The Scottish Association for Marine Science | **NEWSLETTER 31**

SCOTTISH ASSOCIATION for MARINE SCIENCE

SAMS

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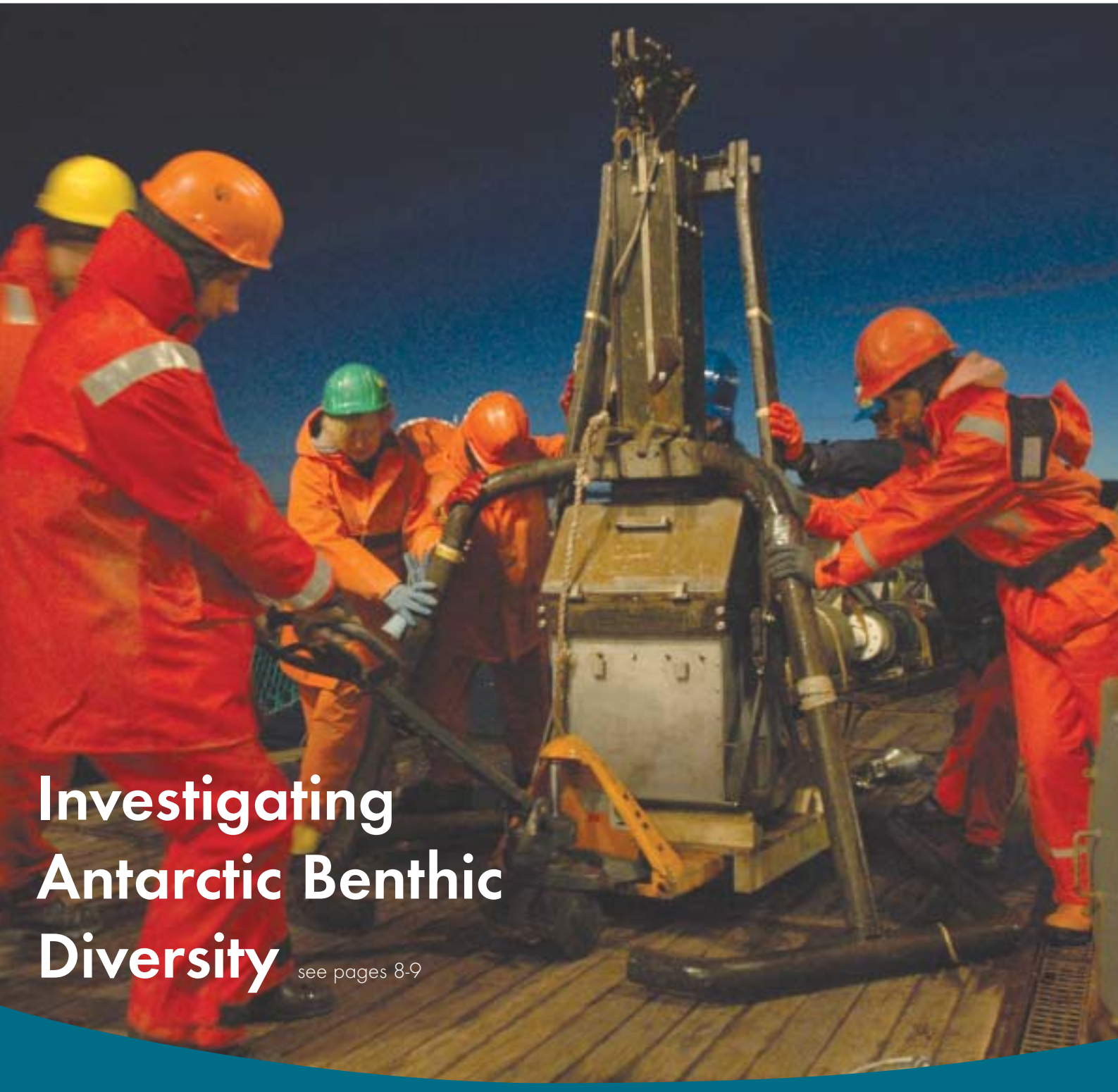

Investigating Antarctic Benthic Diversity

see pages 8-9

International Whaling Commission Meeting 2005

see pages 12-13

November | 2005

diary

Scottish Marine Group
Scottish Marine Research Overseas
27 October 2005, 10am-4pm
Stirling University,
Cottrell Building, 4A
E: J.M.Mair@hw.ac.uk

SAMS AGM & SAMS UHI Graduation
7 November 2005, 4.15pm
SAMS

16th Annual Newth Lecture
Can't see the fishermen for the fish: net benefits demand wider perspective
Dr Michel Kaiser
7 November 2005, 5.15 pm
SAMS

Sustainable Development Research Centre
Sustainability - Creating the Culture
2-4 November 2005
Aberdeen (AECC)
www.sustainableresearch.com/events/conferences.asp

11th Annual International Partnering Conference
Bio-Europe 2005
7-9 November 2005
Dresden, Germany
www.ebdgroup.com/bioeurope/

BlueBioNet Congress
17-18 November 2005
Malaga, Spain
www.blue-bio.net/index_en.html

3rd International Symposium
Deep-Sea Corals
28 November - 2 December 2005
Miami, USA
http://conference.ifas.ufl.edu/coral/

Alginet final meeting
Algae in Aquaculture
26-27 January 2006
E: ccap@sams.ac.uk

IMarEST
World Maritime Technology Conference
6-10 March 2006
London
www.wmtc2006.com/welcome/

Oceanology International 2006
21-23 March 2006
London
www.oe06.com

Society for Underwater Technology
Diving for Science and Archaeology
(at Oceanology International 2006)
21-22 March 2006
London
events.sut.org.uk/pdf/060321sciarchdiveb.pdf

Deep-Sea Biology Symposium
9-14 July 2006
Southampton
www.noc.soton.ac.uk/GDD/DEEPSEAS/symp-pages/sypmhome.html

Challenger Society for Marine Science
UK Marine Sciences Conference 2006
11-15 September 2005
SAMS
www.sams.ac.uk/challenger

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Front cover: Sediment is collected from the deep Antarctic seabed using a boxcorer. (© A Rose, Senckenberg Institute).

About SAMS

The Scottish Association for Marine Science (SAMS) is a Scottish charity (est. 1884), learned society, and company limited by guarantee committed to improve understanding and stewardship of the marine environment, through research, education, maintenance of facilities and technology transfer. SAMS is a Collaborative Centre of the Natural Environment Research Council, and hosts the National Facility for Scientific Diving, and the Culture Collection of Algae and Protozoa. It is an academic partner of UHI Millennium Institute under whose auspices SAMS delivers the BSc (Hons) Marine Science, and trains currently 22 PhD students.

As the owner and operator of the 2004 opened, new Dunstaffnage Marine Laboratory - three miles north of Oban - SAMS is an internationally renowned marine research establishment currently employing circa 120 staff. Our research activities encompass the entire breadth of marine science. SAMS focuses much of its scientific activities on multidisciplinary research questions from Scottish coastal waters to the Arctic Ocean.

SAMS is funded by an agreement with the Natural Environment Research Council for its Northern Seas Programme, by commissioned research for other public and private organisations, and by donations and subscriptions from its ca 600 members. SAMS operates SAMS Research Services Ltd, which delivers SAMS' commercial activities including the European Centre for Marine Biotechnology and Seas@SAMS.

