The Scottish Association for Marine Science NEWSLETTER 28

SAMS

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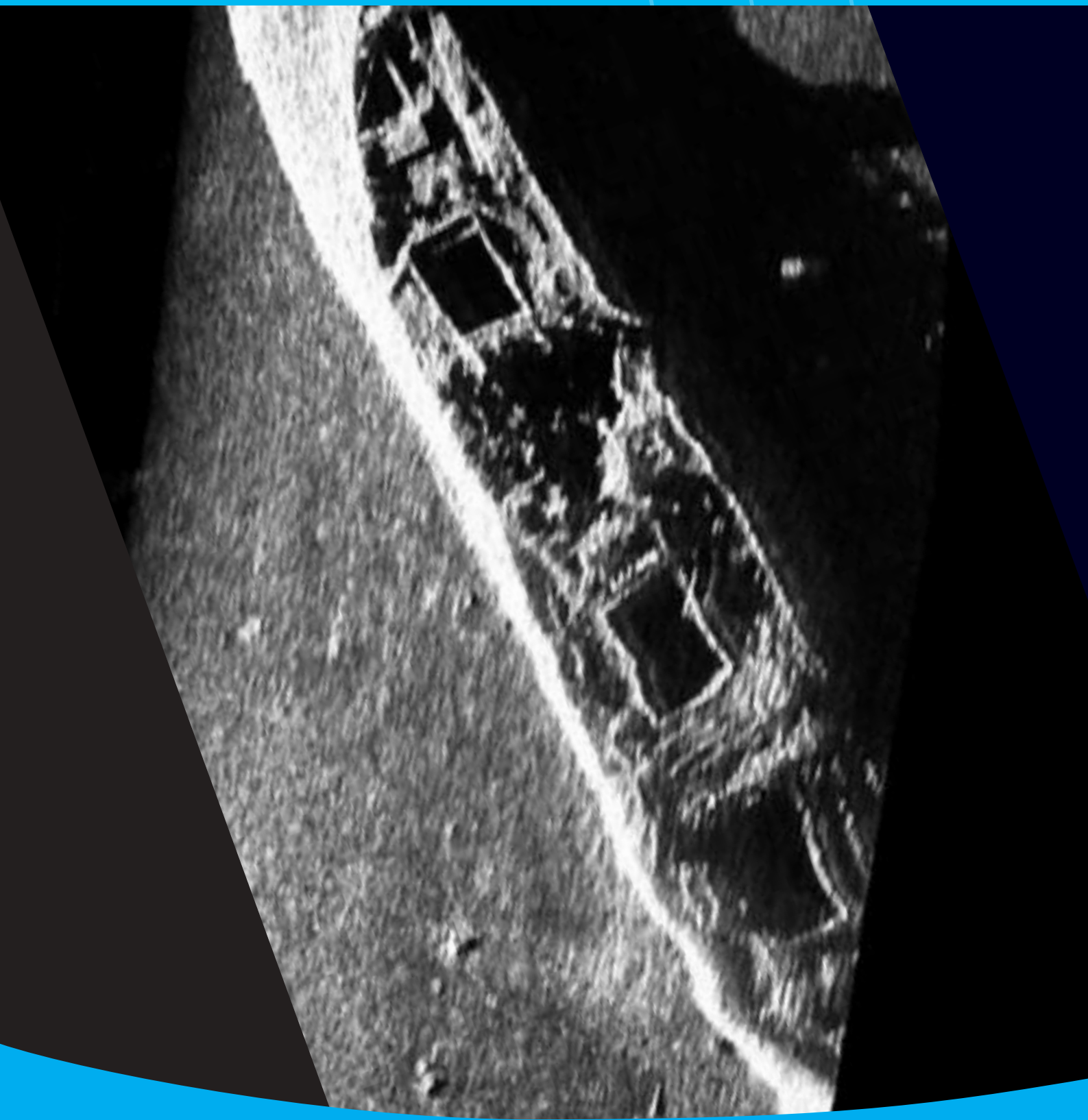

SEEING IN SOUND

TECHNIQUES FOR SEABED HABITAT MAPPING SEE PAGE 5

September 2003

Next Underwater Optics meeting
at PHOTONEX exhibition 2003
8 – 9 October 2003
National Agricultural Centre, Coventry
For more information please contact:
Michael Wall Tel: 01256 844443

AWI, CADIC & Hamburg University
Interactions between the Magellan Region and the Antarctic
and
Antarctic Benthic Deep-Sea Biodiversity
International Symposium & Workshop
19 – 24 October 2003
Ushuaia, Argentina
Website:
www.tierradelfuego.org.ar/cadic/ibmant.htm
Email: ibmant@tierradelfuego.org.ar

SMG Autumn meeting
Sea Fjords
Thursday, 30 October 2003
10.00 – 16.00
University of Stirling
For more information please contact:
Dr Hamish Mair Tel: 0131 451 3314
Email: j.m.mair@hw.ac.uk

SAMS AGM
4 November 2003 4pm
Dunstaffnage Marine Lab, Oban
Followed by
14th Annual Newth Lecture
Dr Phil Williamson (NERC/UEA)
Is Marine Management a Myth?

Oceanology International
16-19 March 2004
London ExCeL
www.oceanologyinternational.com

GLOBEC
4th World Fisheries Congress
Reconciling Fisheries with Conservation
2-6 May 2004
Vancouver, Canada
www.worldfisheries2004.org/

ICES-GLOBEC Symposium
The Influence of Climate Change on North Atlantic Fish Stocks
11-14 May 2004
Bergen, Norway
Contact: harald.loeng@imr.no

A Century of Discovery:
Antarctic Exploration and the Southern Ocean
28-30 June 2004
Southampton Oceanography Centre
www.soc.soton.ac.uk/Discovery

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Front cover: Sidescan sonar image of the wreck of the *MV Breda*, Ardmucknish Bay, Oban.
© Dr Jenny Collier, Imperial College London

Views expressed in this Newsletter are the views of the individual contributors and do not necessarily reflect the views of SAMS.

About SAMS

The Scottish Association for Marine Science (SAMS) is a charity committed to promoting research and education in marine science. It is based at the Dunstaffnage Marine Laboratory near Oban, and is a full academic partner in the UHI Millennium Institute.

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 600 members from all over the world.

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 forms please contact the editor.

