AUSTRALIAN

ANTARCTIC

MAGAZINE

ISSUE 18 2010

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The Australian Antarctic Division, a Division of the Department of the Environment, Water, Heritage and the Arts, 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.

Australia's four Antarctic goals are:

- 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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Graphic Design: Clemenger Tasmania

ISSN 1445-1735 (print version)

Australian Antarctic Magazine is printed on 9lives 80 recycled paper, a certified FSC mixed source paper with 80% recycled fibre and 20% chlorine free pulp.

Australian Antarctic Magazine can be viewed online: www.antarctica.gov.au/magazine

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WENDY PYPER

ABOUT THE COVER

Marine scientist Dr Keith Martin-Smith took this stunning photo of an amphipod collected from the Tressler Bank off east Antarctica, during a marine science voyage early this year (see pages 1-3). The name *amphipoda* means 'different-footed' and refers to the different forms of their legs - they have seven pairs of walking legs, with the first four reaching forward, and the fifth to seventh reaching backwards. Amphipods range in size from 1 to 340 mm and live in all aquatic habitats and some moist terrestrial habitats (such as under pot plants in the garden).

SOUTHERN OCEAN MARINE LIFE IN FOCUS

Amphipods are ubiquitous inhabitants of Antarctic benthic communities, from shallow seas to abyssal depths. As they moult in order to grow, some species, such as this one, develop heavy armature as they get older. Photo by Dr Keith Martin-Smith

Between December and January this year I joined marine scientists aboard the *Aurora Australis* for a seven-week research and resupply voyage. The stories on pages 1-8 provide a glimpse into just some of the scientific work that was conducted. You can read more about the voyage at www.aad.gov.au/default.asp?casid=37258

For two days our iconic orange icebreaker, *Aurora Australis*, has been crunching a path through heavy pack ice. At an average speed of less than one knot, it's slow going even for this 4000-tonne veteran of Australia's Antarctic expeditions. But our destination – an unexplored region of the Southern Ocean known as Bruce Rise, about 230 nautical miles north-west of Casey station, on the east Antarctic coast – is a carrot to the 20 or so marine scientists on board.

We're here to conduct a collaborative project between government scientific agencies and the Australian fishing industry, which will contribute to sustainable fishing and conservation measures set by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR). This international body, established in 1980 as part of the Antarctic Treaty system, has the weighty task of managing all marine living resources, except whales and seals, between the Antarctic continent and the Antarctic Polar Front.

Principal Research Scientist with the Australian Antarctic Division Dr Andrew Constable and on-the-ground project manager Graeme Ewing say the project aims to assess the vulnerability of sea floor ('benthic') habitats and associated invertebrate communities ('benthos') to interactions with fishing gears. The major focus on this trip, however, is to establish a picture of the benthic environment in the region, by collecting samples of the marine creatures with a research trawl net, and video and still footage of their associated environment using trawl-mounted camera equipment.

A team of biologists and volunteers, led by Ty Hibberd and Kirrily Moore, is on standby to rotate on 12-hour shifts to identify and preserve invertebrates captured in net samples from the deep; between 500 and 1500 m below. Many of the biologists have been studying their field identification guides to benthic invertebrates in preparation for this task. Posters of the species we're likely to see – including sea stars, sponges, crustaceans and worms – have been pinned to the walls of the ship's 'wet lab', where the samples will be sorted.

A sudden quietness heralds our departure from the sea ice into open water. The camera team swings into action, lowering a trawl-mounted camera to gauge the complexity of the terrain and habitat and identify possible sample sites. They work closely with a team on the bridge, running the ship's acoustic echosounders to better define the depth of the area and identify any promising features, such as trenches or canyon heads that may support a diverse marine benthos.

The first pictures of the sea floor reveal a consistently flat and muddy 'paddock'. Further camera runs fail to find any of the biodiverse benthic habitats the scientists expected, other than a rock which, being the only bump around, has attracted a crowd of invertebrates. After three days of camera operations the scientists are surprised, but not in the way they expected.

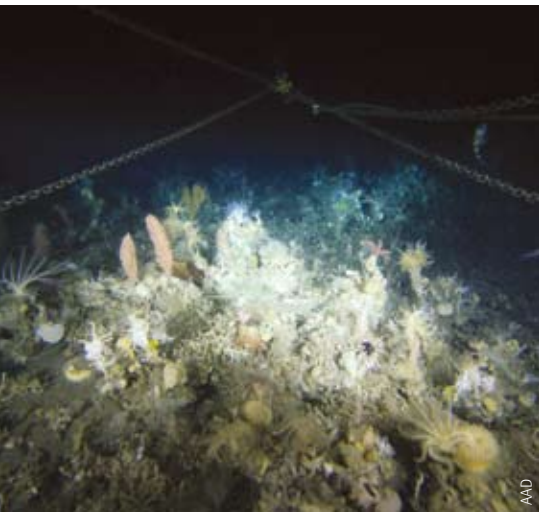
'The Bruce Rise habitat is not as we imagined,' Dr Constable says. 'It is a relatively muddy plateau, with animals like sea cucumbers and worms that are equipped to feed in muddy environments.'

Dr Constable and Mr Ewing decide to relocate the project to the Tressler Bank off the Shackleton Ice Shelf, which is known to have a range of geological features likely to harbour a richer benthos.

Unlike Bruce Rise, Tressler Bank offers up a biological bonanza. A sweep of the sea floor with the trawl-mounted cameras reveals a diverse range of terrain and habitats including a steep shelf break plunging from 400 m to 1200 m. Rocky outcrops on the slope of this shelf break host dense aggregations of habitat-forming invertebrates, such as sponges, corals and bryozoans.

I help sort some of the first tubs of 'creepy-crawlies' brought into the wet lab, picking out different species with forceps and putting them into individual containers filled with sea water for the biologists to classify, weigh and photograph. The work is back-breaking as we

Biologist Ty Hibberd (left) sorts invertebrates including feather stars and pencil urchins (foreground).



Still footage taken by a trawl-mounted camera at Tressler Bank showing the diversity of marine invertebrates on the sea floor, including feathery 'gorgonians' or soft corals (two orange feather-like structures at left of image), hydrocorals, feather stars (crinoids), brittle stars, sponges and pencil urchins.

jostle for space, hunched over long sinks, gently untangling long-armed brittle stars and feathery hydrozoans and sifting through shards of coral, shells and grit for hidden gems. While some invertebrates don't take kindly to being crushed by hundreds of kilograms of their compatriots, many are surprisingly resilient. Amphipods, for example, like the 'beach fleas' or 'sandhoppers' on the beach, have a tough and often ornate exoskeleton, which, along with their small size, allows them to weather the worst of conditions.

The wet lab hums with excitement as scientists discover species they're particularly interested in. With so many experts on board – including specialists in corals, isopods (sea slaters) and amphipods – it's impossible not to learn something. Sea spiders or 'pycnogonids', for example, are particularly large in Antarctica, possibly because of a lack of predators. Most of their vital organs are housed in their stilt-like legs, and they walk along the sea floor scavenging or preying on sponges, worms, corals, jellyfish and bryozoans. Under the microscope they have some particularly sharp looking pincers.

A few spectators wander in and ask if we've caught anything for tonight's dinner. Another wag pins his doggerel to the wet lab wall: 'Rhyme of the Ancient Marinator: Yeah slimy things did walk with legs upon the slimy sea...which, after a light basting with soy and lime and 10 min on a hot grill, crisp up beautifully and taste a treat.' Despite the light-hearted banter, every creature caught is treated with wonder and respect.

After five days of biological nirvana, the biologists have catalogued and photographed about 430 species. There could well be more, but detailed scrutiny of broadly classified animals will need to wait until we're back on dry and stable land. The specimens have been stored in thousands of jars of ethanol and formalin and will be returned to the Australian Antarctic Division's collection for genetic and taxonomic analysis, some of which will be undertaken by experts at the Australian Museum in Sydney, the Tasmanian Museum and Art Gallery, and the Institute for Marine and Antarctic Studies.

WENDY PYPER

Corporate Communications, Australian Antarctic Division

Antarctic Division scientist Dr Keith Martin-Smith took these images using a digital SLR camera with 60 mm and 105 mm macro lenses and flash kit. Specimens up to 30 cm could be photographed in a dish of seawater against a black backdrop.

1. *Nudibranch – This nudibranch (which means 'naked gills') is a soft-bodied marine mollusc. There are more than 3000 species of nudibranchs, which are renowned for being very colourful and attractive.*
2. *A shrimp – This female hump-backed shrimp has a brood of green eggs attached to swimmerettes beneath her abdomen.*
3. *Snake star - Snake stars, like their relatives the sea stars or 'star fish', have five arms radiating from a central disk. They have a tough endoskeleton made of calcium carbonate 'ossicles', and are often found wrapped around structures like branching corals as a snake may curl itself around a tree branch.*
4. *Giant sea spider – This giant sea spider or pycnogonid is about 30 cm in size.*

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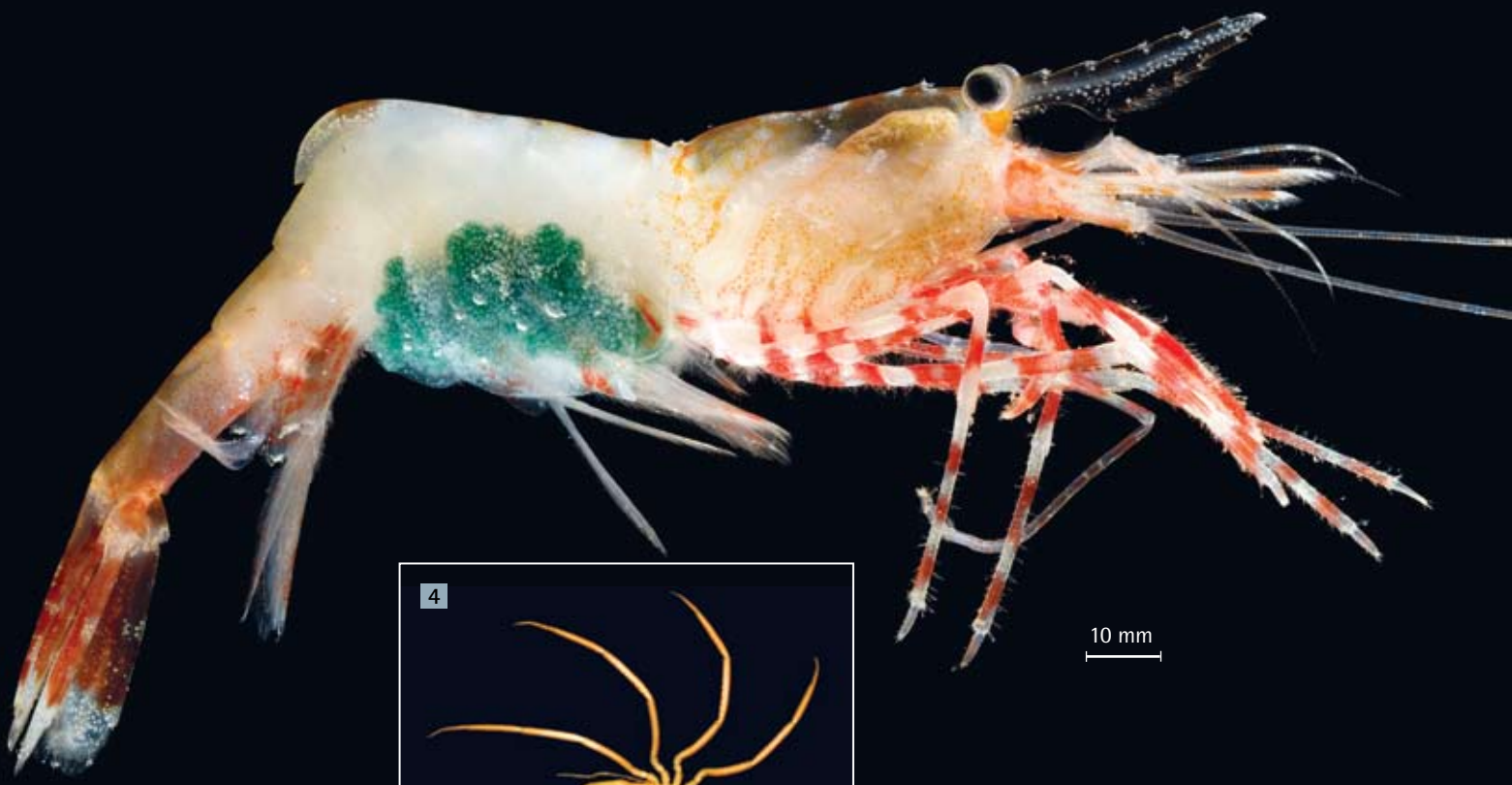

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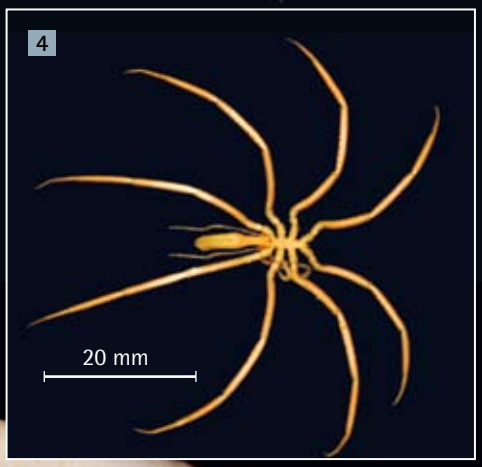

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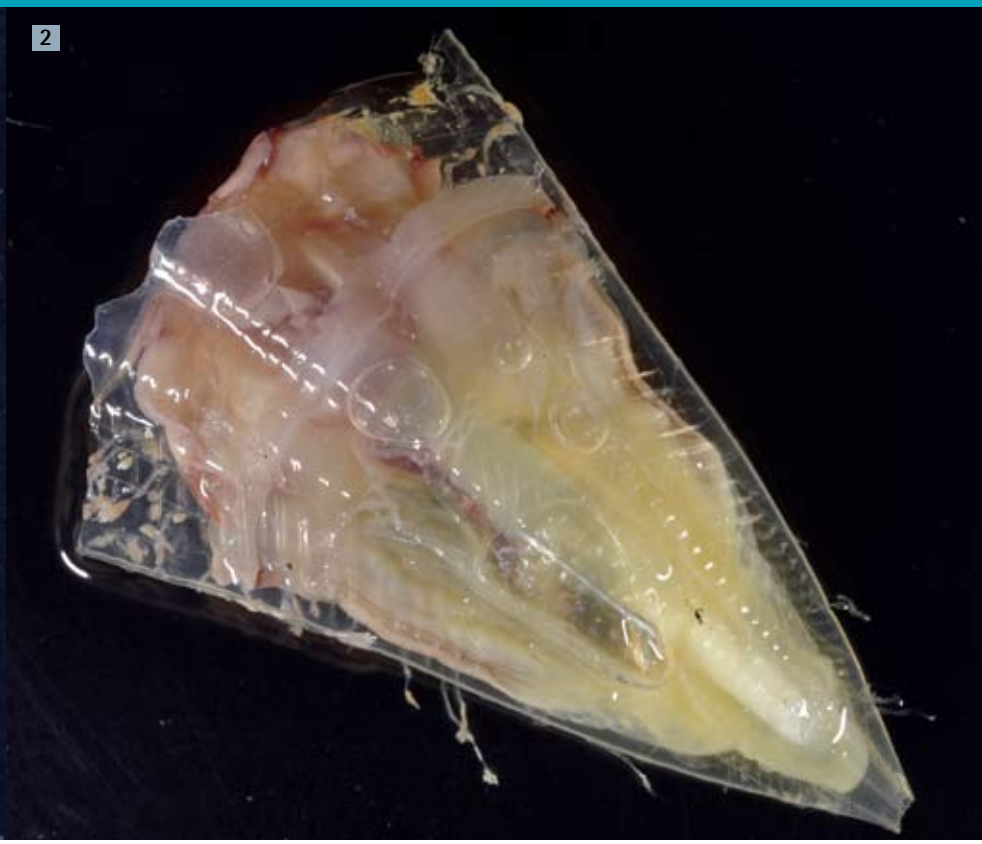

2

KEITH MARTIN-SMITH

Snails and 'snot' tell acid story

After only two days at sea, and while most people are still finding their sea legs, a team of scientists from the Antarctic Climate and Ecosystems Cooperative Research Centre (ACE CRC), University of Tasmania and Australian National University, has begun a relentless schedule of trawling for snails.

The team is researching the effects of ocean acidification on tiny marine snails, known as pteropods, and planktonic, single-celled, shell-forming organisms called foraminifera. Pteropods are an important food source for marine predators in the Antarctic food web and sometimes replace krill as the dominant zooplankton group in parts of the Southern Ocean. Foraminifera are prey for many small marine invertebrates and fish. Both organisms are indicators of changes in the ecosystem that could have profound implications for commercial fish species, seals and whales.

About 40% of man-made carbon dioxide is absorbed by the Southern Ocean and forms a weak acid (carbonic acid) when it mixes with water. This acid readily releases hydrogen ions, and as acidity is determined by the concentration of hydrogen ions (measured on the pH scale), the more acidic a solution, the more hydrogen ions are present and the lower the pH. Increasing hydrogen ions affect the ability of pteropods and foraminifera to form shells, resulting in thinner, lighter, and pitted or etched shells. As colder water absorbs more carbon dioxide than warmer water, the effects of ocean acidification will be seen first in the Southern Ocean. According to Dr John Baxter, a scientific adviser to government from the Scottish Natural Heritage who has joined 'Team Acid' on the ship, ocean acidity has increased by 30% (a pH change of 0.1) since the beginning of the Industrial Revolution and is already affecting shell-forming marine organisms. Observed effects include thinner shells, fewer pteropods in areas where they were previously common, and an increase in gelatinous organisms such as jellyfish and salps.

Team Acid is undertaking the first study of the effects of ocean acidification on pteropods and foraminifera in their natural environment (previous studies have been conducted in the laboratory or through modelling). ACE CRC pteropod biologist Dr Donna Roberts says the team wants to establish a baseline of the health of these organisms in the ocean now, so that they can detect changes in the future.

To do this they are deploying a 'rectangular midwater trawl' (RMT) – a pair of rectangular mesh nets – at different latitudes, from 47-54°S, along a line from Hobart to Casey. They hope to catch larger pteropods with a 4 mm mesh net, but the main species they're looking for is the tiny (0.5-1 mm) *Limacina helicina antarctica*, which will be caught in a 150 micron mesh net. The microscopic foraminifera will also be sieved from the water brought up in the trawl and preserved for later shell integrity analysis.

Team Acid will conduct eight trawls: four in subantarctic waters (45–49°S), three in polar waters (54–56°S) and one in the narrow channel of water where the subantarctic and polar waters meet (51°S). They expect to see a change in the shell weight, size and species of pteropods as we move further south into the colder and more acidified water, and hope to collect a good sample of the common *Limacina helicina antarctica*.

On the trawl deck the ship's crew winch the two RMTs into the heaving seas. Each net has a 'cod end' attached to it – cylindrical canisters to contain the sample. The nets remain closed until they reach the required depth, between 20 and 200 m below the surface, at which time the team can remotely open the net to collect the sample.

Up in a control room above the trawl deck, the team hovers around a pair of monitors displaying information about the temperature, depth, salinity and biomass as the nets descend. This information is relayed from a 'CTD' (conductivity,

temperature, depth) instrument attached to the nets, and the ship's acoustic echosounders, which can detect organisms in the water, such as swarms of krill or phytoplankton. When an area of high biomass is reached, dots and blobs appear on the screen and the team opens the nets up.

The team has chosen to sample between 20 and 200 m as this is the region where scientists think the pteropods construct their shells. This hypothesis is based on an analysis of pteropod shells collected in ocean sediment traps. These shells contained isotopes (different forms of molecules such as carbon and oxygen) typical of the water column at these depths.

Fifteen minutes after deployment, the RMTs are retrieved. Team Acid and its accompanying paparazzi crowd into the ship's 'wet lab' and begin bucketing and sieving through the samples. Both cod ends contain a glutinous mass of salps – 'another bucket of snot' as one crew member describes it – but this subantarctic sample also yields some surprises – about 12 large pteropods (*Clio recurva*) and six of the smaller *Limacina helicina antarctica*. A tiny squid, a large selection of amphipods (small crustaceans) and some translucent predatory worms called chaetognaths, also appear. The huge abundance of salps and other gelatinous creatures is typical of these waters. Some theories suggest an increase in salps is occurring, creating a 'jellyfish ocean'.