SAMS Membership

Ordinary: anyone interested in marine science. Subscription - £12

Student: any person under 18, or registered students at Higher Education Institutes. Subscription - £5

Corporate: organisations interested in supporting marine science. Subscription - £60

Unwaged: anyone without a regular wage. Subscription - £5

For further information and application materials please contact the company secretary, Mrs Elaine Walton (Elaine.Walton@sams.ac.uk).

Editor

Dr Anuschka Miller
SAMS, Dunstaffnage Marine Laboratory, Oban, Argyll PA37 1QA, UK
Tel 01631 559300
Fax 01631 559001
Email Anuschka.Miller@sams.ac.uk

To keep up-to-date on events at SAMS, please visit our website:

www.sams.ac.uk

SAMS Board

Designed by Design Links Edinburgh / Glasgow

Dear **SAMS** member

Dr Anuschka Miller, EDITOR

Marine science is a fascinating discipline to be involved with, not only because of the subject matter and the exciting adventures experienced in the pursuit of collecting data but also, and perhaps first of all, because of the people engaged in it. One of these was Professor John Gage, who died this summer. John was as one of the longest-serving and most productive scientists at SAMS, highly respected internationally, a scientific star, and sometimes a diva. I shared with John an interest in politics and admired him for his active engagement in public debates. He was concerned about the destructive impacts of certain fishing practices on the deep-sea environment, and brought this to the attention of the public and politicians. John was also very supportive of the development of a university for the Highlands and Islands, and always encouraged those of us at SAMS working on making it a reality. I miss him.

Of course John was not the only scientific personality engaged with issues of public interest at SAMS. On pages 12 and 13 newly appointed SAMS scientist Dr Ben Wilson, infamous for sharing last year's IgNobel prize for biology with Bob Batty and others, reflects on his wealth of impressions from this year's International Whaling Commission meeting in South Korea. Ben will have his work cut out as the resolution of the whaling issue seems to remain a major challenge for the future.

This issue has a few pages more than most previous SAMS Newsletters. This reflects the flurry of activities at SAMS and in Scottish marine science. I find it an increasingly impossible task to choose which stories to cover, and which to leave out: it's all so interesting! I hope you'll agree.

SAMSnews

Professor Graham B. Shimmield, DIRECTOR

SAMS AND THE ARCTIC

As I write this introduction I am looking out at a vast expanse of broken sea ice in the central Fram Strait near 80°N. I am taking part in the SAMS Northern Seas cruise on board the RRS *James Clark Ross*. Being here in the vastness of the ocean surrounded by ice, it is hard to see the impact of man's activities on our planet. But then a polar bear comes into view, and the entire ship's company unleashes a barrage of digital technology capturing the moment. It is estimated that the summer sea ice extent will have reduced by 80% by the end of this century. Are we witnessing in our own life times irreversible trends in Arctic marine ecosystems?

Such large-scale questions deserve internationally coordinated responses, and it is for this reason that SAMS is heavily involved with the International Polar Year (2007-8), and is representing the UK's contribution to the new marine laboratory at Ny Alesund, Svalbard. I was delighted to be invited to attend the opening ceremony with the Norwegian Prime Minister, spending several hours with him afterwards in the informal setting of a cruise up the Kongsfjord to the glacier. Norway is acutely aware of

the importance of its natural resources and the impact of climate change on its traditional and new industries. Our collaboration with the Norwegian Polar Institute, and the Universities of Tromso and Bergen is an excellent way to develop lasting scientific links for future Arctic research.

SAMS ARDTOE CLOSURE

In April our investment in the former Seafish Ltd–owned aquaculture research facility at Ardtoe failed to convince stakeholders such as the Scottish Executive that investment would pay off in the long term. Research there was to focus on the sustainability of marine ecosystems, concentrating particularly on early life stages of white fish (cod, haddock and halibut). NERC had kindly supported a campaign to raise awareness of the value of the facility, but the Board was faced with the difficult decision to liquidate the subsidiary company when funding was no longer matching the outgoing costs. Through the work of the receiver, a substantial proportion of the jobs were retained with the new owners, Viking Fish, and the transfer of new appointees, Drs Dave Schoeman and Ben Wilson, to Dunstaffnage.

THE EUROPEAN CENSUS OF MARINE LIFE

Also in April, SAMS was confirmed as the project office for the European coordination of the international programme, the Census of Marine Life (CoML). With the appointment of Dr Bhavani Narayanaswamy as the project officer the new office will serve a range of existing projects within the CoML family, as well as helping to develop new projects with a particular European slant. The CoML is an ambitious, multi-million dollar international programme that will take our understanding of life in the oceans to a new dimension. A report of this project is given on page 6.

PROFESSOR JOHN GAGE

I would like to pay a very special tribute to Professor John Gage as a friend and colleague. John passed away on 18 July following a battle with cancer. He was the first person I knew from the former days at the SMBA, and was synonymous with the scientific reputation of the Association. John's enthusiasm and drive for the science, and his desire to try new approaches to deep-sea biology have been an inspiration to many. There is no doubt that SAMS will miss his towering intellectual contribution to the field of deep-sea biology. Tributes can be found on p 5.

FUTURE CORE STRATEGIC FUNDING

Over the coming months, SAMS enters another round of peer review with NERC for continuation of core strategic funding. This time, we are being encouraged to work together with the other marine laboratories in the UK. I believe the innovation and ambition we have demonstrated in the first five years of the Northern Seas Programme, and the international links we have forged, will stand us in good stead.

With that I return to the sound of crashing ice on the bow, and the biting wind of the Arctic wilderness, reminding myself that this is why I have made marine science my career, and how very fortunate I am.

> SAMS director Professor Graham Shimmield (left) and SAMS Vice-President Dr Ian Graham-Bryce hosted the opening event, here with Baroness Michie of Gallanach and Baroness Greenfield, the guest of honour.

SUSAN GREENFIELD OPENS ECMB

On the 5th April, Baroness Susan Greenfield opened the new European Centre for Marine Biotechnology. Surrounded by guests and staff, she gave an excellent and upbeat assessment of the importance of private venture and technology transfer in developing the basic capabilities in biotechnology, and marine biotechnology in particular, in the UK. She praised SAMS for visionary commitment, and the support and engagement of the enterprise companies, particularly Highlands and Islands Enterprise and Argyll and the Islands Enterprise, as well as the support from the European Regional Development Fund.

> 5th April 2005: Baroness Susan Greenfield declares the European Centre for Marine Biotechnology officially open.

> ECMB occupies the smaller of the two wings of the Dunstaffnage Marine Laboratory.

Professor John David Gage 1939-2005

PERSONAL TRIBUTES

Professor John Gage died on the 18th July 2005 after a short illness. To those of us in the deep-sea scientific community, we lost not only an esteemed scientific colleague but a mentor and personal friend.

TOWARDS THE DEEP SEA: JOHN'S EARLY YEARS

John Gage, born 14 November 1939, was a native of Salisbury, Wiltshire, and his early interest in marine biology stemmed from diving along the south coast of England. He went to the University of Southampton to study Zoology in 1958 and, on graduating, elected to pursue a PhD on the integrative behaviour and life history in some marine commensal associations. After his PhD he undertook a post-doc at Woods Hole (1964-1966) under the great Howard Sanders, who stimulated John's interest in deep-sea biology. A second post-doc took him to the MBA in Plymouth.