Editor

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www.sams.ac.uk

SAMS Board

Designed by Design Links Edinburgh / Glasgow

Dear **SAMS** member

Dr Anuschka Miller, EDITOR

Last month the European Commission imposed an emergency ban on deep-water trawling around the Darwin Mounds to protect reefs formed by the cold-water coral *Lophelia pertusa*. Avid readers of previous Newsletters might remember that deep-sea scientists at SAMS had for some time called for the protection of the diverse *Lophelia* reef habitats after seabed surveys had suggested their sensitivity to trawling. To raise public awareness about *Lophelia* and the deep sea SAMS earlier this summer opened "Into the Deep", a permanent exhibition at the Scottish SeaLife Sanctuary in Barcaldine, supported by Copus and SNH, featuring the UK's only live display of *Lophelia*.

Our research on *Lophelia* recently attracted a visit from one of our most distant SAMS members based in Rio de Janeiro. Ana Cristina Cupelo and her colleague Fernando de Paiva from HABTEC Ltd travelled to Oban to discuss a collaborative project with Dr Murray Roberts (see picture) to investigate the impact of oil exploitation on Brazilian deep-water coral reefs.

Over the last years SAMS has increased its educational activity through the development of a multidisciplinary degree course in marine science, which was honours validated this spring. As a new provider of undergraduate education we depend on you, our friends and members, to help spread the word to ensure

© E. Poloczanska

that we can recruit some of the best students.

For many years the Scottish Marine Group has been convened by Dr Hamish Mair from Heriot-Watt University. This October's focus will be on sea fjords (see diary). The annual spring meeting is devoted to postgraduate students across Scotland, providing them with a platform to rehearse their presentation skills. The best overall, visual and poster presentations given this year are summarised on pages 10 and 11. I would like to express my sincere appreciation to Hamish for organising these events.

SAMSnews

Professor Graham B. Shimmield, DIRECTOR

© J. MacLaughlan, SAMS

The last six months have seen an unprecedented number of consultations and inquiries into the state of our marine environment and resources. The immense pressure on our fishing and aquaculture industries is now debated in political, social and academic circles. Simultaneously, the Royal Commission on Environmental Pollution, the Royal Society of Edinburgh, and the Cabinet Office Strategy Unit are examining different aspects of the fishing industry and its environmental and socio-economic consequences. Early this month the inaugural meeting of the Scottish Aquaculture Research Forum was held to discuss the implementation and funding of the research priorities identified (not least by SAMS) in the Strategic Framework for Scottish Aquaculture. Agencies in Scotland (Scottish Environmental Protection Agency and Scottish Natural Heritage) are facing the real challenges of implementing the monitoring and research programmes that accompany the Water Framework and Habitats Directives under European law. Defra has recently completed a 10-year examination of its future science priorities, and NERC, with other Research Councils, now focuses closely on delivering new proposals in a bid to win additional funding from the annual public expenditure round.

My point in identifying this plethora of activity is to comment on the enormous effort that is required to distil research strategies that are tractable, fundable and meaningful to our society. I see significant opportunity to combine innovative research, across discipline boundaries, with the regulatory framework. Monitoring activity now underpins our ability to examine the interannual effects of human impacts and climate change, as well as demonstrating the enormous improvements in remote controlled technology. However, there appears to be reluctance, in many quarters, to really engage all the research providers, funders and users to achieve significant outcomes for marine affairs, that address both sustainability and stewardship in the context of successful enterprise, and the need to manage, maintain and preserve our natural heritage. There are no short cuts through the challenges ahead, although I do believe that the SAMS strategy of excellent, relevant, independent science, and a willingness to engage and to learn from all our endeavours will take us forward with a strong sense of purpose.

EUROPE'S LARGEST ALGAL COLLECTION

At SAMS there have been some significant developments over the last quarter to report. Further details are elaborated in the articles in this Newsletter. The decision by NERC to recombine the marine and freshwater algal collections at Dunstaffnage has been welcomed most strongly. This returns the collection to its original structure when it was based in Cambridge. I am delighted that Dr John Day and his team will be relocating from Windermere to join us; this ensures the continuity and expertise that is required for this facility. In addition, Dr Frithjof Küpper, formerly at Roscoff, France and the University of California - Santa Barbara, will join SAMS in October as Head of Algal Ecology and the Culture Collection. Frithjof's expertise on algal ecology and biochemistry, augmented by experience in biotechnology applications, will ensure a cohesive development between the CCAP and the European Centre for Marine Biotechnology. With the significant support of NERC, we are now able to combine all the culture facilities and staff in the ECMB wing of the new Dunstaffnage development. Our challenge is to ensure that the largest algal collection in Europe has a strong linkage with research initiatives in both the marine and freshwater sciences, and acts as a catalyst for innovative applications and potential commercial developments.

© Andy Johnstone, SAMS-UHI

Work on the new laboratory building for the SAMS group – comprising of SAMS, the European Centre for Marine Biotechnology and SAMS Research Services Ltd. - is nearing completion. Staff will move into the new facilities during the autumn.

NEW PHYSICAL OCEANOGRAPHER

A key aspect of our science programme is Marine Physics. I am delighted to welcome Dr Toby Sherwin from Westlakes Research Centre, and formerly from University of Wales, Bangor. Toby joins Mark Inall's group initially working on the EU-funded MOEN project. His expertise in the physics of overflows, and the relationship to climatic forcing, significantly enhances our Northern Seas Programme. Toby's work on the Wyville-Thompson Ridge (one of our target sites within the Northern Seas Programme) is described on page 8. Toby also brings a huge wealth of experience, not only in the academic world of marine physics, but with dealing in real-world applications when he was at Bangor and Westlakes. This enhances our capability to deliver both new insights and capability for tackling issues and applications in physical oceanography.

HONOURS DEGREE IN MARINE SCIENCE

Within the education role of SAMS, I am delighted to report on the excellent result of the validation of the Honours year for the BSc Marine Science under the auspices of the UHI Millennium Institute. This is the first dedicated marine science degree covering all aspects of oceanography and applied marine sciences in Scotland. The Honours year marks a significant step forward in our ability to educate students to the standard necessary for high quality employment, or for continuing with post-graduate studies. Our first students enter the Honours year later this month and we wish them every success with their dissertation modules that characterise this formative year.

