OCEAN Challenge

Volume 14, No. 3, 2004
(published Summer 2006)

The views expressed in *Ocean Challenge* are those of the authors and do not necessarily reflect those of the Challenger Society or the Editor.

SCOPE AND AIMS
Ocean Challenge aims to keep its readers up to date with what is happening in oceanography in the UK and the rest of Europe. By covering the whole range of marine-related sciences in an accessible style it should be valuable both to specialist oceanographers who wish to broaden their knowledge of marine sciences, and to informed lay persons who are concerned about the oceanic environment.

***Ocean Challenge* is sent automatically to members of the Challenger Society.**
For more information about the Society, or for queries concerning individual subscriptions to *Ocean Challenge*, please see the Challenger Society website (www.challenger-society.org.uk) or contact the Executive Secretary of the Society (see inside back cover).

INDUSTRIAL CORPORATE MEMBERSHIP
For information about corporate membership, please contact the Executive Secretary of the Society (see inside back cover).

ADVERTISING
For information about advertising, please contact the Executive Secretary of the Society (see inside back cover).

AVAILABILITY OF BACK ISSUES OF OCEAN CHALLENGE
For information about back issues, please contact the Executive Secretary of the Society (see inside back cover).

INSTITUTIONAL SUBSCRIPTIONS
Ocean Challenge is published three times a year. The subscription (including postage by surface mail) is £80.00 ($US 152) per year for libraries and other institutions. New subscriptions, renewals and information about changes of address should be sent to Parjon Information Services, PO Box 144, Haywards Heath, West Sussex, RH16 2YX, UK.

DATA PROTECTION ACT, 1984 (UK)
Under the terms of this Act, you are informed that this magazine is sent to you through the use of a computer-based mailing list.

Cover printed by Trade Winds, London.
Text printed by Halstan & Co. Ltd, Amersham.

OCEAN Challenge

The Magazine of the Challenger Society for Marine Science

SOME INFORMATION ABOUT THE CHALLENGER SOCIETY

The Society's objectives are:

To advance the study of Marine Science through research and education.

To disseminate knowledge of Marine Science with a view to encouraging a wider interest in the study of the seas and an awareness of the need for their proper management.

To contribute to public debate on the development of Marine Science.

The Society aims to achieve these objectives through a range of activities:

Holding regular scientific meetings covering all aspects of Marine Science.

Supporting specialist groups to provide a forum for discussion.

Publication of a range of documents dealing with aspects of Marine Science and the programme of meetings of the Society.

Membership provides the following benefits:

An opportunity to attend, at reduced rates, the biennial five-day UK Marine Science Conference and a range of other scientific meetings supported by the Society.

A monthly newsletter (*Challenger Wave*) which carries topical marine science news, and information about jobs, conferences, meetings, courses and seminars.

The Challenger Society Website is
www.challenger-society.org.uk

MEMBERSHIP SUBSCRIPTIONS

The subscription for 2006 costs £40 (£20.00 for students in the UK only). If you would like to join the Society or obtain further information, contact the Executive Secretary, Challenger Society for Marine Science, Room 251/20, National Oceanography Centre, Waterfront Campus, Empress Dock, Southampton SO14 3ZH, UK; Fax: +44(0)23-80-596149; Email: jxj@noc.soton.ac.uk

ADVICE TO AUTHORS

Articles for *Ocean Challenge* can be on any aspect of oceanography. They should be written in an accessible style with a minimum of jargon and avoiding the use of references. If at all possible, they should be well illustrated (please supply clear artwork roughs or good-contrast black and white glossy prints). Copy may be sent electronically.

For further information, please contact the Editor:

Angela Colling, Department of Earth Sciences, The Open University, Walton Hall, Milton Keynes, Bucks MK7 6AA, UK.
Tel. +44-(0)1908-678398 or 653647
Fax: +44-(0)1908-655151
Email: A.M.Colling@open.ac.uk

Cover printed by Trade Winds, London.
Text printed by Halstan & Co. Ltd, Amersham.

CONTENTS

CONTENTS

Most of figures were drawn by The ArtWorks.
The cover was designed by Ann Alded Associates.
Cover photographs: the buoy:
© Crown Copyright 2005.
Reproduced with permission of *CEFAS, Lowestoft*
The penguin is by courtesy of Ziggy Pozzi-Walker

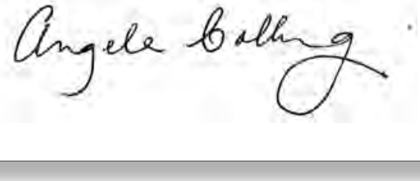
Message from the Editor

It has been some time since the last *Ocean Challenge* was published, for which we offer our most sincere apologies. We suffered serious computer difficulties which interrupted production for several months. Luckily, no material was lost, but we would like to thank authors for their patience.

An important contribution in this issue is a review article by Mike Whitfield which has evolved from his invited talk at the Challenger Society Centenary celebrations on HQS *Wellington*. Originally entitled 'They are ocean plankton, Jim, but not as we know them', it is a *tour de force* describing how our view of marine phytoplankton and bacteria has evolved since the time of the *Challenger* Expedition, and at the same time providing an overview of the relevant marine science. The theme of scientific development can also be found in Martin Angel's 'A passion for ostracods ...'.

