing valuable fish from pelagic longlines will shortly undergo their first proof of concept test in Australian waters.

If successful, the devices could precipitate development of new technologies that will help reduce the death and injury of whales in pelagic (open ocean) longline fisheries, while improving the economic benefits to fishers.

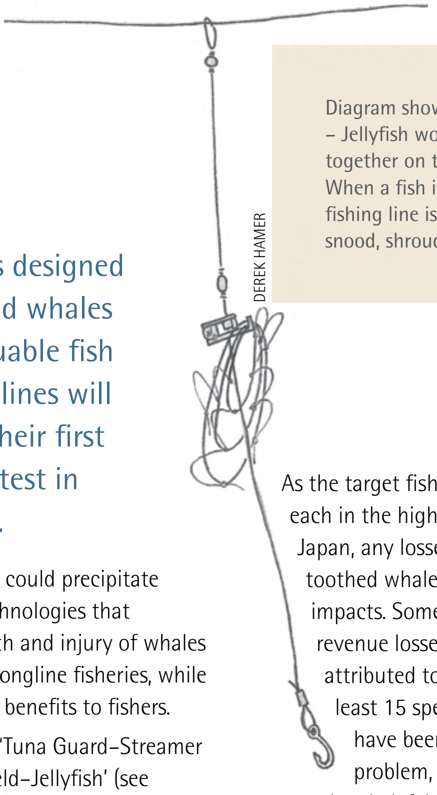
The devices, dubbed the 'Tuna Guard–Streamer Pod' and the 'Whale Shield–Jellyfish' (see illustrations), aim to deter toothed whales from removing or damaging fish caught on pelagic longlines – a practice known as 'depredation'.

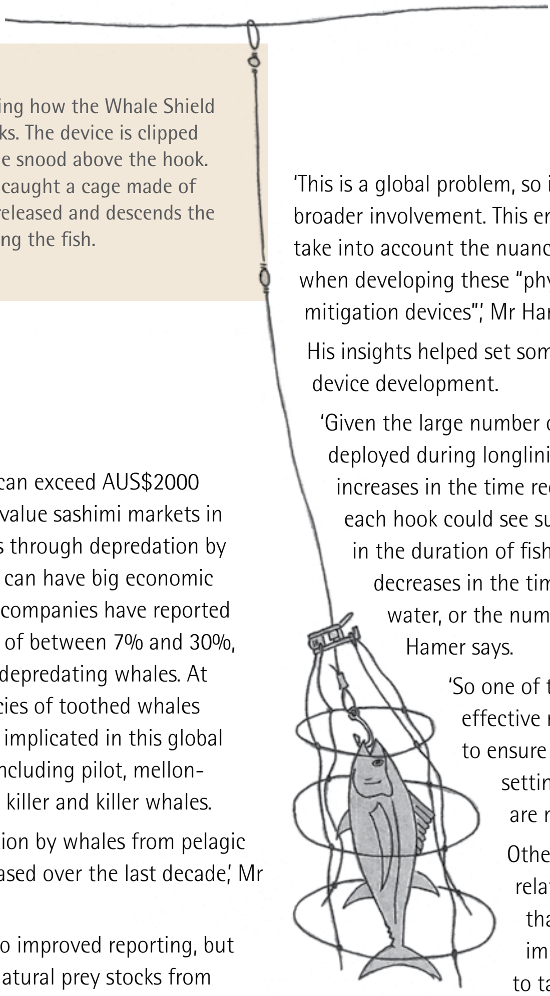
'Both devices work on the principle that depredating whales are deterred by the presence of tangles in fishing gear,' says Australian Antarctic Division marine biologist Mr Derek Hamer.

'We hope to use this apparent behaviour to our advantage to keep the whales away from the longline hooks and the catch, thus preventing bycatch and depredation events.'

The journey from problem to invention began 18 months ago when Mr Hamer, through the Australian Marine Mammal Centre, was tasked with developing a non-lethal method of preventing depredation (of primarily tuna and billfish) from pelagic longlines.

Pelagic longlines are typically comprised of a main line that runs horizontally in the water for up to 75 km, which is suspended by a series of buoys at depths of between 30 and 300 m. Dropping vertically from this main line at regular intervals are lengths of line called 'snoods', which each end in a baited hook. Each longline can accommodate up to 3600 baited hooks.





DEREK HAMER

Diagram showing how the Whale Shield – Jellyfish works. The device is clipped together on the snood above the hook. When a fish is caught a cage made of fishing line is released and descends the snood, shrouding the fish.

As the target fish can exceed AUS$2000 each in the high-value sashimi markets in Japan, any losses through depredation by toothed whales can have big economic impacts. Some companies have reported revenue losses of between 7% and 30%, attributed to depredating whales. At least 15 species of toothed whales have been implicated in this global problem, including pilot, mellon-headed, false killer and killer whales.

'Reports of depredation by whales from pelagic longlines have increased over the last decade,' Mr Hamer says.

'This may be linked to improved reporting, but declines in whales' natural prey stocks from overfishing may have forced some toothed whale populations to switch to alternative food sources that have become more reliable and abundant.

'Also, toothed whales are intelligent animals and over time many individuals may learn that tuna caught on longlines are an easy source of food. It is also possible that this depredating behaviour could be passed down the generations.'

Mr Hamer began addressing the problem by talking to fishers and in late 2009 he spent almost three weeks on the Queensland-based longliner *FV Fortuna*. Here he observed the general fishing operation and interactions with toothed whales, gained insights into the perceptions of the crew towards depredation and sought their advice on possible ways to mitigate the behaviour.

He then broadened his 'fact-finding mission' to Samoa and Fiji, where depredation of longlines by toothed whales also seems to be increasing.

'This is a global problem, so it's logical to have broader involvement. This ensures we can take into account the nuances of each fishery when developing these "physical depredation mitigation devices",' Mr Hamer says.

His insights helped set some ground rules for device development.

'Given the large number of hooks typically deployed during longlining, even very small increases in the time required to set or haul each hook could see substantial increases in the duration of fishing activities, or decreases in the time the line is in the water, or the number of hooks set,' Mr Hamer says.

'So one of the criteria for an effective mitigation device is to ensure that impediments to setting and hauling time are minimal or negligible.'

Other fishers had also related to Mr Hamer that fish caught in or immediately adjacent to tangles in the fishing gear remained undamaged. In fact, depredation mitigation devices based on a similar principle have been trialled successfully in a 'demersal' (sea floor) longline fishery in South America, to deter sperm and killer whales. However, as pelagic fishing gear is in reach of diving toothed whales (unlike demersal gear which runs along the sea floor), pelagic depredation mitigation devices are necessarily more complicated than demersal ones. These observations now underpin Mr Hamer's device development.

To imitate tangles in the fishing gear the Tuna Guard–Streamer Pod uses lengths of fine chain that dangle next to the caught fish, while the Whale Shield–Jellyfish uses a cage-like structure that completely envelops the caught fish. The devices remain clear of the baited hook until a fish is caught and then the pressure of the fish on the line causes the device to deploy and descend the snood towards the hook.

WENDY PYPER

WENDY PYPER

Derek Hamer demonstrates the Whale Shield – Jellyfish: photo 1 shows the device in its undeployed form and as it would attach to the fishing line, and photo 2 shows the cage deployed.

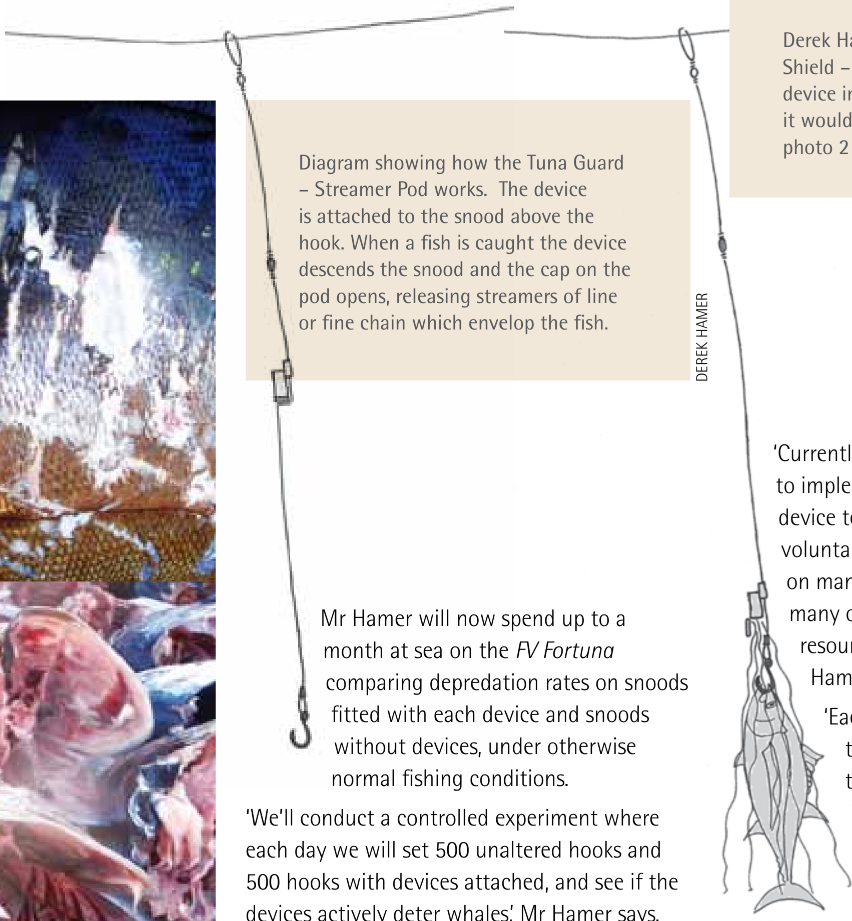


Diagram showing how the Tuna Guard – Streamer Pod works. The device is attached to the snood above the hook. When a fish is caught the device descends the snood and the cap on the pod opens, releasing streamers of line or fine chain which envelop the fish.

DEREK HAMER

DEREK HAMER

DEREK HAMER

Physical damage sustained by a catch of albacore tuna and attributed to depredating whales. Photo 3 shows tooth marks on the torso and 4 shows a more typical result where the body has been completely removed behind the gills.

Mr Hamer will now spend up to a month at sea on the *FV Fortuna* comparing depredation rates on snoods fitted with each device and snoods without devices, under otherwise normal fishing conditions.

'We'll conduct a controlled experiment where each day we will set 500 unaltered hooks and 500 hooks with devices attached, and see if the devices actively deter whales,' Mr Hamer says.

'If we encounter major hurdles in the first trial then we may have to go back to the drawing board, but we'll have a lot more knowledge to draw on. If the trials are successful we'll look at modifying the devices to improve their operational capacity and reduce cost.'

Despite the potential advantages for whale conservation and depredation mitigation, the use of mitigation devices will come at a cost. Whether fishers take up the technology will depend on the running costs of their operation, the value of the target fish and the cost of the devices.