Dr Roberts is surprised at the catch, saying she expected more of the smaller pteropods and less of the larger ones. It will be interesting to see if this trend continues.

At the seventh RMT site at 54°S, Team Acid hits the jackpot. One large *Clio recurva* shell and a whopping six small *Clio pyramidata antarctica* shells are captured. Dr Roberts wears a huge grin as she preserves the impressive specimens in ethanol.

The final RMT goes in at 58°S – inside waters managed by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) – and pulls up an amazing array of species – a magnificent pelagic polychaete (worm), lots of amphipods, juvenile krill, ctenophores (small jellyfish-like creatures), two naked (shell-less) pteropods, small salps and some mysterious, gelatinous, eyeball-like spheres, which someone suggests could be fish eggs. The naked pteropods are particularly interesting. Scientific theory suggests that these may become the dominant pteropods in the ocean as ocean acidification increases.

When they return to Australia, team member Alex Pentony Vran, an engineer from the Australian National University, will examine the mechanical properties of the captured pteropod shells to provide definitive evidence that they are becoming more fragile. Previous work has focused on changes in shell weight and the use of optical microscopy to examine shell thickness. In contrast, Mr Pentony Vran will take the shells captured on this trip, apply force to them with an extremely fine diamond-tipped probe, and measure their response to this force. This will allow him to put a figure on how strong or weak the shells are.

The team has plenty of work ahead of them, but after five days of frenetic activity, they can now enjoy the voyage at a snail's pace.

WENDY PYPER
Corporate Communications,
Australian Antarctic Division


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KEITH MARTIN-SMITH


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1. Clio pyramidata antarctica.
2. Clio recurva.
3. Limacina helicina antarctica.
4. *Team Acid leader Dr Donna Roberts and engineer Alex Pentony Vran.*
5. *These jelly-like salps may increase as oceans become more acidic.*

WENDY PYPER

SCIENCE THROWN OVERBOARD

A trio of American research technicians assembled and deployed almost 13 kilometres of cable and instruments, to monitor the flow of Antarctic Bottom Water from the Mertz polynya.

Jeff Pietro, Brian Hogue and Daniel Bogorff, from the Woods Hole Oceanographic Institute (WHOI), based at Cape Cod on the east coast of the United States, are edgy. After a year of preparation the technical trio, dubbed 'Team America', are itching to deploy five oceanographic moorings from the trawl deck of the *Aurora Australis*. But after days of calm seas, the swell has picked up for the first scheduled mooring deployment, and the team must wait for conditions to be declared safe.

The team's work is part of a collaboration involving WHOI, CSIRO and the Antarctic Climate and Ecosystems Cooperative Research Centre (ACE CRC) to measure some of the outflow of dense (cold and salty) Antarctic Bottom Water produced in the Mertz polynya (near Dumont d'Urville). Recent work by the ACE CRC in the region has found that dense water near the sea floor is becoming fresher (less salty and less dense). This may be because of increased precipitation (rain, snow), a decrease in sea ice formation (sea ice formation increases the saltiness of water beneath the ice), or increased glacial melt in Antarctica. The five moorings will help scientists determine the cause.

The moorings will also measure the average currents over the Antarctic continental slope for the first time. Previous measurements from ships suggest that a strong, deep-reaching clockwise gyre fills the deep basin off the Antarctic territory and the moorings will test this hypothesis.

The moorings will be deployed at different depths in a line running from 62-65°S and 113°E. Each mooring is a different length – 4220 m, 3520 m, 2520 m, 1520 m, and 1020 m – and various instruments are attached at critical points along the wire to correspond to regions of the ocean profile the scientists want to study. The moorings are anchored to the sea floor by about two tonnes of steel, and the cable and instruments are suspended in a straight line above using a series of small floats every 500 m and one large, yellow, buoyant sphere at the top. The whole package sits almost 500 m below the ocean surface, lending it the name 'sub-surface mooring'.

Among the many gizmos attached to each mooring cable is a McLane Moored Profiler. This robot is programmed to move up and down its section of cable measuring current speed, temperature, conductivity and depth. In two years it will profile over 1 million metres of water.

Each mooring also has a number of stationary Vector Averaging Current Meters (VACM) – the workhorses of physical oceanography – which measure current speed and direction, temperature, and pressure. Every 30 minutes, these instruments record an average of their measurements over that time. Two moorings also have Acoustic Doppler Current Profilers that sit on the top buoy and profile the top 500 m of water.

Finally, Team America receives the call to proceed. Over six hours they, and the ship's crew, painstakingly assemble the first mooring in 500 m sections, beginning with the big yellow buoy at the top. Four kilometres of cable is gradually winched out, instruments and smaller buoys are attached, and the 500 m sections are lowered into the ocean.

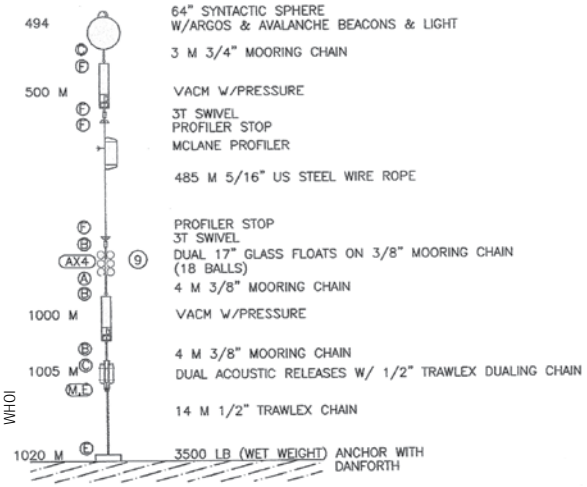
The ship moves slowly towards the final mooring position trailing a string of yellow buoys behind it. Once in place, the two-tonne anchor is attached to the final section of cable and the whole lot is released. The anchor sinks to the spot scientists have selected to study, dragging down the entire mooring in a straight line.

Over the next two days Team America and the crew repeat this procedure and successfully deploy all five moorings. In the sea ice zone the order of assembly is reversed, with the anchor going in first at the designated spot, and the top buoy last.

In two years time the team will return to collect the moorings, which each have an acoustic release at their base. An acoustic code will unlock the moorings from their anchors and the buoys will float each mooring to the surface, where they can be winched back to the ship.

Two months after the moorings were deployed the Mertz Glacier Tongue broke away from the Antarctic continent, after another massive iceberg crashed into it (see page 19). This may lead to changes in the polynya and in the volume, temperature and salinity of the dense water formed there. The US-Australian mooring experiment is perfectly timed to detect any changes in the deep ocean resulting from this unexpected change in the geography of Antarctica.

WENDY PYPER
Corporate Communications, Australian Antarctic Division



Main photo: A giant yellow buoy is deployed from the ship's trawl deck.

Left: This diagram of the shortest mooring shows the large buoy on top, the Vector Averaging Current Meters (VACM), the McLane Moored Profiler, which moves up and down its section of cable, a cluster of small floats at 500 m, and an acoustic release just above the anchor. Each of these components was attached individually as the mooring was fed out the back of the ship.

Above left: The Vector Averaging Current Meters awaiting deployment. These instruments average the continuous current speed, temperature and pressure every 30 minutes.

Above right: The McLane Moored Profiler measures current velocity, conductivity and temperature at programmed depths. This instrument alone costs US$70 000.

Below: Team America –Jeff, Bryan and Daniel – from the Woods Hole Oceanographic Institute. WHOI is the largest non-profit, marine education institution in the world and is famous for its deep-sea submersible, Alvin, used to discover the wreck of the Titanic.

ANTARCTICA – a catalyst for science communication

KEVIN MAY

One of the hardest things about visiting Antarctica is answering the inevitable question when you return: 'what's it like?'

I'm still grappling with how best to describe it, after travelling on the *Aurora Australis* to Casey and Davis stations at the invitation of the Australian Antarctic Division earlier this year. I've been reliving it for months in my role as producer for the ABC television science show, *Catalyst*, as I log the mountain of tapes, write scripts, edit the stories, and watch them go to air.

To my mind, Antarctica is the closest I can come to experiencing another planet without actually leaving this one. And not just because of the hostile climate and the alien landscapes. Getting there and back is like a journey into space – after weeks of transit time in a custom-made vessel, you've got only a few hours on the ground, where you can't survive without striking heroic poses in a special suit and over-sized boots.

The people and places involved in Antarctic research make this grand enterprise a science journalist's dream. In our two-person crew, Kevin May was cameraman and I was reporter, producer and sound recordist. Our mission was to bring back four science stories for *Catalyst*, dead or alive.

We achieved our aim, and more. When making science programs for ABC-TV, the phrase I dread – and hear all too often – is 'you should have been here last week!' The beauty of being on a scientific research vessel is that there's no chance of missing the action. In the case of the benthic sampling project (page 1), that meant 50 people working 12-hour shifts around the clock for 10 days, while the ship's crew manhandled the beam trawl off the stern and 'flew' it at just the right depth along the seabed to bring back samples. The twenty 40-minute tapes we shot, many of them on the trawl deck, became 11 minutes of sparkling science TV called 'Trawl Team'.

With most of our time spent at sea, it's no surprise that two of our stories were about Southern Ocean biology and the impacts of climate change on its ecosystems. Another was on the use of the lidar at Davis to scan clouds at the edge of space. Because of the six-hour time difference between the ship and Davis in a short stop-over, we didn't get to shoot that one until 3am our time!

Yet another story was about satellite tagging emperor penguins to track their movements. This is where the rule about working with children and animals comes into play – especially migratory birds. The scenery at the Amanda Bay breeding colony (near Davis) was spectacular; our interview with the scientist was animated; but the sea ice was rotten and the penguins had wisely moved on. The challenge was to use their absence constructively for a story about where 'Happy Feet' disappears to, rather than see it as a setback.

While we were welcomed as part of the expedition, Kevin and I were conscious that our need to shoot as much as possible on land was secondary to the essential tasks of the voyage, namely resupply. We were amazed at the willingness of station leaders and others to assist us, in the midst of organised mayhem, whether piping fuel ashore or assisting an international rescue effort for an injured expeditioner.

A request to get a little closer to the local Adélie penguins resulted in a zodiac trip around Newcomb Bay (Casey), out to one of the large breeding colonies at Shirley Island. A C-212 flight preparing for the whale survey offered to fit us in, and strapped in Kev with the back ramp open as we flew over pack ice. A helicopter flight over the Sørsdal and Chaos glaciers gave us amazing footage of iridescent blue pools of glacial melt cascading into crevasses. Thanks to the stations and the crew of the *Aurora Australis*, these were but a few of many experiences of a lifetime, providing images that will be used by the ABC for years to come.

See the *Catalyst* special on Antarctica and extended interviews with scientists at www.abc.net.au/catalyst/antarctica/

MARK HORSTMAN
Science Reporter and Producer, Catalyst

Above: Mark at the Shirley Island Adélie penguin breeding colony.

Below: Mark and Kevin at work filming a marine science story.

WENDY PYPER

ANTHONY HULL

First non-lethal whale study answers big questions

The first non-lethal whale research expedition to Antarctic waters has collected vital information for the conservation and management of Southern Ocean whale populations.

Between February and March this year, the six week Australia-New Zealand-led expedition used skin biopsy, photography, satellite tagging, and passive and active acoustics to study the population structure, distribution, movement, feeding and ecological role of Southern Ocean whales. The expedition was the first project conducted under the banner of the Southern Ocean Research Partnership (SORP), which was formed in March 2009 and involves 12 countries.

'The partnership aims to provide the results of non-lethal research to the International Whaling Commission as a scientific basis for sound conservation and management of Southern Ocean whales,' said expedition leader Dr Nick Gales, of the Australian Antarctic Division.

Working from two small boats (supported by New Zealand's research vessel *Tangaroa*) the research team collected 64 skin biopsy samples and 61 individual tail fluke photographs from humpback whales. They also satellite tagged 30 humpback whales in their Southern Ocean feeding grounds. By deploying 110 sonobuoys (passive 'listening' devices), they recorded sounds from blue, humpback, minke, fin and sperm whales and an unidentified beaked whale and tracked the movements of blue whales for 36 hours.

'This is the first time small boats have been used to work with whales on the high seas in the challenging Antarctic environment, but they proved highly successful, despite the generally poor weather experienced during the trip,' Dr Gales said.

Individual or pods of whales were sighted 326 times, accounting for at least 624 animals from eight species. Blue whales proved elusive, however, despite acoustic detection of their presence. Humpback whales were the most commonly sighted species, particularly around the Balleny Islands.

'On occasions when whales were sighted in good weather, the small boats were launched,' Dr Gales said.

'The sightings surveys will contribute to one of the major SORP projects investigating the distribution and mixing of Southern Hemisphere humpback whale populations around Antarctica.'

The satellite tagging team approaches a humpback whale.

The satellite tagging results will also feed into this project by providing information on the medium-scale movement of humpbacks in their Antarctic feeding grounds, and links between their Antarctic feeding grounds and their tropical breeding grounds. While the team tagged 30 humpback whales, the failure of a newly designed tag meant that fewer tags than expected succeeded in transmitting daily whale locations. These should continue to transmit for at least several months.

'The working tags will provide valuable data on the foraging behaviour of these animals, and we hope to be able to establish migratory routes between the Balleny Islands region and the tropical humpback whale breeding grounds,' Dr Gales said.

Photo-identification will also help build the distribution and mixing picture.

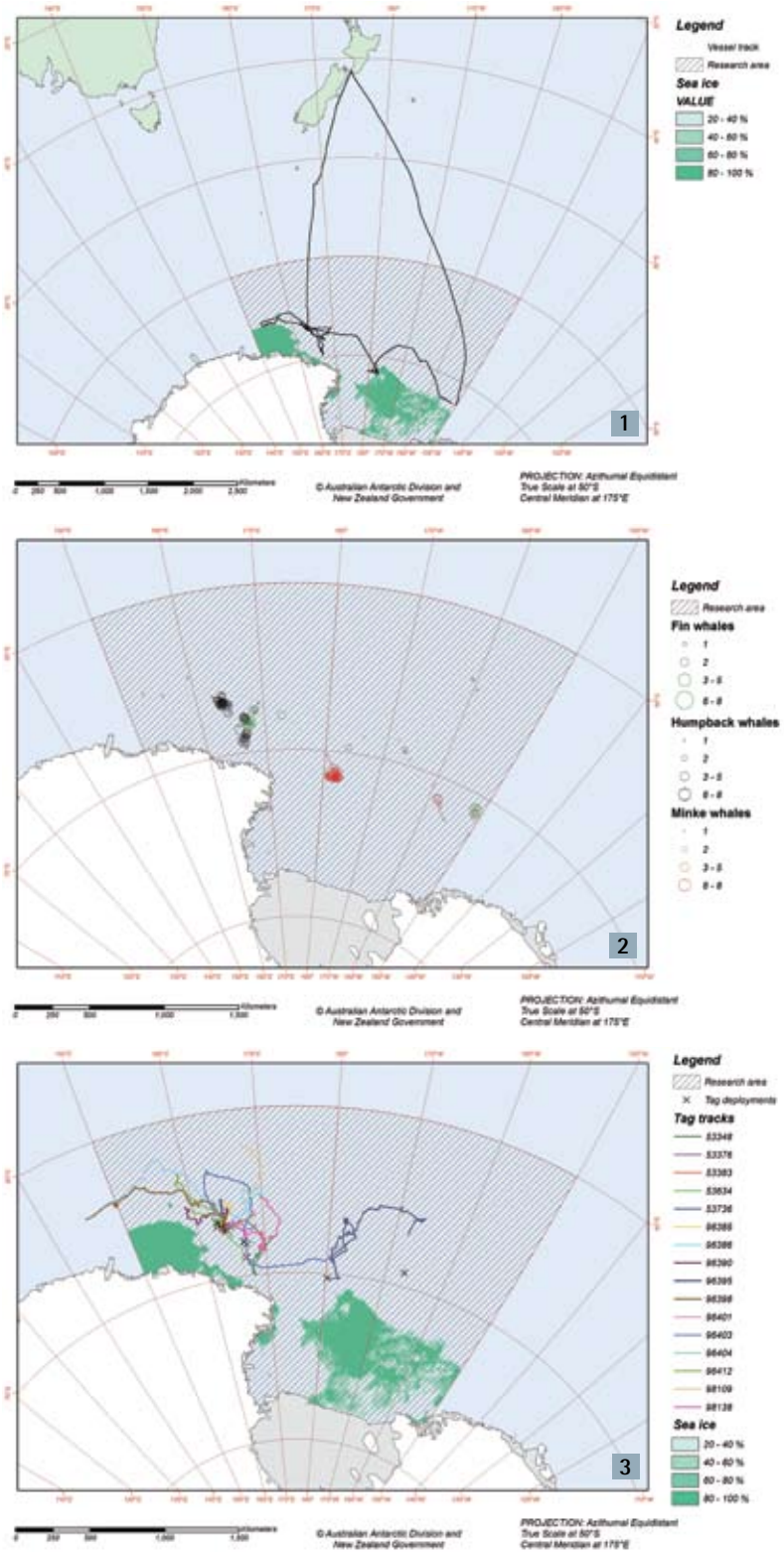
'Matching tail fluke photos taken in the feeding grounds on this expedition, with those taken on breeding grounds by others, will contribute to our understanding of the mixing between breeding populations on common feeding grounds in Antarctica,' Dr Gales said.

To complete the picture, genetic analysis of the skin biopsy samples from 64 humpback whales will give scientists an insight into, among other things, the population structure in Antarctic waters, and the sex composition of whales in Antarctica compared to those migrating along the East Australian coast. The team will also use genetic techniques to study age-related gene expression, which could lead to a simple, non-lethal ageing method for baleen whales.

Passive acoustic sonobuoys were deployed to identify the sounds produced by whales in the study region and compare them to sounds recorded in other regions of the Southern Ocean. Preliminary analysis of the results has shown that blue whales were the most commonly recorded species and their sounds were similar to those recorded from blue whales at other Antarctic sites. In contrast, humpback whales were rarely recorded, but their limited recordings were intriguing.

'We did record a humpback whale song with the repetition of distinct stereotypic phrases,' Dr Gales said.

'As far as we know, this is the first instance where structured song-like sounds have been recorded from humpback whales on their Southern Ocean feeding grounds. Previously, it was thought that humpback whales only sang during their migration to and from, and while on their breeding grounds.'



The team also recorded a repetitive vocalisation in an aggregation of minke whales, revealing the likely source of a mystery sound.

'Repetitive song-like sounds have been recorded in long-term Southern Ocean acoustic datasets, but the source of the "song" has never been identified,' Dr Gales said.

'The bearing to this sound from the sonobuoy was in the same direction that whales were sighted, supporting the likelihood that minke whales are the source of this "song"'.

To learn more about the diet of whales, active acoustic instruments (ship-based 'echosounders'), which emit 'pinging' sounds into the water and listen for the returning echo, were used to detect aggregations of krill and small fish in humpback feeding areas. Dense schools of krill – the largest of which was about one kilometre across – were usually found around whale aggregations. Schools of what are thought to be Antarctic silverfish (*Pleurogramma antarctica*) were also detected around the Balleny Islands. Samples of krill, phytoplankton and small invertebrates (such as salps, amphipods and squid larvae) were collected and their carbon and nitrogen signatures will be compared to those found in the whales' skin biopsy samples to identify the whales' prey and feeding locations.

Dr Gales said the results of the Antarctic whale expedtion will be reported to the International Whaling Commission and shared with other members of the Southern Ocean Research Partnership.

WENDY PYPER
Corporate Communications, Australian Antarctic Division

1. *The whale expedition voyage track. The expedition departed Wellington, New Zealand, on 2 February and returned 15 March, 2010.*
2. *The distribution of large baleen whale sightings during the voyage.*
3. *Satellite tag tracks of the whales as of 3 May, 2010.*

Journal focuses on Antarctic research

One of the most comprehensive ecosystem surveys ever conducted in the Southern Ocean is the focus of a special issue of *Deep Sea Research Part II: Topical Studies in Oceanography* published in May.