NEW BUILDING NEARLY COMPLETED

Finally, the new building is nearing completion. Inside, there are a myriad of fitters installing everything from a state-of-the-art ultra-clean trace metal laboratory to analytical gas supplies, miles of IT cabling and huge quantities of ducting for the fume cupboards and temperature controlled laboratory spaces. Of course, there are enjoyable tasks such as picking the colour scheme for walls, carpets and furniture – and the rather difficult task of deciding on office allocations! Through October the building will undergo thorough testing and commissioning with an entry date likely in mid November. I think all agree that the design and concept really sets a clear statement of intent for the future of SAMS and our role as a research, education and learned society for marine science in Scotland. ●

Seeing in Sound

MAPPING SEABED HABITATS IN UK COASTAL WATERS

Dr. Craig Brown, SAMS

For centuries man has been mapping the surface of the earth. With the dawn of the space age and developments in satellite technology, the production of maps of the surface of our planet has become increasingly more sophisticated. With remarkable success and accuracy modern techniques employ the use of electromagnetic waves (*e.g.* light) to image the earth remotely from space. However, as we move offshore to map the surface of our planet beneath the oceans, electromagnetic waves prove inappropriate as their transfer through seawater is insufficient. In this opaque environment sound transmission is the single most effective means of directing energy transfer over long distances, and therefore acoustic techniques are the preferred method of remotely imaging the seafloor.

Typical sidescan sonar fish. The tow fish transmits and receives sound as it is towed behind the research vessel to produces a 'photograph-like' image of the seabed. DARD sidescan sonar system

In recent years, the need to image and map the distribution of habitats and biota on the seabed has arisen with an increase in the demand for information on the status of the natural environment and the impact of human activities. Seabed maps constitute an invaluable tool for environmental managers and scientists. They provide a sound basis for making decisions from assessments of the severity of specific impacts on the seabed through to facilitating monitoring survey design.

A variety of acoustic systems are available today, from single beam acoustic ground discrimination systems, which infer the nature of the surficial sediment, through to sophisticated swathe systems, which provide data relating to bathymetry or seabed texture.

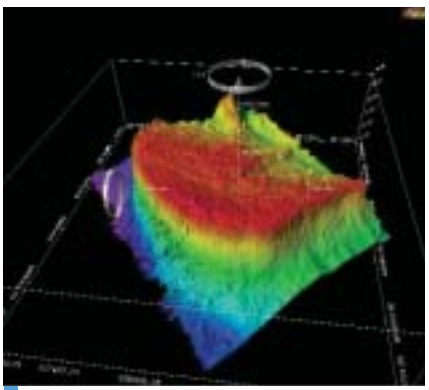
Which system to use for a specific task depends on a number of factors, including the seabed properties to be measured (*e.g.* bathymetry, surface texture, sediment type), the area of seabed to be surveyed, and whether complete coverage of the seabed is required. Many of the current acoustic systems have a proven record of measuring and imaging geological properties associated with the seafloor. Their use in studying benthic ecosystems, on the other hand, is a relatively new field and interest is high in assessing their suitability for seabed habitat mapping.

SIDESCAN SONAR

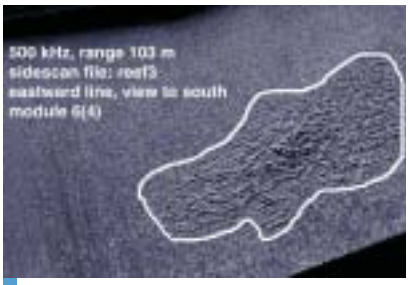
In the spring of 2002 SAMS, with Imperial College, conducted an extensive sidescan sonar survey around the developing Loch Linnhe Artificial Reef, off the east shore of Lismore near Oban, to produce baseline habitat maps of the area. These would aid in the detection of any environmental impacts on the seabed as a consequence of reef construction. Sidescan Sonar produces 'photograph-like' image of the seabed based on sound transmitted and received from a towed sensor. Based on textural patterns and the intensity of the reflected sound, the image can be used to identify discrete seabed features and objects and to infer sediment types. Data from this survey are currently being processed, but preliminary results indicate that the technique was successful in identifying distinct habitat types across the region, and was capable of accurately mapping artificial reef modules (see images).

MULTIBEAM SONAR

In the Summer of 2003 survey work on the The MINCH project (Mapping INshore Coral Habitats) utilised a sophisticated multibeam sonar system to image the seabed in the Minch, West of Scotland.



Multibeam sonar image of the north channel peaks.



Sidescan sonar image of artificial reef blocks. The white line delineates the spread of reef blocks (~40m), clearly identifiable as a rougher feature.

This type of system uses a transducer mounted on the hull of the research vessel to collect data, relating primarily to bathymetry, over a swathe of seabed several hundred meters wide. By running parallel survey lines, large areas of the seabed can be mapped.

ROXANN

In September 2003 SAMS hosted a National Seabed Mapping Workshop, focusing on the use of another type of acoustic system, RoxAnn. This acoustic ground discrimination system collects data from a single beam echo sounder in order to infer sediment type, and is widely used for mapping seabed biotopes in Special Areas of Conservation (SACs). The aim of the workshop was to standardise data collection and processing methodologies using this system. Key research teams from around the UK participated in the workshop. On the final day of the workshop environmental managers/advisors involved in the implementation and end use of biotope maps attended. Issues relating to accuracy, predictive capability and system limitations were discussed along with wider issues relating to the future direction of seabed habitat mapping within the UK. ●

My PhD Project

Comparisons of artificial and natural reefs

Jenny Beaumont, SAMS/UHI

Artificial reefs have been deployed world-wide for a variety of reasons, e.g. to enhance fish stocks, to protect vulnerable habitats, or for recreational use for SCUBA diving and fishing. Popular construction materials include old ships, concrete blocks, and old vehicle tyres. However, there seems to be no limit to what may be termed an "artificial reef" with examples of old fridges and submerged cars serving as materials.

Despite the widespread use of artificial reefs, surprisingly little research has been conducted to establish if, how, and why these reefs might work. Published studies suggest that population densities of fish and other mobile species are often higher on and around artificial reefs than in surrounding areas. This may be a result of the increased physical complexity of reef structures offering more niches and shelter from both environmental factors and predators, or from an increased availability of food.

A controversial debate currently considers whether artificial reefs actually increase the productivity of an area or simply attract mobile individuals from the wider surroundings. This is an important question, not least because many mobile species, such as lobsters, crabs and fish, are potentially commercially valuable.