'Currently no longline fisheries are required to implement depredation mitigation device technologies, so uptake will be voluntary. This can be better than relying on management and regulation, because many of the world's fisheries lack the resources to ensure compliance,' Mr Hamer says.

'Each licence holder or fisher will have to do their own cost-benefit analysis to determine if the investment in these devices is economically worthwhile. We are hopeful there will be an economic incentive in it if fishers come home with a more valuable catch. As such, our short to medium term goal is to produce a device that works, then to make it cheap enough to purchase.'

Only time will tell if a win-win solution for whales and fishers can be untangled from the depredation problem.

WENDY PYPER

Corporate Communications, Australian Antarctic Division

More information

www.marinemammals.gov.au/regional-initiatives/depredation-project

During the International Polar Year (2007-09) the Australian Antarctic Division provided logistic support to an ambitious project that aimed to visualise the subglacial Gamburtsev Mountains, which in some place are buried under 3000 m of ice. Australia supported 'Antarctica's Gamburtzev Province Project' (AGAP) by running a field camp – AGAP North – from which two aircraft, racked with geophysical instruments, flew survey lines over the hidden mountain range (*Australian Antarctic Magazine* 16: 16-18, 2009). Surveys were also conducted from a second camp – AGAP South – run by the United States. In March this year AGAP scientists published their startling results in the journal *Science*; liquid water locked deep under the Antarctic ice sheet regularly thaws and refreezes to the bottom, contributing more than half the thickness of the ice sheet in places and actively modifying its structure.

Following is an edited version of a story by science writer David Funkhouser of Lamont-Doherty Earth Institute (one of the scientific institutions participating in AGAP), which describes the discovery and its importance.

Antarctic ice sheet grows from below


2

BAS

Scientists working in the remotest part of Antarctica have discovered that liquid water locked deep under the continent's coat of ice regularly thaws and refreezes to the bottom, creating as much as half the thickness of the ice in places, and actively modifying its structure. The finding, which turns common perceptions of glacial formation upside down, could reshape scientists' understanding of how the ice sheet expands and moves and how it might react to a warming climate. The study, published in the journal *Science* in March, is part of a six-nation study of the Gamburtsev Mountains, which lie buried under as much as 3000 m of ice.

Ice sheets are well known to grow from the top as snow falls and builds up annual layers over thousands of years. But until recently, scientists have known little about the processes going on far below. In 2006 researchers in the current study showed that lakes of liquid water underlie widespread parts of Antarctica. In 2008–09 they mounted an expedition using geophysical instruments to create 3-D images of the 1200 km-long, 3400 m-high Gamburtsev Mountain range. The expedition also captured detailed images of the overlying ice and subglacial water.

'We usually think of ice sheets like cakes—one layer at a time added from the top. This is like someone injected a layer of frosting at the bottom—a really thick layer,' says project co-leader Professor Robin Bell, a geophysicist at Columbia University's Lamont-Doherty Earth Observatory.

'Water has always been known to be important to ice sheet dynamics, but mostly as a lubricant. As ice sheets change we want to predict how they will change. Our results show that models must include water beneath.'

The scientists found that refrozen ice makes up 24% of the ice sheet base around Dome A – a 4.2 km-high plateau that sits over part of the Gamburtsev range and forms the high point of the East Antarctic ice sheet. In places, slightly more than half the ice thickness appears to have originated from the bottom, not the top. Here, rates of refreezing are greater than surface accumulation rates. The researchers suggest that such refreezing has been going on since East Antarctica became encased in a large ice sheet some 32 million years ago. They may never know for sure – the ice is always moving from the deep interior toward the coast, so ice formed millions of years ago, and the evidence it would carry, is long gone.

Deeply buried ice may melt because overlying layers insulate the base, trapping in heat created by friction or radiating naturally from underlying rock. When the ice melts, refreezing may take place in multiple ways. If it collects along mountain ridges and heads of valleys, where the ice is thinner, low temperatures penetrating from the surface may refreeze it. In other cases, as water gets squeezed up valley walls the pressure exerted on it changes rapidly. At depths, water remains liquid even when it is below the normal freezing point, due to the pressure exerted on it by the overlying ice.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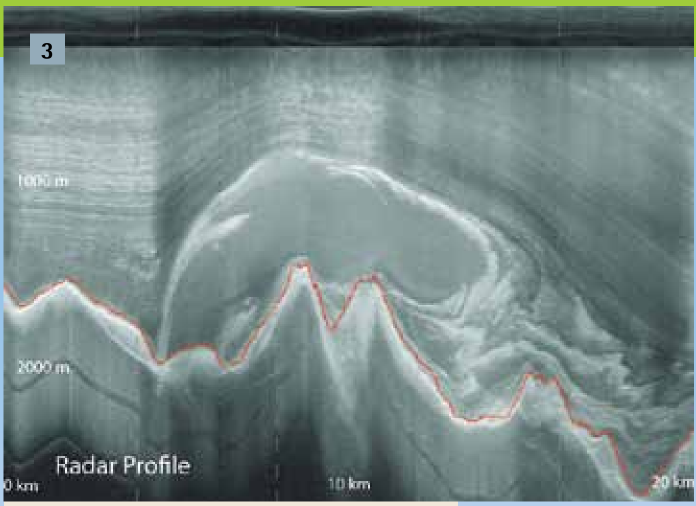

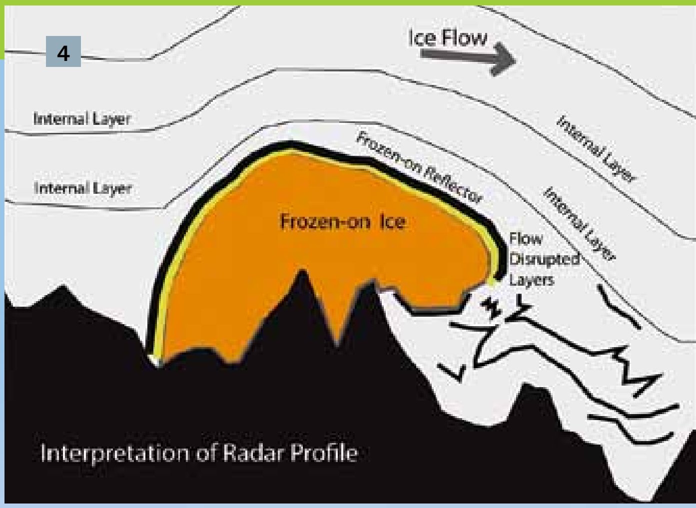

LAMONT-DOHERTY EARTH INSTITUTE

1. The AGAP North field camp run by the Australian Antarctic Division
2. Members of the AGAP South team in front of a twin otter aircraft.
3. A radar image and interpretive graphic (4) showing the upward deflection of the internal layers of ice over a section of refrozen ice that spans almost 15 km of the Gamburtsev Mountain range. The refrozen ice is 1100 m thick and the internal layers are deflected upward by 400 m.

But once it moves up to an area of less pressure, the supercooled water can freeze almost instantly. Images produced by the researchers show that the refreezing deforms the ice sheet upward (see radar image).

'When we first saw these structures in the field we thought they looked like beehives and were worried they were an error in the data,' says Professor Bell.

'As they were seen on many survey lines, it became clear that they were real. We did not think that water moving through ancient river valleys beneath more than one mile of ice would change the basic structure of the ice sheet.'

Because the ice is in motion, understanding how it forms and deforms at the base is critical to understanding how the sheets will move, particularly in response to climate changes.

'It's an extremely important observation for us because this is potentially lifting the very oldest ice off the bed,' says Professor Jeff Severinghaus, a geologist at Scripps Institution of Oceanography in San Diego who was not involved in the study.

He says it could either mean older ice is better preserved or it could 'make it harder to interpret the record, if it's shuffled like a deck of cards.'

The research was conducted between November 2008 and January 2009 from two base camps around Dome A; AGAP South, run by the United States, and AGAP North, run by the Australian Antarctic Division. Using aircraft equipped with ice-penetrating radars, laser ranging systems, gravity meters and magnetometers, they flew low-altitude transects back and forth over the ice to draw 3-D images of what lay beneath.

The aim was to understand how the mountains arose and to study the connections between the peaks, the ice sheet, and subglacial lakes. They were also hunting for likely spots where future coring may retrieve the oldest ice.

'Understanding these interactions is critical for the search for the oldest ice and to better comprehend subglacial environments and ice sheet dynamics,' says Dr Fausto Ferraccioli of the British Antarctic Survey, who led the project from AGAP North.

'Incorporating these processes into models will enable more accurate predictions of ice sheet response to global warming and its impact on future sea-level rise.'

The researchers now will look into how the refreezing process acts along the margins of ice sheets, where the most visible change is occurring in Antarctica. Based on their data, a Chinese team also hopes to drill deep into Dome A in the next two or three years to remove cores that would trace long-ago climate shifts. They hope to find ice more than a million years old.

DAVID FUNKHOUSER

Lamont-Doherty Earth Institute

http://www.ldeo.columbia.edu/news-events/some-antarctic-ice-forming-bottom

BAS

ANDREW LOWTHER

Keeping track of wildlife

Electronic recording devices attached to marine creatures such as whales, seals, seabirds and fish, are providing scientists with a fascinating glimpse into life in the marine realm and information that will help manage and protect the animals and their ecosystems.

In March an international contingent of marine scientists met in Hobart to discuss the science and technology of 'bio-logging' – the collection and analysis of data using animal-borne instruments (or tags) to understand the animals' behaviour, physiology and ecology. The *Fourth International Science Symposium on Bio-logging* also attracted industry groups involved in the development of the electronic bio-logging tags.

Australian Antarctic Division whale researcher Dr Nick Gales said bio-logging tags play an important role in Antarctic and subantarctic research on flying seabirds, penguins, seals and whales.

'There is a huge range of tags available, depending on the species you are studying and the information you want to collect,' he said.

'The tags either transmit their data to your computer via satellite, or store it in an internal memory where it can be extracted once the tag is retrieved. They can be attached internally or externally and can record a vast range of parameters, including sea water properties, depth, speed, location, temperature, light and tilt.'

The tags effectively provide a diary of the animal's activities and its environment over minutes, months or years. But the vast amount of data that can be collected means researchers now face the challenge of how to analyse, interpret and use it.

Australian Antarctic Division seabird ecologist Dr Graham Robertson has used bio-logging tags to study albatross and petrel species at risk of becoming bycatch in longline fisheries. Now he uses the technology to develop seabird-saving devices for the fishing industry.

'I use time-depth recorders to study the sink rates of demersal (sea floor) and pelagic (open ocean) longlines and to design experiments that test the effects of gear modifications on the sinking of these lines,' he said.

The research has enabled Dr Robertson to develop an award-winning 'Underwater Bait Setter', which deploys baited hooks six metres under water where the seabirds can't get them. The work is contributing directly to the conservation of seabirds through changes in fishing practices and policies.