The Baseline Research on Oceanography, Krill and the Environment-West (BROKE-West) survey, undertaken by Australian Antarctic program scientists in 2006, surveyed over 1.5 million km² of ocean off the East Antarctic coast (between 30° and 80° east). During the 10-week voyage, scientists examined everything from ocean circulation, temperature and chemistry, to microbial communities, phytoplankton, krill and fish, as well as whales and seabirds. The main focus, however, was on the distribution and abundance of Antarctic krill, to provide information to the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) to help manage an expanding krill fishery (*Australian Antarctic Magazine* 8: 12, 2005).

The volume, edited by Steve Nicol of the Australian Antarctic Division and Klaus Meiners of the Antarctic Climate and Ecosystems Cooperative Research Centre, contains 20 scientific papers that detail the results of the survey. These include:

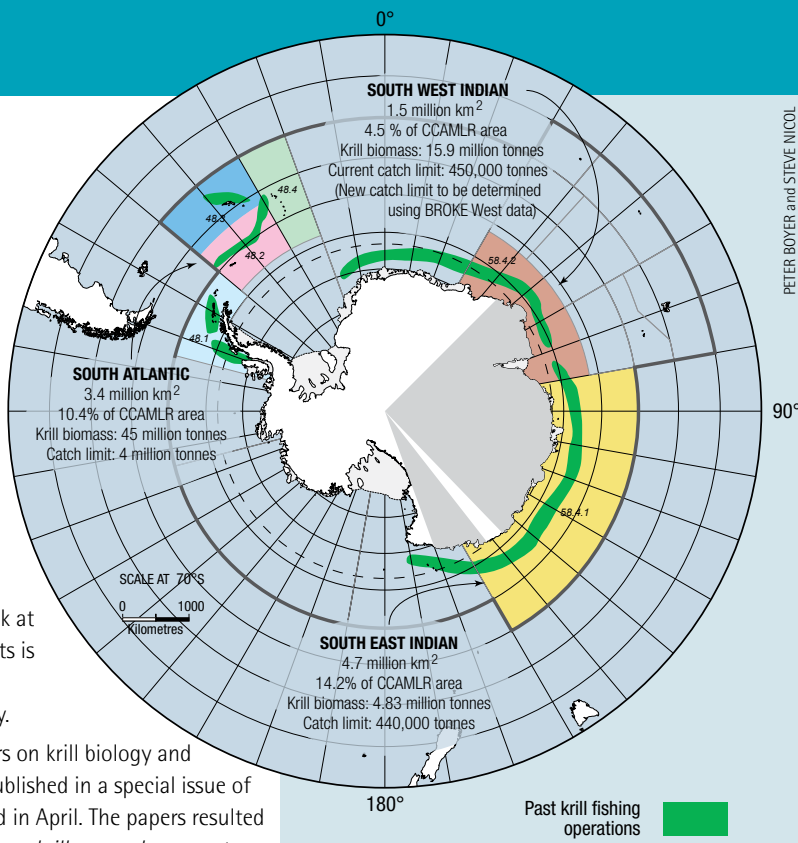
- demonstrating that krill and their predators were abundant throughout the survey area;
- observing an increase in temperature and salinity in bottom waters in the eastern sector of the study area;
- identifying potential sources of Antarctic Bottom Water;
- identifying pathways of carbon dioxide uptake and release by the ocean;
- observing algal blooms under the sea ice and near the ice edge that are controlled by iron concentrations.

A more detailed look at some of these results is presented in the accompanying story.

A series of 17 papers on krill biology and ecology was also published in a special issue of the journal, released in April. The papers resulted from the *Workshop on krill research: current status and its future*, held in Japan in 2007. Co-editor of the volume, Australian Antarctic Division krill biologist Dr So Kawaguchi, says the research discussed in the papers includes:

- studying krill at multiple spatial and temporal scales;
- studying swarm structure using the latest acoustic techniques;
- modelling approaches used to describe variability in the krill system;
- distribution, biology and ecology of krill species, from the Southern Ocean to the tropics;
- krill ageing, growth and behaviour.

Deep-Sea Research Part II publishes topical issues from the many international and interdisciplinary projects that are undertaken in oceanography, as well as collections of papers presented at conferences.



Above: In 2006 the BROKE-West survey covered a region of the Southern Ocean designated as CCAMLR Division 58.4.2 (orange sector). The survey estimated krill biomass in the sector to assist CCAMLR to set precautionary catch limits for the krill fishery. Ten years earlier, a BROKE survey had conducted similar work in the adjacent CCAMLR Division 58.4.1 (yellow sector). BROKE-West also studied oceanographic and biological processes to build a comprehensive picture of the ecosystem.

Below left: Dr So Kawaguchi with jars of krill collected in the Southern Ocean.

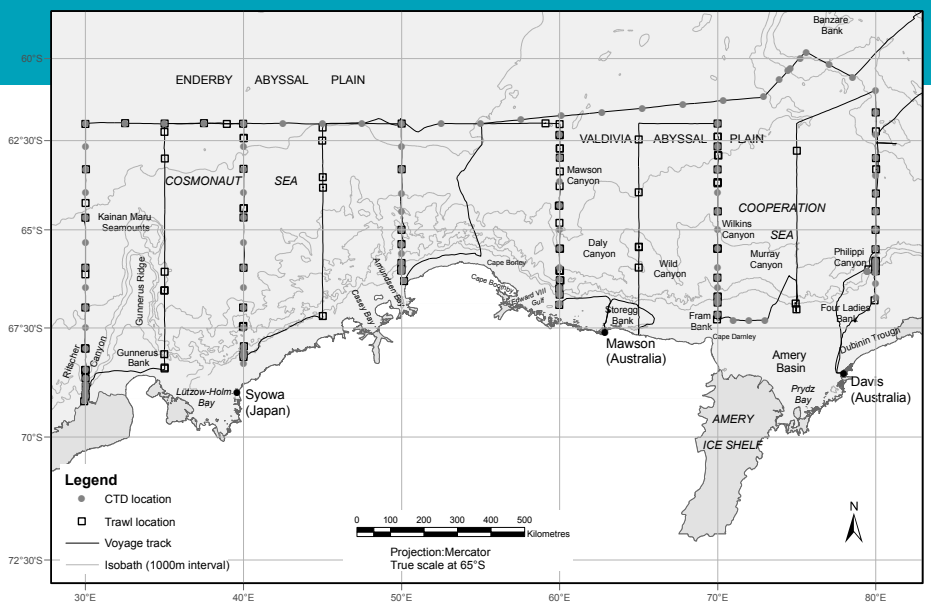

AAD

BROKE–West breaks ground in marine research

A comprehensive survey of the South West Indian Ocean off the East Antarctic coast has shown it to be a region rich in marine life and the site of important oceanographic processes.

The Antarctic coastline east of Mawson station has rarely been visited by Australian research vessels, and the ecosystems of this region have never been comprehensively documented. The main aim of the Baseline Research on Oceanography, Krill and the Environment-West (BROKE-West) was to characterise these ecosystems and establish an accurate estimate of krill distribution and abundance in the South West Indian Ocean (see map). This would allow the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) to calculate precautionary catch limits for the krill fishery in the area. The survey was also designed to study the region's oceanography (as part of the Antarctic Climate and Ecosystems Cooperative Research Centre's climate research program), and to examine the links between biological production and ocean processes.

Using acoustic instruments (which emit 'pinging' sounds into the water and listen for the returning echo as the sound bounces off krill swarms) we found that the distribution of krill in the region is



DAVID SMITH, AADC

more widespread than in other areas of East Antarctica. We also found that there may be a coastal krill population (as there is elsewhere) and an oceanic population. The distribution of these populations can be related to the location of oceanic boundaries (fronts) and to the underlying current systems. There seems to be larger amounts of krill in this region compared to the area to the east (CCAMLR sector 58.4.1 on map), which was studied in the original 'BROKE' survey in 1996. However, the density of krill is not as high as that found in the South Atlantic, where larger populations of seals and seabirds are found and where the krill fishery has concentrated in recent years.

From the results of the acoustic survey we provided an estimated krill biomass figure of 28.75 million tonnes to CCAMLR in 2007. A precautionary catch limit of 2.645 million tonnes per year was subsequently set – an increase from 450 000 tonnes set in 1992 using data collected in the early 1980s. This increase reflects the improved equipment and methodologies available nowadays, rather than an increase in the size of the krill population.

The oceanographic component of BROKE-West had a number of aims. These included describing the three-dimensional ocean circulation, estimating the exchange of water between the Australian-Antarctic Basin and the Weddell-Enderby Land basin, and examining the formation of Antarctic Bottom Water. To do this we deployed 118 casts of the 'CTD' sampling package to measure, among other things, conductivity (related to salinity), temperature, depth, current speed, oxygen and carbon dioxide.

The work confirmed the presence of a significant source of Antarctic Bottom Water in the region between 60 and 70°E. These waters are so named because they fill the abyssal ocean around Antarctica and are the densest waters (because they are cold and salty) found on earth. They play the important role of carrying oxygen-rich waters to the abyss and are drivers of the global deep ocean circulation. There are very few such sources, so the confirmation of a source in this area is highly significant.

Comparison of the BROKE-West oceanographic data with historical data showed that deep waters in the eastern sector of the survey area are becoming warmer and saltier. However, the western-most part of the survey area is unchanged. This finding is intriguingly different from results found elsewhere off East Antarctica and will require further analysis and interpretation.

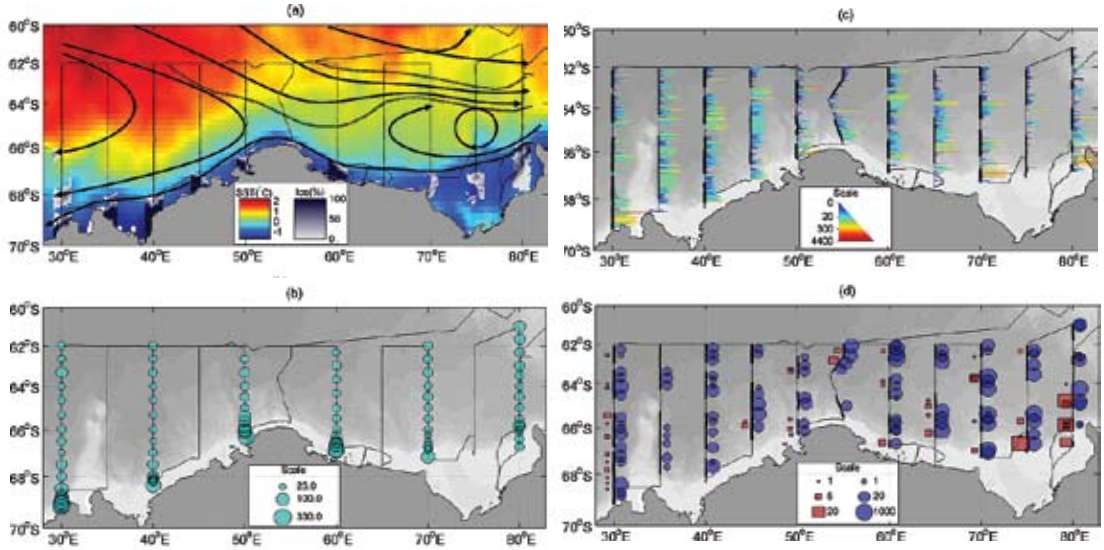
The vast array of BROKE-West data also allowed us to examine the relationship between oceanography and ecosystem productivity in the region, and to investigate the storage of anthropogenic carbon dioxide and pathways of carbon dioxide uptake.

We found that the highest phytoplankton production in summer occurs along the coast. Phytoplankton blooms broadly followed the surface ocean currents and polar frontal zones – where cold, northward-flowing Antarctic waters meet and mix with the warmer subantarctic waters. There is much lower productivity in the more northern waters of the survey area, despite what appear to be favourable conditions – good light and nutrients. This is possibly because of the lack of iron in the water, coupled with heavy grazing by krill and other herbivorous animals.

We also found areas of ocean where deep water is being drawn towards the ocean surface by the winds and releasing carbon dioxide to the atmosphere. In contrast, near the coast, carbon dioxide is being absorbed by the ocean. This correlates well with phytoplankton growth and other biological production near the coast, which utilises carbon dioxide.

The special volume of *Deep Sea Research Part II: Topical Studies in Oceanography* published in May (see related story page 11) contains the first analysis of the data we collected on the distribution and abundance of all parts of the marine ecosystem – viruses, bacteria, phytoplankton, protozoa, zooplankton, krill, fish, squid, seabirds and whales. The next step will be to create a single dataset that combines the results from the geographically adjacent BROKE and BROKE-West surveys, to produce an overview of the ecosystems off the entire coastline of East Antarctica. There are few such comprehensive datasets for the Southern Ocean so these voyages will leave a legacy that will, hopefully, be the object of study for many years to come.

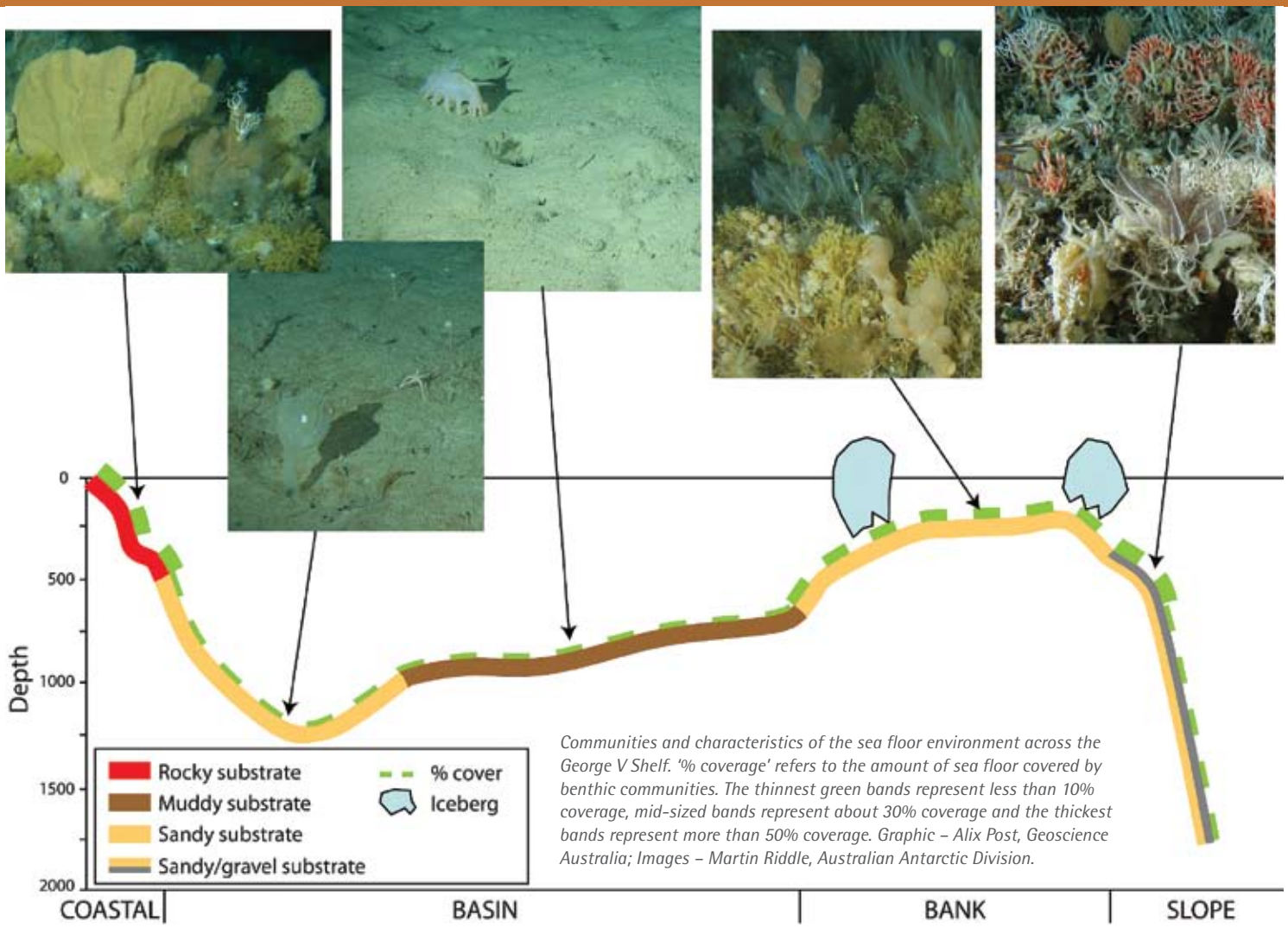
STEVE NICOL
Program Leader, Southern Ocean Ecosystems, Australian Antarctic Division



BEN RAYMOND, AADC

Above: The BROKE-West survey region of CCAMLR Division 58.4.2, between 30 and 80°E.

Left: The top image (a) shows the mean February sea surface temperature, sea ice concentration, large scale ocean circulation (solid arrows) and the Antarctic Circumpolar Current front (lower dotted line) and its southern boundary (upper dotted line). Image (b) shows the chlorophyll-a concentration in mg/m² (related to phytoplankton productivity) from 0–150 m depth. Image (c) shows krill density from 0–250 m depth in g/m². (d) shows the number of baleen whales per sighting (red squares) and number of seabirds per three-hour observation (blue circles).



Communities and characteristics of the sea floor environment across the George V Shelf. '% coverage' refers to the amount of sea floor covered by benthic communities. The thinnest green bands represent less than 10% coverage, mid-sized bands represent about 30% coverage and the thickest bands represent more than 50% coverage. Graphic – Alix Post, Geoscience Australia; Images – Martin Riddle, Australian Antarctic Division.

SHEDDING LIGHT ON THE SEA FLOOR

In 2007–08 scientists from Australia, Japan and France set out to survey the marine life and habitats in the region adjacent to Terre Adélie and George V Land in East Antarctica (*Australian Antarctic Magazine* 14: 2-13, 2008). The Collaborative East Antarctic Marine Census (CEAMARC) – part of Australia's contribution to the International Polar Year – aimed to understand the processes that have lead to the evolution and survival of marine life existing in the region today, so that scientists can predict how these organisms may respond to future climate-related changes in their environment. Scientists involved in the census are now finalising the collation and analysis of data and the following pages (13-18) provide an insight into some of the results. The team aims to publish its findings as a series of papers in a special volume of a scientific journal in late 2010.

A vast proportion of life that dwells on the sea floor has never been seen by human eyes. This is a fascinating problem for marine scientists, but concerning for the marine managers who need to know what is living on the sea floor, and where it is located, so that communities which are unique or vulnerable to human activities can be protected.

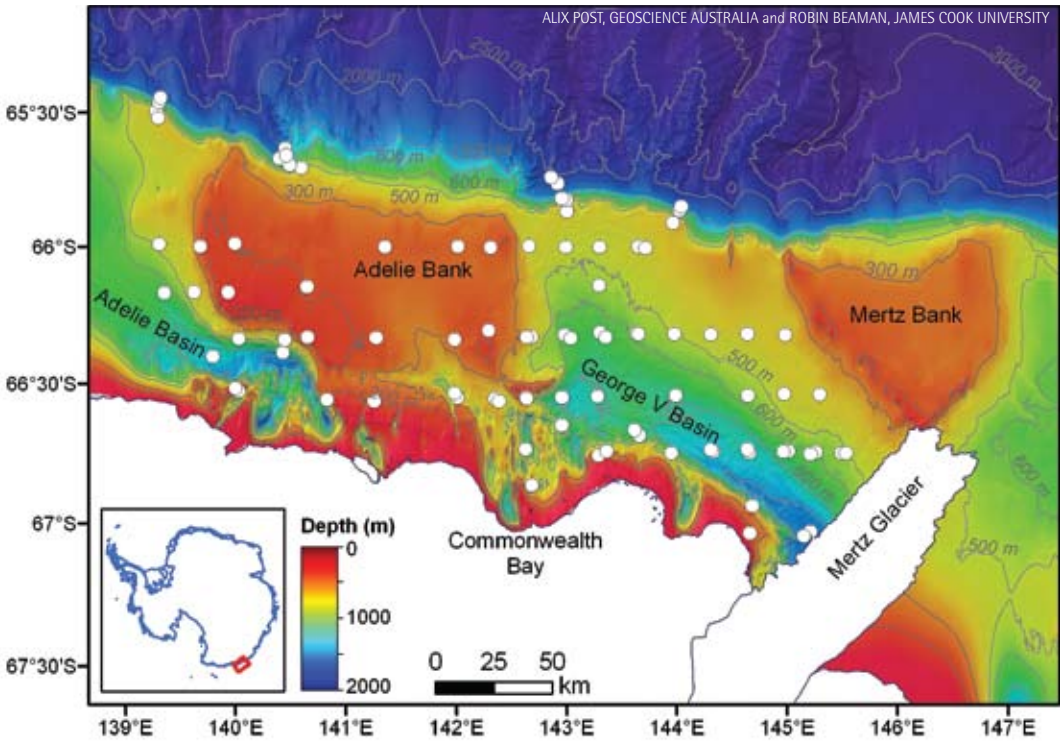
Scientists working aboard the *Aurora Australis* during the 2007–08 Collaborative East Antarctic Marine Census voyage were determined to unlock the secrets of these 'benthic' (sea floor) communities in the George V Shelf region off East Antarctica. Using underwater video and still cameras, we collected 15 hours of video footage and 1800 still images of benthic animals living at depths ranging from 140 m to more than 2000 m. This imagery revealed a vast array of organisms and communities, including deep-sea corals, which are so unique and fragile that they were immediately protected as 'Vulnerable Marine Ecosystems' by the Commission for the Conservation of Antarctic Marine Living Resources (*Australian Antarctic Magazine* 15: 19, 2008). We have since viewed and interpreted all of the footage to work out where different organisms live, and why they live there.