As part of a collaborative programme between SAMS and Foster Yeoman Ltd., a local quarrying company, an experimental artificial reef is under construction on the west coast of Scotland. Situated in Loch Linnhe, the artificial reef, when finished, will consist of 42 discrete reef modules of varying sizes and designs totalling in the region of 25,000 tonnes of reef blocks. The Loch Linnhe Artificial Reef will allow wide-scale research on various aspects of reef design and use, as well as on the reef's impacts on the surrounding marine ecosystem.

My PhD project compares aspects of the biology of artificial and natural rocky reefs. I am developing a method to assess the productivity of these reefs, with the ultimate aim of helping to establish whether artificial reefs are as productive as natural rocky reefs.

Hard substrates introduced into the marine environment become quickly colonised by sessile marine fauna. These colonists are mostly filter feeders, gaining energy for growth and reproduction by sieving drifting planktonic organisms and particles from the surrounding water. These filter feeders in turn are a key food resource for many of the mobile predators and grazers that inhabit reef communities.

As part of my project I am conducting a study of the recruitment and subsequent colonisation of hard surfaces at both natural and artificial reef sites in Loch Linnhe, to obtain background information on the larval supply to the areas and the potential for faunal settlement on the reefs. In addition I will be assessing the different ways to analyse the epifaunal communities that develop.

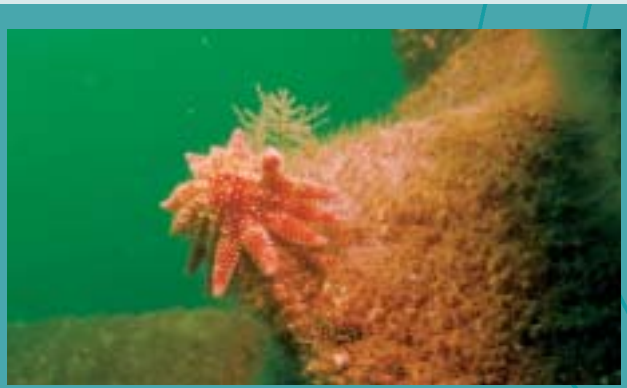
The Loch Linnhe Artificial Reef blocks are made from a mix of concrete and aggregate. Half the reef modules comprise of simple, solid rectangular blocks, the other half of more complex blocks with large holes. An important part of my PhD project will be to compare the differences in colonisation of the natural rock in Loch Linnhe and the artificial reef material, and also to investigate the differences in biomass accumulation on the different type of reef blocks.

Mobile macrofauna such as sea urchins begin to inhabit the Artificial Reef.

In addition to the colonisation work I will be using analytical techniques, such as fatty acid and stable isotope analyses, to explore differences in trophic chains of natural and artificial reefs. That, combined with some fish stomach-content analysis, will give some insight into how, or if, the food web and community structures of the two reef types differ. ●

Jenny Beaumont is coming to the end of the first year of her PhD conducted at SAMS under the supervision of Dr Martin Sayer, Dr Craig Brown and Professor Graham Shimmield.

Complex blocks (each measuring 40cm x 20cm x 20cm) of the Loch Linnhe Artificial Reef shortly after deployment.



Reef blocks are quickly covered by sessile organisms such as barnacles and hydroids. Soon larger mobile predators such as sunstars also appear.

SAMS in the Tropics!

BENTHIC PROCESSES IN THE ARABIAN SEA

Dr Tracy Shimmield, SAMS

THE ARABIAN SEA ENVIRONMENT

The Arabian Sea is one of the world's most import "upwelling" regions – an area where strong surface winds (the Monsoon) push the upper water to one side allowing deep, nutrient-rich water to come to the surface. This nutrient-rich cold water supports very high rates of plankton growth, making the area a paradise for pelagic fish and fishermen alike. The products of all this marine life eventually sink through the water, while bacteria decompose much of their organic matter. This bacterial activity consumes the available oxygen, which results in huge oxygen deficits – as oxygen in deep-water is only replenished very slowly through water replacement. Over some 200-1,400m depth, the ocean water is practically oxygen-free, giving rise to the world's largest "oxygen minimum zone" (OMZ).

THE ARABIAN SEA PROJECT

The aim of our research programme is to discover the impact of this OMZ on sediment communities and biogeochemical cycles at the location of the impingement of the Pakistan continental margin with the OMZ. The main objectives are to assess community structure, function and their controls on the redox status, on the fluxes of dissolved organic carbon, nutrients and trace metals, and on the alteration of organic matter (*i.e.* organic matter burial efficiencies). The results will hopefully clarify the role of benthic organisms as a control on sediment biogeochemistry and organic matter distributions, and will yield improved diagenetic process models.

For this research we are making use of the latest generation of seabed landers fitted with oxystat systems to preserve *in situ* oxygen concentrations for chamber experiments on the seafloor. The technology was developed by the Marine Technology Group at SAMS and enables landers and bottom water samplers to accurately sample and analyse in the deep waters of the Arabian Sea. Incubation experiments on sediment and benthos samples are used to investigate the rates and mechanisms of microbial processes.

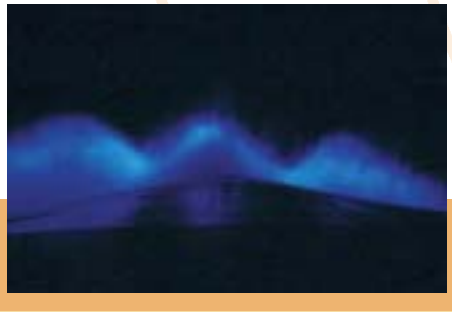
FOUR RESEARCH CRUISES

Between March and October 2003 four major research cruises have been taking place onboard the British research ship *RRS Charles Darwin*. Two cruises were conducted before the monsoon through March to June of this year, with the final two cruises taking place after the monsoon between August and October. This will allow us to determine what changes if any occur in the benthic community and geochemical processes pre- and post monsoon.