The following stories provide a taste of some of the research discussed at the bio-logging conference and the variety of ways bio-logging devices can be used.

A satellite tagging team approach a humpback whale in the Southern Ocean.

Foraging behaviour of Australian sea lions

The foraging behaviour of critically endangered Australian sea lions (*Neophoca cinerea*) has been investigated using a combination of fine scale bio-logging data of individual's movements and biogeochemical analysis of whiskers.

University of Adelaide PhD student Andrew Lowther tracked 20 adult females from seven colonies for up to nine months in their South Australian range, between Pages Island in the east and Lilliput, Olive and Blefuscu islands in the west.

He found that individuals consistently visited the same foraging areas but there were significant differences in where different adults foraged – with some preferring deeper waters and others remaining in very shallow coastal waters.

'Individual adult females seem to have specific areas and food items they prefer, returning again and again to the same reef or seagrass bed regardless of the season,' Mr Lowther said.

To confirm that this behaviour wasn't an artefact caused by limitations in the study design he examined the stable carbon ($\delta^{13}C$) and nitrogen ($\delta^{14}N$) isotope ratios recorded in the whiskers of each animal. These isotopes (different molecular forms of an element) reflect the carbon and nitrogen signatures of the prey the sea lions consume and vary depending on the type of prey consumed and the prey's environment. Each whisker provided up to two years of historical foraging data.

The biogeochemical analysis confirmed the tracking data: the foraging behaviour of individuals was stable over time, and there was variation between seals foraging in the same 'ecotype' (inshore or offshore).

Mr Lowther says that variation in the way individual animals use their environment will give an indication of their 'evolutionary potential' – whether at a population level they could survive climate-driven changes to their habitat. But an understanding of how adaptable Australian sea lions are to change requires an understanding of colony or population behaviour, rather than a small sub-set of animals.

To gain this understanding, Mr Lowther took whisker samples from up to 60% of pups in each breeding colony. As pups feed on their mother's milk, the isotope ratios in their whiskers can be used to infer the ratios in their mothers and therefore the foraging location of the mothers. The analysis showed a more complex and detailed set of foraging behaviours than tracking alone. Two groups of sea lions demonstrated stable inshore or offshore foraging patterns while a third group remained inshore but fed on the same prey as offshore foragers.

'Determining where and on what animals feed gives conservation managers a clearer picture of how to best protect this uniquely Australian species of sea lion,' Mr Lowther said.

This research was supported by the Australian Marine Mammal Centre at the Australian Antarctic Division.

Tracking European eels to the Sargasso Sea

European eels (*Anguilla anguilla*) are a scientific enigma. No-one knows exactly where they spawn and spend their early lives and no-one has ever caught an adult eel in the open sea. Scientists have, however, been able to approximate where their spawning grounds must be based on the size of juvenile eels captured in the waters between Europe and the east coast of North America.

From this, scientists know the eels undertake a 5000 km spawning migration from Europe to the Sargasso Sea. During this time they develop from adolescence to sexual maturity, under conditions of starvation and extreme exertion.

Eel stocks fluctuate naturally, but stocks across Europe have declined by 95% in the last 30 years and the causes are uncertain. The conditions that eels experience during their migration, the threats they face and the types of behaviours that they exhibit are therefore of direct interest to those who want to conserve this species. However, the difficulties related to tracking eels in the Atlantic Ocean have driven many scientists to distraction.

In 2007, Microwave Telemetry produced a pop-up satellite archival tag (the 'X tag'), which was small enough to fit large female eels (about 90 cm in size). Using the X-tag externally, and internal archival tags, a team of scientists from the Centre for Environment, Fisheries and Aquaculture Science in the UK and other European research institutions, began tracking 40 large female eels. The eels were tracked over five months and more than 2000 km from their release off the coasts of Ireland, Sweden and France.

The eels migrated towards the Sargasso Sea at speeds of 5–25 km per day. During their oceanic migration the eels adopted a diurnal (day/night) vertical migration pattern, ascending rapidly into shallow water (about 200 m) at dusk and

Andrew Lowther prepares sea lion blood samples in the field.

An adult female harbor seal rests on an iceberg in Glacier Bay National Park.

Harbor seals on an iceberg in Glacier Bay National Park.

Above:
Finn Okland (right) and Cedar Chittenden holding a tagged eel.

Right:
A tagged eel just after release.

returning rapidly into deep water (up to 1200 m) at dawn. Due to the large depth change at dawn and dusk, eels experienced a temperature gradient of up to 5°C twice per day and a pressure change of up to 100 bar. Across the sampled population, geographic migration was observed between 1.5°C and 12°C.

The scientists say that while there are still many questions, the tags have been highly effective at providing some of the first detailed insights into eel behaviour. More information is expected when the eels die (after spawning) and their internal archival tags are washed up on beaches, where they will be retrieved.

More information: www.eeliad.com

A drift archival tag, used to track a European eel, washed up on a beach.

Tracking harbor seals in Alaska

Harbor seal numbers in Glacier Bay National Park, Alaska, declined by up to 11.5% per year between 1992 and 2008. There are many hypotheses to explain this decline but recent research led by Oregon State University PhD student Jamie Womble suggests that the diving and foraging behaviour of seals may be influenced by prey availability in the different habitats used by seals.

To find out, Ms Womble and colleagues from the National Park Service and the Alaska Department of Fish and Game attached bio-logging tags (time-depth recorders and VHF tags) to two groups of seals in the park: seals that used terrestrial sites as haulouts and seals that used glacial ice sites. Ms Womble tracked the seals during the breeding season (May and June) when the seals' movements were more restricted.

Twenty five juvenile and adult female harbor seals were tagged for an average of 56 days to see where they dived, how deep and how long they dived, and to quantify the duration of their foraging trips. Prey (fish) availability was also assessed using hydroacoustic surveys (using sound to detect the presence of fish in the water) in each habitat.

Ms Womble identified four behavioural dive groups. The first two groups, made up primarily of terrestrial seals, foraged in relatively shallow areas with 90% of their dives occurring in the upper 50 m of water. In the third and fourth behavioural dive groups, comprised of glacial ice seals and three terrestrial seals, approximately 70% of dives occurred in the upper 50 m, while some seals occasionally dived to between 200 and 300 m. As well as diving deeper, seals from the glacial ice site had longer foraging trip durations.

The hydroacoustic work showed that the relative density of prey was consistently higher adjacent to the terrestrial haulout site than at the glacial ice site. Near the terrestrial site, most prey occurred in shallower depths, between 10 and 90 m. At the glacial ice site the prey density was consistently lower and prey occurred at a greater range of depths – extending up to 340 m.

These results suggest that harbor seals employ different foraging and diving strategies in different oceanographic zones of Glacier Bay. The biomass of fish and the depth they occur at may also influence the diving behaviour and foraging strategies of seals in different habitats.

'Seals using the glacial ice site may be working harder to obtain prey,' Ms Womble said.

'This could potentially be a problem for young animals that may have more limited diving capabilities than adults. If they can't forage at deeper depths they may have to travel greater distances to areas of higher prey availability.'

Travelling greater distances to forage may also come at a cost. Increased travel distances could result in increased risk of predation by killer whales, Steller sea lions, or sleeper sharks. It could also have a higher energy cost for adult females, which could limit their ability to feed young pups.

More information: http://mmi.oregonstate.edu/jamie-womble

ANTARCTIC ENVIRONMENT AT RISK FROM FRESH FOOD


KATE KIEFFER


DANA BERGSTROM

Above: About 90% of fresh fruit and vegetables examined by the Australian team were free of contaminants such as soil, mould and insects, but about 10%, including this onion, were either contaminated with fungi or bacteria, or contained invertebrates.

Right: Expeditioner Sharon Robinson chooses a meal from the buffet at Australia's Casey station.

Results from the first major investigation into the effect of human activities on the invasion potential of alien (non-native) species into Antarctica show fresh food could pose a risk to Antarctica's biosecurity.

Australian Antarctic Division terrestrial ecologist, Dr Dana Bergstrom, led the Australian component of the *Aliens in Antarctica* project during the International Polar Year (2007–09). Dr Bergstrom's team examined fresh fruit and vegetables destined for Australian Antarctic and subantarctic stations, for seeds, spores and eggs that could pose a threat to Antarctic ecosystems if they became established. Together with teams associated with the British, South African, French and Japanese Antarctic research programs, they examined more than 11 250 items of fresh fruit and vegetables sourced from six continents and destined for nine Antarctic stations.

The teams' report, published in the journal *Biological Conservation* in March, showed that fresh food was a significant pathway for the transport of soil, microorganisms and invertebrates (such as insects, spiders and slugs) into Antarctica. Soil was found on 12% of imported fresh food, 28% of food items showed microbial infection (rot caused by bacteria and fungi), and more than 56 invertebrates were collected.

As one gram of soil can contain more than a billion bacteria, and some 90 different soils are estimated to be introduced into Antarctica each year, the potential exists for alien microbes to become established in Antarctica.

'The consequences of such introductions are, as yet, unknown, but are likely to impact upon existing microbial community structure, with implications for biogeochemistry and ecosystem functioning, and may cause disease in native plants and invertebrates,' the report authors said.

Similarly, many of the fungi identified during the project were known to be 'generalists', occurring in many environments outside Antarctica and therefore more likely to be able to adapt to Antarctic conditions than 'specialist' fungi.

The project teams also found a strong link between the numbers of alien insects on stations and the level of logistic activity involving food transport to the station. For example, the number of insects caught at the UK's Rothera station was highest following the major ship resupply of the station in December, when the station population and fresh food consumption were high.

The report provides a list of measures to reduce the risk of alien introductions from fresh food to the Antarctic and subantarctic. These include:

- Transporting food when transit times between the departure point and Antarctica is shortest, to reduce the likelihood of spoilage;
- Ensuring root vegetables and leafy vegetables have been cleaned to remove soil and invertebrates;
- Avoiding sourcing out-of-season foods that may have already been cold-stored for many months, as they may be more susceptible to spoilage and risk carrying cold-selected microorganisms;
- Storing produce in refrigerators or cool rooms during transit by ship;
- Destroying any insects discovered on ships or aircraft;
- Inspecting food for spoilage or invertebrates before offloading in Antarctica;
- Disposing of food waste and packaging in appropriate ways, such as incineration or sterilisation by autoclaving.

Dr Bergstrom said around 90% of the 2000 pieces of fresh fruit and vegetables inspected prior to export to Australian Antarctic and subantarctic stations were deemed clean.

'Australia already has many of the suggested measures in place and the Australian Antarctic Division works closely with its providores to reduce the risk of introductions to Antarctica,' she said.

'When these measures are adopted by organisations operating across the whole region, Antarctica's biosecurity will be enhanced and the current risk to the native biota will be effectively reduced.'

WENDY PYPER

Corporate Communications, Australian Antarctic Division

The Antarctic Treaty 50 years on

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The 23rd of June 2011 marks 50 years since the entry into force of the Antarctic Treaty, which has provided a stable and enduring governance regime for the Antarctic region. What has changed in that time? How has the Treaty grown? Are the challenges the same?