To do this we recorded the types of animals we could see in the footage and characteristics of the physical environment, such as the nature of the sea floor sediments (mud, sand, gravel, pebbles, cobbles, boulders), the sea floor relief (flat, low, moderate, high), and sea floor features such as iceberg scours, ridges and ripples. This process allowed us to build up a picture of what is living on the sea floor and the types of environments the animals live in.

A detailed bathymetry (depth) model and the sediment samples collected during the voyage also helped us to understand how the benthic communities related to the different environments within the study area. These datasets reveal that the George V Shelf is far more complex and rugged than was previously thought. The expansion and flow of ice streams across the George V Shelf during past glaciations has created deep glacial basins extending to 1200 m. Shallow (200–250 m) outer shelf banks mark the edges of the expanded ice streams, and rugged nearshore depressions were created by the advance of smaller glaciers (below). The deep glacial basins have since been draped with thick, muddy sediments. The shallow banks, in contrast, are prone to erosion and iceberg scouring and generally have only a thin cover of sandy sediments.

The differences in depth and sediment type between the basins and banks creates distinct environments for the sea floor animals. We found that benthic communities varied according to water depth, the type of sediment and the sea floor relief. The deep basins with their thick sediments, for example, have high numbers of mobile animals that forage in the sediments for food, while the shallow banks have high numbers of stationary animals that attach to the hard substrates commonly found there (figure on page 13).

So far, this analysis has revealed the way in which sea bed communities are governed by environmental properties, but these communities represent only one layer of this marine ecosystem. Australian, Japanese and French researchers are currently analysing samples collected from the sea surface and the water column to look at the distribution of 'pelagic' communities. Our aim is to combine these datasets to gain an understanding of the entire marine ecosystem, from the sea surface to the sea floor, and to start to explore how the ecosystem as a whole responds to environmental conditions. By understanding where different communities in this ecosystem occur and the interactions between them, we will be able to better protect the biota on this Antarctic shelf.



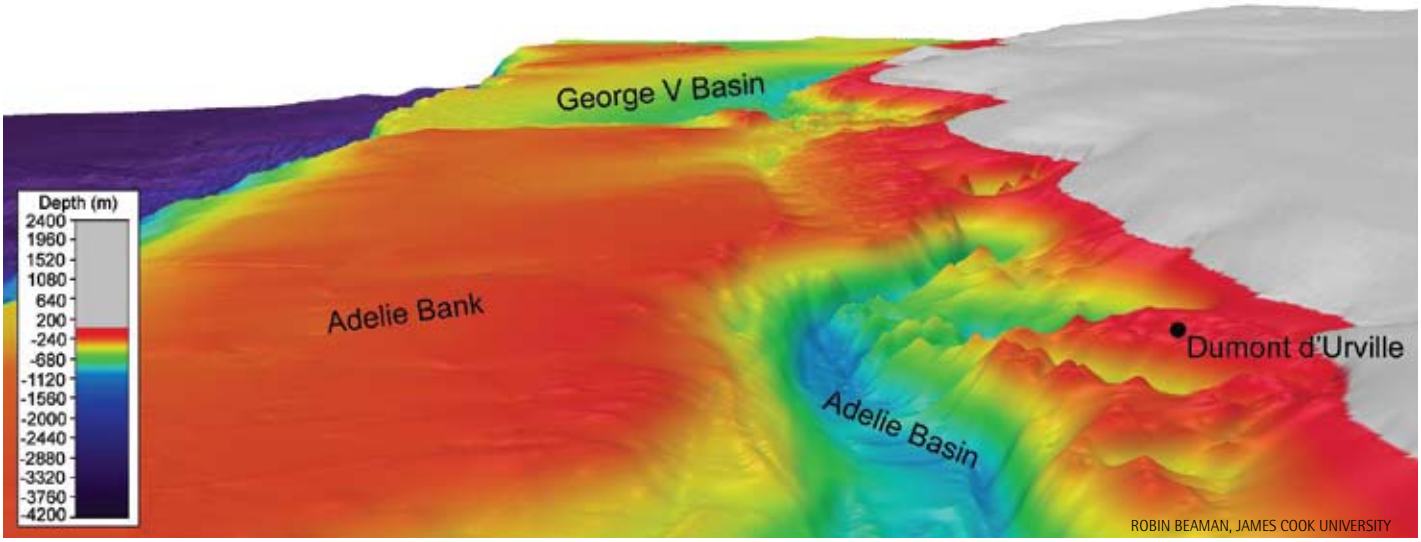
ALIX POST[1], ROBIN BEAMAN[2] and MARTIN RIDDLE[3]
[1]Geoscience Australia, [2] James Cook University, [3]Australian Antarctic Division

More information

A.L. Post, P.E. O'Brien, R.J. Beaman et al. Physical controls on deep water coral communities on the George V Land slope, East Antarctica. *Antarctic Science* (in press) http://journals.cambridge.org/repo_A74VLUIs

Above: Map of sampling locations. White dots show the location of underwater video and still image transects.

Below: Oblique view across the George V Shelf through the deep Adélie Basin, across the rugged nearshore depressions and shallow Adélie Bank. The Adélie Basin is one of the deep basins carved out by ice streams during previous glaciations.



PLANKTON IN THE SPOTLIGHT

A system of oceanographic profiling instruments and high definition video is allowing scientists to study fragile, planktonic organisms that are often destroyed by traditional sampling methods.

Flashing its strobes at 15 times per second, the autonomous visual plankton recorder (AVPR) is lowered from the deck of the *Umitaka Maru* and into the freezing waters below. Upon its return to the surface from depths of up to 1000 m, scientists will see for the first time images of living plankton, of the particles of organic matter upon which they may feed (marine snow), and who knows what else. This recently developed, state-of-the-art machine has been brought from the Japan Agency for Marine-Earth Science and Technology (JAMSTEC) and installed into a stainless steel frame, along with sensors to measure conductivity (salinity), temperature, depth, dissolved oxygen, turbidity, transmissivity and fluorescence (chlorophyll concentrations), and a high-definition video camera system with a powerful light to illuminate the depths.

Among the images that this system brought back to the surface were schools of the Antarctic silverfish (*Pleurogramma antarcticum*), often at depths of around 400 m over the continental shelf – an awfully long way for a penguin to dive after them. This video data will be compared with sonar data from the ship and the results from trawls done at the same stations to provide a clearer picture of the behaviour and distribution of this important prey fish.

The AVPR system also photographed many different planktonic organisms, including juveniles of the comb jelly *Callianira antarctica* that were so fragile they were not sampled successfully in any of the seven different types of net used to survey the water column. Other fragile denizens of the Southern Ocean are the siphonophores – colonial jellyfish that form chains that are often ripped apart into their individual constituents in a plankton net and need to be pieced back together under the microscope, like a jigsaw puzzle, to determine their species. These chains are the asexual generation of the life cycle, while the sexual generation is a much smaller colony called a 'eudoxid'. The AVPR photographed a variety of these tiny eudoxids and gathered the first data on their exact distributional depths and their inferred habitat preferences.

As well as plankton photographs, the AVPR system took colour images of the other particles in the water column. To no-one's surprise the highest concentrations of particles were found in the upper hundred metres and were clearly linked to the chlorophyll concentrations in the water. This suggested that these particles were phytoplankton in origin – the plants of the open ocean.

As well as the copious quantities of diatoms with their skeletons made of silica, the AVPR also recorded the presence of a potentially very important but largely unknown group of organisms – the Acantharia. These animals are planktonic, single celled organisms, which produce skeletons composed of strontium sulfate. This is a very rare material for an organism to produce in such quantities, but an important trace element needed by a variety of marine animals, from squids to corals. The ratio of strontium to calcium in the skeletons of animals such as corals is often used as a paleothermometer, to infer water temperature over geologic time. In our age of rapid climate change, any organism that can significantly affect the concentrations of strontium in seawater needs to be studied.

Unfortunately the skeletons of Acantharia dissolve rapidly, making them difficult to study by traditional means. The AVPR photographed Acantharians throughout the water column, all the way to its maximum deployment depth of 1000 m. Analyses of these results should give us a greater understanding of the role Acantharians play in the biogeochemical cycles of the Southern Ocean – one of the most important oceans affecting the climate of the Earth.

DHUGAL LINDSAY
Deep Sea Ecosphere Research Team, Japan Agency for Marine-Earth Science and Technology

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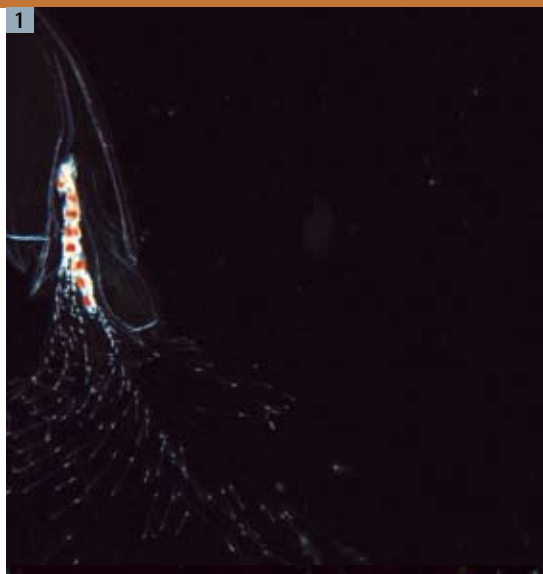

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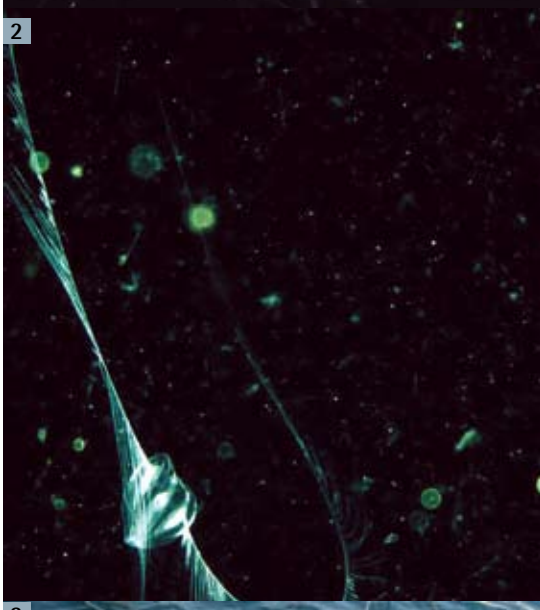

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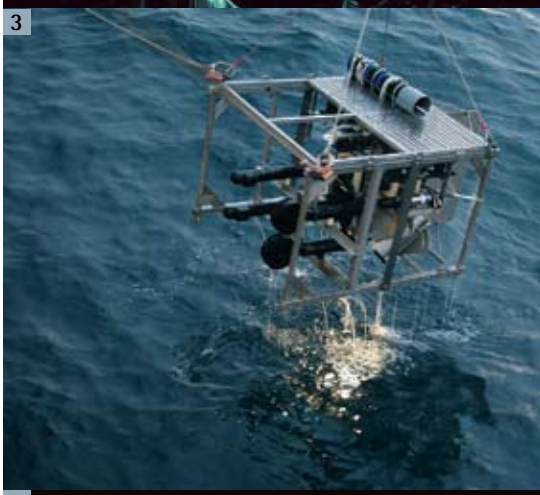

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JAMSTEC

1. *This photograph of the siphonophore* Diphyes Antarctica, *taken by the AVPR, shows it deploying its tentacles to catch its prey at 156 m depth just over the continental shelf.*
2. *This juvenile of the comb jelly,* Callianira Antarctica, *was photographed with its tentacles outstretched just below the surface in the waters near the Mertz glacier. Phaeodarian colonies are also visible.*
3. *The Autonomous Video Plankton Recorder deployed in its stainless steel frame with cameras, lights and associated sensors.*
4. *This eudoxid or sexual stage of the siphonophore* Dimophyes arctica *was photographed by the AVPR at 879 m depth just over the continental shelf break.*

1

Sorting the catch

French scientists have been busy sorting, analysing and distributing thousands of invertebrate and fish specimens collected between Terre Adélie and George V Land in East Antarctica.

During the Collaborative East Antarctic Marine Census (CEAMARC), Australian and French scientists on board the *Aurora Australis* sorted tons of benthic organisms (those that live on the sea bed) and demersal fishes (those living close to the sea bed). They collected a total of 3630 samples, each being composed of one to several individuals. All these samples were labelled and fixed in ethanol (benthic organisms) or formalin (fish), and stored in drums. Most of this material, except for the cephalopods, was sent from Hobart (Australia) to the Museum National d'Histoire Naturelle in Paris (MNHN), where it was sorted again to obtain a more accurate separation of each group. One assistant working full-time for one year re-sorted the material to 5633 samples (not including fish, which were identified and studied separately). This assistant was helped by scientific specialists for some of the groups, and by invited scientists from other French institutions or other countries.

Once the samples were entered into the MNHN databases, they were progressively sent to specialists in museums and institutions all over the world (Australia, France, Germany, USA, UK, Belgium, Chile and South Africa) where they are now being studied. The data obtained from these studies are being shared through the Marine Biodiversity Information Network of the Scientific Committee on Antarctic Research (SCAR-Marbin). This work will contribute to a substantial increase in Australian and French national collections.

The analyses of the collections are already well advanced. While molluscs, crustaceans, cnidarians and pycnogonids are still being identified, studies of some other groups are almost complete:

- All the sea squirts have been analysed, resulting in 33 species being recognised, including three new deep water species.
- All sea stars have been entered into the MNHN databases, photographed and sequenced.
- Of the more than 1000 feather star specimens collected, all have been sequenced, and five species of feather stars have been identified.
- Nineteen species of sea urchins have been identified, including two very rare, deep water ones.
- Of the 2500 teleost (bony) fishes caught, 530 have been photographed and sequenced.

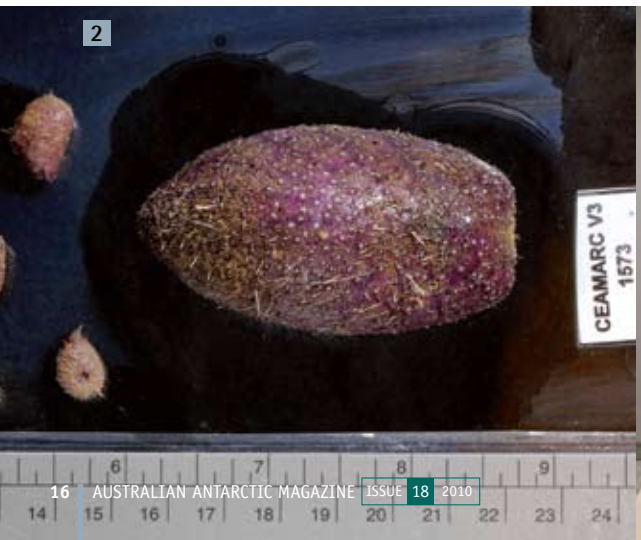
Before CEAMARC, only 21 demersal fish species had been recorded in this sector, which now incorporates 67 species, including some very rare species and a new Zoarcid (an eel-like fish).

Such taxonomic and phylogenetic studies are prerequisite to any ecological study. The results from this research voyage are already, or will be, integrated into a series of wider projects encompassing biogeographic mapping of the Southern Ocean. A very precise overview of this high biodiversity and of its various assemblages should be rapidly obtained, as scientists have at their disposal accurate identification tools, complemented by oceanographic parameters, information on the substrates (such as rocks, sand or gravel), and videos and photographs. All organisms that have been sequenced will significantly enrich the Barcode of Life database (a repository of DNA sequences; www.boldsystems.org/views/login.php).

The calving of an enormous iceberg from the Mertz Glacier tongue (see page 19) in February this year will likely affect local ocean circulation in the CEAMARC study region. This may have a serious impact on the local marine environment, as its scouring effects will probably reach depths of 400–500 m. Contrary to similar important iceberg calvings recently observed elsewhere in Antarctica, this one has been preceded by very detailed in situ analyses of the benthic assemblages. This should allow for a precise estimate of the importance of the impact of the calving and should lead to further studies of how benthic organisms and demersal fish have responded to it.

NADIA AMEZIANE and
CATHERINE OZOUF-COSTAZ

Museum National d'Histoire Naturelle and Centre National de la Recherche Scientifique, Paris



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1. *A new zoarcid deep-sea species,* Barbapellis pterygalces, *characterised by the presence of many skin folds and crests situated on the head. The fish plays a foraging function on muddy sea beds.*
2. Pourtalesia aurorae, *an extremely rare and deep sea urchin.*
3. *At the MNHN Zootheque, re-sorting samples from drums into bottles, for further identifications and computerisation.*

Using fish to identify ecological regions

PHILIPPE KOUBBI 1

Fish are helping scientists identify different ecological regions in the Dumont d'Urville Sea.

The Dumont d'Urville Sea, ranging from Terre Adélie to the Mertz Glacier tongue, in George V Land was investigated during the Collaborative East Antarctic Marine Census (CEAMARC) to understand the composition of the marine biota in relation to their environments, and to establish baseline information that could be used to track changes over time.

One aim of the sampling network was to conduct an ecological regionalisation of this area. 'Ecoregionalisation' is a combination of regional oceanographic features (such as banks, depressions, coastal zones and open ocean), and the spatial distribution of species. To do this, scientists from the Tokyo University of Marine Science and Technology, the Muséum National d'Histoire Naturelle of Paris, the Laboratoire d'Océanographie of Villefranche-sur-mer on the French Riviera, and the Australian Antarctic Division, studied the fish of the Dumont d'Urville Sea. Antarctic fish are good indicators for delineating ecoregions because they are long-lived, exhibit a range of functional roles in the ecosystem, and are adapted to different ecosystems.

Historical surveys listed about 20 species of fish, but we have now identified 91 species belonging to 21 families. This shows the importance of having integrated international surveys.

Fifty-one per cent of the species belonged to the Notothenioids, a group highly endemic (or specific) to the Southern Ocean shelves (such as icefish, toothfish and Antarctic silverfish). These are followed by Myctophids (lantern fish), a deep sea family very abundant in the Southern Ocean that migrates from the deep layers (greater than 200 m) to the surface layers.

We also collected all the life stages of the fish; from larvae to the adults of many species. Early life stages of Channichthyidae (bloodless icefish) are known to be associated with swarms of Antarctic krill, but *Pleuragramma antarcticum* (Antarctic silverfish) is the dominant pelagic fish (living in the water column) over the shelf. All have major roles in the food web between plankton and top predators (such as penguins, seals and whales). However, our intensive surveys were not able to collect all potential species, such as *Dissostichus mawsoni* (toothfish) or skates – although these species were collected by others or viewed on video, respectively.

Different ecoregions were found in the pelagic and continental shelf zones. In the pelagic zone, we found a clear distinction in species composition between the surface water layer (0–200 m), the intermediate layer (200–600 m) and the deep layer.