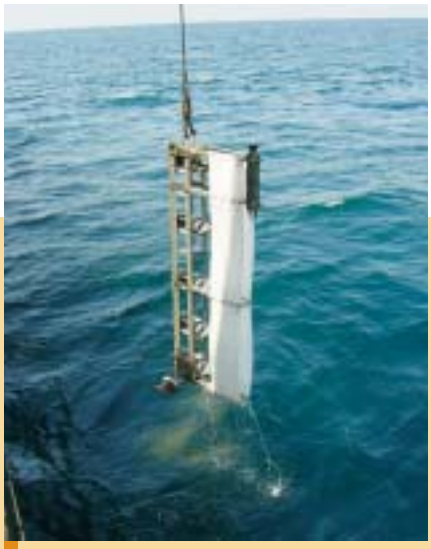
The first and the third cruise include videography and photography of the seabed and coring of sites along a depth transect from 140m to 1,800m. Cores are collected to study the benthic organisms and to analyse inorganic trace element concentrations and organic compounds in the solid sediment and the porewater. The cores for these analyses must be handled in an oxygen-free environment to maintain OMZ conditions. Portable glove bags filled with nitrogen are utilised for this purpose. A benthic boundary layer sampler (BBLS), designed at SAMS, is being used to investigate sediment-water fluxes along the depth transect sampling the bottom 3 m immediately above the sediment surface.

The second and fourth cruises focus on process studies, using both *in situ* monitoring and shipboard sediment incubations. Most measurements are made *in situ* on the seabed, employing lander technologies such as the SAMS *Profilur* and *Elinor* chambers.

The project is funded by the Natural Environment Research Council (NERC) and involves four main partners: SAMS, University of Edinburgh, University of Liverpool and Southampton Oceanography Centre. ●



Witnessing the breathtaking surface bioluminescence – here in the ship's bow wave – is one of the most memorable experiences of Arabian Sea research cruises.



The benthic boundary layer sampler (BBLS) allows deep water to be collected short distances above the undisturbed seabed.

The British research ship *RRS Charles Darwin* moored in Port Sultan Qaboos, Muscat, Oman between two of the four research cruises in the Arabian Sea between March and October 2003.

Sediment cores are sectioned in a nitrogen atmosphere to obtain porewater. This work is conducted in a cold room with temperatures equal to those on the seabed – making it necessary to wear winter clothing in the tropics!

Many infaunal benthic organisms are very small and are commonly identified using light microscopy. This sample represents the 300 mm fraction from 500 m deep sediments.

The effect of the Wyville Thomson Ridge on ocean currents in the North Atlantic

Dr Toby Sherwin, SAMS

In 1868 Charles Wyville Thomson (later leader of the famous Challenger expedition) discovered that whilst deep waters south of the Faroes were close to freezing (0.5 ºC), those at a similar depth NW of the Hebrides were much warmer (6.4 ºC). These observations initiated interest in the role of submarine topography on the flow of deep currents, and led to the discovery of the Wyville Thomson Ridge in the early 1880s.

This ridge, which stretches north-westward from the Scottish shelf and rises to within 500 to 600 m of the surface, plays a major role in controlling the Arctic branch of the global thermohaline circulation – the ocean current system that warms the landmasses bordering the North Atlantic. Despite its significance, the ridge is not represented properly in numerical models of ocean circulation and climate change because of its relatively small scale. This limitation shows the importance of making *in situ* measurements of the flow across the ridge.

SAMS is collaborating with the Fisheries Research Services, Aberdeen in an EU project called MOEN (Meridional Overturning Exchange with the Nordic Seas), which is investigating the exchange of heat and salt across the Iceland-Scotland Ridge, of which the Wyville Thomson Ridge is part. The project has partners from six other countries ranging geographically from Iceland to Sweden, and is closely linked to the SAMS Northern Seas Programme.

The ridge affects both the Arctic inflows and outflows. To its north, in the Faroe-Shetland Channel, warm saline North Atlantic Water (NAW) makes its way north-eastward along the Shetland side of the Faroe-Shetland Channel over cold and less saline water moving slowly south-westward beneath it (Fig. 1). Water of intermediate temperature (Modified NAW, or MNAW) occupies the Faroese side of the channel.

Drifter and satellite observations show that the NAW can form huge meanders that punch their way into the MNAW and across the channel to the Faroese side. There are typically three or four meanders at intervals of about 60 km downstream of the Wyville Thomson Ridge. The fastest currents, which can reach surface speeds in excess of 0.75 m s^{-1}, are encountered along the boundary between these water masses. (By comparison tidal currents are typically 0.1 to 0.2 m s^{-1}.) When they become too large the meanders can collapse into mesoscale eddies with diameters in the order of 50 km.

Although the ridge seems implicated in their creation, the exact criteria for the formation of these eddies and meanders have not been established, and the extent to which they vary over the annual cycle is not known. It is also impossible to say how climate change, which may result in a slowing down of the thermohaline circulation, will affect mesoscale surface currents in the channel.

Most of the cold water flowing southward through the Faroe-Shetland Channel is deflected north-westward through the Faroe Bank Channel and into the Iceland Basin, although some of it nevertheless crosses the ridge. Much of the early informative work on this cold water overflow was conducted by the late Dave Ellett of SAMS who mapped the topography of the ridge in detail and measured the overflow on its southern side on a number of occasions.

A recent cruise of the *FRV Scotia* observed a large outflow of cold Norwegian Sea Deep Water across the top of the western end of the ridge and into the Rockall Trough (Fig. 2). The current flowed north-westward along the ridge before cascading down a narrow gully that discharges into the Cirolana Deep. Its maximum speed near the seabed was estimated at over 1.5 m s^{-1}, and the total flux of cold water was up to 0.8×10^6 m^3 s^{-1}. This huge flow was about six times the normal flux across the ridge.

The pathway through the Rockall Trough for this overflow water is poorly known but evidence from the cruise suggests that it may be present in significant quantities along the Ellett line, 300 m to the south of the ridge. Further research is being undertaken by SAMS to investigate the frequency and cause of large overflow events, and to determine the fate of the overflow water.