37 YEARS AT DUNSTAFFNAGE

In 1967 he was appointed to the Scottish Marine Biological Association, then in the process of moving from Millport to its new premises at Dunstaffnage. Thus began John's long association with the SMBA (now SAMS), which was to continue throughout his working life. During this long and industrious career he was awarded a DSc from the University of Southampton (1984), became a Fellow of the Institute of Biology (1984), gained individual merit promotion in NERC (1986), and held Honorary Chairs at the Universities of Southampton (appointed 1997) and Aberdeen (appointed 2000).

John always wanted to find out more and to see how the results of his science were being used. Unlike many, he didn't give the impression that the science belonged to him, he was keen for others to take his ideas forward, to use them. He was a gentleman scientist of the old school.

He was always interested in what I was doing, yet my work seemed to have little or no connections with his. But he was more than happy to spend time explaining how the different parts contributed to the whole environment. I think that is the image of John I will remember: he saw the bigger picture. There are not many Johns in the world, in fact he was unique.

Dr Dave Long
British Geological Survey

John's early years at Dunstaffnage were spent looking at the ecology and population biology of invertebrates in sea lochs. However, by the early 1970s his interest had been drawn to deep-sea biology in the Rockall Trough. In a brave and ultimately successful decision he undertook temporal studies in the deep sea to determine if there was any annual variation. To do this John established the Permanent Station at 2900m depth in the southern Rockall Trough. This was later supplemented by the megabenthos-rich Station M at 2200m at the base of the Hebridean Slope. By this time I was working regularly with John. In conjunction with the physics group at Dunstaffnage a series of regular cruises visited these stations until the mid 1980s, and more sporadically thereafter. The population analyses of invertebrates from these cruises demonstrated unequivocally for the first time that there were seasonal (annual) variations in growth in the deep sea.

Then John became involved in the modelling of these populations, an interest he maintained until his retirement in November 2004.

John also painted on a broader canvas: He maintained his interest in the NE Atlantic by involvement in a series of EU-funded programmes. But he developed an additional interest in oxygen minimum environments, and conducted cruises to the Oman Margin and later the Pakistan Margin.

These are all scientific facts evidenced by extensive publications culminating in the first text on deep-sea biology for over 20 years.

EQUIPPING THE NEXT GENERATION

A less well-known attribute of John's was his ability to bring young people into deep-sea biology. I was possibly one of the first to benefit from his scientific generosity in that he invited me to sea, shared samples and showed me how to run cruises. Subsequently, many of my own graduate students, as well as other students, benefited from participating on John's cruises. There are a number of young (and not so young) deep-sea biologists, whose first experience of deep-sea biology was with John.

Lastly, John had an international outlook. He worked with some of the best in the world, and was the first among equals.

On the 18th July, I lost a scientific colleague, a close personal friend and one of the great guides to my career. Although we worked 500 miles apart, I always felt he was in the lab next door, ready for discussion or advice should I need them. He will be sorely missed by all his scientific colleagues and friends. ●

Professor Paul Tyler
National Oceanography Centre, Southampton

> John's work in the Rockall Trough proved for the first time that seasonal growth patterns exist in deep-sea animals.

I was the last student to complete a PhD with John (2000) before going on to do a post-doc with him. Working with John always remained challenging, both at an intellectual and a personal level.

He taught me many things: to be a determined person, to have a desire to succeed, and to be incredibly diplomatic, and to compromise when the need arises. All these have stood me in good stead.

John and I may have had our disagreements, but he was my mentor, the person I wanted to tell about the exciting things we had discovered in the Antarctic (pages 8-9), and about more recent work that was undertaken on seamounts and banks in the NE Atlantic. Both of these areas John never got to explore, however, I feel that he would have been really pleased to know that we are finally undertaking work that he would have loved to have done.

Dr Bhavani Narayanaswamy
(John's academic daughter)
SAMS

European Census of Marine Life comes to SAMS

Dr Bhavani E Narayanaswamy, SAMS

The European Census of Marine Life (EuroCoML) has officially started. Its headquarters at SAMS will act as a node for coordination and support of European scientists and programmes that aim to contribute to the worldwide census due in 2010. Professor Graham Shimmield is the chairman of EuroCoML, and Dr Bhavani Narayanaswamy is the project officer.

ASSESSING AND EXPLAINING MARINE LIFE

The Census of Marine Life (CoML) is a 10-year initiative, which started in 2000. It is a global project that has grown to involve scientists from more than 70 nations. Its aim is to assess and explain the abundance, diversity and distribution of marine life in the oceans – with regards to the past, present and future.

To achieve maximum coverage of and participation in the Census of Marine Life, national and regional committees were formed. In Europe almost 30 countries border a coastline. But rather than forming national committees, scientists within Europe decided to create just one committee, the European Census of Marine Life (EuroCoML). This unified pan-European approach should allow a greater number of scientific experts to undertake larger research projects in areas within Europe, where marine life is either being exploited or not well studied.

THE AIMS OF EUROCOML ARE TO:

- improve marine taxonomy and species data in the European region
- improve biodiversity and ecosystem information for applied resource management in waters where European nations hold major influence
- increase European participation in those CoML projects where untapped potential remains
- expand partnerships and coordination with relevant European programmes and organisations in tandem with the general growth of CoML

EUROCOML AIMS TO MEET THESE GOALS BY:

- increasing awareness and rousing interest within the European scientific and sponsorship community
- organising workshops, and
- providing advice and supporting fundraising efforts

> Pictures courtesy of L A Henry, SAMS, European Cold Water Coral Reef Ecosystems, FW6 Marie Curie Fellowship.

PRESENT, PAST AND FUTURE MARINE LIFE

Under the CoML umbrella, 14 field projects are currently underway (see www.coml.org) to study current marine life. These projects range from the coastlines to the open ocean, from shallow to deep waters, from pole to pole, investigate all organisms from microbes to whales, and include the study of unusual environments such as chemosynthetic ecosystems and seamounts.

The History of Marine Animal Populations (HMAP) programme investigates the animals that used to populate the oceans in the past.

By incorporating HMAP and the current field projects, the Future Marine Animal Populations (FMAP) programme attempts to predict what will live in the oceans of tomorrow.

All gathered information will feed into the Ocean Biogeographic Information System (OBIS), a web-based provider of global geo-reference information on marine species. Such a system is already in place for European species: EurOBIS is run by Edward Vanden Berghe at the Flanders Marine Institute in Belgium.

Although EuroCoML is only just starting, three field projects of CoML are being led by European marine scientists: the Mid-Atlantic Ridge Ecosystems (MAR-ECO), Biogeography of Chemosynthetic Ecosystems (ChESS), and Census of Diversity of Abyssal Marine Life (CeDAMAR) (see pages 8-9 of this Newsletter). More projects to be led by European scientists are in the pipeline.

EuroCoML has funds to support workshops aimed at generating project proposals that will go some way to answer the questions posed by the Census of Marine Life. To obtain a workshop pro-forma or for further information, please visit our new website www.eurocoml.org or contact Bhavani Narayanaswamy at SAMS (BN-T@sams.ac.uk.)

The European Census of Marine Life would like to acknowledge funding from the Stavros Niarchos Foundation (Greece), and from Argyll and the Islands Enterprise.