Using a simple measure it would be easy to say the Treaty has quadrupled – the 12 original signatories to the Treaty are now well out-numbered, with 36 other nations having subsequently acceded to it. While these figures may impress, what is interesting is the pattern of growth in States adhering to the Treaty. There was a marked increase in interest in the 1980s when attention turned to issues of resource development in the Antarctic. This interest was paralleled by overt challenges in the United Nations to the legitimacy of the Treaty – challenges that were successfully defended, ultimately leading to a strengthening of the Treaty and modernisation of the way the Treaty Parties conducted business. But consideration of just the numbers of Parties involved is not enough to describe the developments.

More useful is the content of the governance regime spawned by the Treaty. The Treaty consists of just 14 articles – remarkably short compared to contemporary international legal instruments. Perhaps its brevity reflects the short time taken for its negotiation, but this would not do justice to the importance of its content. The Treaty embodied principles crucial to governing activities – ensuring peace in the region, guaranteeing freedom for scientific research and free exchange of scientific results, setting aside arguments over sovereignty, and exchanging information on Antarctic activities. It also provided a right of inspection of other nations' activities. In a regime which also prohibited military manoeuvres and was the first nuclear non-proliferation treaty, this was a ground-breaking forerunner of modern compliance arrangements. So considerable substance and foresight was embodied in a relatively spare skeleton.

Importantly, the Treaty also provided the mechanism for regular communication between the Parties. It essentially gave the representatives of governments, assembling at the Consultative Meetings, a free hand to develop recommendations that could be taken back to governments for consideration. As a result, the 14 Treaty articles have been complemented by countless other legal instruments, Measures,

2

ANDREW JACKSON

1. A Twin Otter flies over the flags of countries participating in Antarctica's Gamburtsev Province project. Such scientific collaboration today is the result of the Antarctic Treaty system.
2. At Antarctic Treaty Consultative Meetings, such as this one in Madrid in 2006, the principles of the Treaty are vigorously pursued, the health of the system monitored and the fundamental ways of operating protected.

Decisions and Resolutions. These include discrete regimes such as the Convention on the Conservation of Antarctic Seals, the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR), and the Protocol on Environmental Protection to the Antarctic Treaty. Procedures have also been adopted relating to the exchange of information, conduct of inspections, scientific cooperation, management of protected areas, conduct of tourism, ship safety and many other practical matters. The CCAMLR Commission also generates Conservation Measures. Together, these instruments and agreements form the body of what is now known as the Antarctic Treaty System.

The 'system' also includes the institutions that underpin the legal framework. These include forums, such as the Antarctic Treaty Consultative Meeting (ATCM) and its Committee for Environmental Protection, the CCAMLR Commission and its Scientific Committee, as well as affiliated bodies such as the Council of Managers of National Antarctic Programs (COMNAP) and the Scientific Committee on Antarctic Research (SCAR). Linking these are the supporting administrative bodies including the Antarctic Treaty Secretariat and the CCAMLR Secretariat. The overarching forum is the ATCM, where the principles of the Treaty are vigorously pursued, the health of the system monitored and the fundamental ways of operating protected.

Just three weeks after the Treaty entered into force the ATCM convened for the first time in Canberra, in what is now Old Parliament House. It is not normal practice for a Treaty to specify the location of the first meeting, but in this instance it did. On the agenda were a number of issues designed to flesh out the broad principles of the Treaty, taking advantage of the provision in Treaty Article IX that the Parties could adopt measures to further the Treaty's objectives.

A focus of that Canberra meeting was practical issues, including ways to facilitate exchange of information and the prospects of institutional support for the Treaty. This latter item proved problematic and it was to be another four decades before a Treaty Secretariat was established. The Parties also avoided discussion of jurisdictional issues, despite proposals that they be tackled promptly – in fact, such issues continue to be side-stepped. But such sensitivities did not prevent progress on many other pressing issues, including the first discussions on ways to protect the environment and conserve living resources. These debates led initially to the Agreed Measures for the Conservation of Antarctic Fauna and Flora. The Agreed Measures applied to the land and ice shelves of the Antarctic but left a vacuum with respect to the high seas. The Parties then addressed pelagic sealing in the separate Seals Convention. By the end of the 1970s attention turned towards other resource management issues – initially the other living resources of the Southern Ocean (essentially krill and finfish), then the non-living resources (hard minerals and hydrocarbons). CCAMLR was adopted in 1981 to deal with the former, and the Convention on the Regulation of Antarctic Mineral Resources (CRAMRA) was negotiated in 1988.

Debate over the minerals convention triggered considerable external interest in the Antarctic Treaty system, including criticisms within the United Nations about the apparent exclusivity of the Parties in dealing with the issues, and criticism from environmental stakeholders about the potential impact on Antarctica's natural values. Following intense debate, precipitated by Australia's decision not to sign the minerals convention, the Parties did an about-face and adopted the Protocol on Environmental Protection to the Antarctic Treaty. This agreement prohibited mining, set environmental principles for the conduct of all activities in Antarctica, and integrated a number of existing environmental provisions in a legally binding regime.

These developments do not mean that economic use has been set aside. Indeed, CCAMLR is very active in regulating the use of marine living resources, tourism is under increasing regulation and the Parties have addressed biological prospecting.

On reflection, four key stages in the evolution of the Treaty system can be defined, each building on the preceding stages to strengthen the system. Initially the Treaty focussed on consolidation and administration. The second stage dealt with the primary resource issues. The third stage put emphasis on environmental protection and management. The fourth stage is fostering global acceptance of the Treaty's contribution to the world's diplomatic and environmental health; as a result there is growing recognition of Antarctica's global, rather than regional, significance.

Throughout these stages the primary activity on the ground in Antarctica has been scientific research. This has undergone its own transformation from basic, descriptive programs to highly integrated programs, relying heavily on international collaboration and addressing global issues. The Treaty has made such approaches possible because it has instilled confidence in the operating environment.

One of the most remarkable achievements of the Antarctic Treaty System is the way it has dealt with potentially destabilising Antarctic issues. For example, the differences of view over sovereign claims, the politics of cold war rivalries, the potential intrusion of rights under the Law of the Sea – all melted away without these issues ever being on the agenda of the ATCM. Protecting the stability of the Treaty has always taken a higher priority.

Australia hosted the 12th ATCM in 1983, again in Canberra, just on the cusp of critical Treaty system developments. CCAMLR had just begun its early work, the minerals debate was gathering momentum and the external challenges to the Treaty were beginning to emerge. In 2012 Australia will again host the ATCM. By then the Treaty will have celebrated its 50th year and will be looking ahead to the future management of the Antarctic region. There will no doubt be further growth in the number of Parties, new ways of collaborating in science and logistics, and evolution of the suite of management measures. Inevitably there will also be unexpected challenges. But some things may never change: respect for the fundamental principles of peace and cooperation in the region, and commitment to consensus decision-making – the glue that binds all the Parties.

ANDREW JACKSON

Adviser to the ATCM 35 Steering Committee and Former General Manager, Strategies Branch, Australian Antarctic Division

Antarctic wildlife is protected as a result of the Antarctic Treaty's environmental protocol.

Australia's role in the Antarctic Treaty System

This year, to help mark 50 years of the Antarctic Treaty, a major book is being published to record Australia's engagement in the Treaty. The preparation of this work has spanned two years and is the result of a collaboration between the University of Tasmania (UTAS), the Australian National University (ANU) and the Australian Antarctic Division. The content, however, is the work of many and brings together experienced practitioners and academic authors in a new history and assessment of Australia's role in the Treaty.

The book treads a dual path, interposing an historical narrative with thematic chapters that examine common threads throughout the 50-year period. The scene is set with a chapter telling the story of Australia's early involvement in Antarctica and the steps leading to the proclamation of the Australian Antarctic Territory – events that were to lock Australia in as a key player. The narrative chapters build on this to relate Australia's instrumental role in the Treaty negotiations and the early blossoming of the Treaty system. The story then discusses the consolidation of the Treaty system and the path it weaved through potentially disastrous destabilising challenges – external confrontation in the United Nations and internal friction over access to Antarctica's living and non-living resources. New information is used to reveal what had been happening behind the scenes.

Douglas Mawson proclaims British sovereignty over King George V Land in 1931. The area is now part of the Australian Antarctic Territory.

The thematic chapters assess issues such as Australia's sovereign interests as an Antarctic claimant state, the effect of domestic and international law, science as an enduring national interest, and the remarkable achievements of Australian Antarctic diplomacy. The book concludes with a discussion of Antarctica in Australian culture and a brief look towards the future. Human dimensions, evidenced by the contributions of key players, are drawn out in vignettes of explorers, scientists, administrators and diplomats.