Thus the Wyville Thomson Ridge plays an intricate role in controlling currents that ultimately moderate the climate of northern Europe. Through MOEN and the Northern Seas Programme SAMS is addressing issues touched on here. ●

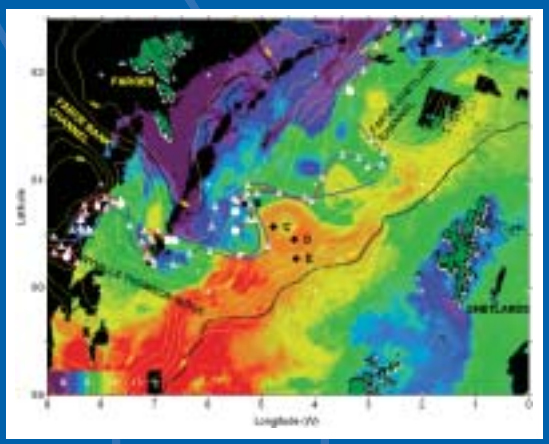


Fig 1: Sea surface temperatures in the Faroe-Shetland Channel 19 May 1999 overlaid with i) drifter tracks coloured red and blue with start of day denoted by a white triangle; ii) black diamonds marked B to E denoting positions of long term current meters to monitor the currents in the channel. Isobaths are in 200 m intervals. Note the warm NAW in the red and yellow band on the Shetland side of the channel, the cooler MNAW overlying the Faroese side. Black areas were covered with cloud.

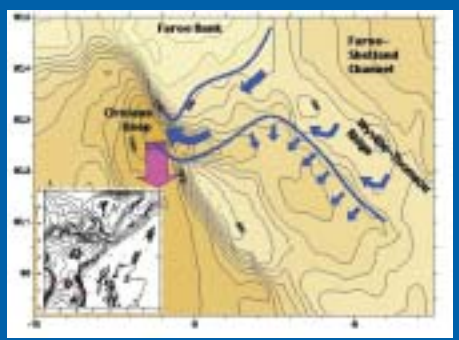


Fig. 2: Schematic representation of the pathway taken by the cold water overflow across the western end of the Wyville Thomson Ridge. Water is carried around the southern flank of the Faroe Bank before cascading down a narrow gully and into the Cirolana Deep. The inset shows the location of the figure and the Ellett line in relation to Scotland and the Rockall Trough.

The reunification of the Culture Collection of Algae and Protozoa

Christine Campbell, Dr John Day, and Dr Frithjof Küpper

After 17 years in separate locations, the Culture Collection of Algae and Protozoa will reunite in 2004 when the freshwater algal and protozoan section (CCAP-F) moves from the NERC Centre for Ecology and Hydrology (CEH) Laboratory Windermere to join the marine section (CCAP-M) in the new SAMS building at Dunstaffnage.

CCAP-F WILL MOVE TO SAMS

The forthcoming relocation of CEH Windermere stimulated a review of the options for the future of CCAP-F. On examining the scientific and financial cases associated with a number of locations, NERC - the major funding provider for CCAP - decided that co-location of both sections of CCAP at SAMS would significantly enhance the collection scientifically, increase the critical mass of the CCAP, and provide the best value for money.

The plan is for the reunited CCAP to occupy custom-designed new laboratory facilities within the European Centre for Marine Biotechnology. It will be headed by Dr Frithjof Küpper, the new leader for the Algal Research Group, with Dr John Day and Christine Campbell continuing their curatorial roles. Until the move, both parts of the Collection will continue to share a common searchable online catalogue on (http:// windermere.ceh.ac.uk/ccap/) or on the UKNCC website http://www.ukncc.co.uk.

CCAP HISTORY

The foundations of the CCAP were laid by Professor Ernst Georg Pringsheim, who with his collaborators, Victor Czurda and Felix Mainx, isolated a number of cultures at the Botanical Institute of the German University of Prague in the 1920s. Pringsheim and his cultures moved to England, where the collection was expanded and in 1947 taken over by E A George for Cambridge University. In 1970 these cultures formed the basis of the Culture Centre of Algae and Protozoa at Cambridge, financed by the NERC. During 1986 the cultures and their associated activities were divided between the Freshwater Biological Association Windermere Laboratory at Ambleside (freshwater algae and all protozoa) and the Scottish Marine Biological Association at Dunstaffnage (marine algae). These moves represented a relocation to two institutes with long-standing and continuing research activities in phycology, protozoology and other aspects of aquatic science. As the collection was now held at two locations rather than a single centre, it was renamed the Culture Collection of Algae and Protozoa, retaining the acronym CCAP.

CCAP SERVICES

CCAP at its new unified site will:

- provide academic and commercial customers with high quality protistan and cyanobacterial cultures and advice
- act as a Patent Depository Authority under the Budapest Treaty
- provide specialist services for aquaculture, ecotoxocity and biocide testing
- provide bulk cultures on special request
- provide contract and consultancy services
- offer training courses
- provide ‘‘in house” support to SAMS researchers
- offer nucleic acid extracts from algal cultures for sale
- develop an image database with digital photomicrographs of algal strains in the collection, soon available on the CCAP website.

CCAP RESEARCH

Dr Frithjof Küpper joins SAMS as a group research leader in autumn 2003. His work will focus on algal models in inorganic biochemistry and chemical ecology, with special reference to biogeochemical cycles.

Dr John Day, the Windermere Curator, will bring his cryopreservation research to SAMS including the COBRA project. COBRA (Conservation of a Vital European Scientific and Biotechnological Resource:

Marine diatom *Odontella sinensis* CCAP 1054/3

Microalgae and Cyanobacteria) is an EU-funded project to develop a physical and virtual European Biological Resource Centre based on existing algal culture collections. COBRA’s central aim is to apply cryopreservation methodologies to currently “preservation recalcitrant” strains of microalgae and cyanobacteria. COBRA partners represent a range of different sectors (culture collections, biotechnology industries, and academia) and countries (Czech Republic, France, Germany, Portugal and the UK). For more information see www.cobra.ac.uk.

THE FUTURE

The linking of the two CCAP sections will establish a unique and exciting resource. CCAP is one of six major protistan service culture collections in the world, and no other collection offers such a wide range of freshwater and marine cultures in association with the protozoan strains. The expanding research and biotechnology environment at Dunstaffnage will provide a perfect home to enable the scientific development of the collection, maximise biotechnological exploitation of the strains, and provide customers and users of the collection with an enhanced service. ●

WINNER OF THE 2003 SAMS PRIZE FOR THE BEST POSTGRADUATE POSTER PRESENTATION

Parasites: their use in identifying fish stocks

Neil Campbell, University of Aberdeen

The scientific management of fisheries relies upon an understanding of the biological processes affecting exploited populations. One of the most important pieces of information for a fishery manager is knowledge of stock structure. One method to define fish populations is through the use of naturally occurring parasites as biological tags. This approach relies upon the fact that many parasites have complex life cycles and need a particular set of host species to be present in an area to reproduce successfully. A homogeneously mixed population will show the same prevalence of parasites throughout its range, while two discrete populations should show variations.