My PhD Project

Japanese skeleton shrimp in Scottish waters

Gail Ashton, SAMS UHI

The invasion of non-native ('alien') terrestrial plants and animals beyond their natural range of distribution has been making headlines for many years. Scottish invaders - of which Scottish Natural Heritage in 2001 had identified 988 species - include such infamous organisms as the American mink, the grey squirrel, Sika deer, Japanese knotweed, and rhododendrons. The introduction of non-native invasive species changes the well established, recognisable identity of many habitats and impacts on native species. It is considered the second greatest threat to global biodiversity after habitat destruction.

But, of course, such non-native invasive organisms are not restricted to terrestrial and freshwater environments. We are becoming increasingly aware of a growing number of marine aliens, both plants and animals, including the Chinese mitten crab, Wakame, Japweed, and the leathery sea squirt (www.marlin.ac.uk/marine_aliens/about.htm).

For my PhD I am conducting the first detailed study of *Caprella mutica*, a Japanese skeleton shrimp that has been recently discovered on the west coast of Scotland. These caprellid amphipods – which join 22 native caprellids in our waters – are relatively large and robust, and orange to red in colour. *Caprella mutica* can be positively identified by the relative size of the three projections on the grasping margin of the propodus of gnathopod II (see image).

ORIGIN OF *C. MUTICA*

Caprella mutica is native to sub-boreal north-east Asia (Russian and Japanese waters), where it is found in abundance on macroalgae and artificial structures such as buoy lines and harbour walls. In introduced areas it is typically found on artificial structures, for example aquaculture nets and cages, buoy lines, marine vessels and oil platforms. During the summer it occurs in phenomenal densities of over 10 000 m^{-2}, and can give fish farm nets the appearance that they are moving in one great swaying action. The fact that it is found predominantly on artificial structures implies that humans may be playing a role in the introduction of *C. mutica*.

HOW DID *C. MUTICA* GET HERE?

The most common vectors for the introduction of marine aliens are shipping transport and transport associated with aquaculture. As caprellids have been identified on ship hulls and in ballast water, shipping is an obvious candidate vector. But as *C. mutica* is particularly abundant at aquaculture farms, vessel movements between such sites are also a possible vector.

The introduction of *C. mutica* into North Pacific America has been attributed to the movement of oysters for cultivation. But considering restrictions on the movement of alien species (and on the species allowed as packaging material), boat traffic between aquaculture sites is a more likely culprit.

On the west coast of Scotland I have found *C. mutica* on boat hulls, drifting macroalgae and free in the water column. These are the most likely vectors for small-scale movements.

< The Japanese skeleton shrimp, *Caprella mutica*, was spotted for the first time in Scottish waters in 2002. Since then we have identified it at many locations on the west coast.

> In Scottish waters *C. mutica* is largely confined to artificial structures such as aquaculture nets.

> *Caprella mutica* can be distinguished from other caprellids by the prominent middle projection on the propodus of gnathopod II (© K Willis, SAMS).

IS *C. MUTICA* ALSO INVADING OTHER AREAS?

To date, *C. mutica* has been identified from all oceanic coasts in the northern hemisphere. It was first reported as an introduced species in Humboldt Bay, Pacific North America in 1973. Since then it has been introduced to Europe (Netherlands, 1995) and Atlantic North America (several locations since 2003). The first and only sighting from the southern hemisphere was from New Zealand in 2004. It is predicted that *C. mutica* will continue to spread along invaded coastlines, and will be introduced to new sites in the southern hemisphere.

DOES *C. MUTICA* CAUSE ENVIRONMENTAL PROBLEMS?

We don't really know. As they are larger than native species, they could out-compete these in natural habitats. In summer months, when they are found in highest abundances, they cause extra work in lifting fish farm nets, in some cases demanding stronger machinery. Several mussel farmers have expressed concern that the caprellids may prevent juvenile mussels from settling onto their ropes, or that they feed directly on newly settled mussels. This concern is shared by their colleagues on the east coast of Canada. The relationship between *C. mutica* and mussels is the subject of a project soon to be launched with Canadian collaborators.

As no negative impacts of *C. mutica* on the invaded environment have been scientifically proven to date, strictly speaking it cannot be called an alien invader.

DOES *C. MUTICA* HAVE ANY USES?

They could one day be used for fish food, medicines, anti-fouling materials… who knows…

I am often asked what they taste like, but must admit that my scientific curiosity hasn't stretched quite as far yet, and the much improved student funding preserves me from being forced into such experimentation…●

Gail Ashton is a second year PhD student at SAMS UHI, supervised by Drs Liz Cook, Kate Willis and Mike Burrows (all SAMS). She is a NERC-funded student.

Cool adventures

AN EXPEDITION TO ASSESS DIVERSITY OF ANTARCTIC DEEP-WATER FAUNA

Drs Bhavani E Narayanaswamy & John A Howe, SAMS

We have recently returned from a three-month sampling trip to the icy seas around Antarctica. The cruise on board the German research ship *Polarstern* was the third cruise for the Antarctic Benthic Deep-Sea Biodiversity Programme (ANDEEP) in conjunction with the physical Weddell Sea Convection Control Programme (WECCON). Almost 50 scientists from over a dozen countries participated in this multi-disciplinary expedition. Here we give an account of our latest Antarctic adventure.

The main aim of ANDEEP is to survey the fauna of the Scotia and Weddell Seas. These seas are over 4000m deep and belong to the least explored parts of the world's oceans. We know almost nothing about the bottom-dwelling animals that inhabit these cold and permanently dark environments.

Animals from the shallow waters of the Antarctic continental shelf exhibit striking and unusual characteristics such as gigantism and longevity. These features are believed to reflect the isolation of the shelves and their special environmental characteristics, particularly the persistently cold climate. The deep waters surrounding the Antarctic continent in contrast are not isolated but fully connected with the Pacific, South Atlantic and Indian Oceans. One hypothesis even suggests that the deep waters of the Weddell Sea have been distributing Antarctic deep-water animals northwards into the Atlantic Ocean over millions of years.

Our cruise started on 21 January from Cape Town on a gloriously sunny but windy day. We stood with friends and colleagues on the top deck and watched as the ship pulled up her anchor and we said farewell to Cape Town. This was the last view of solid land we would have for several weeks. At the beginning the main focus of the cruise was to collect physical data along the Greenwich Meridian transect. We sampled a few stations in the Cape Basin to help complete the DIVA project led by the Germans, but our intense phase of sampling was yet to come.

On the 11 February we arrived at the shelf ice of Queen Maud Land and the main German base of Neumayer. While supplies were being unloaded to restock the base in preparation for the long and harsh winter, we made good use of our first opportunity to get off the ship and explore the ice. The station is located ten metres under the shelf ice, and the tour of the facilities was therefore particularly interesting. We then headed back for the ship to join an amazing multinational gathering with Swedish scientists, who had flown in, South Africans from the research ship R/V *Agulhas*, the Germans from the base, and us.

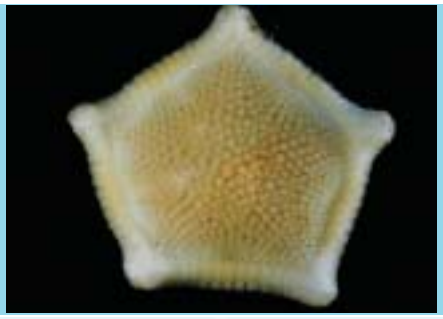
Shortly after this relaxed little break the biological and geological sampling kicked into full swing along the Kapp Norvegia transect. We focussed our efforts on collecting sediment cores from the multi-corer and boxcorer. This was a very busy process as the cores had to be selected and removed, the overlying water siphoned

> Bhavani and John in Antartica (© A Rose, Senckenberg Institute).