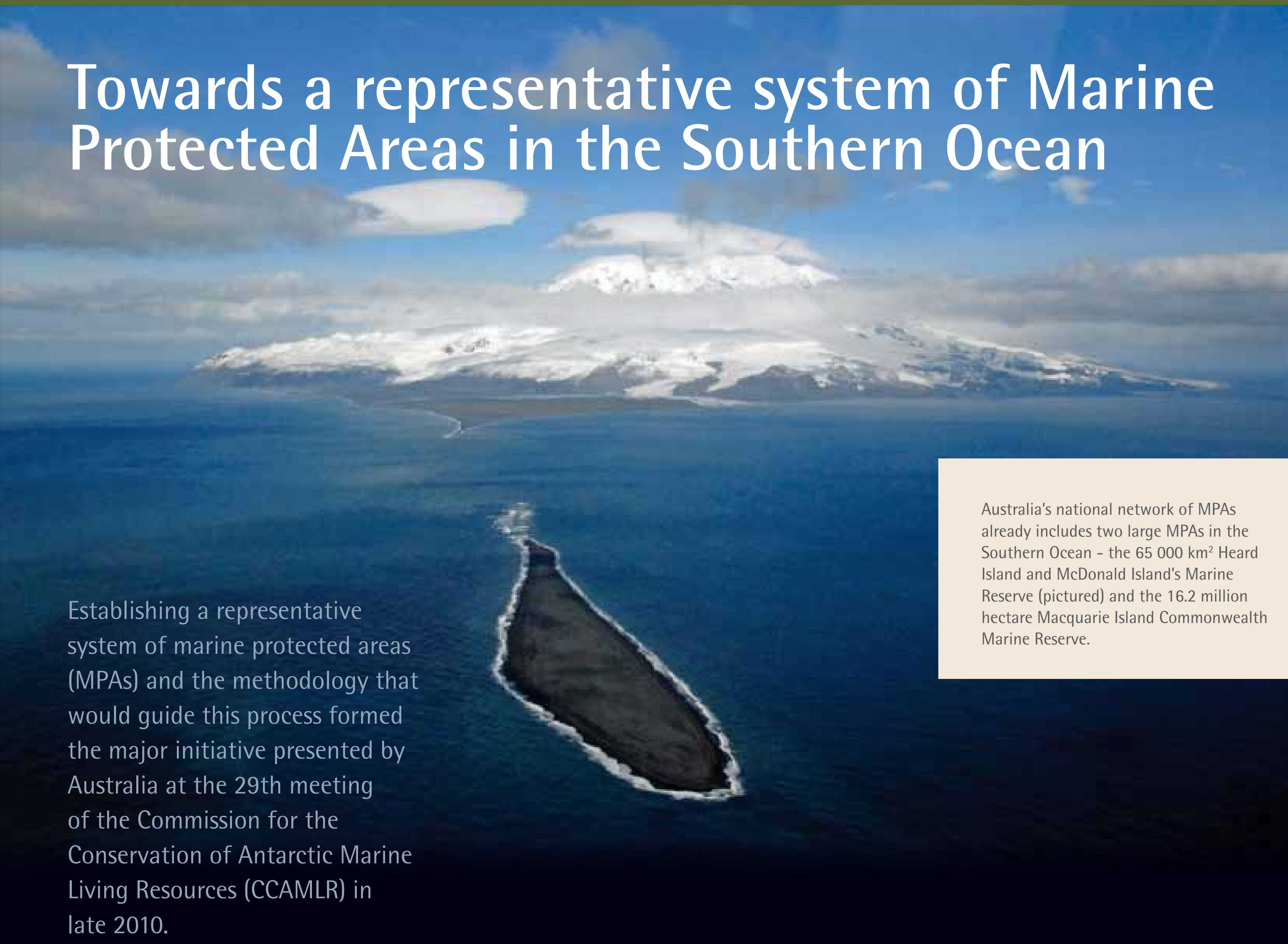
The book aims to complement existing assessments of the evolution of the Antarctic Treaty System by providing a forthright, frank and uniquely Australian perspective. And so it should, as Australia has had a lead role in many developments; famously, in the demise of the minerals convention, and sometimes with understated subtlety. Ultimately, in the Treaty's consensus-based politics, all the Treaty Parties contribute to its successful development. But this book unashamedly explores what Australia has done, sometimes with remarkable diplomatic prowess and sometimes with less success, to influence those developments.

The book is edited by Associate Professor Marcus Haward of UTAS and Professor Tom Griffiths of the ANU, both of whom are well-published in the fields of Antarctic law, politics and history. Vivid maps and previously unpublished images will be included in this hard cover volume.

Australia and the Antarctic Treaty System: 50 Years of Influence will be published in late 2011 by the University of New South Wales Press.

ANDREW JACKSON

Towards a representative system of Marine Protected Areas in the Southern Ocean



Australia's national network of MPAs already includes two large MPAs in the Southern Ocean – the 65 000 km² Heard Island and McDonald Island's Marine Reserve (pictured) and the 16.2 million hectare Macquarie Island Commonwealth Marine Reserve.

Establishing a representative system of marine protected areas (MPAs) and the methodology that would guide this process formed the major initiative presented by Australia at the 29th meeting of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) in late 2010.

The proposal was a substantial contribution to CCAMLR's efforts toward meeting a goal set in 2002 by the United Nations' World Summit on Sustainable Development (WSSD) that recognised the vital role that MPAs play in conserving marine biodiversity. The WSSD agreed that MPAs (including representative networks of MPAs), consistent with international law and based on scientific information, should be established by 2012. CCAMLR has been working steadily toward achieving this goal with the first CCAMLR MPA declared in 2009 near the South Orkney Islands.

The benefits of MPAs are well documented; for example, the conservation of ecosystem processes, species, habitats and biodiversity. MPAs also have the potential to offer scientific areas to help distinguish between the effects of harvesting and other activities from natural ecosystem changes, and provide opportunities for understanding the natural dynamics of the Antarctic marine ecosystem without interference.

The objective of CCAMLR is the conservation of Antarctic marine living resources, where conservation includes rational use. Fishing for krill, toothfish and other species such as icefish and crab are carefully regulated through CCAMLR's management regime. CCAMLR's focus on ecosystem management and conservation makes it a key player in the global effort to establish representative MPAs.

The scale of the task ahead for CCAMLR in developing a representative system of MPAs should not be underestimated. In the nine years since the WSSD's agreement, CCAMLR's Scientific Committee has been working to determine where MPAs should be, what should be protected and how MPAs should be managed. In 2009 the Scientific Committee agreed to a work plan to achieve the 2012 deadline. This involved identifying 11 priority areas, finalising data collection and characterising regions in terms of biodiversity patterns, ecosystem processes, physical environmental features and human activities.

Australia led two MPA proposals at the 2010 CCAMLR meeting. One set out general principles to establish a framework necessary for considering a representative system of MPAs within the CCAMLR Area. The second proposal set out a method to assess candidate areas that are considered 'data poor' and provided a worked example of this method by proposing a number of areas in Eastern Antarctica that could be considered for inclusion in the representative system. Agreeing on a common approach for establishing MPAs is pivotal. The level of participation and discussion among the 25 CCAMLR Members, prompted by Australia's proposals, reached new heights.

A CCAMLR MPA workshop scheduled for August 2011 will discuss candidate areas for protection and the intention is that these will be submitted for consideration at the annual CCAMLR meeting in Hobart in October.

Australia will continue to play a key role in helping CCAMLR achieve its MPA goals in 2011 by presenting proposals at the August MPA workshop in France and at the annual CCAMLR meeting. The expectation is that CCAMLR will continue with its work plan and make progress towards achieving the 2012 WSSD target.

LIHINI WERAGODA and RHONDA BARTLEY

Territories, Environment and Treaties Section, Australian Antarctic Division

GARY MILLER

Oates Land to inland – Australian

In January 2011 Australia conducted inspections of other nations' Antarctic facilities, under the provisions of the Antarctic Treaty and its Protocol on Environmental Protection. These inspections followed on from successful inspections conducted in January 2010 (*Australian Antarctic* Magazine 18: 26-27, 2010). In addition to being an important mechanism that allows independent verification of compliance with these international agreements, inspections provide Australia with a chance to understand our region, interact with other nations in Antarctica, and demonstrate Australia's commitment to the Antarctic Treaty System.

The inspection team comprised Dr Tony Worby and Ms Gillian Slocum of the Australian Antarctic Division, and Mr Tim Bolotnikoff of the Department of Foreign Affairs and Trade.

After landing at the United States' Pegasus Runway in Antarctica, the inspection team travelled between locations in Australia's ski-equipped C-212, covering approximately 4940 km over eight days.

The first stop was Italy's summer-only Mario Zucchelli station in Terra Nova Bay. While an inspection of the station was not conducted, the inspection team toured the station facilities and talked to many scientists about their research and spent time on the station's research vessel, *Skua*, observing some of the marine science research being undertaken.

The team then deployed to the coast of Oates Land, around 600 km from Mario Zuchelli, and observed the Russian station, Leningradskaya, from the air. Located on a 300 metre-high nunatak, a few kilometres south of the coast, Leningradskaya station has not been occupied since 1991. The inspection team completed approximately 20 low-level flights over the station over 50 minutes, with the rear ramp of the C-212 providing a particularly good vantage point from which to view the station and take photos.

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On the last day of their stay at Mario Zucchelli station, the inspection team flew by helicopter across the bay to inspect Germany's Gondwana station, and to visit the site of the Republic of Korea's proposed new year-round station, Jang Bogo.

Gondwana is a summer-only station and was unoccupied during the 2010–11 season. As the facility was secured at the time of the visit, the inspection was limited to the exterior of the station buildings and facilities.

The Republic of Korea intends to commence constructing a new station in the Terra

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EXPEDITIONER PHOTO

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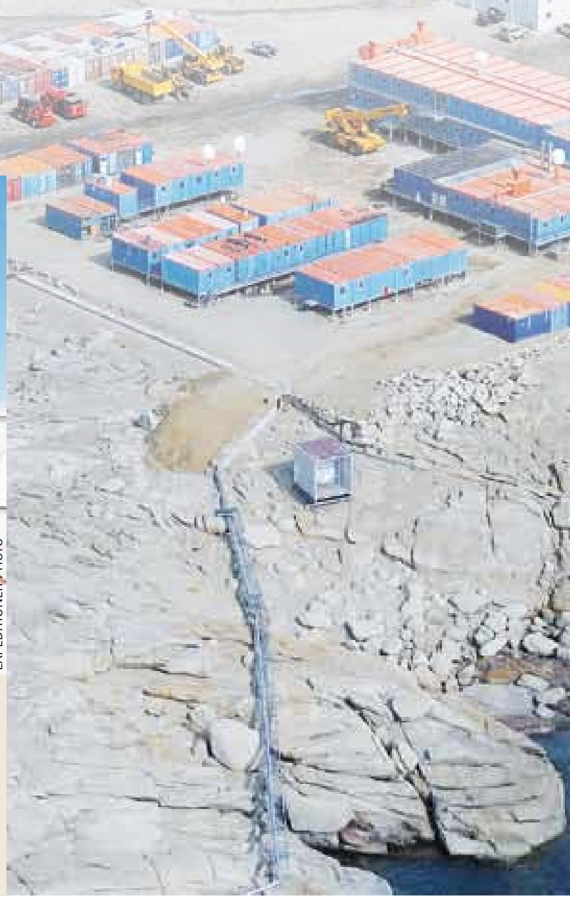

1. The inspection team at Vostok, L-R: Tim Bolotnikoff, Tony Worby, Gillian Slocum and Vostok Station Leader Alexey Turkeev.
2. Italy's Mario Zucchelli station.

inspection activity in 2011


TIM BOLOTNIKOFF

TIM BOLOTNIKOFF

3. Concordia station at Dome C is jointly operated by France and Italy.
4. A scientist removes an ice core from the drill rig at Vostok station.

Nova Bay area in December 2012 and recently circulated a draft Comprehensive Environmental Evaluation to Antarctic Treaty Parties for consideration. The inspection team's visit to the proposed station site will help inform Australia's review of this document.

The team then flew over the trans-Antarctic mountains to Concordia station, at Dome C on the Antarctic Plateau. The year-round station, which is jointly operated by France and Italy, is 3233 m above sea level. The altitude and extreme cold can induce acute mountain sickness in visitors, but the inspection team suffered only mild shortness of breath.

The team spent a day with several scientists, learning more about the research programs underway at Concordia station. A particular highlight was talking with the glaciologists about the drilling program, which involved extraction of the oldest Antarctic ice core between 1999 and 2004, providing a climate record that extends back more than 700 000 years.

The Russian Federation's Vostok station, 560 km from Concordia, was the next stop. Vostok station sits above sub-glacial Lake Vostok, hidden under 3700 metre-thick ice. It is the coldest place on earth, having recorded a temperature of -89.2°C in winter 1983. The station was opened in 1957 and is occupied all year round. The team inspected the station, with a focus on the major scientific project to obtain a deep ice core and investigate Lake Vostok. The current focus of the project is to sample lake water. The inspection team were present when an ice core was brought to the surface from a depth of 3684 m.