My work focuses on applying this technique to two pelagic fishes, the horse mackerel, *Trachurus trachurus*, throughout European waters, and the herring, *Clupea harengus*, to the west of the British Isles. Both are multidisciplinary studies, funded by the European Union. This approach has the advantage of allowing comparisons of results from parasites, otolith studies, morphometrics, and genetics.

The first project, HOMSIR (Horse Mackerel Stock Identification Research), is coming to a close. Our results support the current ICES stock definition of three stocks in the Northeast Atlantic and suggest that the population in the Mediterranean also consists of three stocks, centred on the western, central and eastern basins.

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Parasitic tags are also used for identifying stocks of larger fishes, for example Spanish Mackerel (*Scomberomorus commerson*) around the coasts of Australia.

The second project, WESTHER, is still in an early stage. It aims to shed some light on the jumble of herring stocks in the Clyde, Irish Sea, and west coasts of Ireland and Scotland.

The use of parasites as biological tags is a cheap and accurate method of defining stocks. As part of a multidisciplinary study this technique is a valuable tool for fishery managers.

For more information on these two projects, see www.homsir.com and www.clupea.de/westher ●

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Neil Campbell investigates the parasitic infections of a sea bird.

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Seabirds are important definitive hosts for many parasites of small pelagic fishes.

WINNER OF THE 2003 SEPA PRIZE FOR THE BEST VISUAL POSTGRADUATE PRESENTATION

Terrigenous organic matter in Scottish sea lochs

Pei Sun Loh, SAMS-UHI

Lignin is restricted to cell walls of terrestrial vascular plants, and can therefore serve as a tracer for land-derived organic matter. Lignin distributions along transects of Loch Creran and Loch Etive should establish how much terrestrial organic matter contributes to the upper and lower basin sediment.

Alkaline cupric oxide oxidation of sediment samples yields a series of simple lignin-derived phenols. Abundance patterns of these phenols are used to identify woody and non-woody tissues of flowering plants and non-flowering plants. For example, syringyl phenols (S) composed of syringaldehyde, acetosyringone and syringic acid are derived from flowering plants, while vanillyl phenols (V) which include vanillin, acetovanillone and vanillic acid are oxidation products of non-flowering plants. Cinnamyl phenols (C) which include p-coumaric acid and ferulic acid are produced by non-woody tissues of both flowering and non-flowering plants. It should thus be possible to use S/V and C/V ratios to deduct plant tissue sources. As the vanillyl acid/aldehyde ratio is elevated with fungal degradation, it can be employed to estimate the diagenetic state of sedimentary lignins.

Indirect measurements of potential biodegradability are obtained from the C/N ratio, percentage weight loss on ignition and O_2 uptake from intact sediment cores. Early results indicate that organic matter content as well as the rate of organic matter decomposition are higher at the head of the loch and decrease down the loch. This indicates a relationship between the 'freshness' of terrestrial organic material and its potential for breakdown in marine systems or its effect on the biodegradability of the sedimentary organic matter. ●

Scottish Marine Group

WINNER OF THE 2003 SAMS PRIZE FOR THE BEST POSTGRADUATE PRESENTATION

Trouble in transit for Scottish scampi

Iain Ridgway, University of Glasgow

In the UK *Nephrops norvegicus* are marketed as scampi tails. Tasty they may be, but at market this product has a relatively low economic value. With our continental neighbours, however, they fetch high prices if sold as whole animals (langoustines). To compete on this market, the animals must arrive at their destination - usually mainland Spain - alive and in good condition.

The *Nephrops* fishery is the second biggest in the UK, and has become more important due to the decline in white fish fisheries. In Scotland 95% of *Nephrops* are trawled, with the remainder being creeled. In 2002 exports from the UK *Nephrops* fishery, of which Scottish landings represent three quarters, were valued at £70 million.

In 1999, wholesalers reported large-scale losses. Large proportions of their catches were unmarketable, as the animals exhibited opaque abdominal musculature, or were moribund, with death resulting 2-3 days after capture.

IDIOPATHIC MUSCLE NECROSIS

Initial studies on the histology of the condition showed that the pathology was restricted to the abdominal musculature, where whole muscle bundles were necrotic. In other crustaceans this condition is reported as tail rot, spontaneous muscle necrosis, or idiopathic myopathy. In *Nephrops* it has been named Idiopathic Muscle Necrosis (IMN). Normally any necrotic tissue is encapsulated by haemocytes, but animals with IMN do not display this immunological response.

This PhD project looks at the histology of IMN and the physiological impact on the animal. The eventual aim is to produce a code of practice for the industry that increases meat quality and survival rates during transport.

IMN progresses from individual muscle bundles to total opacity of the abdomen. Initially this progression, which may follow more than one pathway, was charted. Many infected animals can restrict the necrosis to individual fibre bundles, from where it may or may not progress immediately following capture. In other cases progression may be delayed for longer.

Controlled experiments were performed with animals held in the same tube sets used by fisherman to transport *Nephrops*. The onset of IMN was accelerated by exposure to air both immediately after trawling and when repeated on recovered animals. This suggests that stress caused by post-capture aerial exposure may be a contributing factor.

WHAT CAUSES IMN?

There are various hypotheses concerning the causes for IMN, including nerve atrophy (caused when animals destroy their nerves while trying to escape the trawl) and internal hypoxia, which results in the accumulation of abnormally high levels of lactic acid. The term “idiopathic” means that the animal itself is causing the tissue breakdown rather than a pathogen. But detailed pathological studies have revealed that animals exhibit gross clinical signs of bacteraemia independent of IMN.

To investigate this the tail meat of both necrotic and healthy animals was plated onto marine agar and incubated. Results showed that bacterial counts for animals exhibiting extensive necrosis were significantly higher (10^7 CFUs g^{-1}) than for healthy animals (10^3 CFUs g^{-1}). To identify which bacteria cause such increased abundance, necrotic tail meat was plated onto TCBS agar, which selects for *Vibrio* species. The results confirmed that the infection was mainly due to *Vibrio*.

Bacterial isolates were also studied with Biolog, a colorimetric test, which clusters the isolates. Findings from this test, combined with biochemical test results, suggest that animals suffered from an opportunistic bacterial infection comprising several bacterial species. Ultrastructural studies found bacteria in the muscle and discovered clear signs of proteolytic activity, which *e.g.* leads to meat spoilage.