The continental shelf regionalisation, based on fish living near the sea floor, showed a clear difference between continental margins, inner-shelf depressions, banks and coastal zones. Some species were caught specifically in inner-shelf depressions and especially in the George V Basin. This shelf regionalisation is probably related to both recent environmental features and past environment. Further investigation is needed to determine if colonisation of the shelf occurred from the continental margin itself, or from shelter sites over the shelf that were not covered by ice, after the Last Glacial Maximum.

What have we learned from CEAMARC? The list of species known for this area has increased for all the taxa, especially for fish but also for gelatinous plankton and benthos. The Mertz Glacier tongue broke off at the beginning of the year, releasing a very large iceberg. This will change the currents and the biological productivity of the area, it will impact benthic communities (organism living on the sea floor) by scouring, and it will then modify fish habitats. Other surveys in the Dumont d'Urville Sea will try to follow the consequences of this major change in the area. Some will be led by the Australian Antarctic Division, others like the French ICO^{2}TA project (Integrated Coastal Ocean Observations in Terre Adélie) supported by Institut Polaire Paul Emile Victor, will continue to study the changes in the pelagic environment (plankton and pelagic fishes) each year.

2 PHILIPPE KOUBBI

3 PHILIPPE KOUBBI

PHILIPPE KOUBBI
Observatoire Océanologique de Villefranche sur Mer, France

More information

Koubbi Philippe, Ozouf-Costaz Catherine, Goarant Anne, Moteki Masato, et al. Estimating the biodiversity of the East Antarctic shelf and oceanic zone for ecoregionalisation: example of the ichthyofauna of the CEAMARC (Collaborative East Antarctic Marine Census) CAML surveys. *Polar Science*, in-press.

1. *These Antarctic silverfish,* Pleuragramma antarcticum, *are the dominant pelagic fish living in the shelf region of the Dumont d'Urville Sea.*
2. *A deep sea angler fish in the family Oneiroididae.*
3. *A juvenile icefish.*


TUMSAT

INTERNATIONAL FLAVOUR ENHANCES JAPANESE RESEARCH CRUISE

1

Fish scientist Masato Moteki provides a Japanese perspective on the social aspects of ship-based research.

The Collaborative East Antarctic Marine Census (CEAMARC) research cruise onboard the Japanese vessel *Umitaka Maru*, was very different from the previous experiences of the Tokyo University of Marine Science and Technology (TUMSAT) team. In particular, this cruise was coloured with both anxious (at least in the beginning) and glorious aspects, which were no doubt because of the multinational composition of scientific members on the cruise.

Of the 28 scientists who participated in this cruise, 18 were Japanese, four Australian, three French, one Belgian, one Argentinean, and one Canadian. Foreign students and scientists alike had been onboard the *Umitaka Maru* several times in the past. However, this was the first time that such a diverse number of scientists from five countries were onboard at one time.

First, from Australia, was Dr Graham Hosie, the CEAMARC leader; this means he was a key player as well as chief villain in planning this cruise! He loved Japan and sake with a passion. There was also Dr Dhugal Lindsay, who worked for a Japanese institution, spoke Japanese fluently, and even wrote haiku in Japanese. Lastly were Margaret Lindsay and Andrea Walters, PhD students from the University of Tasmania, who had fantastic smiles and were popular among all the young Japanese students.

French scientist Dr Philippe Koubbi was an ichthyologist (fish scientist), like me. He was a reliable person and also a master of the Café de France (to be described later). Patrice Pruvost sent reports of our activities on the *Umitaka Maru* to France and published updates on a French website every day. Then there was Eric Tavenier. He was always very funny. Once we heard the sound of his laughter, it was not easily forgotten.

From Belgium was Jean-Henri Hecq, the most senior but also the most determined to learn Japanese mannerisms. Upon embarking the *Umitaka Maru*, he quickly became the best among the foreign scientists at using chopsticks.

Dr Russell Hopcroft, from Canada, was an expert at taking exquisite photos of beautiful zooplankton. Lastly, our Argentinean, Veronica Fuentes, was a young scientist studying gelatinous plankton with Dr Hopcroft and Dr Lindsay.

You can imagine how interesting the meal times among this multinational group of scientists were. On the *Umitaka Maru* most of the meals were basically Japanese food; usually variations of steamed rice and fish. On a nearly one-month-long cruise, an unpalatable meal could be a source of stress. However, our stewards (cooks) tried hard to plan every meal and menu, even though such efforts were likely a bit inconvenient. The result was that every meal time was eventful, filled with the exchange of laughter and jokes in English, French and Japanese.

Some research ships are 'dry ships' where drinking is prohibited, but the *Umitaka Maru* was a 'wet ship'. This is not to say that it had a bar (*Umitaka Maru* was a TUMSAT training vessel before she was a research vessel). However, secret bars were hosted in many cabins. The busiest place was the Café de France mentioned before. This bar opened between observations, and we knew it was open when we heard Eric laughing. English, French and Japanese were spoken at Café de France. For the Japanese team members, who mostly spoke little English and French, this bar also served as a good foreign language class.

After 26 days on 'the road to Antarctica', we arrived back in Hobart, Australia, on 17 February 2008. Consideration and respect for others are necessary in leading a multinational life. We could list what we accomplished scientifically on this cruise, such as 47 and 35 hauls by two types of trawl systems, which were great achievements. More importantly, though, the dependability evidenced among the scientists during this cruise expanded into international, cooperative sample analysis afterwards and resulted in the production of many important scientific contributions. This relationship is expected to continue during subsequent collaborative programs, such as the upcoming CEAMARC-2.

MASATO MOTEKI
Tokyo University of Marine Science and Technology, Japan

1. *The* Umitaka Maru *off Dumont d'Urville Station.*
2. *A United Nations of scientists share dinner on the* Umitaka Maru.


TUMSAT

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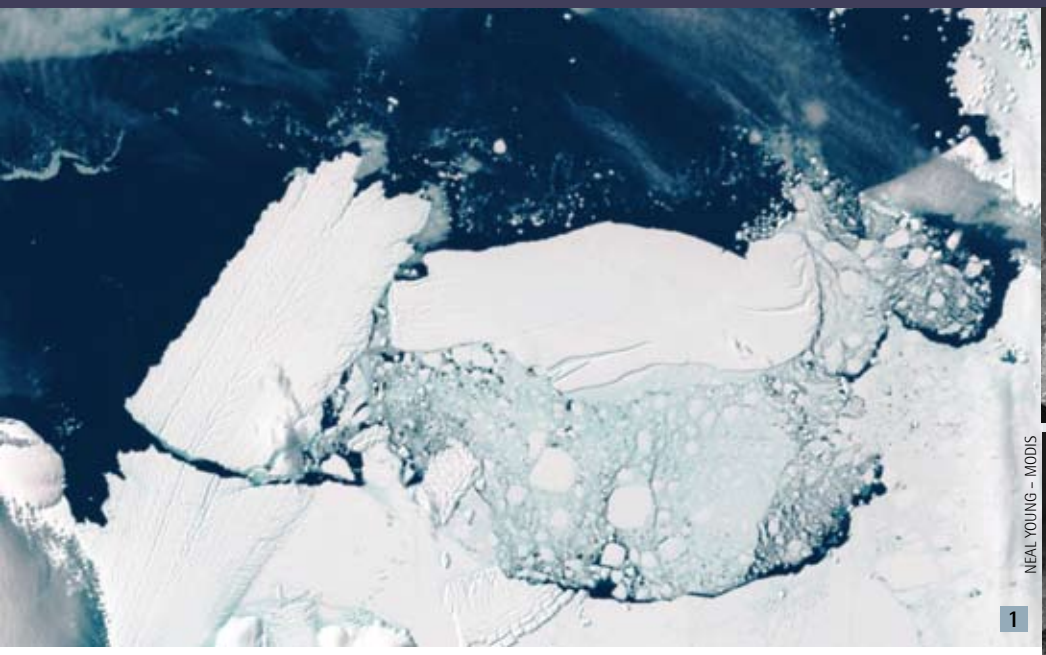

NEAL YOUNG – MODIS

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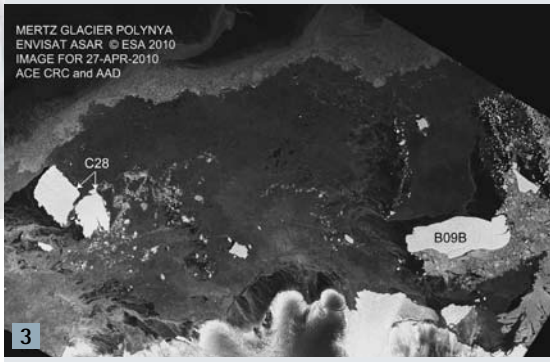

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1. *New iceberg, C28 (left), seen on 20 February 2010 following the collision of iceberg B09B (right) with the Mertz Glacier tongue.*
2. *This image acquired by the Advanced Synthetic Aperture Radar on ENVISAT on 20 March 2010 shows the Mertz Glacier region, the new iceberg C28, which has moved into a polynya (P) in the Adélie Depression, and the grounded B09B iceberg. (GB – grounded bergs).*
3. *This image taken on 27 April shows C28 has split in two (after hitting a submerged peak) and moved west of the polynya. B09B remains grounded.*

Mertz Glacier tongue unhinged by giant iceberg

In mid-February 2010 a massive iceberg designated B09B collided with the Mertz Glacier tongue – a section of the glacier that protruded about 100 km from the Antarctic coastline at about 145°E. The collision precipitated the calving of another massive iceberg, C28, from the tongue, measuring 78 km long and between 33 and 39 km wide. This calving event removed about 80% of the tongue, leaving only a 20 km-long stub. The calving had been anticipated, as rifts cutting across the tongue had been developing over many years, but the timing and collision was not.

The calving event was detected by Australian and French researchers who have been studying the Mertz Glacier as part of the International Polar Year project, Cooperative Research into Antarctic Calving and Iceberg Evolution. The project involves surveys using satellite data and GPS beacons deployed on the glacier, to measure the evolution of rifts and the calving process. The team had followed the development of two major rifts from opposite sides of the Mertz Glacier tongue for some years. The rifts had almost joined when B09B collided with the eastern flank of the tongue, completing the break. B09B originally calved from the Ross Ice Shelf in 1987 and drifted round to the east of Mertz Glacier by 1992. It was grounded for many years and started moving in late 2009.

The region about the Mertz Glacier plays an important role in the global ocean over-turning circulation. Polynyas in the region (areas of open-water or low sea ice concentration) produce about 25% of the Antarctic Bottom Water, which drives the deep over-turning circulation of the global ocean, carrying oxygen and nutrients to the ocean depths in all ocean basins. The effect of strong off-shore winds and heat loss from the ocean make polynyas very efficient sea ice 'factories'. The salt rejected during the freezing of new sea ice creates the cold, dense water which sinks to the ocean bottom and ultimately forms Antarctic Bottom Water.

The calving of the glacier tongue and the shift of icebergs has changed the geography of the main polynya that was adjacent to the glacier. As C28 drifted west, it initially caused the Mertz polynya to be divided into several smaller areas, which disturbed the ice factory role. At the beginning of April, C28 collided with a submerged peak and split into several massive sections. By the end of April the sections had drifted across the edge of the continental shelf into deep water, about 250–300 km west of the glacier and well clear of the polynya.

Iceberg B09B remains grounded about 50 km north-east of the remaining Mertz Glacier tongue. The behaviour of the Mertz polynya appears to have returned to its previous active ice factory role, after a temporary reduction in sea ice production when C28 was in the area of the polynya.

The changed geography is expected to impact on the ocean circulation in the polynya region and further changes are anticipated when iceberg B09B once again begins to move. This may yet have a longer-term impact on bottom water formation and biological productivity in the region. So there may be flow-on effects up the food chain in the region, which includes nearby penguin colonies. A number of ongoing field and research activities will follow up this calving event and its impact on the local environment.

NEAL YOUNG[1], BENOIT LEGRESY[2], RICHARD COLEMAN[3] and ROB MASSOM[1]

[1] *Australian Antarctic Division and Antarctic Climate and Ecosystems Cooperative Research Centre*
[2] *Laboratoire d'Etudes en Géophysique et Océanographie Spatiales*
[3] *Institute for Marine and Antarctic Studies*

Antarctic ice cores shed light on Western Australian drought

The ice core drilling team in a blizzard at Law Dome. Left to right: Mark Curran, Joel Pedro, Vin Morgan, Tas van Ommen, John Burgess, Andrew Moy, Graeme Denny, Tessa Vance (front).

MARK CURRAN

Sitting in a battered tent in a 120 km/h blizzard on Law Dome, celebrating Christmas 2008, Australia seems far, far away to me and my seven colleagues.

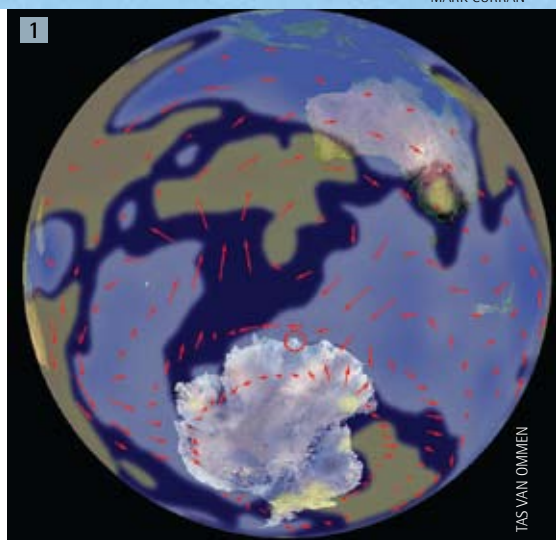
We are here because the place provides a unique location for drilling detailed ice core records of recent climate change. But in the past few years we have begun to appreciate that this isn't as far removed from Australia as we might have thought; in fact the snow that is now burying us (covering our tent two metres deep) is providing some direct insights into climate changes in Australia. One of our team, from Denmark in Western Australia, knows first-hand about the drought that has gripped this southwest corner of Australia for over 30 years – his whole life. Over the same time, snowfall at Law Dome has increased and now we have some understanding of why.

The evidence of a climate link had been accumulating, like the snow, since the first ice cores were drilled on Law Dome in the 1980s. My colleague Vin Morgan, who pioneered this work, was 'enjoying' his 40th Antarctic anniversary on this snowy Christmas tent trip with us at Law Dome. Vin published a key paper in 1991 showing that snowfall had increased dramatically in the area after the late 1960s. Ice cores drilled since then show that this high snowfall was continuing and so we set about comparing the ice core records to meteorological records.

What we found was very interesting. Figure 1 shows how the prevailing winds and the amount of water vapour in the atmosphere depart from normal during high snowfall years at Law Dome. Perhaps not surprisingly, we see a large region of unusually moist air flowing down from south of Tasmania towards Law Dome and East Antarctica generally. What is less expected and striking is a region of unusually dry air flowing from south of Western Australia and across the southwest corner of the Australian continent.

Prompted by this, we looked specifically at Western Australia rainfall and found that for long-term records (which extend back to around 1900) we see low winter rainfall when the snowfall at Law Dome is high. Figure 2 shows a graph of winter rainfall averaged over southwest Western Australia and snowfall at Law Dome (depicted inverted so high snowfall is downwards). The two records are smoothed over several years to remove short-term weather effects, which add short-term random variations, particularly because of snow surface irregularities.

The connection was obviously interesting, but the pivotal question is what it tells us about the causes of the drought and future prospects. This is where the ice core records are particularly useful because unlike the Western Australia climate records, we can investigate changes for many past centuries, rather than just the one for which we have meteorological observations. When we look at the long-term ice core record we see that the last 30 years have indeed been unusually snowy. Not only is it the most extreme



such period in 750 years of data, it is so far above average that it doesn't appear to belong in the natural range of variations that would be expected.

Another clue comes from the pattern of atmospheric circulation. The high snowfall pattern, with its southward flow of air from the Tasman Sea and northward flow of dry air to Western Australia (Figure 1), is part of a Southern Hemisphere pattern (called the zonal wave three circulation) that has increased in intensity in recent decades. This increase is attributed in some climate models to ozone depletion and increased CO_2, pointing to a human contribution.

So where does this lead? The work provides a new set of climate observations that can be used to help test and develop climate models. It also suggests that the present shift to high Law Dome snowfall, and drought in southwest Western

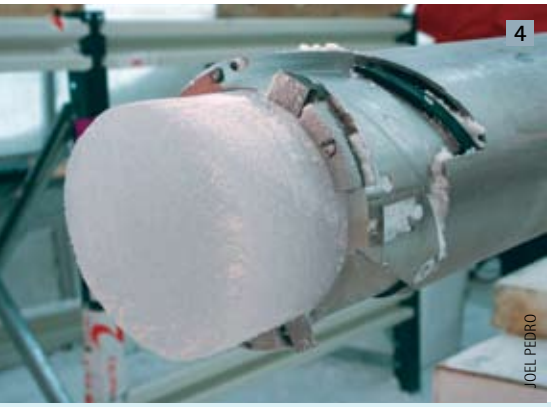
Australia, is unusual. As the hole in the ozone layer 'heals' in coming decades, this particular driver of climate patterns will diminish, but the influence of CO_2 in driving this northward/southward flow will continue. Models will be the key to understanding the balance between these two influences.

In the meantime, the ice cores offer even more information to help understand the changes. Salt blown in from the sea, sulphur chemicals from algae in the oceans, and water from the distant mid-latitudes, all carry signatures of climate variability. We need more of this information, which is why sitting in a tent in a blizzard drilling an ice core is a compelling way to spend Christmas.

TAS VAN OMMEN
Ice, Ocean, Atmosphere and Climate program, Australian Antarctic Division

More information

van Ommen, T.D. and Morgan, V.I. (2010) Snowfall increase in coastal East Antarctica linked with southwest Western Australian drought. *Nature Geoscience* 3: 267-272. doi:10.1038/NGE0761 http://www.nature.com/ngeo/journal/v3/n4/abs/ngeo761.html


JOEL PEDRO

DESERT RESEARCH EXPOSES ICY STORY

It may seem an unlikely collaboration, but Nevada's Desert Research Institute (DRI) in the United States is helping Australian Antarctic Division glaciologists analyse the chemical constituents of two Antarctic ice cores.

Glaciologists Dr Mark Curran and Dr Barbara Frankel said the two cores – one drilled from the summit of Law Dome in 2005–06 and the other taken about 10 km west of the summit in 2008–09 – contain about 150 and 250 years of climate history respectively, bound up in the frozen water molecules inside the core.

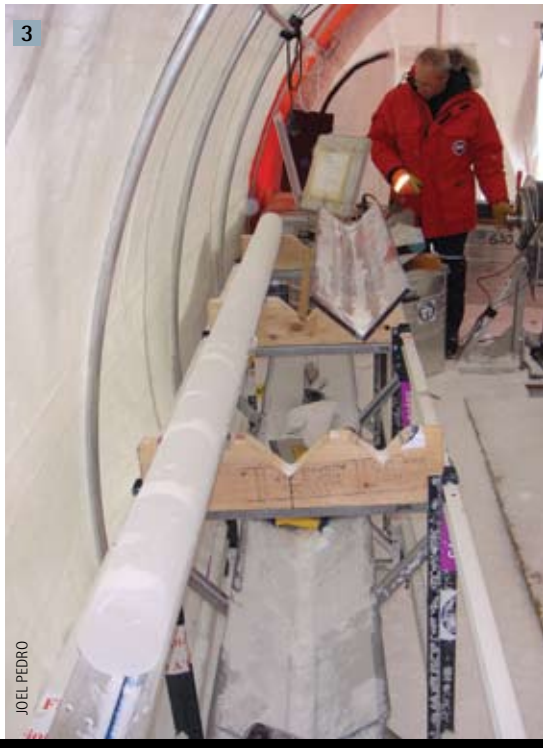
'Over the past 200 years, humans are believed to have altered the atmosphere more than would have occurred naturally and we will be able to track those changes through the unique chemical tracers in the ice that can be measured by the DRI facility,' Dr Frankel said.