The inspection team were warmly welcomed with friendship and openness by personnel at all stations visited and inspected. Australia would like to formally thank France, Italy, the Russian Federation and the United States for the generous hospitality and logistics support they provided to the inspection team.

Australia will report on the inspections to the Antarctic Treaty Consultative Meeting.

GILLIAN SLOCUM

Manager, Territories, Environment and Treaties Section, Australian Antarctic Division


GILLIAN SLOCUM

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GLENN JACOBSON

A harp in the south

Harpist Alice Giles travelled to Antarctica on an Australian Antarctic Arts Fellowship, almost 100 years since her grandfather stepped ashore with the first Australasian Antarctic Expedition (AAE).

As my grandfather Cecil Thomas Madigan, meteorologist on the AAE of 1911–1914, sat in the hut at Commonwealth Bay, he meticulously recorded in his diary the hymns he enjoyed singing and the gramophone records that brought him cheer, describing how live and recorded music was an essential component in maintaining equilibrium. Today, 100 years later, there remains very little music written by Australian composers that directly relates to Antarctica, even though Australians have had a consistent presence on the continent.

As recipient of an Antarctic Arts Fellowship my main aim was to combine the historical music and words of that original AAE with especially written contemporary music, and perform this live on the Antarctic continent. The concept of performing a concert in Antarctica was unusual, but hopefully my adventure will open this to future discussion and consideration.

There was very little time, from receiving confirmation of my Fellowship to the ship's departure in February (2011), to commission new pieces and to construct the program. I selected pieces mentioned in the Madigan diaries as a start. The composers I asked to become involved in the project – Larry Sitsky, Jim Cotter, Martin Wesley-Smith and Joshua McHugh - came back to me with a range of excellent pieces reflecting their individual concepts of Antarctica. I then selected excerpts from the diaries to connect everything together. Wesley-Smith's piece 'Aurora Wynnis' includes sung and spoken words from the diaries referring to my grandmother, at that time Madigan's fiancée.

Meanwhile, Australian National University (ANU) staff trained me in recording and editing techniques, as I was to be a one-woman production team. I also shipped off my large electro-acoustic harp and my recording, video and electro-acoustic equipment to the wharf in Hobart. I had been hoping to live-stream the concert from Mawson station, but on learning that the available bandwidth was too small, I arranged to send back shorter sound and video clips instead. I set up a blog site which would comprise the 'live' element


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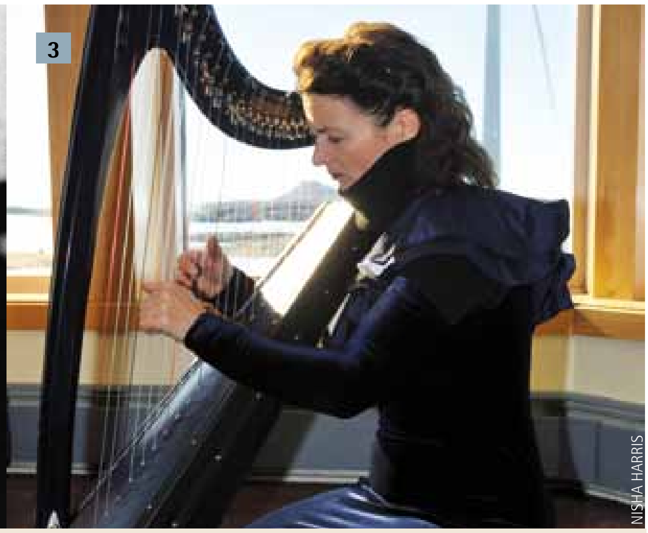
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1. Alice adds some glamour to Mawson station with her electro-acoustic harp on the sea ice.
2. Alice's grandfather, Cecil Thomas Madigan, was the meteorologist on the AAE of 1911–1914, based at Commonwealth Bay.
3. Alice practices her small lever harp at Mawson station. Almost 100 years since her grandfather's visit to Antarctica with the Australasian Antarctic Expedition (1911–14), Alice performed a program of the music and words of the AAE, combined with especially written contemporary music.

of the adventure (http://aliceinantarctica.wordpress.com/).

When deciding what type of instrument to take I had to consider the intense cold and dry atmosphere of Antarctica, so I settled on an electro-acoustic harp rather than my acoustic harp. I also took a small lever harp made by Tasmanian Andrew Thom, for practice during the ship voyage and for any outside performances. Sitsky wrote a second piece for this small harp and I was able to play and video this outside on several occasions at Davis and Mawson stations. I found it especially appropriate next to the elephant seals and the rocks, as it had a rather deep, sombre character.

My time on the Antarctic continent was more limited than I expected and I had very little opportunity to make outdoor recordings because of the inclement weather. I ended up with two half days at Davis and one afternoon at Mawson where the wind was not too high to go outside and record! I did collect some sounds of the wind playing the strings of the harp, the swish of the slushy ice in the bay, the wind itself, and the operatic bass of the elephant seals. I also recorded the marvelous machinations of the *Aurora Australis* engine room and the ship cracking through the sea ice. These recordings will be shared with the composition and digital arts students of the ANU. I am also putting together a selection of photographic images from the voyage to accompany future performances of the program I gave at Mawson station. This will open the ANU Conference *Antarctica-Sounds and Cultural Connections* in June (http://music.anu.edu.au/antarctica) and I hope many subsequent performances.

My blog became a creative focus for me in an unexpected way as it forced me to organise my thoughts and feelings as the voyage progressed. I am very glad now that I have this to fall back on as I rapidly become re-assimilated in that strange other world – *real life*. I am now considering the best ways to use that written material alongside the audio-visual records. The blog felt different from a diary because I saw it as a performing artist would and tried to translate my 'in the moment' emotions and experiences of the senses to a broad readership. Throughout the wonderful ship voyage and on the continent itself, I felt able to think more clearly and creatively, feel more extremely and tap into more energy than usual. One fellow expeditioner confessed to a similar experience; I wonder if this is common?

Many times during the voyage I was asked about what I was going to compose. It is hard to explain the division in classical music between composer and performer. Classical composition is a highly sophisticated skill that is studied and practised, just as a performer practises long hours and focuses on their own skill set. Very few people are able to combine the two skills. Although I did turn my hand to a couple of small musical sketches I consider them, alongside some brief improvisations outside in response to the environment, as a diary entry. Performance for me is a special kind of creativity, bringing something very important to life and communicating the abstract and complex emotions and symbols it contains to the direct experience of the listener. Performance in a particular space and in relation to nature has now become a matter of great interest to me and will engage much of my thought in the future.

My fellow expeditioners were all incredibly supportive of my performances and provided me with warm encouragement and responsiveness. This illustrated to me the need to consider musical performance as a vital part of Antarctic life, just as it is a vital part of all human existence anywhere. Recorded music has a quite different function and effect that is not a substitute.

When I look back it is difficult to pinpoint highlights of the trip because it is the overall impact that is strongest for me. I am sure this is familiar to other expeditioners; with life trimmed to essentials, the feeling of being privileged to enter into another world for a short time, a world where nature is still overwhelmingly dominant, pristine and powerful. Although I live on a beautiful 17-hectare property, the life I lead is hectic and relentless. To express the essence of nature in performance is to have experienced its essence in the quiet of the soul. Playing a concert in front of the windows of the Red Shed at dawn, improvising on the beach at Davis, or imagining what music I would hear in my heart while on the heaving Southern Ocean; these experiences helped me engage with nature in a way I had never considered at home.

ALICE GILES

Head of Harp Area, Australian National University
www.metronomeinc.com

South Korean film crew to winter with emperor penguins

A South Korean film crew wintering at Mawson station this year are no strangers to living in remote and hostile environments.

1. Assistant producer Bang Bo-Hyun (left), cameraman Song In-Hyuk and senior producer Kim Jin-Man at Mawson station in March this year.
2. The Korean film crew film Hägglund training at Mawson.

The three-man team of producer Kim Jin-Man, assistant producer Bang Bo-Hyun and cameraman Song In-Hyuk, have already shot documentaries in isolated areas of the Amazon and Himalayas.

Now they are aiming to capture the beauty and fragility of the Antarctic continent in their new documentary *Tears of Antarctica.*

'This is the last in our series of environmental documentaries, where we explore unique environments and how humans and animals adapt to challenging surroundings,' Mr Kim Jin-Man said.

The film crew is one of five Korean crews from Munwha Broadcasting Corporation (MBC) filming in Antarctica this year. MBC is one of the country's major television and radio networks, with 19 regional stations, 10 subsidiaries and more than 4000 employees.

Over the next 12 months the five MBC film crews will be embedded at stations across the continent, including at Japan's Syowa base, Germany's Neumayer base, the Argentinean Esperanza base and on the subantarctic South Georgia and King George islands.

The focus of the Mawson-based crew will be the emperor penguin colony at Auster Rookery. Series Producer Kim Jin-Man said the emperor penguins have an incredible story to tell as they symbolise the struggle for survival that all creatures face on the frozen continent.

The film crew plan to spend the majority of the winter months based at tiny Macey Hut, about 51 km east of Mawson station, near the emperor penguin rookery. The crew will return to Mawson every month to get supplies and have much needed showers.

Both Kim and cameraman Song have worked in the industry for 15 years, and have experienced a number of challenging work conditions. For example, they spent almost six months deep in the Amazon rainforest filming a remote tribe that has rarely had contact with the outside world. Capturing the life of the Zoe tribe involved spending days in open canoes travelling up the Amazon, dealing with swarms of mosquitoes and camping in basic huts in damp conditions.

'They were all naked and still used traditional hunting methods to sustain their families. They had never been in contact with modern society before. It was a fascinating insight into a disappearing culture,' Mr Kim said.

Two years ago Song spent 200 days on Mount Everest filming a story about two Korean University students who perished in their attempts to climb the mountain. Song's film followed the friends of the deceased as they searched and found the bodies of their loved ones in order to provide a traditional burial for them.

Preparation and planning for the Korean crew's Antarctic trip has been intense. Once in Antarctica there are no options for fixing or buying new equipment in the event of an accident. They have packed 500 kg of equipment, including sound recording gear, a 3-D camera and an underwater camera.

'We are hoping to be able to find a hole in the ice where the emperor penguins are accessing the ocean and put an underwater camera there to capture the action,' Mr Bo said.

'The five programs series, including the other teams based across the continent, will cost MBC about $3 million to film and produce, but the end result will be spectacular.'

The three men, who hail from the 10 million-strong city of Seoul, are looking forward to experiencing the isolated community life, in the company of just 19 wintering expeditioners at Mawson station.

'It's an amazing opportunity to not only live in a remote environment, but also immerse yourself in a different culture," Mr Bo said.

Kim and Song will return to Korea in November, while Bo will remain at Mawson until February undertaking post-production work. The documentary series will air in Korea in December and a feature-length film will be made for worldwide distribution.