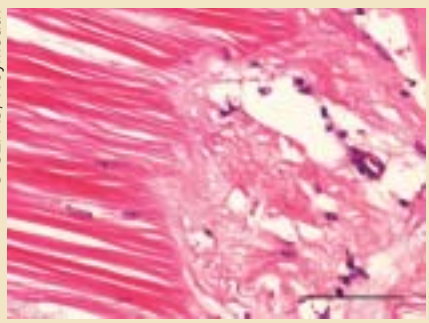
It now appears that we are studying two conditions, IMN and bacteraemia. While they may be independent, both relate to the stressful conditions of capture and post-capture treatments.

The next step in this project will focus on the cause of these conditions, and attention is turning to the immune system.

Crustaceans have a primitive non-self recognition immune system, primarily based in the haemocytes. Total haemocyte counts, and measurement of ProPhenoloxidase reveal that stress caused by trawling and aerial exposure suppresses the *Nephrops* immune system. This makes the animal susceptible to infections, which in turn affect meat quality and survival.

The studentship is a NERC case award with support from CEFAS.

Sorting the mixed catch during a sampling trip on *RV Aora* in the Clyde Sea.



Light micrograph showing junction of necrotic muscle on right with healthy muscle on left. Scale = 250µm

Signs of bacteraemia: Compared with a healthy *Nephrops* (H), the animal with bacteraemia (B) displays red pleopods and a white abdomen.

Alien invasion

A new non-native invasive species on the west coast of Scotland

Dr Liz Cook, Dr Kate Willis and Matias Lozano (SAMS)

SAMS scientists recently identified an 'alien' caprellid, *Caprella mutica*, commonly known as a skeleton shrimp, in densities of up to 10,000 individuals m^{-2} on artificial structures associated with mariculture activities and marinas on the west coast of Scotland.

THE CAPRELLID *CAPRELLA MUTICA*

Caprella mutica is native to the coastal waters of East Asia and Siberia. The exact date and mode of introduction to Scotland is unknown, but the creature has a track record of turning up in the most unexpected places. In the 1970s and 1980s, it was discovered on the Pacific coast of North America after accidental introduction through shipments of Japanese oysters. More recently it has been reported in European waters, with sightings in the mid-eighties in Norway and the Netherlands. The mode of introduction has not yet been identified, but it is speculated to having been introduced as a result of mariculture activities or in ballast water of commercial tankers. Very little is known about the biology and ecology of this 'invader', making it difficult to predict its impacts on local habitats and the economy.

INTRODUCED SPECIES

Many introduced species remain localised in their distribution to a particular estuary or harbour, and most such invaders disappear during the first year after their introduction. However, some invasive species have had dramatic impacts on the biodiversity and/or the biological functioning of the harbour, estuary or coastline they invaded. For example, the Zebra mussel, *Dreissena polymorpha*, is extremely prolific in the Great Lakes, Canada, causing the extinction of native species and fundamentally altering the system it invades. In addition to the biological cost, invading species can also have significant impacts on the economy. It is estimated that invasive plants, animals and insects had cost the US economy over $100 billion in cumulative losses by 1991.

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Caprellids occur often in high densities on a variety of substrates, here on the tube of a fanworms.

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Caprellids are also often seen on tunicates. The red enlargement in the centre of some individuals is a brood pouch, the most obvious feature to separate the sexes.

NON-NATIVE SPECIES IN BRITAIN

There are approximately 65 established non-native species recorded in Britain, including marine species such as the Wire Weed, *Sargassum muticum*, and the Chinese Mitten Crab, *Eriocheir sinensis*. While a number of studies document their distribution, only few investigations assess their impact on either the marine environment or the UK economy.

Unlike in other countries, there is currently no trend in the UK for the number of invasive species that become established being on the increase. But this might change in coming years due to a substantial increase in commercial shipping between the Pacific and Europe through the Arctic Sea made possible by significant sea ice retreat, and a rise in aquaculture-related activities in coastal regions.

It is therefore important to investigate why certain species are able to colonize 'new' environments more successfully than others, what effect they have on the invaded environment, and whether the invader could be eradicated or their spread minimized.

C. MUTICA IN SCOTLAND

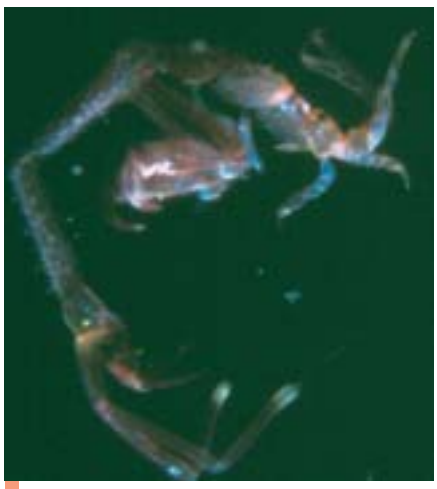
Preliminary studies at SAMS have established some initial facts about *Caprella mutica* in Scotland:

- Individuals are typically larger than native caprellids. Males reach up to 35mm in length and females grow to 15mm.
- Most display bright orange colouration.
- They can be found in high densities (>10,000 individual m^{-2}) particularly from May to September.
- C. *mutica* can be found on a range of substrates, including hydroids, algae, buoys, boat hulls and aquaculture lines.
- To date, the caprellid has been found on the west coast of Scotland in the Lynne of Lorne, Loch Creran, Loch Linnhe, the Sound of Mull, Loch Sunart and the Western Isles.
- First sighted 8 – 10 years ago.
- Females keep their eggs in a central brood pouch. Each female can produce up to 150 hatchlings every 45 – 50 days.
- Observations suggest that reproductive maturity is reached within two months of hatching at summer water temperatures.

Many questions remain concerning introduction and expansion pathways as well as the ecological and economic consequences of this alien invasion. *Caprella mutica* is likely here to stay and the early discovery of a new invasive species offers us the rare opportunity to study the invasion process from early on.

The authors would be grateful if readers could report sightings of this skeleton shrimp in Scotland to Dr Liz Cook ejc@dml.ac.uk or phone 01631 559000. ●

The authors acknowledge the help of Professor Ichiro Takewchi with the identification of C. mutica.



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Caprella mutica - an East Asian non-native coastal species recently identified along parts of the west coast of Scotland.