> Running into pack ice at night is fascinating yet eerie. The expertise of captain and crew kept us safe and working (© A Rose, Senckenberg Institute).

> Map showing the cruise track.

(© B Danis, Institut Royal des Science Naturelles de Belgique).



> We know more about the large mammals of Antartica, such as fur seals (right), than the fauna of the Antarctic deep seabed, such as this seastar (left).

(© B Narayanaswamy, SAMS).

off, and the cores sliced. Then each sample had to be gently elutriated to keep the animals as intact as possible, as this makes identification easier. We sorted and identified samples on ice to keep the animals alive for as long as possible, and took photos of any particularly interesting specimen. Back at SAMS John will be examining his deep-sea sediment cores for geochemical and physical characteristics that might provide clues as to the changing depositional environment over the last 10 000 years. Bhavani will use her samples to investigate the abundance and diversity of the macrofauna living on and in the sediment.

After one particularly long night at work we suddenly found that we had gained companions in the form of two humpback whales. They spent hours swimming around the ship, keeping scientists and crew entertained, before we left for our next sampling station.

As we continued our sampling we occasionally ran into pack ice. At times this was so thick that the ship had to use her weight to break a route through it. This was fun for us to watch but we all relied heavily on the expertise of the captain and crew to guide us through.

From Kapp Norvegia we moved out into the Weddell Sea to undertake sampling at some very deep stations, about 4500m deep. At some of these stations the outside air temperature was so cold (-16° C excluding wind chill) that, as the equipment came out of the sea, the overlying seawater in the cores began to freeze. These cores had to be sliced and sieved indoors to prevent damaging the fragile organisms that we had tried so carefully to collect. Coincidentally that also helped to prevent damage to the scientists! One night, while we were sampling in the Weddell Sea, we saw the British Antarctic Survey ship, the RRS *James Clark Ross*, all lit up in the distance. Members of the SAMS sea ice group were on board.

From the Weddell Sea we headed into the intriguing Powell Basin for some sampling. The samples looked extremely interesting and promising. Further analysis, however, is required to validate our excitement.

Next we visited the Argentine base of Jubany on King George Island. Here we collected two scientists before heading to Adelaide Island and the BAS Rothera base. Travelling down the Peninsula became increasingly more breathtaking.

The entire ship was invited to tour the base at Rothera, where we bumped into an ex-SAMS member of staff, Simon Morley, and to visit the RRS *Ernest Shackleton* that was providing supplies for the winter.

We had made such good time in the previous months that we could fit in a few extra sampling stations before we headed for Punta Arenas in Chile. ●

ANDEEP is a field project for the Census of Diversity of Abyssal Marine Life (CeDAMAR), and data generated from the projects will be used for the Census of Antarctic Marine Life. Both are Census of Marine Life programmes (see page 6).

We would like to thank the Trans-Antarctic Association for travel bursaries. BN would further like to express her gratitude to Dr J Blake, ENSR Woods Hole, for providing equipment through an NSF grant. Finally, a big THANK YOU to the crew and our fellow scientists for making this expedition one that we will never forget!

> The German Antarctic base Neumayer is located 10m under the ice shelf. (© A Rose, Senckenberg Institute).

> Once samples arrive, there is frantic activity (© J Howe, SAMS).

15th ANNUAL NEWTH LECTURE (2nd November 2004, Dunstaffnage)

Hydrothermal exploration: o

Professor Chris German, National Oceanography Centre, Southampton (now at Woods Hole Oceanographic Institution, USA)

In this lecture I discuss recent developments in the search for hydrothermal activity at the bottom of remote ocean basins, its relevance to the origins of life on Earth and its potential as a mechanism for seeking out life elsewhere in our solar system.

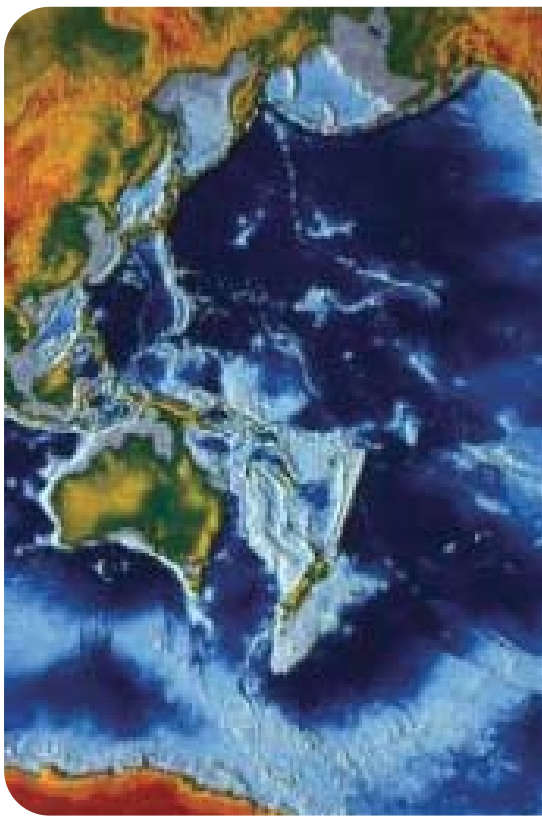
> Hydrothermal animals in the Pacific (tube worm, left) differ from the blind shrimp that fill the same niche in the Atlantic (© C. Fisher and T. Shank).

At the time of the Challenger Expedition, little more than a century ago, it was mistakenly believed that the floors of Earth's deep ocean basins were monotonously flat, lifeless and, consequently, deeply uninteresting. We now know quite the opposite to be the case. By the end of World War II much greater attention was being paid to the shape of the ocean floor. Ridges such as the Mid-Atlantic Ridge, halfway between Europe and North America, were discovered to exist also in the middle of other ocean basins. With the advent of the plate tectonic revolution, the significance of these ridges was finally recognised: fresh magma is erupted along mid-ocean ridge spreading centres, forcing plates apart at rates between 1 and 20cm y^{-1}. Only as the freshly formed ocean crust cools, over tens to hundreds of millions of years, does this material finally become dense enough to sink back into the Earth's interior, forming the deep trenches of *e.g.* the westernmost Pacific.

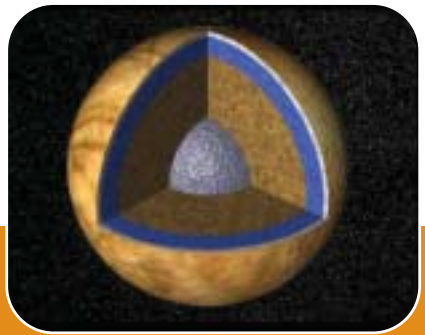
With the advent of satellite altimetry techniques it is now possible to pick out the large-scale topography of the global ocean bottom. This reveals that mid-ocean ridges actually form a nearly continuous globe-encircling volcanic mountain chain, which extends for more than 55 000km from the Arctic via the Atlantic and Indian Oceans into and across the South and then East Pacific Oceans.