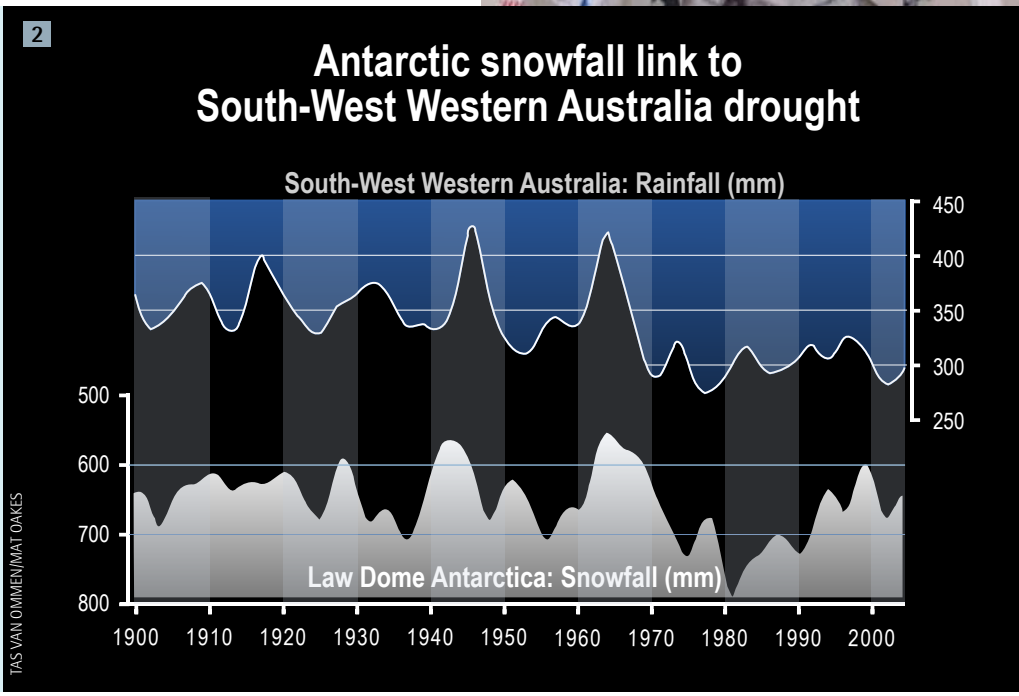
The ice cores will be analysed by a team led by Dr Joe McConnell in the DRI's Trace Chemistry Laboratory. The team is a world leader in the analysis of metals and other chemical species present in snow and ice in ultra-low concentrations – parts per quadrillion or 1×10^{-15} grams of ion per gram of melted ice sample – using 'inductively coupled plasma mass spectrometers'.

'The technique provides the maximum amount of information from the minimum amount of ice and complements our existing ice core work at the Antarctic Division,' Dr Curran said.

Using current technology available in Australia it would take two years to do the same work the $6 million DRI facility can do in two months. The glaciology team plans to send more ice cores to the desert team as they are drilled.

'Combined with our analysis at the Antarctic Division, we will use the results from the DRI to get a better understanding of how the earth's atmosphere changes over time, how it responds to human contributions and, hopefully, to use as a predictive tool, along with other ice core records, to model past and future atmospheric change,' Dr Frankel said.


JOEL PEDRO



1. *Figure 1: Atmospheric moisture and wind patterns from meteorological data, for years with high snowfall at Law Dome (red circle). Blue shades are areas with above average moisture in the atmosphere, tan areas depict below-average moisture and red arrows show how the wind deviates from its normal direction. The map shows moist air being transported south to East Antarctica and Law Dome, accompanied by dry air flowing northward to Western Australia.*
2. *Figure 2: Average winter rainfall for southwest Western Australia (top) and snowfall (as equivalent water) at Law Dome over the period of meteorological observation. Note, the snowfall record is inverted to show the see-saw connection between the two sites. Since the late 1960s there has been a 15-20% decline in winter rainfall in south-west Western Australia, and a 10% increase in snowfall at Law Dome.*
3. *Tas van Ommen with an ice core in the drill tent at Law Dome.*
4. *An ice core.*

A. CAMPBELL-DRURY

1

Phillip Garth Law AC, CBE

1912 –2010

"Greetings! It has been an eventful year....Notably, I have had three portraits painted, which is remarkable at my age....I tore an artery in my ankle and was taken by ambulance to hospital....it bled again... I left my old house is Stanley Grove...one of the most dramatic and difficult events of my life... celebrated my 95th birthday with a dinner for 160 people at the Melbourne Club... one of the greatest evenings of my life... flew to Hobart to attend... Midwinter Dinner and the Phillip Law Lecture... spent 5 days in hospital... In February Vic Roads cancelled my driving licence. I passed various tests in October and had it restored. So here I am back to normal, at Christmas."

Thus wrote Phil Law, Antarctic scientist, explorer and administrator, academic, and tertiary education pioneer, in his personal Christmas letter 2007. This note, outlining one year in his 98, illustrated both the meticulous records that he kept as well as how he shared his distinguished, challenging, adventurous and exciting life with others.

The unique archival collection of Law's diaries, correspondence, reports, interviews, films, lectures, photographs, papers and books in the National Library of Australia, which traces his life, family, education and careers, makes him arguably one of the most recorded persons in Australian history. Despite the difficulty of competing with such an archive, this brief tribute on his Antarctic period comments on Phil Law the mentor, Antarctic scientist, colleague and friend to all his expeditioners. Building on Sir Douglas Mawson's legacy, Law developed the Australian National Antarctic Research Expeditions (ANARE), despite less than adequate finances, staff and facilities, and laid the foundations for Australia's current Antarctic commitment, research and influence.

Seconded from his lecturer position in the Physics Department at the University of Melbourne in July 1947, Law became Senior Scientific Officer in an expedition which, soon afterwards, was given the official title of ANARE. Scientific programs were organised for the newly established Heard Island and Macquarie Island stations and Law performed cosmic ray observations on the less than successful Antarctic voyage of HMAS *Wyatt Earp*; his personal account of this voyage is a classic and details the intriguing happenings after the voyage. On 18 May 1948 ANARE was formally incorporated into the Department of External Affairs and an Antarctic Division (AD) of the department was created, with Law being appointed Officer-in-Charge of the AD (succeeding Stuart Campbell as Leader of ANARE) on 3 January 1949. The title of Director came later.

In 1950 Law spent a summer with the Norwegian-British-Swedish Antarctic Expedition to the Weddell Sea. The charter of the suitably ice-strengthened *Kista Dan*, enabled the establishment of Mawson Station in MacRobertson Land in 1954 and Davis Station in the Vestfold Hills in 1957. Law oversaw the transfer of Wilkes from the USA to Australia in 1959 and planned its replacement by Casey station from 1965; it was opened in 1969, three years after Law resigned from the AD. During his tenure Law explored over 5000 km of coastal Antarctica, and station personnel, using aircraft (including wintering RAAF crews), tractor traverses and dog teams, explored and mapped over one million kilometres of territory.

Despite the high cost of Antarctic logistics, a limited budget and science being secondary to the political considerations of exploration and sovereignty, scientific research was accomplished. A small AD headquarters, housed in a number of locations in Melbourne, worked with government agencies and universities and developed its own research capabilities in auroral and upper atmospheric physics, glaciology, medical studies and human physiology. All scientists and lay staff were encouraged to publish in major journals, and a very successful ANARE publications series was established. From 1953–57 Law was a member of the Australian Committee, International Geophysical Year (IGY). It was largely due to his efforts that ANARE took part in the IGY in 1957–58, and that Australia became a founding member of the International Council of Scientific Unions' (ICSU) Scientific Committee on Antarctic Research (SCAR). Law's involvement in

PETER ORMAY

2


RICHARD THOMPSON

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SCAR was renewed after he left the AD and again became Chairman of the Australian Academy of Science's National Committee for Antarctic Research (ANCAR) from 1966–1980.

The AD headquarters had a relaxed atmosphere despite deadlines due to the short, intense, Antarctic summer field season. Law was demanding but his personality, determination, enthusiasm, work ethic, sense of fairness, attention to detail and involvement of all meant a loyal and dedicated staff who could see him at any time through his 'open door'. Morning and afternoon teas were held in one room, where everyone was expected to attend; much business being transacted during these interludes. Law was also a great communicator and master of publicity, and publicity did much for the success of both the AD and ANARE. He had a knack of getting what he wanted from External Affairs where his style was much more direct and argumentative. He confessed to finding the bureaucracy at times stultifying.

In an unusual divisional structure, in addition to the Assistant Directors (Logistics and Scientific), four other positions came directly under Law's control – Photography, Publications and Public Relations, Library and Information Service, and Geography and Place Names – reflecting his attitude to publicity. The AD library, records systems, and Law Collection of thousands of photographic slides result from this policy. Dating from the *Heroic Age*, publicity has always been important to polar endeavour. From the inception of ANARE, journalists, photographers and authors were among expedition staff. Seeing the need for recognition of expeditioners, dignitaries farewelled every voyage, and met each individual voyager. Typical of the releases was this heading from a 1965 ANARE Newsletter, published in *Antarctic* (Vol 4, p23):


A. CAMPBELL-DRURY

4

"NEVER A DULL MOMENT IN THE AUSTRALIAN ANTARCTIC

Closing one station, re-siting another, forced landings, a huge ice breakout, searching for men marooned by blizzards, an aircraft sinking through thin ice: all these have been taken in their stride by ANARE men in the course of a full Antarctic programme this summer."

A common perception in the parent department in Canberra was that the high profile of the AD and its leader meant both were untouchable.

Although today much of pre-embarkation training and the conduct of Antarctic station life is taken for granted, when it was introduced in the 1940s and 1950s it was very innovative. As well as developing equipment and supplies, policies had to be laid down, and selection methods established. Accomplished at many sports, Law introduced pre-departure gym classes and swimming at the YMCA. Some of his other innovative actions included: a plethora of manuals; indoctrination week lectures; an alcohol policy; the taking of Boy Scouts to Macquarie Island; the training of doctors and lay assistants at the Royal Melbourne Hospital; a Personal Cables Officer to handle personal telegrams and communications between Australia and Antarctica; excellent food and wines; and music and libraries on the stations. Law's 1959 Sir Richard Stawell Oration, published later in the *Medical Journal of Australia* as *Personality Problems in Antarctica*, and his 1957 Annie B Cunningham Lecture on *Nutrition in the Antarctic* are seminal international works on these subjects.

On voyages, no one will forget putting on a tie and jacket for dinner each night, or pre-dinner drinks on a rotational basis with Law and his deputy, or Phil smoking a cigar with a glass of wine alongside, playing his squeeze box or piano-accordion all night as everyone sang from the

JOHN STANWIX

5

ANARE Song Book. Law's ability to catnap before making a landing was amazing; fully clothed with pack on back he would lie on the Leader's Cabin floor waiting to embark on boat, pontoon or DUKW (amphibious truck). Favourable weather and ice conditions were frequently referred to as 'Law Luck', while the catchcry 'too much Law and not enough order' was often recited during periods of boredom, or when only a few persons got ashore at a landing, or cargo operations did not go to plan.

Dr Law achieved wide recognition for his contribution to the Antarctic, science, education and the community with many decorations, awards and accolades, including a CBE 1961, AO 1975, and AC 1995. A man of great principle, Law declined an OBE and although awarded a Polar Medal in 1965, he declined that also until 1996, when he received it at an investiture at Buckingham Palace. A base, plateau, islands and promontory are all named for Law, but he considered the only 'decent' feature his name appeared on was Law Dome; the reason for this, in Law's opinion, being his chairmanship or membership of the Australian Committee on Antarctic Names for nearly 40 years.

No memoir on Phil Law is complete without reference to his wife Nel, the first Australian woman to visit Antarctica. An accomplished artist she painted a fine Antarctic series. Concerned with, and a great supporter of, 'those left behind', she was instrumental in establishing the Antarctic Wives Association. After her death in 1990 Phil sent a letter to friends and colleagues overseas; an excerpt reveals her influence and the support she gave to her husband:

"Nel was a remarkable woman – beautiful, intelligent, talented and, above all, happy. I look back gratefully upon our long marriage – 48 years. She put up with my long and frequent absences, she supported me loyally in my various careers and she had a profound cultural influence upon my life. Ours was a union of passionate love and deep mutual affection."

Until his death Dr Law kept an intense interest in matters Antarctic, especially the AD. Changes to organisation, policy, logos and errors in books or papers gained sharp rebuke as authors and later directors found. His greatest disappointment was changing the title ANARE to Australian Antarctic program, some 50 years after ANARE became a household name and in Australian dictionaries.

Phil Law's life was extraordinary and he shared it with all through his brilliant communication skills. His influence on ANARE personnel was considerable and he followed careers with great interest. It is fortunate for future generations that the nation has such a record of the life and work of Phillip Garth Law.

DESMOND LUGG
Australian Antarctic Division 1962-64 and 1968-2001

Read an interview with Phillip Law in 1999: www.science.org.au/scientists/interviews/l/pl.html

1. *Phil Law ca. 1956.*
2. *Phil Law playing the accordion on the* Nella Dan, *ca. 1965.*
3. *Phil Law stands at the foot of the flagpole, raised on 13 February 1954 at the establishment of Mawson Station.*
4. *A historic gathering: Phillip Law, Sir Douglas Mawson, General Riser-Larsen and Captain John King Davis at the Oriental Hotel, 33 Collins Street, Melbourne, in 1954.*
5. *Phil Law in snow in Oates Land, 1962.*
6. *Phil Law on the beach at Davis in 1963, with the huskies and his much-travelled Qantas bag. A stack of cleaned petrol drums in the background await their return to Australia.*

6

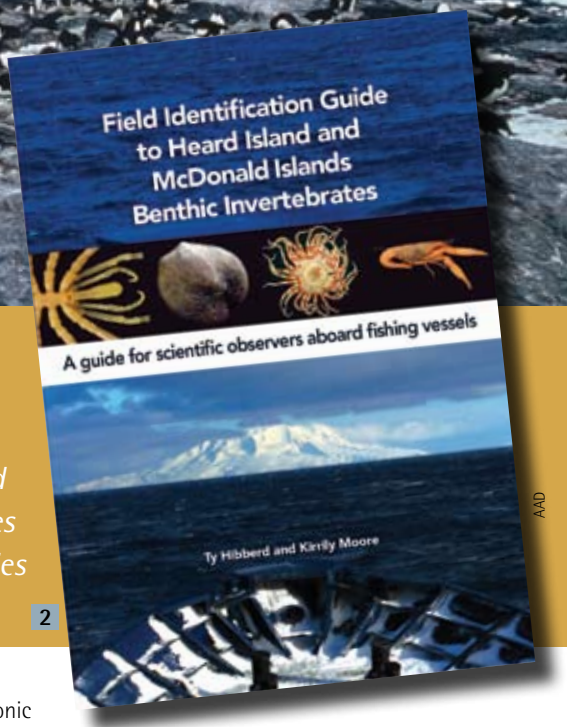
DES LUGG

PATRICK QUILTY

New measures to protect marine species in the Southern Ocean

1

Australian scientists and policy makers were at the forefront on a number of key initiatives at the 28th meeting of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) in November last year. CCAMLR is part of the Antarctic Treaty system and is the primary forum for the conservation of the marine living resources of the Southern Ocean. This includes maintaining the diversity of species and carefully regulating fishing operations.



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Two new measures were adopted to improve the management of krill populations in the Southern Ocean. Krill fishers will now be required to spread their effort over a larger area, rather than concentrate it in one spot, and are strongly encouraged to have scientific observers on board the fishing vessels.

Australia's Commissioner to CCAMLR, Australian Antarctic Division Director Lyn Maddock, said these initiatives have significant implications.

'This is an important step in managing this fishery and ensuring fishing activities do not have adverse effects on krill populations or their predators in the long term,' she said.

'Observer coverage in the fishery is vital to collecting the data needed to assess the impacts of the fishery on the fragile Antarctic ecosystem.'

Illegal, unregulated and unreported (IUU) fishing remains a serious concern in the Southern Ocean. An Australian proposal for more rigorous port inspections of vessels carrying toothfish caught in the Convention Area was unanimously supported by the 25 members representing 24 nations and the European Community. Another Australian proposal to streamline the catch documentation scheme to track the landings and movement of toothfish caught in the Convention Area, through a mandatory electronic system, was also adopted by CCAMLR. This is an important tool in the fight against IUU fishing.

The Commission also declared its first Marine Protected Area (MPA) at the South Orkney Islands. The MPA covers more than 90,000 km^2 near the Antarctic Peninsula. MPAs are used to protect important areas and are a tool for improved high seas biodiversity conservation and management, by controlling the types of activity that can take place within their borders. Ms Maddock said the declaration of the MPA was a first step towards a representative network of MPAs within the Southern Ocean.

'The South Orkney Islands MPA will conserve unique oceanographic features and important foraging areas used by albatrosses, petrels and penguins,' Ms Maddock said.

Australia's own Heard Island and McDonald Islands Marine Reserve also came into the spotlight with the launch of the *Field Identification Guide to Heard Island and McDonald Islands Benthic Invertebrates*. The publication, by Ty Hibberd and Kirrily Moore, was a joint initiative of the Australian Antarctic Division and the Fisheries Research and Development Corporation. It is already being used as a training guide, and by trained CCAMLR scientific observers on fishing vessels, to identify invertebrate bycatch in the Heard Island and McDonald Islands region.

The guide contains more than 600 photos and diagrams of invertebrates found in the depths of the Southern Ocean. Launching the guide at an Antarctic Division-hosted function for international delegates to CCAMLR, Ms Maddock said, 'The guide helps to plug the gap in reference material to identify these species at sea. It is the first of its kind for this region and a credit to all those involved'.

The field identification guide is available on the Heard Island website: www.heardisland.aq/research/fish_and_invertebrates.html

The next CCAMLR meeting will be held at its Hobart headquarters in October 2010.

RHONDA BARTLEY
Policy Adviser, Australian Antarctic Division

1. *A Marine Protected Area at South Orkney Islands will conserve important penguin habitat.*
2. *This* Field Identification Guide to Heard Island and McDonald Islands Benthic Invertebrates *was launched at the 28th CCAMLR meeting.*

Australia makes flying inspections

In January Australia inspected five sites in eastern Antarctica in the exercise of its rights and responsibilities under Article VII of the Antarctic Treaty.

Article VII gives Treaty nations the right to appoint inspectors and to inspect all of the facilities of other Treaty nations at any time, with complete freedom of access. This provision was included in the Treaty as a safeguard to ensure compliance by the original signatories at a time (the late 1950s) of Cold War tensions and suspicions. The inspection process was picked up in the 1980s and refreshed when the Treaty's Environmental Protocol was developed, and now reflects the additional modern emphasis on environmental stewardship.

These inspections are an important responsibility for signatories to the Antarctic Treaty, where all member nations bear some cost of the stewardship, leadership and compliance monitoring of all activities in the region. The Antarctic Treaty nations have developed extensive checklists to guide inspections, and elements of them formed the basis for Australia's 2010 inspection program.

Our inspection party comprised Australian Antarctic Division Director Lyn Maddock, and me (General Manager Policy), and a representative of the Department of Foreign Affairs and Trade, Peter Nagy. Mr Nagy also provided Japanese and Russian translation services in recognition of the general agreement among Antarctic nations that inspection teams should include a member fluent in the language of the nation whose facilities are being inspected.

We flew from Casey to Australia's Davis station in early January and, after overnight survival training, flew west in our C212 turboprop aircraft to begin the inspection program. Our first visit was to the Russian base, Molodezhnaya, which was established by the USSR in 1962 on the coast of Enderby Land, some 800 km west of Mawson. It operated continuously until the mid 1990s and was once the largest Soviet/Russian station in Antarctica. It comprises many large and well-separated buildings, bulk fuel storage tanks, and a ski-way, about 12 km inland.

As Molodezhnaya was unoccupied at the time of the inspection, and its ski-way was unusable, we inspected it by air – the rear ramp of the C212 providing an excellent vantage point for safely harnessed inspectors during several low altitude and low speed passes. As there was substantial snow cover, detailed or firm conclusions about compliance with the Treaty or the Protocol, or the environmental state of the station and ski-way precincts, was difficult. However, some observation was possible and a full set of photographs has been provided to the Russian government to assist in planning and managing future activities at the site.

Departing Molodezhnaya, the C212 flew 200 km along the massively fractured ice coast to land on the ski-way inland of Japan's Syowa station, and was ferried to the station by helicopter.