NISHA HARRIS

Corporate Communications, Australian Antarctic Division

1

Mawson air tractor tail to tour Australia

AAE

A piece of Antarctic history was returned to Australia this summer and will become the centerpiece of a touring exhibition celebrating the 1911–14 Australasian Antarctic Expedition (AAE). The tail of the Vickers monoplane, which travelled south with Sir Douglas Mawson's pioneering expedition 100 years ago (*Australian Antarctic Magazine* 18: 30-32, 2010), was returned to Hobart in January. The fragile metal, twine and canvas relic was rapidly deteriorating in its icy home and was deemed a priority for urgent restoration.

2

MATT TUCKER

1. The air tractor in Antarctica.
2. Materials Conservator Antonia Ross, from the Mawson's Huts Foundation, prepares the air tractor tail for shipping back to Australia.

Mawson envisioned that the monoplane would be used to map the Antarctic continent, but it was damaged during a test flight in Adelaide just prior to the departure of the AAE. Despite this, Mawson pushed ahead with plans to take the plane south, removing the wings and converting the frame into an air tractor, which was to be used to tow sledges across the ice. It only made a few short depot runs before the engine irreparably broke down. The engine, propeller and other items, probably including the tail piece, were removed and the frame was abandoned on the shores of Boat Harbour when the expedition left Commonwealth Bay in 1913.

It wasn't until the 2002–03 summer season that the tail was re-located, buried under the ice within the workshop of Mawson's Huts. It was excavated and stabilised by conservation workers from the Mawson's Huts Foundation and stored on the mezzanine level of the Main Living Quarters until this summer. Materials Conservator Antonia Ross said the extensive work required on the tail meant it had to be returned to Australia.

'Unfortunately the humidity inside the hut is over 95%, which really affected the condition of the tail. The metal frame is warped and corroding, the textile material is fragmented and the twine binding it all together is extremely brittle,' Ms Ross said.

'Getting the tail stable enough to move was a difficult task, but the process we chose worked really well. We laid it out on hard plywood backing and used lots of cling wrap to keep it in place and buffering foam to prevent any movement during the week-long sea voyage to Tasmania.'

The tail was then packed in a transport crate and flown out to the *L'Astrolabe*. It was transported in the cargo storage area of the ship, which allowed it to gradually acclimatise to the increasing temperature. Silica gel was placed within the foam supports to absorb any moisture.

The tail will now head to the Western Australian Museum for conservation. Head of Materials Conservation at the museum, Dr Ian Godfrey, said it's a challenging and exciting project.

'It's obviously a very complex object. There are two different types of metal on there, there's fabric and twine in various states of disrepair, so it's going to be difficult to treat. Once we have restored the tail piece, we will have to prepare a support for it so it can be mounted safely and displayed,' he said.

'The tail is a significant part of Australia's Antarctic history. It was a good example of Mawson's innovation and that's why it's so important to conserve it. He took the first radio down there to ensure communication was possible and he wanted to be the first to fly around as well. I think in a lot of ways, Mawson was lucky the plane crashed in Adelaide before he left because it would have crashed in Antarctica, with tragic consequences. As an air tractor, it didn't go very far and wasn't a great success, but it was still symbolic of what he was trying to do there.'

The tail will travel around the nation as part of the AAE Centenary Exhibition *Traversing Antarctica: the Australian Experience*, curated by the National Archives of Australia (see page 36). Mawson's Huts Foundation is still hopeful of locating the remainder of the air tractor frame and will continue the search next season.

NISHA HARRIS

Corporate Communications, Australian Antarctic Division

Husky's tale comes full circle

ROBERT NASH

2

Australian National Antarctic Research Expedition veteran Gordon Bain has been instrumental in returning one of the last Antarctic huskies to her birthplace, 19 years after her removal under the Environmental Protocol to the Antarctic Treaty.

The last litter of Antarctic huskies was born at Mawson station on Monday 10 August 1992. The three puppies were born to Cardiff and Cocoa and were named Cobber, Frosty and Misty. Huskies had been at Mawson since the station was established by Phillip Law in February 1954.

On Monday 23 November 1992 I was on the docks in Hobart with a bunch of other people, watching the RSV *Aurora Australis* returning from her first voyage to Antarctica for the season. As the ship got closer we saw, heard and smelled husky dogs on the heli-deck. These were the younger working huskies returning from Antarctica as a result of the eviction orders stemming from the Madrid Protocol.

Once the ship was secure the gathered media and everyone on the dock clamoured to see the dogs. A very special treat was seeing the three husky pups at the guard rails on the deck in the care of returning wintering expeditioners, Dave Pottage and Al Rooke, and glaciologist Tony Worby. For pups only 15 weeks old, they had all the characteristics of the 'Mawson breed' – much larger than other husky puppies.

The puppies and 19 adult working dogs left Hobart a day or two later on a flight to Los Angeles, followed by a long road journey to Ely, Minnesota, up against the Canadian border. A film *The Last Husky* (Aurora Films) documents the huskies' last sea ice trip across the ice along the coast to the emperor penguin rookeries and the 20 000 km, two-week journey to Ely by helicopter, ship, aircraft and truck. The three pups and 14 of the adult dogs went to the Voyageur Outward Bound School; the other five adults went to Paul Schurke's Wintergreen Lodge nearby. But that day on the Hobart docks was not to be my last encounter with Misty.

Eight years later, in March 2001, I went to Ely with an American school teacher friend, Betty Trummel, and one of her students. We had been in touch with the Voyageur Outward Bound School and learned that Misty was still there and working.

Our trip was memorable. The school's Program Director, Dave Backler, and his staff very kindly hitched up two dog teams and our party took off on a wonderful sledging run through the forested lakes country. I went with the team that included Misty, who was now nine years old. Despite having seen huskies on the dog lines at Mawson over the years I had not had the opportunity to travel with them. Being able to do so with Misty in a place far removed from her birthplace was a joy. It was hard leaving. We learned that the adult dogs that had gone to Ely in 1992–93 had either died or retired and even Misty's siblings, Cobber and Frosty, had died.

I retired not long after that and began a significant involvement in Antarctic education programs in Tasmanian schools and a long association with the Midwinter Festival. But huskies were never far from my thoughts; they were a recurring theme in many of the talks I gave at schools and on occasions during the midwinter festivals.

In June 2009 the Australian Archives had an exhibit relating to huskies as part of that year's Midwinter Festival. I was one of the volunteers looking after the school groups that came through the exhibit during the festival week. In preparation for the sessions I gathered sundry husky memories and artefacts, including snippets about the repatriation of the huskies, their life in North America and my own contact with Misty. Deb Barrett, a volunteer who brought one of the school groups through, said that she had recently been speaking with Dave Pottage and that Dave would have some further information about Misty. I established contact with Dave

Gordon Bain made 12 voyages to Antarctica during an 18-year career with the Australian Antarctic Division. He visited Australia's three Antarctic stations, Macquarie Island, Heard Island, the Bunger Hills and other field sites, as well as Dumont d'Urville, Zhongshan and Progress stations. During his trips he worked in voyage management and as a volunteer in various science programs. Since his retirement in 2001 he has been involved in Antarctic educational activities, including development of the Tasmanian Ice Boxes with American school teacher Betty Trummel, volunteering at the Tasmanian Midwinter Festival and membership of the Tasmanian Polar Network.

and through him a contact with Frank Hashek in Indianapolis. Dave had met Frank at Ely years earlier when Frank was a participant on one of the Outward Bound courses.

From Dave and then Frank I got the news that Misty had retired in late 2002 and that after negotiations with the Voyager Outward Bound School, Frank had taken Misty into retirement in Indianapolis in August 2003. Misty led a full and interesting life in retirement but sadly passed on 4 December 2007. She was cremated.

In one of my early contacts with Frank I raised the prospect of Misty's ashes returning to Australia. He responded favourably saying also that 'if they did indeed go to Mawson station, it would be as if Misty was going home'. Then began the slow process of getting appropriate parties 'on board' with the arrangement, making arrangements to get the ashes back, creating a suitable memorial and arranging for the ashes to go to their final homes.

Misty's ashes arrived in Hobart on 27 January 2010, marking my third contact with her. Frank retained a portion of the ashes in Indianapolis, intending to scatter them in the forest and lakes country around Ely that was Misty's home ground during her working life.

With encouragement and advice from many people, the support of the Tasmanian Polar Network and the Australian Antarctic Division, my friend Tony Adams and I set about creating two suitable memorial pieces – one to go back to Mawson, the other to remain in Hobart on public display.

The memorials comprise many elements reflecting not only Misty but also all other huskies that served with Australian expeditions in Antarctica:

- Misty's ashes are in a velvet bag supplied by her last owners, Frank and Judy Hashek of Indianapolis.
- The velvet bag is in a box made from myrtle (*Nothofagus cunninghamii*), a temperate rainforest species found extensively in Tasmania and in Antarctica's fossil record.
- Part of the box sits on a portion of an original runner from a sledge pulled by huskies at Mawson, where they had lived and worked from the station's founding in 1954 until their removal in 1992. The sledge runners were kindly supplied by the Australian Antarctic Division.
- The other part of the box sits on a block of North American timber representing the country in which Misty spent most of her life.
- Huskies were used at Wilkes from 1959. Dog operations ceased in the area when 'old' Casey replaced Wilkes in 1969. A piece of weathered timber, incorporated into the memorials, is a remnant from the tunnel of 'old' Casey station which operated until 1988 – the donor wishes to remain anonymous. The memorials carry a plaque identifying Misty as The Last Mawson Husky and a second plaque with some words based on Robert Louis Stevenson's 'Requiem':

Under the wide and starry sky,
Gladly did I live and gladly die.
Here she lies where she longed to be,
Home is the sailor, home from the sea.

Misty was returned to Mawson, in the care of Mawson Station Leader Mark Williams, in March this year, 19 years after she left.

GORDON BAIN

Australian Antarctic Division 1983-2001.

1. On the trail with Misty (right) at the Voyager Outward Bound School in 2001.
2. Alan Rooke (left), Tony Worby holding Misty (centre) and Dave Pottage holding Frosty, on arrival in Hobart from Mawson on the *Aurora Australis*, November 1992.
3. American school teacher Betty Trummel with Misty at the Voyager Outward Bound School in 2001.
4. Gordon Bain (left) and 2011 Mawson Station Leader Mark Williams, with Misty's plaque and ashes.

A challenging Antarctic season

1. The Sikorsky S76 (left) and Squirrel helicopters during the Mawson resupply from the sea ice.
2. Davis station resupply from the *Aurora Australis*.

The 2010–11 Australian Antarctic season started with the first Casey expeditioners flying to McMurdo on Australia's Airbus A319 and then across to Casey on a United States LC130 Hercules. The collaborative arrangement saw us utilise the Hercules's heavy lift and ski capability to get people and cargo to Casey, while the US used the Airbus throughout the season for several passenger transfers to and from McMurdo in return.