One of the most surprising discoveries at mid-ocean ridges have been hydrothermal vents. Here seawater reacts with freshly-formed young ocean crust, and hot (350-400°C), metal-rich, toxic, and highly acidic fluids are emitted from the seabed. The first known hydrothermal fields were found along the fast-spreading East Pacific Rise, just off Mexico, where volcanic activity is at its highest and ridge-spreading at its fastest (about the rate that human hair grows). By contrast, the slow-spreading Mid-Atlantic Ridge (spreading at the rate that fingernails grow) was initially considered to be dormant. In recent years, however, we have used systematic exploration techniques to show that hydrothermal vents can occur in every known ocean basin, from the Pacific to the Indian Oceans, from North to South Atlantic, and even in the Arctic and Antarctic. In most cases, these hydrothermal vents are very similar in fluid composition, resulting from interaction between seawater and basaltic material, the most common rock type formed at all mid-ocean ridges.

The reason why we have been keen to find many different vent sites is biological: At every new vent site, new species previously unknown to science have also been discovered. To date, more than 500 such species have been found in a period of about 25 years. This is equivalent to an average rate of discovery of one new species every fortnight for more than a quarter of a century. Importantly, the organisms inhabiting hydrothermal fields, unlike the hydrothermal fields themselves,



are NOT the same in all ocean basins. Instead, even though less than 10% of all the world's mid-ocean ridges have been investigated thoroughly to date, we can already identify at least six discrete biogeographic provinces: two in the NE Pacific Ocean, two in the North Atlantic, and one each in the Indian and SW Pacific basins. Although we know there to be hydrothermal activity present in other ocean basins (*e.g.* the South Atlantic,



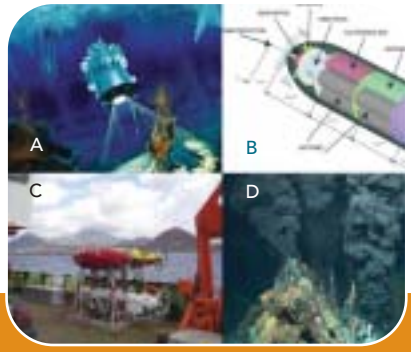
> On Jupiter's second moon, Europa, a liquid salty ocean underlies a thick ice cap. If there is volcanic activity, hydrothermal systems are likely . But will they sustain life? (NASA-JPL)

ases for life in distant oceans

> Mid-ocean ridges (pale blue) form a 55 000km long, nearly continuous mountain chain at the centre of the world oceans (NASA image).

Arctic and Antarctic) we have yet to dive there to discover what the local organisms look like.

Despite the differences in species between hydrothermal fields, every hydrothermal ecosystem shares the occurrence of *chemosynthesis*: the ability, at the base of the local food chain, to extract energy from the reduced chemicals emitted from hydrothermal fluids (*e.g.* methane, or hydrogen sulphide). This contrasts sharply with the more familiar life-sustaining process powered by solar energy we rely on, *photosynthesis*. At hydrothermal vents life is extremely dependent on anaerobic hyperthermophiles, or, in layman's language, bugs that thrive at high temperature in low-oxygen environments.



Relevant exploration has begun:
A NASA's original concept plan (NASA-JPL)
B The latest design for space development (F Bruhn)
C The ABE vehicle from Woods Hole (C German)
D A vent recently discovered with ABE (K Haase)

The same types of organisms, especially those that thrive in the presence of free hydrogen, are situated at the base of what can be considered a theoretical, 'DNA-based' tree-of-life. This makes vent systems very relevant to the origins of life on Earth.

Recently, one area of my research has attracted interest from NASA: My particular expertise is to use chemical signals in the water column, coupled with geophysical imaging of the seabed, to track down where hydrothermal sources must be on the underlying seafloor. Over the past ten years we have pioneered the use of state-of-art deep-tow vehicles to locate new vent fields. In the past few months we have been further developing the use of *in situ* chemical sensors mounted on autonomous underwater vehicles. This latest development is of broadest impact because we have begun to use robots to do at least some of the exploration for us. If, in the future, robots may be able to do it all, this would be very exciting for astrobiology.

In the same decade that we have been progressing our exploration techniques, the Galileo and Cassini missions to the outer solar system have been demonstrating the presence of liquid oceans on the moons of Jupiter and Saturn. In one case in particular, Europa (the 2nd moon of Jupiter) has been shown to host a deep and salty ocean beneath a thick icy crust, but underlain, it is believed, by deep-sea volcanoes. Wherever such a setting exists on Earth, hydrothermal vents arise, even in the Arctic, where an overlying ice-cap also exists. It is not beyond the wit of man, therefore, to devise an expedition that could send a robot submarine to Europa and search for hydrothermal vents on its seafloor. Whether there will be life associated with any such vent, deep beneath the ice-covered ocean and protected from Jupiter's radiation belts, we cannot predict without looking. But we have taken some important steps forward in our ability to explore this further. The next small step will almost certainly be to use the same techniques to explore our own Arctic basins. ●

Deadlock, dead whales and

PERSONAL REFLECTIONS ON THE IWC MEETING

Dr Ben Wilson, SAMS

> South Korean food was a challenging experience for western palates.

At the age of eight I might have been unsure of the boundaries between physics and chemistry but I was clear about what science was. Many years later, while sitting with 140 other professional scientists in a windowless meeting room in South Korea, the definition of science had become as cloudy as the miso soup that I had had for breakfast. The meeting I was sitting in was the annual scientific committee meeting of the International Whaling Commission.

The Commission, formed in 1946, began as a multinational club not to save the whales but to regulate competition within the whaling industry. Since then, the IWC has gone through many changes and the current discussions of the 66 member nations are now dominated by the global moratorium on commercial whaling.

Contrary to public opinion, whaling is not just something of the past. This year over 600 whales will be harpooned by Norwegian boats and done so legally because of the country's formal objection to the moratorium at its outset. Japan and Iceland also continue to harpoon whales but through what many see as a legal loophole: Nations are allowed to take whales for research purposes through a procedure known as Scientific Permit Whaling. The ruling was intended to permit actions such as an occasional take for a museum needing a skeleton or to answer a vital scientific question. The meat and other products can then be lawfully sold and eaten. What might be considered a valid scientific question is, however, open to interpretation. Japan has become particularly interested in scientific questions that can apparently only be answered by close inspection of the still steaming internal organs of whales from the Pacific and Antarctic. The government of Japan announced at this year's meeting a massive expansion of this scientific research effort. Unsurprisingly, this opened disputes within the scientific committee that ran deep into the Korean night.

For me, attending the IWC is an experience like no other. It's not a conference where people aim to network or promote their research. Instead it is an intensive, highly politicised two-week onslaught of aggressively chaired meetings and precisely bounded discussions. The intention is to produce a consensus report developing the scientific issues for the member-nation politicians. The challenge is finding any kind of consensus.

I attend as part of the UK scientific delegation and devote most of my efforts to several of the important but, thankfully, less publicised sub-committees. In particular, I sit on a sub-committee that deals with the world's small cetaceans: dolphins, porpoises and small whales. Most of our work focuses on the least known or most vulnerable species, and working with invited experts, draws international attention to their particularly urgent conservation concerns.