Syowa was established in 1957 on East Ongul Island, Dronning Maud Land. The station generously hosted our inspection party and aircrew for three days, giving us ample time to tour the station with the outgoing Station Leader, Professor Akira Kadokura, and become acquainted with the Japanese scientific and operational programs.

We flew on to Mawson's Rumdoodle snow airstrip to refuel, and visited Mawson for dinner and a tour of the station. This was the first Mawson visit by an Antarctic Division Director for 13 years. We then continued on to Davis where, with the support of a Sikorsky S76 helicopter, we spent the week focusing on Russia's Druznhaya IV and Soyuz stations, and Antarctic Specially Protected Area 168 in the Grove Mountains.

Russia's summer-only base, Druzhnaya IV, was established in 1987. The base comprises several small timber structures including a powerhouse, accommodation, dining and communications office, on Landing Bluff, about 215 km southwest of Davis. The station was occupied when inspected, with several geoscience field parties operating in the vicinity.

Russia's Soyuz field camp was established in 1982 on an exposed low rock ridge on the eastern shore of Beaver Lake, in the south western corner of the Amery Ice Shelf, 422 km southwest of Davis. It has never been inspected. The camp, which consists of 12 light plywood huts in a line along the ridge, was unoccupied at the time of the inspection, and appeared not to have been visited for several years. Again, a set of photographs was provided to the Russian

The sites inspected by Australian officials under Article VII of the Antarctic Treaty.

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government to assist with planning and conducting future activity at the site.

Our final inspection task was a C212-supported flight to Antarctic Specially Protected Area 168 – Mount Harding, in the Grove Mountains. These magnificent mountains rise from below the Antarctic ice cap to tower more than 2000 m above it in majestic spires and wind-carved boulder fields – the main reason for their specially protected status. China's over-ice traverse route from Zhongshan station to Kunlun station stages through this area, and Australia has an automatic weather station there to support forecasting and climate science for eastern Antarctica.

Back at Davis we set aside our official inspection duties to make courtesy calls to Australia's neighbours and partners in the Larsemann Hills Antarctic Specially Managed Area, 100 km southwest of Davis: Zhongshan (China), Progress II (Russia), and the construction site of the new Indian station. We also visited Australia's own, currently unoccupied Law-Racovita summer base, shared with Romania. The five nations active in the Larsemann Hills area meet routinely in conjunction with the annual political, operational, environmental and scientific meetings of the Antarctic Treaty parties to develop collaborative science and operational programs and to find ways of minimising the environmental impacts of their combined activities in the region.

Finally we returned to Casey, stopping to refuel at Australia's Edgeworth David summer field base, where an aerial whale census program had been based for several weeks.

Our inspection activity covered more than 12 000 km, and was entirely supported by air. Between inspection tasks we took every opportunity to involve ourselves in the daily routines and current issues of Davis and Casey. This knowledge will greatly assist management of the stations and their complex operations from the remote Kingston headquarters.


1

Of general note and continuing concern is the high cost of establishing, maintaining, and operating facilities in the remoteness and extreme environment of Antarctica, and the difficulties of eventually decommissioning, cleaning up and removing them. These issues are faced by all Antarctic operators, and provide much of the focus for potential environmental and operational collaborations among Treaty parties.

The reports of the individual inspections of this program were provided in draft to each nation whose facilities were inspected, to check facts and to provide an opportunity for comment and response. The full report was then compiled and provided to all Antarctic Treaty parties at the XXXIII Antarctic Treaty Consultative Meeting in Uruguay, in May.

Inspections provide the incentive for all parties to continue to improve the efficiency and compliance of their activities and to learn from and collaborate with each other. Australia's commitment to the Antarctic Treaty, to sound stewardship, and to environmental protection, continues through our strong engagement in Antarctica, the Southern Ocean, and in all the forums of the Antarctic Treaty system, and through further inspections planned for the coming years.

TOM MAGGS
General Manager Policy, Australian Antarctic Division

PHOTOS BY TOM MAGGS

1. *Part of the Russian Federation's Molodezhnaya station, currently unoccupied.*
2. *A new atmospheric physics building under construction at China's Zhongshan station.*
3. *Antarctic Division Director Lyn Maddock (right) at Russia's summer-only station, Druzhnaya IV, with inspectors and the Station Leader.*
4. *The inspection party, flight crew and Syowa Station Leader (L-R): Tom Maggs; Mr Peter Nagy (DFAT); Professor Akira Kadokura (Station Leader, JARE 50); Ms Lyn Maddock (Australian Antarctic Division Director); Mr Dan Colborne (SkyTraders Senior Pilot); Mr Troy Fleet (SkyTraders Senior Pilot); and Mr Roger Schulz (SkyTraders Senior Engineer).*

4

FROZEN IN TIME

Walkley Award winning print journalist, Jo Chandler, visited Antarctica this summer on an Australian Antarctic Arts Fellowship to file stories for Melbourne-based broadsheet *The Age*, and undertake research for her new book about climate research in extreme environments.

1

During Jo's three and a half week visit she spent nine days in a field camp at the Bunger Hills, near Casey, working with scientists conducting aerial surveys for whales. She also filed stories on ice core work at Mill Island, the ICECAP project studying the ice structure and geology of the Aurora Subglacial Basin, Law Dome and Totten Glacier, ocean acidification, a range of human interest stories, and two blogs for *National Times*.

Jo's new book will draw on her Antarctic experience to examine climate science, in Antarctica and the reefs and rainforests of tropical Queensland, through the stories of the people and the work occurring at these frontiers. It promises to be a 'reflection on the spiritual and personal journeys people take when they go to wild places' as well as 'an adventure story, a thriller, a romance, a buddy movie, a comedy, a biography of the character of scientific communities, and an exploration of human motivation and capacity.'

The following 'Letter from Antarctica' was first published in the A2 section of *The Age* on 30 January 2010.

2

WHEN I finally lie down to sleep it will be morning, almost breakfast. But I'm a time traveller — what's another ripple in the continuum? In a place where the sun shines bright at midnight, the laws of space and time, and the conventions of human ritual become riddled with wormholes of possibility.

And so it is that at dinner time I pull a snug woollen beanie on my head and plaster my face pale with sunscreen. I slide on sunglasses and a pair of thick gloves, hoist a hefty survival pack on to my back, buckle up, and set off into the icy wilderness rather than joining the others in the mess tent. Instead, main course and dessert are stuffed in deep jacket pockets — cheese sandwich to the right, chocolate bars to the left.

I unquestioningly follow the lead of a bloke I barely know, but who is soon my friend — in extremity, fraternity. For now it's enough that he has a grey beard and the easy authority of the-man-in-charge. I settle contentedly in his footsteps.

Cookie — Graham Cook — is the outgoing leader of the Antarctic science settlement of Casey. He has completed a rare trifecta: three winters spent governing the communities of Australia's most remote outposts, the others being Davis and Mawson.

Now, after another 15 months on the ice, he's between yearning to leave and dread of it. He has forfeited authority to the incoming leader, and is savouring a farewell indulgence: a 'jolly' — an expedition for the heck of it. It's the lightest

burden of responsibility he has carried for a long time. Just he and me.

We are walking inland across the Bunger Hills, East Antarctica, from a village of tents strewn on the shore of a frozen bay, the summer base for a scientific whale survey team.

Cookie has his co-ordinates locked on a GPS nestled somewhere within his many layers, but for now he's happy navigating by gut, recognising the lakes and peaks he just scoped from the air on the low, sweeping flight in to our field camp aboard the C-212. He's finding a scenic route rather than following the blinkered dictates of the set waypoints. It may add a half-hour or more to our walk. But then we have all night.

Our objective is to visit and explore a 55-year-old Soviet ice station set up at the height of the Cold War.

Our route is just eight or nine kilometres each way — but it's rough, so maybe three hours walking each leg. It tracks the meandering path of a long-departed glacier.

The essence of the rocks scraping and clattering under our boots might date back more than 2.5 billion years. Their present form was rendered as recently as a billion years ago by cataclysmic heat and pressure. 'They're not the oldest rocks on the planet,' a geologist will later tell me. 'But they're not far off.'

Time — geographic, human, personal — feels as messed up as the jumble of rocks. Great lumps of rosy garnet and black basalt; huge crystals melding coral and green; the glint of mica within bodies of dull grey. We pick up rocks like prizes and wonder at them together.

We scramble over the peaks and plough through the odd drift of blizzard, following an estuary up past the point where the water turns from salty to fresh, falling down from a great lake. This is the rarest of Antarctic landscapes, having shed the all-encompassing skin of the ice sheet some 30 000 years ago. It provides a refuge for the toughest of mosses and the hardiest of birds.

It's midnight when we find the cluster of weathered buildings the Soviets called Oasis station when they built them in 1955. A year later they handed them to the Poles.

The decayed station has been occupied sporadically in the decades since, each expedition leaving behind its relics — outmoded technology, rusting tanks and leaking fuel drums, tins of fish, cigarette butts and empty vodka bottles.

In the dining room we find a collection of 78s with 'CCCP' stamped on red labels and a wind-up gramophone that reawakens ghostly choirs, strident marching bands and a soulful soprano. Time is frozen and fluid.

Almost three hours later we pause in the last of the nothingness and Cookie urges me to read the landscape and the maps and find the way home. To my surprise, I do.

We lower our voices as we walk back into camp so as not to wake the others — it's just after 3am. The sun is as low as it will go and the light is soft, with a hint of the confused colour of sunrise bumping into sunset.

We drop our packs, pour shots of Baileys into glasses over handfuls of blizzard snow, and toast the return to familiar dimensions. Already feeling just a little nostalgic.

JO CHANDLER

1. *The old Polish buildings that make up Oasis station, overlooking Algae Lake, and a supply of empty gas bottles (right), used for heating and cooking.*
2. *A tracked troop carrier likely used as an all-terrain vehicle to bring in supplies, support science and move people about.*
3. *Jo at the transition area from a saltwater inlet to freshwater lake on way to Dobrawolski / Oasis station, about four kilometres from the Bunger Hills field camp.*
4. *Jo in the communications building, testing equipment that was still in good working order.*

PHOTOS BY GRAHAM COOK

THE SEARCH FOR MAWSON'S AIR TRACTOR

1

BOB REEVES

In 2007–08 Mawson's Huts Foundation expedition doctor Tony Stewart thought it would be interesting to see if he could find remnants of 'Mawson's air tractor' – a Vickers monoplane used by the 1911–14 Australasian Antarctic Expedition. As a pilot and owner of a vintage aeroplane, he had an interest in aviation history. Searching for one of the early aeroplanes, and the very first to be taken to Antarctica, captured his imagination, time, enthusiasm and energy for the next three years.

I am not a pilot, nor an aviation enthusiast, but I am a scientist, engineer and doctor, and the search has also captured my time, enthusiasm and energy for the past two years. Eighteen months ago I went to Cape Denison with the Mawson's Huts Foundation as the team doctor, and part of my job was to continue Tony's search for the air tractor. We didn't find it, but there was enough positive evidence to keep looking.

Last year (2008–09) I returned as the engineer to complete a number of projects including the air tractor search. Tony went as the team doctor and we combined our efforts to narrow down the location. Of course the aim was to find the frame, but time and weather were against us. We did, however, narrow down the options considerably and have put the team for 2010–11 in a good position to finish the search.

The Vickers monoplane was based on the R.E.P. 60 HP five-cylinder, air-cooled, semi-radial engine aircraft designed by Robert Esnault-Pelterie, a remarkable French inventor. The steel fuselage was built in France while the wings were made in England. After being tested at Vickers' airfields at Dartford and Brooklands, it was crated and shipped to Australia for use by the Australasian Antarctic Expedition. Disaster fell when the wings were damaged beyond repair on 5 October 1911, during a practice flight in Adelaide.

The wings were removed and the machine was taken south, where Bickerton spent weeks converting the frame into an air tractor. Writing in the *Home of the Blizzard* after his return from Antarctica, Mawson said that the reason for taking the aircraft was more to attract publicity for the expedition's cause rather than for its serious use in reconnaisance in the Antarctic.

The machine was tested on 15 November 1912, followed by a successful depot-laying trip with 700 pounds of supplies on 2 December. The next day the air tractor was taken on its first, and last, major trip. Bickerton wrote:

'While moving along, the idle cylinder was ejecting oil, and this, together with the fact that it had no compression, made me hope that broken piston-rings were the source of the trouble. It would only take two hours to remove three cylinders, take one ring from each of the two sound ones for the faulty one, and all might yet be well!

These thoughts were brought to a sudden close by the engine, without any warning, pulling up

with such a jerk that the propeller was smashed. On moving the latter, something fell into the oil in the crank-case and fizzled, while the propeller could only be swung through an angle of about 30°. We did not wait to examine any further, but fixed up the man-hauling sledge, which had so far been carried by the air-tractor sledge, and cached all except absolute necessities.'

The air tractor never worked again, and the frame was abandoned on the shores of Boat Harbour when the Mawson expedition left in 1913. The engine, propeller and other items were removed before departure.

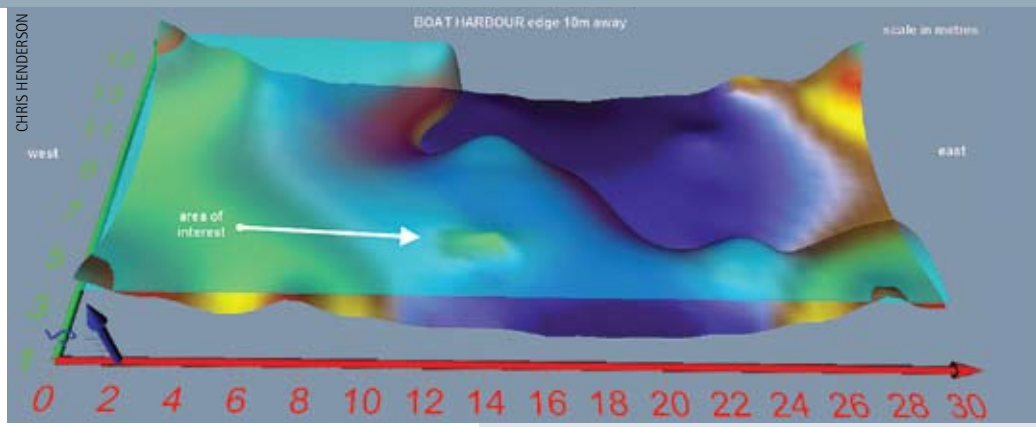
The frame remained on the ice for 63 years, before it disappeared. Bob Reeves, an Antarctic Division photographer, took the last photograph in 1976, showing all but 500 mm of the frame buried in the ice. By the next expedition in 1981, there was no frame. It seemed to me that the frame could not possibly have blown away (as some suggested), and the ice had been shown not to move, so the frame must have sunk in the ice. But photographs showed little sinking for about 60 years, so why had it disappeared between 1976 and 1981? A study of the continuous temperature records from Dumont d'Urville station (200 km away) showed that there was an extended period of high temperature in the years 1976 and 1981. Comparison between Cape Denison and Dumont d'Urville data showed the temperature could be up to 10 degrees higher at Cape Denison.

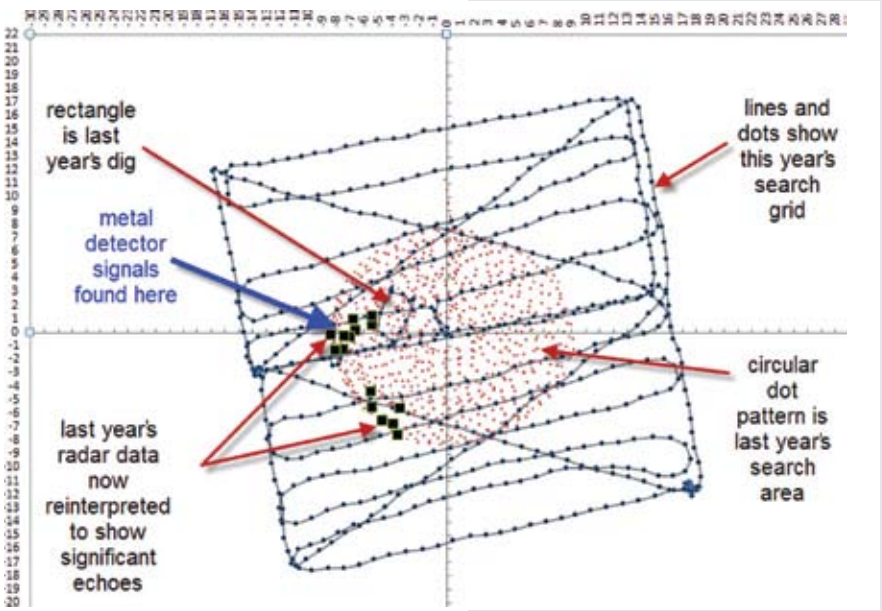
Mawson's reports indicated that the landscape can change very quickly in above zero temperatures. This was confirmed during the 2001 Mawson's Huts Expedition, and our experience this year (2009–10) was the same – it only took three or four days of continuous above zero temperature and heavy rain for the surface ice near the harbour to turn to slush. The temperature records showed that in both 1976 and 1981 the temperature stayed high for about six weeks. This is long enough for a substantial melting of the ice, and I think that the frame sank in situ to the rock surface, three metres below the present ice surface. In fact, the results of our ice auger drilling are consistent with the hypothesis that a large area of ice at the harbour edge may have melted down to bedrock, taking the frame with it.

To accurately estimate the position of the air tractor, comparison was made between three historical photographs. Careful study of the pictures enabled three transits to be drawn, which crossed at one point on the ice. We are pretty sure that this is where the frame sank.

The plateau ice above and on either side of the Cape Denison area is constantly moving. However, there are no features of moving ice in the vicinity of the air tractor's resting place, and discussion with glaciologists confirmed what Mawson said – the ice is stationary.

In 2009 I used ground penetrating radar to map the ice in the search area. I found an anomaly which looked significant, and we dug a 3 m x 3 m hole. We found nothing but a layer containing





The top graphic shows the shape of underlying rock in false colours with blue being the deepest layer. Superimposed over this bedrock is a transparent layer where we found hard ice when drilling. The cutaway area of this transparent layer shows where soft ice forms a 'bay' in the search area. This soft ice completely melted away at some stage and seaweed was recovered from areas of soft ice during the search. The anomaly at 14, 6 is roughly where the air tractor should lie.

The second graphic shows the story so far. The grid pattern is the search area, mapped using differential GPS. The red dots show the 2008 ground penetrating radar data and the black squares show the significant radar anomalies – the metal detector showed something in one of these areas.


2
FRANK HURLEY

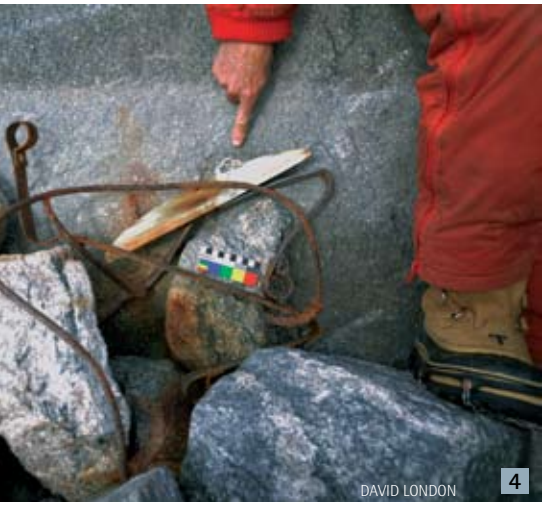
ERIC DOUGLAS 3

seaweed at around 2.5 m. I came away from that expedition with a clear plan to find out more about the depth of the ice and the shape of the harbour floor, since we knew nothing of the detailed sub-surface structure. For example, there could have been a deep trench in the rock into which the frame sank – the only survey of the harbour up till then suggested this could have been the case.

This year I used differential GPS to accurately map the height of the ice; bathymetry equipment to map the harbour floor; and ice augers to map the rock levels in the search area. I found that the rocks under the ice are level with the harbour bottom.

This means that the rock under the search area is about 500 mm below tide datum, and therefore 1500 mm underwater on a high tide. This explains why seaweed was often found at the bottom of the ice auger drill holes. Gravel was also recovered from some of the holes. This suggests a composition of the landform under the ice – gravel, seaweed, rock and ice – similar to that seen in some areas of constantly exposed shoreline in the area.