At the same time, the *Aurora Australis* departed for Davis. The voyage saw a significant amount of science activity, with an airborne laser project and automated underwater vehicle trials undertaken by sea ice researchers. Concurrently, six expeditioners left Hobart for Macquarie Island on the French ship *L'Astrolabe*.

The French voyage subsequently met tragedy, with four French expeditioners dying in a helicopter crash during a long-range fly-off to Dumont D'Urville. Australia assisted with search and rescue efforts that were coordinated by the Australian Maritime Safety Authority. The Australian Antarctic Division's Crisis Management Team was activated and the *Aurora Australis* diverted four days off its course to Davis to assist if required. Hobart-based staff also assisted the search effort, with glaciologists providing ice imagery and forecasts, and aviation staff giving expert knowledge to RAAF and other crews unfamiliar with Antarctic flying. We provided field equipment for those undertaking the search and survival equipment to be dropped to any survivors. Our colleagues at the Bureau of Meteorology worked tirelessly to forecast for the vessels and aircraft involved, while the US program lent aircraft to the search effort from Christchurch and McMurdo. Sadly, the wreckage and bodies were found some 48 hours after the emergency beacon had been activated.

At Casey, science became a focus with the arrival of a Basler aircraft as part of an Australian-US collaboration to undertake geophysical surveys of the Totten Glacier region. Another project saw a field party deploy to the Totten Glacier to undertake ground-based surveys to help calibrate a newly launched satellite system that will determine ice thickness through remote sensing. At the same time, construction crews continued work on the West Wing accommodation at Casey and the new accommodation and operations facilities at Wilkins aerodrome. By the end of the season the West Wing rooms were occupied, providing a greater number and far greater standard of accommodation for expeditioners.

A significant project at Casey this season was the cleanup of waste from the old Thala Valley tip site. This project was made possible through collaboration with the Chinese Antarctic program and some 1005 tonnes of contaminated soil was removed using their ship *Xue Long*.

The challenges of the season continued when one of our C212 aircraft was damaged in a hard landing at the Bunger Hills and subsequently deemed unserviceable. The effort to recover this aircraft was enormous and saw additional engineers flown in from Australia to assist. A Twin Otter was also chartered from Canada to make up the shortfall in fixed wing capability, providing search and rescue coverage for the remaining C212 and allowing our program to continue. The remaining C212 supported the transfer of a small number of people between Davis and Mawson and a wide-ranging treaty inspection program that visited stations in Terra Nova Bay, overflew Leningradskaya and delivered an inspection team to the Russian Vostok station (see story on page 26). The C212 at Bunger Hills was eventually retrieved to Casey skiway, with both C212s departing shortly thereafter for Australia.

3. Heritage carpenter Mike Staples works on the restoration of Biscoe Hut at Mawson.
4. Containers of waste from the Thala Valley tip site are loaded from the Casey wharf on to a barge, for transfer to the *Xue Long*.

At Davis our two squirrel helicopters transferred people between Davis and Mawson and supported a range of science projects and operational activities. Scientific work included penguin and marine ecology research projects, Geoscience Australia surveys, and some atmospheric physics projects, including installation and operation of a German iron LIDAR. Expeditioners also completed the new Davis living quarters and numerous other construction and maintenance projects. Davis hosted a number of visits by Chinese, Russian and Indian expeditioners from the Larsemann Hills and the Davis team evacuated a sick Chinese expeditioner from Dome A by Twin Otter aircraft.

At Mawson there were numerous flights of helicopters, C212, Twin Otter and even a German Basler attempting to reach Casey for a collaborative science project. The Béchervaise Island penguin research team spent the summer hard at work while two heritage carpenters continued the restoration of historic Biscoe Hut. The station also supported science projects from Geoscience Australia and atmospheric physics researchers.

In January a major marine science voyage departed Hobart on the *Aurora Australis* to investigate the Mertz Glacier area. This voyage was a significant and fascinating study of the marine ecosystem that remained after the huge tongue of the Mertz Glacier broke off (see story on page 1).

Airbus flights finally commenced in February, after a season where melt conditions continuously thwarted the efforts of the Wilkins runway construction crew to open the runway. To mitigate the impacts of Wilkins's closure Australian, Italian and French expeditioners flew by Airbus to McMurdo and then took C212 or Basler aircraft to Casey. The Airbus also flew numerous dedicated flights for the Italian and US programs in return for their support of our operations through McMurdo.

Last, but not least, on Macquarie Island expeditioners hosted 10 tourist ship visits over the summer and completed installation of a new facility to detect nuclear detonations, on behalf of the Australian Radiation Protection and Nuclear Safety Agency. Science projects on the island investigated the albatross and giant petrel populations, the island's fur seal population, terrestrial ecology and vegetation change, and bioremediation of fuel spills, to name just a few! A team was also busy testing baits and other measures in anticipation of the next eradication attempt of rabbits, rats and mice.

As I write this (in May) I am travelling on the *Aurora Australis* to Macquarie Island. Two weeks ago the *L'Astrolabe*, on charter to the Australian Antarctic Division, completed the cargo resupply of the station by LARC. Now we are establishing bait depots at Hurd Point, Green Gorge and the isthmus, along with a complete refuel of the station. Macquarie Island will remain very busy over winter with 43 people on station supporting, amongst other programs, the eradication project. This eradication will see over 200 tonnes of bait spread by four helicopters. The baiting will be followed up by ground hunting teams, including 12 dogs.

The 2010–11 season has thrown many challenges at the Australian Antarctic program and these have all been met with typical professionalism and problem solving by the whole team. It has been a productive season that has seen completion of infrastructure projects, a major environmental cleanup, wide use of international collaboration and the operation of numerous science projects and campaigns.

ROBB CLIFTON

Support and Coordination Manager, Australian Antarctic Division

IN BRIEF

Director retires

Australian Antarctic Division Director, Lyn Maddock, has announced her retirement, effective from mid-June 2011. A new Director is expected to begin in July. Lyn joined the Division in early 2009 and has overseen endorsement of the new 10-year Science Strategy, steps to replace Australia's icebreaker, *Aurora Australis*, Australia's contribution to the Antarctic Treaty Consultative Meetings and planning for the 2012 Australian Antarctic Expedition Centenary celebrations.

'I would like to thank everyone for giving me the chance to work with a great bunch of people, doing a great job for a great cause. I am proud to have been part of the effort,' Lyn said.

Hawke Fellow to sequence Antarctic krill genome

The inaugural R. J. L. Hawke Post Doctoral Fellowship in Antarctic Environmental Science has been awarded to geneticist Dr Bruce Deagle.

Dr Deagle will use modern genetic technologies to sequence the genome of Antarctic krill and examine gene expression and how this relates to temperature and ocean acidification.

'Developing a deeper understanding of this keystone species through modern genetic technologies will allow us to identify likely physiological responses of krill to future environmental changes in the Southern Ocean,' Dr Deagle said.

The first R. J. L. Hawke Post Doctoral Fellow, Dr Bruce Deagle, in his lab at the Australian Antarctic Division.

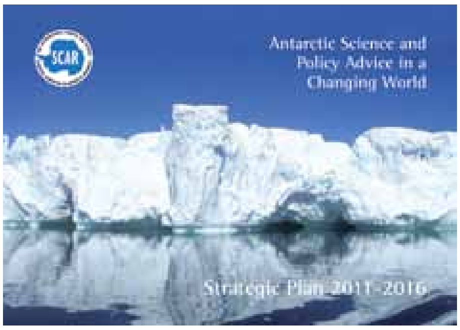
Dr Deagle moved from Canada to Australia in 2000 and undertook a PhD through the University of Tasmania and the Australian Antarctic Division, focusing on developing new molecular methods for studying the diet of wild animals using DNA found in their scats. He is considered a world leader in this field.

Dr Deagle has spent more than 10 years applying genetic technologies to research on many aspects of animal ecology, including the evolutionary biology of stickleback fish, the diet of Australian fur seals and age-related genetic signals in whales.

The $300 000, three-year Fellowship, which honours former Australian Prime Minister Bob Hawke's contribution to protecting Antarctica, aims to develop a new generation of scientists and build capability in Antarctic environmental science. Fellows will be based at the Australian Antarctic Division in Hobart.

New SCAR strategic plan 2011–2016

The Scientific Committee on Antarctic Research (SCAR) has released a new five-year strategic plan (2011-2016). SCAR's strategic vision is for a world where the science of the Antarctic region benefits all, excellence in science is valued and scientific knowledge informs policy. For details see www.scar.org/



Traversing Antarctica: the Australian Experience

The National Archives of Australia is developing a touring exhibition, *Traversing Antarctica: the Australian Experience*, to mark the 100th anniversary of the 1911–14 Australasian Antarctic Expedition led by Douglas Mawson. Opening at the Tasmanian Museum and Art Gallery on 2 December 2011, the exhibition will celebrate the enduring scientific, historic and social legacy of this landmark expedition and the unbroken connection that continues to the present day.

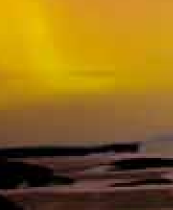
Developed in collaboration with the Australian Antarctic Division and several state museums and libraries, the exhibition is a journey of discovery through the stories, science and wonder of Antarctica's past, present and future. It will contain official government correspondence, maps, photographs, objects, film, digital media and sound that showcase Australia's role.

The exhibition will tour nationally until 2014. The tour will include a series of public programs by a range of experts from the Australian Antarctic Division that highlight Australia's role in the continuing scientific discovery in Antarctica. For more information about other Centenary celebrations visit http://centenary.antarctica.gov.au/

Flying visit boosts Australia's Antarctic relations

Australian Antarctic Division Director, Lyn Maddock, visited McMurdo and Scott bases in Antarctica in February, as part of an information-gathering and relationship-building exercise. She travelled from Christchurch to McMurdo on the New Zealand Airforce 757 aircraft and spent three days reviewing the scientific and logistic activities of the American and New Zealand bases.

During the trip, Lyn Maddock signed an updated Memorandum of Understanding for cooperation between the Australian and New Zealand Antarctic programs, along with Chief Executive of Antarctica New Zealand, Lou Sanson. (The NZ Minister of Conservation, the Hon. Kate Wilkinson, at centre of photo, looks on).



CHRIS WILSON

FREEZE FRAME

CHRIS WILSON worked at Casey, Davis and Mawson stations as the Australian Antarctic Division's Building Services Supervisor between 2006 and 2011.

It was a bitterly cold March morning at Mawson station when I looked out my bedroom window to discover a spectacular aurora behind one of the wind turbines. With the wind around 40 knots, I found a spot on the leeward side of the Wombat building and composed the image in the faint glow of a nearby light. I took a series of shots, but the strong colour contrast in this one drew my eye. I used a Canon 1Ds Mark III camera with a 17 mm TS-E lens. This image 'Blown Away' received a special mention in the 2011 Extreme Environment Photographic Competition.

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