In one of my first years, I thought to make myself useful by offering to rapporteur for the Small Cetacean sub-committee. With help from the chair, the rapporteur turns the discussions into a report. Anticipating a glorified stenographer role I got a nasty shock. For a start, this sub-committee's discussions may have 40 to 60 contributors, total as many as 16 hours of involved group discussions, and draw on dozens of background papers. Condensing the divergent viewpoints and complex material into a 10 page report is not a process of simply taking and writing up notes, it's a creative slog. But here's the kicker: this report has to be written during the meeting and then agreed (line by line, word by word) by everybody on the sub-committee. Furthermore, many of the meetings

dietary challenges

2005 IN SOUTH KOREA

already run late into the night. The rapporteurs are often lobbied by interested parties outside the formal discussions, and the rapporteurs are themselves scientists contributing to the discussions of their own and other sub-committees. Put all of this together and the reason for the bloodshot, harried, disorientated, coffee-crazed look common to the meetings' rapporteurs is evident.

The venues of the IWC meetings have been nothing but spectacular: Japan, Monaco, Australia, Italy and next year it's the Caribbean. But somehow the intensity of the closed-door meetings blank out whatever attractions the venues might have to offer. This year was no exception. South Korea was clearly excited about the arrival of the annual IWC jamboree. The meeting was held in the city of Ulsan, the historical base for Korea's now extinct whaling industry. Accordingly, they'd pushed the metaphorical boat out for us. It started the moment we stepped off the plane. There, at the airport, was a uniformed guide waiting to take us to a bus emblazoned with the Korean meeting's bizarre logo (the world flanked on either side by a giant whale and dolphin grinning and sporting the thumbs-up sign). The expressway to the city and every other major road I saw was similarly emblazoned. As we sped past an electronic roadside information sign, it quickly flashed "A warm welcome to IWC members". Restaurants, clothing stores, and even banks welcomed us. One afternoon, I was getting something from my hotel room and chanced to look out the window. There, outside in the city's central street, were between four and five hundred of the nation's navy standing to attention saluting our hotel!

It went on and on. They'd rushed the opening of a fabulous new whaling museum specifically for our arrival; there were traditional dances outside the hotel every evening; the labels on the local spirit bottles in the supermarket announced our meeting. With difficult discussions in the hotel basement going on from dawn till dusk, most of these unexpected gestures were entirely lost on us. One, however, really caught our attention: Midway through the meeting, there's a day left blank. If things are going well, it's a day off, but, more usually, it's the agenda catch-up day. That evening the City Mayor invited the scientific committee to a game of football. Of course nobody had brought kit but the chance of some physical exercise and light relief were hugely welcome and people scurried off to find whatever suitable attire they could muster. At the appointed hour a fleet of coaches arrived and transported us to the pitch – not just any old pitch but a fully flood-lit, manicured, FIFA refereed World Cup Stadium! The resulting ramshackle match with a passing resemblance to football might not have been quite what the attending TV crew and local spectators had been expecting but it was a wonderful moment in IWC history. By a twist of fate or clever design, the self-chosen teams got mixed up at the last moment and scientific adversaries were handed similarly coloured football tops assigning them to play side by side on the same teams. Just for a few minutes, long-standing differences were forgotten as everybody sought the childhood dream of scoring a goal in a World Cup Stadium…

As much as the South Koreans were welcoming, the food was, well, challenging. There was no warm-up menu, it was full-on weirdness from the start. My first meal was seafood soup, from which my spoon immediately dredged up a sea slug. Each meal was a new challenge made even more interesting by translation issues. There were toasted silk worm larvae, cheese sushi, meat wrapped in nettle leaves, raw eggs on rice, desiccated squid, fermented cabbage, noodle soup complete with ice cubes, and many, many other things that shall remain, thankfully, forever unidentified… ●

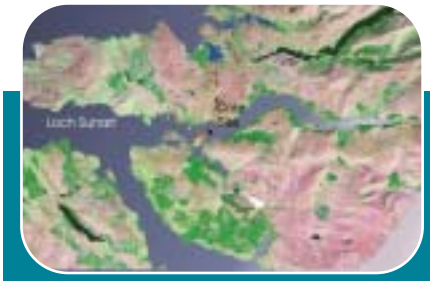
> The City Mayor invited the scientific committee to a game of football – in South Korea's World Cup Stadium!

> The opening of the fabulous new Ulsan Whale Museum had been timed to coincide with the IWC meeting.

10,000 years of environmental change

READING THE STORY WRITTEN IN THE SEDIMENTS OF LOCH SUNART

Dr John Howe, SAMS & Dr Bill Austin, St Andrews University



> Loch Sunart is ideally located to monitor changes in westerlies and precipitation.

> The RV *Marion Dufresne* has a giant-corer handling system that allows cores of up to 60m to be collected.

We have been examining a sediment core from Loch Sunart for records of environmental change covering the last 10 000 years. In June 2004 the Calypso piston corer on the French Polar Institute's research vessel RV *Marion Dufresne* collected a 22m core, the longest ever taken from Scottish coastal waters. Loch Sunart on the Ardnamurchan Peninsula is up to 120m deep and 28km long. It is ideally located to monitor both changes in the strength of the prevailing westerlies and in precipitation. Both these parameters have a profound influence upon circulation.

A detailed analysis of the core is revealing exciting new information on the history of climatic and sea level changes since the end of the last Ice Age. The information locked in these 'natural archives' includes records of past climate variations such as ocean temperature, chemistry, and precipitation. Sediment cores provide plenty of evidence for past abrupt climate changes and demonstrate how the climate system operates on timescales that cannot be measured instrumentally. To judge whether current climate warming is unusual, we have to base this on a solid understanding of past events and natural variability that only cores can reveal.

Our work is now focussing on oxygen isotopes recorded in the shells of foraminifera, on grain size variations, and on radioisotopes preserved within the sediments that have accumulated on the floor of the loch. The research, part of the SAMS Northern Seas Project, builds on several years' work conducted by the Universities of St Andrews and Caen at the Argyll loch, including a detailed geophysical survey with acoustic technologies to gather images of the bottom sediment of the loch.

SAMS and the University of St Andrews have been examining fjordic processes and their records of environmental change from diverse locations such as Scotland, Norway, and Svalbard. Drs. Austin and Howe are co-hosting an **international conference on fjordic records and processes** at SAMS as part of the Challenger Society Marine Science conference on 15th September 2006. For more information please contact John Howe (John.Howe@sams.ac.uk) or Bill Austin (bill.austin@st-andrews.ac.uk).

Monitoring toxic algae

DEVELOPING AN EARLY WARNING PROGRAMME FOR SHELLFISH TOXINS

Dr Keith Davidson, SAMS

> The dinoflagellate *Dinophysis*, which can produce the toxin that causes diuretic shellfish poisoning, is one of the phytoplankton genera included in the new toxic phytoplankton monitoring programme. (© E. Mitchell).

The Food Standards Agency Scotland (FSAS) recently awarded SAMS a large contract to monitor Scottish waters for toxin-producing phytoplankton, which supplements the statutory monitoring of shellfish flesh.

Under certain conditions various species of phytoplankton, a primary food source for many mollusc and crustacean shellfish, can produce toxins. Humans, who eat shellfish with raised concentrations of these toxins, may become very seriously ill with various forms of shellfish poisoning.

In compliance with EU directive 91/492/EEC, we now monitor Scottish waters for eight different species / genera of potentially toxin-producing phytoplankton including:

- dinoflagellates of the genus *Alexandrium* that may produce saxotoxin, responsible for paralytic shellfish poisoning
- dinoflagellates of the genus *Dinophysis* that produce okadic acid, causing diuretic shellfish poisoning
- diatoms of the genus *Pseudo-nitzschia* that synthesise domoic acid, the toxin leading to amnesic shellfish poisoning

We are developing over 30 sampling sites around the Scottish coast and islands, from where volunteer collectors regularly return water samples to SAMS for phytoplankton analysis.