Using a pulse induction metal detector and a coil to place down the ice auger holes, we found that the only place with a positive reading was the spot where we previously determined the frame sank. The ice auger also brought up a small piece of corroded wire from this area.



DAVID LONDON 4

Putting it all together

This search has taken months of preparation, help from many interested parties, including the Australian Antarctic Division, and a physical search on three consecutive expeditions. We are now in a position to make some comments, all of which point to the likely location of the frame:

1) The harbour bottom is a shallow flat structure, which continues under the ice where the plane sank.
2) The ice in the search area is three metres deep and shows evidence of a substantial melt in the past.
3) There is only one place where we found metal, and ground penetrating radar shows an anomaly in this area.

It is likely that something lies three metres under the ice. It might be the frame, or it might be fragments. Ice auger drilling and metal detection are effective and fast ways to search the area. A dig should be attempted, but it takes about two days and four people to make a big enough hole. One hole is about the limit for one expedition, so it needs a bit more confirmation before the chainsaws come out.

On New Year's Day 2010 the tide was extraordinarily low, and one of our carpenters was poking around the sea edge near the search area. He found four connecting pieces, about 100 mm in size each, from the last section of the tail, which was cut off before the frame was abandoned. The media turned this into the frame being 'found', which of course it wasn't.

What it does show though is that the frame, or parts of it, can survive for nearly 100 years in this environment. This gives us further hope that when the next expedition digs for the frame, there will be something to find.

DR CHRIS HENDERSON
Mawson's Huts Foundation

Was the air tractor a Vickers No.1 or a Vickers No.2?

There has been some discussion about the designation of the air tractor – whether it was the first or second Vickers plane. In fact it was originally No.2, but was promoted to No. 1 (Harald Penrose, *British aviation – the pioneer years, p.* 308):

'...A.R. Low [the designer of the Vickers-R.E.P No.1 Monoplane] was phoned by Bertie Wood, who asked him to go to Brooklands to watch test flights being conducted by Robert Fenwick and Lieut H.E. Watkins acting on behalf of Dr Douglas Mawson, to whom Captain Wood had sold the next Vickers-R.E.P. for the following year's Australian Antarctic Expedition. Fenwick took off with an abnormally sharp climb, turned sharply at the end of the aerodrome, stalled, and spun half a turn in the ground. Vickers had quickly acquired their first repair job...'

Herbert Wood did not let it be generally known that the first machine had crashed. No.2 was quickly substituted and redesignated No.1 and then sent to Australia for Mawson. In short, Mawson ordered the No.2, but owing to the crash of the first aircraft Mawson's aircraft was promoted.

More information about Vickers aircraft: www.aviastar.org/air/england/a_vickers.php

1. *Last photo of the frame taken in 1976 by Australian Antarctic Division photographer Bob Reeves. The frame has not been seen since.*
2. *Bickerton with the air tractor. Note the third custom-built seat which was cut from the frame, and recently found at Cape Denison among the rocks across the harbour. The frame is at least 2.5 m tall.*
3. *The frame in 1931, as left on the ice in 1913. Note the mid-section containing the seat has been removed, and the last 3 sections of the frame have also gone.*
4. *Remains of an air tractor seat found and catalogued in 2008 by Anne McConnell. The seat was found on the northeastern edge of Boat Harbour about 200 m from the frame. Note the remnant of canvas on the back of the wooden platform.*

1 LUKE EINDOR

THE LIFE OF BIRDS

DARREN SOUTHWELL 2

3 LUKE EINDOR

4

When approaching Antarctic stations by sea or air it is clearly evident just how small a hold we have on the great white continent. The stations first come into view as a cluster of colourful specks on a small outcrop of land; dwarfed by the vast expanse of ice and snow. Once on station, the purpose-built infrastructure and multi-skilled team provides a safe haven that quickly settles the mind, and you feel surprisingly comfortable in an otherwise hostile land. But whenever you venture away from these already remote outposts the feelings of isolation and solitude can be overwhelming.

I spent six weeks completely isolated from Mawson station, with my colleague Darren Southwell, working on penguins and flying seabirds on nearby Béchervaise Island. Each summer the sea ice connecting the island to the continent melts, so that the only access is via small boats. Despite initially feeling daunted by the vastness of the landscape and the extremity of our isolation, over time I became very comfortable with our situation.

Béchervaise Island is the site of a long-term monitoring program on Adélie penguins (*Australian Antarctic Magazine* 17: 6-8, 2009), and has been visited each summer for the past 20 years by a small team of field biologists. The camp consists of one 'apple' hut, and two larger 'googies', or round pods, which are well designed to provide shelter from the Antarctic weather. These huts provide basic living facilities, are powered by wind and solar electricity, and have gas for heating and cooking.

Our six-week stay was required to closely monitor the breeding performance of the resident penguin and snow petrel colonies. This enabled us to witness eggs hatch and chicks grow, till they were nearly old enough to leave. Daily duties involved long walks around the island checking on nests and counting birds. We regularly encountered other avian residents such as south polar skuas and Wilson's storm petrels. Weddell seals were abundant and often hauled out on passing icebergs and remnant patches of snow around the coast. Less regular visitors included southern giant petrels and emperor penguins.

Interaction with the skuas was unavoidable as they aggressively defended their breeding territories around our camp site and the penguin colonies. They showed no fear of humans and would dive bomb us with great speed, sometimes whacking us in the back of the head. Despite my best efforts to sleep in, most mornings a pair of skuas would land on my hut and roll pebbles from the top. Seemingly the only purpose of such a habit was to stir a response from me.

Living in tiny huts and spending most of our time outdoors meant we were very conscious of the weather and the subtle differences in the surrounding environment. The sea ice we walked across to access the island took weeks to break up at first, but then drifted off within a number of days. We noticed substantial changes in day length during the course of our stay; from 24-hour sunlight in early January, to extended night time by mid-February. The low trajectory of the sun at this time of year provided spectacular sunsets that blended with sunrise, lasting many hours.

Our research kept us very busy and we created routines around work, cooking, leisure activities and fitness sessions. But after numerous weeks you cannot help slipping in to a rather leisurely pace, as if the silence and solitude of the surrounding environment slowly takes over. Many times I found myself engrossed by the dynamic state of the sea ice, as bergs moved to and fro with the tide and wind. I also spent hours at the edge of the penguin colony watching their daily activities and becoming well attuned to the many subtleties of their social behaviour. The constant arrival and departure of adults somewhat resembled that of busy airports, with an endless procession of greetings and farewells. Some individuals met their partners or chicks with little emotion, while others performed elaborate and extended displays with evident endearment and respect. The range of behaviours employed by different chicks also provided an insight into their individualism. Some were highly inquisitive and adventurous, endlessly exploring the boundaries of the colony, and regularly causing a ruckus. Others stayed very close to their nest, seemingly in fear of everything.

Our location off the coast provided panoramic views of the massive ice cap over the Antarctic continent, which rises rapidly from the coast to a height of a kilometre or more. Several mountain ranges were also visible, disappearing over the skyline as they ran southwards. High winds commonly blew snow off the peaks, creating clouds of snow on the lee side of mountains.

Upon departure I couldn't help but feel that our brief stay on the island had given us only a glimpse of what is a grand and ancient land. While I felt we had got to know the island, I am sure we still seemed quite alien to the many animals who call it home. But after six weeks without a shower, we probably blended in with the crowd quite well.

LUKE EINDOR
Field biologist, Australian Antarctic Division


LUKE EINDOR

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LUKE EINDOR

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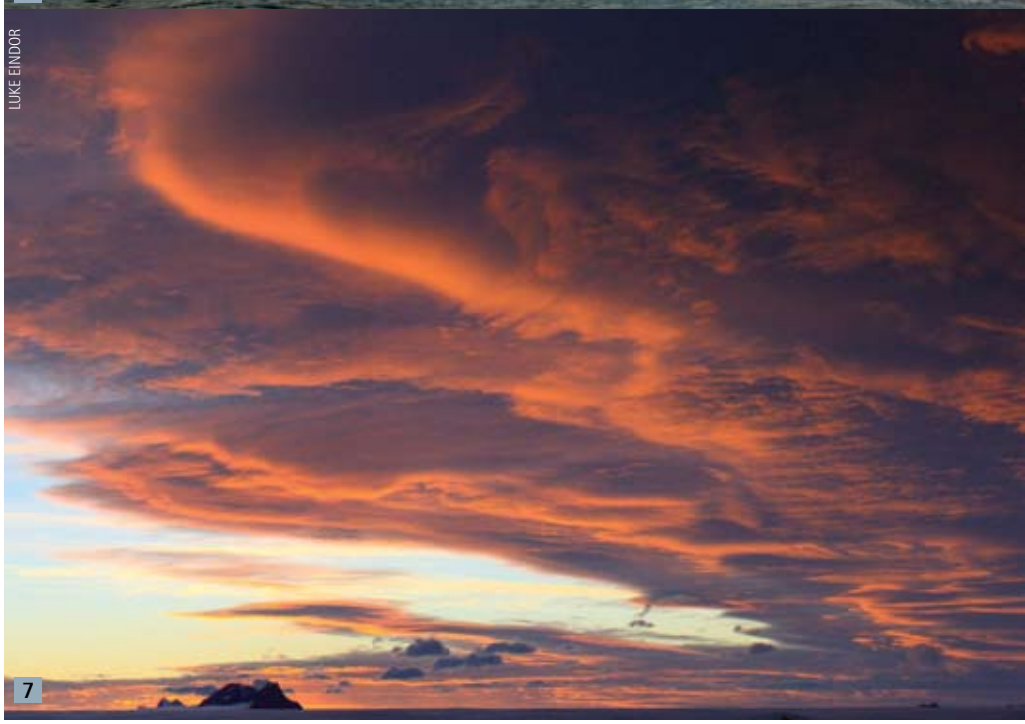
LUKE EINDOR

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1. *Adélie penguins scoot across the sea ice.*
2. *Field biologist, Luke Eindor.*
3. *South polar skuas.*
4. *Adélie penguin chicks snoozing.*
5. *Snow petrels dance in the snow.*
6. *The Béchervaise Island googie (orange) and apple huts.*
7. *Sunset over the David Range from Béchervaise Island with Mt Parsons and Mt Elliot in the foreground.*

IN BRIEF


SALLY CHAMBERS

Former Australian Prime Minister the Hon. Bob Hawke AC

New research fellowship honours Hawke Government

Former Australian Prime Minister Bob Hawke's push, in 1989, to prevent mining in Antarctica and protect the Antarctic environment, has been recognised with a new Antarctic research fellowship and a new Antarctic building, both carrying his name.

The R.J.L. Hawke Fellowship in Antarctic Environmental Science will be awarded on the basis of excellence to new doctoral graduates for policy-relevant science aligned to the Australian Antarctic Strategic Plan.

A new accommodation building constructed at Wilkins runway in the 2009–10 season has also been christened the Hon R.J.L. Hawke AC, Living Quarters, or 'Hawke's Hut'. The demountable building houses a mess, kitchen, laundry and bathroom facilities for runway crews.

The announcement of the fellowship and the building on 14 December 2009 marked the 20th anniversary of the Hawke Government's leadership of an international push to reject mining in Antarctica. Environmental organisations also mounted an effective grassroots campaign at the time.

Federal Environment Protection Minister Peter Garrett said the powerful alliance from the highest levels of the Hawke Cabinet, non-government organisations and the community in understanding the importance of Antarctica, deserved to be recognised and remembered.


PETER BARTLEY

Australia Day Awards

This year an individual Australia Day Award was presented to Bridget Payne for playing a key role in sharing knowledge and promoting teamwork across the Antarctic Division. A team award was presented to the Antarctic Division's glaciology research team, led by Dr Ian Allison, for taking a lead role in several major international collaborations of world-class research on the critical roles that Antarctic ice sheets and sea ice play in the global climate system. The team's work has contributed significantly to greater global understanding of trends in climate change and sea level rise.

The Australia Day Awards are provided to the Department of Environment, Water, Heritage and the Arts by the National Australia Day Council, and recognise the contributions of both individuals and teams in contributing to the achievement of the department's strategic plan objectives.

Bridget Payne, above, and some of the glaciology team members, below.


PETER BARTLEY


SA MUSEUM

A painting by artist J. Van Waterschoot Van Der Gracht, included in the publication.

Rare Mawson publication

To celebrate the centenary of Sir Douglas Mawson's 1911–14 Australasian Antarctic Expedition, the Friends of Mawson, the Friends of the State Library of South Australia and the Mawson Collection Management Committee have published the periodic newspaper, *Adelie Blizzard*, which was produced by AAE expeditioners at Commonwealth Bay in 1912 and 1913. The newspaper was a collection of poetry, scientific results, observations, comedy and fiction written by the expeditioners to keep boredom and depression at bay during the long, dark winters. Only five monthly issues were produced and none has been published before.

The 240-page full-colour facsimile reproduction of the original, hand-typed copy of *Adelie Blizzard* includes pencilled corrections by Mawson and Archie MacLean and additional rare paintings of Commonwealth Bay and Mawson by an artist on the relief ship, *Aurora*. The book is available in a limited leather-bound edition for $295 and a standard edition with a decorated cloth cover for $150. For an order form contact the Friends of the State Library of South Australia: phone (08) 8207 7255, email friends@slsa.sa.gov.au or visit their website www.australianapublications.org.au/contact.php

Amendments to the Antarctic Treaty (Environment Protection) Act 1980

Amendments to Annex II to the *Protocol on Environmental Protection to the Antarctic Treaty* (Madrid Protocol), agreed at the 32nd Antarctic Treaty Consultative Meeting in 2009, will establish more stringent arrangements to protect Antarctic fauna and flora. Federal Environment Protection Minister Peter Garrett introduced the Antarctic Treaty (Environment Protection) Amendment Bill to Parliament on 10 February 2010 to implement the amendments into domestic law. Key amendments include: enabling the Minister to declare invertebrates as specially protected species and specifying restrictions on the taking of native invertebrates; tighter controls on permits allowing non-native organisms into the Antarctic; and stronger measures to guard against the accidental introduction of non-native organisms to Antarctica. Details of the amendments can be found at www.ats.aq/. The Amendment Bill and explanatory notes are available at www.aph.gov.au/bills/index.htm.

The Ammendment Bill will enhance protection of Antarctic fauna and flora such as native invertebrates.


MARTIN RIDDLE


SALLY CHAMBERS

Ice core analyst, Tessa Vance, explains her work to school students.

Polar Palooza

In November 2009 three Australian Antarctic Division scientists went 'on the road', presenting their work to thousands of people around Australia as part of a United States-based education and outreach initiative to raise awareness of the significance of polar science for planet Earth.

The initiative, known as 'Polar Palooza' (the name was inspired by the American Lollapalooza music festival), was supported by the US National Science Foundation (NSF) for the International Polar Year. The show travelled through North America in 2007 and 2008. In 2009, to coincide with the 50th anniversary of the Antarctic Treaty and as a legacy of the recently completed International Polar Year, NSF funded tours in other countries, including Australia.

The Australian Antarctic Division partnered with Polar Palooza and worked with the Australian National Maritime Museum in Sydney, SciTech in Perth, and Questacon in Canberra to deliver a series of interactive, multimedia-rich learning 'adventures' (or presentations).

Our science 'stars', Martin Riddle, Rob King and Tessa Vance, presented their work in marine biology, krill research and ice core analysis. The US researchers covered the effects of shrinking sea ice on penguins and seals, and polar bears in the Arctic, and included an Inupiat (Eskimo) who told the fascinating and concerning story of changing climate on his community in Barrow, Alaska.

The Antarctic Division team had an exhausting schedule of events with multiple and often back-to-back performances to audiences of primary school children and adults. At Questacon they also participated in what is reputed to be one of Australia's biggest ever educational video conferences involving schools from most states. For more information see the Polar Palooza website at http://passporttoknowledge.com/polar-palooza/pp01.php

SALLY CHAMBERS, *Communications Manager, Australian Antarctic Division*


AAD

The first apple hut in Antarctica

An apple in the Big Apple

An Antarctic 'apple hut' is a major feature in an international travelling exhibition about Antarctica showing at the American Museum of Natural History in New York until 2 January 2011. The Tasmanian-made apple huts, or Igloo Satellite Cabins as they're formally known, have been a feature of Australian Antarctic field life for 28 years (*Australian Antarctic Magazine* 14: 30-31, 2008). The exhibition, 'Race to the End of the Earth' recounts the contest between Scott and Amundsen to reach the South Pole in 1911–12. It also includes a section on Antarctic Science Today, showing how scientists live and work in Antarctica today. More information about the exhibition can be found at http://amnh.com/exhibitions/race/

Environment and safety update

Antarctic expeditioners can better avoid sunburn now with access to real time ultra-violet radiation data from Australia's Antarctic and subantarctic stations (www.arpansa.gov.au/uvindex/realtime/antarctic_rt.htm) and the Antarctic Division's headquarters at Kingston (www.arpansa.gov.au/uvindex/realtime/kin_rt.htm). The data went live in December 2009 on the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) website. It is updated every minute. Long-term UV monitoring has been undertaken at the stations since 1988 using sensors located near the stations' medical facilities.

The Australian Antarctic Division's Environmental Policy was recently reviewed and updated with one significant addition – all managers are now accountable for the environmental performance of their teams. In the past, environmental management tended to be seen as the province of specific environmental sections within the organisation, but this change reflects the degree to which it has now been integrated into the mainstream work activities of all staff. Read our Environmental Policy at www.aad.gov.au/default.asp?casid=2648

ANNIE RUSHTON
Environmental Management System Manager, Australian Antarctic Division


GLENN JACOBSON

Information and Communication Technologies Award

Australian Antarctic Data Centre Manager Kim Finney received the inaugural *Australian Public Service Leading Female ICT Professional of the Year* Award in April. The award was developed by the Department of Finance and Deregulation and Dell Australia and recognises excellence across a number of categories centred on the attraction, retention and progression of female ICT talent within the Australian Public Service and from private and public sector organisations.

Kim was recognised for her extraordinary work for a number of different agencies and organisations including the Australian Antarctic Data Centre and former National Oceans Office. She played a lead role in establishing the Australian Ocean Data Centre Joint Facility, and developing successful major ICT funding proposals. In 2008 Kim was elected as the Chief Officer of the Scientific Committee on Antarctic Research (SCAR) Standing Committee on Antarctic Data Management. She drafted a Data and Information Strategy for SCAR, which is now being implemented across the organisation.

Institute for Marine and Antarctic Studies

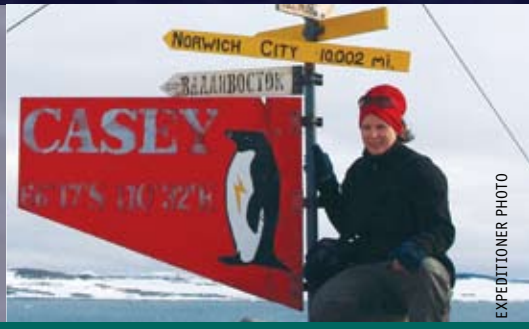
The new Institute for Marine and Antarctic Studies (IMAS), established on 1 January 2010, brings together the many strands of marine and Antarctic research being pursued in and around Hobart, to strengthen research links and exploit new research opportunities. IMAS brings together 200 staff and 140 graduate students from the Tasmanian Aquaculture and Fisheries Institute, the Institute of Antarctic and Southern Ocean Studies and some marine and Antarctic scientists from the University of Tasmania. The institute will also work closely with other research bodies including the Australian Antarctic Division and the Antarctic Climate and Ecosystems Cooperative Research Centre.

For more information see www.imas.utas.edu.au/about-imas

This image was taken from the Aurora Australis *in December last year, after departing Casey and becoming fairly well entrenched in heavy pack ice. While waiting for the C-212 to fly over to give a direction to proceed through the ice, this killer whale surfaced right next to the ship for a few seconds, in what appeared to be the only clear patch of water as far as the eye could see. It was a lucky encounter as these special creatures were elusive for much of the voyage.*

FREEZE FRAME

Susan Doust works in the Southern Ocean Ecosystems Program in the Science Branch at the Australian Antarctic Division. She participated in last season's marine science voyage (2009–10) and has previously summered at Casey station and worked on a fulmarine petrel research program on Ardery Island, off Casey. Her Antarctic experiences have provided much inspiration for paintings and other artworks that she does in her spare time.



EXPEDITIONER PHOTO

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