In the laboratory we then monitor these samples by microscopy for the eight species / genera, and make the data rapidly available to collectors and FSAS alike.

Phytoplankton toxin production varies with species and growth conditions. The presence of a potentially toxic species in a sample only indicates the potential for toxicity, and in itself does not result in the closure of shellfish harvesting in that area. This monitoring programme instead provides an early warning system, and should minimise product recalls.

The factors that cause phytoplankton to actually produce toxins remain poorly understood. Scientifically we hope that the collected data will improve not only our insight into the distribution patterns of harmful algal blooms in Scotland, but also aid our understanding of these factors.

Marine microalgae:

A SOURCE OF MOLECULES FOR MODERN MEDICINE?

Andrew Desbois, Gatty Marine Laboratory, University of St Andrews

> Marine microalgae have many antibiotic compounds that could be exploited for medical use.

Modern society faces the chilling prospect of a post-antibiotic world due to the serious problem posed by increasing bacterial antibiotic resistance. Resistance to conventional antibiotics is becoming more prevalent particularly amongst dangerous human pathogens such as MRSA (the multi-drug resistant form of *Staphylococcus aureus*). This organism infects around 5000 patients annually, and the figure is rising. One approach to combat this global threat is the discovery of new therapeutic antibiotics from under-exploited natural sources, for example the eukaryotic marine microalgae.

> *Phaeodactylum tricornutum* is a marine diatom that occurs in three shapes: oval, tri-radiate or, as here, crescent-shaped.

BIOCHEMICAL DIVERSITY OF MICROALGAE

Marine microalgae are a phylogenetically diverse group of single-celled microorganisms. Their huge genetic diversity provides the platform for the production of an almost unlimited array of chemicals. Despite considerable effort the group has been under-explored for the discovery of novel bioactive molecules such as antimicrobial compounds. Activities in cell extracts have been reported but rarely have further characterisations been performed. Advances in isolation and culture techniques, ever-improving methods for identification, and biotechnological improvements for their production make these organisms an increasingly attractive prospect for novel antibiotic discovery.

THE DIATOM *PHAEODACTYLUM TRICORNUTUM*

The research for my BBSRC-funded PhD, with supervisor Dr Val Smith and our industrial partner Dr Andrew Mearns-Spragg of ECMB-based Aquapharm Bio-Discovery Ltd., focuses on characterising antibacterial compounds found in cell extracts of the marine diatom, *Phaeodactylum tricornutum*. This diatom is a planktonic organism that exists in three morphs: oval, fusiform (crescent-shaped) or an unusual tri-radiate form. It is easy to culture and maintain in axenic (bacteria-free) conditions, which has the advantage that any compound isolated from this culture is definitely produced by the organism. The biology of *P. tricornutum* is well documented. Its genome is in the process of being sequenced, which will, in the fullness of time, permit the genes responsible for all biosynthetic pathways in this organism to be identified.

Axenic cultures grown under controlled temperature and light conditions are harvested and the cells subjected to extraction in aqueous methanol. The extracted constituents can be fractionated by reverse phase HPLC with antibacterial activity identified in each fraction by radial diffusion assay against a variety of target bacteria. In this assay clear zones appear in a lawn of bacteria where growth is inhibited. This assay is extremely useful for small-scale screening of antibacterial factors. But to characterise any individual factors revealed, larger-scale production is essential to provide sufficient quantity of each purified compound.

TETRABUTYL AMMONIUM PHENOLATE

Presently, several candidate antibacterial compounds are being studied by mass spectrometry and NMR. One molecule so far identified in the Comparative Immunology Laboratory at St Andrews is a tetrabutyl ammonium phenolate. However, the low yields obtained from our 20 dm^{-3} batch cultures have been insufficient to determine its complete structure. Future work aims to elucidate this and to establish its biological and potential commercial significance.

GOOD DRUGS MUST BE CHEAP AND EASY TO PRODUCE

Any compound discovered that is to be considered as a potential drug candidate must of course fulfil many requirements including low toxicity, high stability and great efficacy. Another selection criterion of major importance is the availability of cheap production methods. At present it is not economically viable to use microalgae as the production vehicle. However, studies may reveal molecules with novel structural motifs that could be used to design new therapeutics and be produced by synthetic methods.

If we hope to avoid the onset of an era in which our current collection of antibiotics becomes useless, we must continue to investigate under-exploited sources like marine microalgae for antibiotic activity. ●

> Laboratory-scale production of axenic cultures of *P tricornutum* is fairly easy, which is an important factor when selecting experimental organisms for biotechnology.

Maerl beds: nurseries for marine vertebrates and invertebrates

Dr Nick A. Kamenos, University Marine Biological Station, Millport

Maerl beds are an important habitat, comparable to sea-grass beds and even coral reefs in terms of their biodiversity. Current more holistic approaches to marine ecosystem management and high biodiversity observations prompted investigations into the role of maerl beds as nursery areas especially for commercially important species.

Maerl are free-living, non-jointed red coralline algae (Corallinales), which grow as twig-like nodules on the seabed and, where conditions are favourable, can form extensive beds. Live beds are characterised by a thin layer of pink living maerl overlying an accumulation of white dead maerl fragments, which may be several metres deep. Maerl beds form a very fragile three-dimensional habitat requiring specific conditions in which to grow. Beds are often found in shallow, sheltered areas with moderate water flow, overlying a substratum of sand, mud or gravel. Maerl is very slow growing: some of the fossil material at the base of live beds may have been there since the end of the last ice age, 8000 years ago.

During our investigations maerl grounds impacted by towed demersal fishing gears were observed to have a significantly lower three dimensional structure than un-impacted maerl grounds. Such impacts reduce the quality of these habitats and their ability to fulfil nursery area prerequisites. Un-impacted live maerl was observed to fulfil key nursery area requirements for both juvenile invertebrates and gadoid fishes. Densities of juvenile queen scallops (*Aequipecten opercularis*), soft clams (*Mya* sp.), sea urchins *(Psammechinus miliaris* and *Echinus esculentus)* and the common starfish (*Asterias rubens*) on the west coast of Scotland were significantly higher on un-impacted maerl than those on impacted dead maerl and other common substrata.

> Maerl beds are preferred nursery areas for juvenile invertebrates and gadoid fishes.

Additionally, un-impacted maerl was observed to increase the carrying capacity of shallow inshore nursery areas for juvenile cod, saithe and pollack, probably by providing them with a high biomass of juvenile food. Importantly, maerl was selected preferentially to gravel as a foraging ground, which had historically been assumed to be an optimal foraging ground for juvenile gadoids. Juvenile queen scallops appear to be attracted to un-impacted maerl beds following their initial settlement from the plankton.

Results also suggested that un-impacted maerl provides a unique combination of protection from predation coupled with high growth rates. This combination is rarely seen in other nursery habitats, which tend to offer a compromise between refuge and food availability. Until recently the role of maerl as a nursery habitat had been largely overlooked. Currently, maerl grounds are subject to an increasing range of pressures that diminish the quality of this habitat and, in turn, adversely affect potential recruitment to adult populations in the surrounding area. ●

> Towed demersal fishing gears can damage maerl beds and reduce recuitment into adult populations.

> Un-impacted maerl offers both protection from predation and high growth rates.