Recent advances in the study of sediment transport using sound are described by Peter Thorne and Alan Davies, while for those interested in the history of oceanography, and of seafaring in general, we have the story of a man who served on the original *Challenger*, told by his great-grandson. Following this is a discussion of the Challenger Medal awarded to those who served on *Challenger* and worked on the *Report,* by an expert in the field. The role of the BBC in spreading scientific ideas is entertainingly discussed by Allan Jones.

Although Mary Swallow died in early 2006, we are including her obituary in this issue, as it seems proper to mark the passing of someone who played such an important role in the dissemination of marine science, through her work on *Deep-Sea Research*.



The RNLI: a ring of safety around the coast

Rory Stamp

From the busy waters of the Solent to the heavy swells of the Atlantic Ocean, the RNLI's volunteer crews continue to save lives at sea. Thanks to their commitment, and to the generosity of the public, the charity runs more than 230 lifeboat stations around the coasts of the UK and Republic of Ireland.

All shapes and sizes

The RNLI's lifeboats range from 5-m-long inflatables to 17-m-long all-weather lifeboats. The kind of lifeboat that is launched from each station depends on a variety of factors, including the type of casualties likely to be in need of help and where they are likely to be found. For instance, the 'D class' inflatable lifeboats are small and manoeuvrable, making them ideal for rescues in shallow water or near rocks. However, they have limited room for survivors and are not designed for lengthy rescues far out to sea. The 'Atlantic' series of lifeboats, however, are rigid inflatable vessels and are 7–8 metres in length. At 32 knots they are some of the fastest lifeboats in the RNLI's fleet; they can operate in gale force conditions and are capable of towing vessels of up to 12 m in length. In comparison, the RNLI's larger all-weather lifeboats have room for six crew and up to 100 survivors, and are designed to cope with the worst of sea and weather conditions. As a result, some lifeboat stations have an all-weather lifeboat, some have a smaller inshore lifeboat, and some have both.

The launch

Lifeboats are launched in different ways, depending on their size, shape and, crucially, the geography of the coastline. Many lifeboat stations have a team of specially trained volunteers with the specific task of launch and recovery (sometimes including tractor drivers and winchmen).

If all lifeboat stations were based in harbours that did not dry out at low tide, launching would not be necessary, as the vessel would simply lie afloat. This is the case at Falmouth in Cornwall, where crew members need no assistance to launch the all-weather lifeboat. They just have to go aboard, cast off and head for their destination. But at stations where there is no suitable harbour this method is impossible. As a result, the lifeboat has to be somehow transported from her boathouse to water that is deep enough for a launch. Today's launching methods represent a variety of solutions to this problem. For example, the all-weather lifeboat at Cromer, Norfolk, is launched from a slipway at the end of the town pier, where there is always a sufficient depth of water beyond the sandy beach. When returning from a rescue or exercise, she is reversed to the foot of the slipway, a cable is attached to her, and she is winched back up.

The lifeboat at Ilfracombe is a 'Mersey class' all-weather lifeboat that is transported to the sea by tractor and carriage

One of the RNLI's newest slipway lifeboat stations is at Tenby, Pembrokeshire, where a boathouse has been built on a concrete slab that is supported above the waves on steel piles. The lifeboat crew access the station from a cliff top and launch the lifeboat down the slipway. The previous station at Tenby was in desperate need of replacement as spring tides were causing a major build-up of silt at the foot of the old slipway.

Although people strongly associate slipways with the RNLI, the number of stations using this method is actually in the minority. On many parts of the coast, the tidal range can mean that slipways are not an option. At these locations, the only way to ensure a lifeboat can launch at all times is to carry her to the sea. It is a system used at Ilfracombe, north Devon (*see left*), where the all-weather lifeboat is launched from a carriage that is taken in and out of the water by a tractor.

Similarly, smaller lifeboats such as inflatables are usually taken from the boathouse into the sea using a carriage or trolley. On reaching deeper water, the buoyancy of the lifeboat means that she floats away from the carriage and is ready to speed off to the rescue. Carriages and trolleys are pulled into position by tractors, 'quad' bikes, or even specially designed tracked vehicles that can move quickly over mud and soft sand.

A crafty solution

There are some hazardous areas around the coast that lifeboats can't reach, such as quicksands and mudflats. To address such dangers there are four hovercraft in the RNLI's fleet; these launch from Hunstanton, Morecambe, New Brighton and Southend. Hovercraft trials took place at the RNLI's headquarters at Poole, Dorset, and in summer 2002, a mutual interest in Poole Harbour led English Nature and the RNLI to strike up a unique partnership. English Nature needed to detemine whether the rare birds visiting Poole Harbour had enough food. In the past, performing such surveys had been a lengthy and laborious process, with ecologists having to negotiate dangerous quicksands to reach isolated areas. One of the methods used previously involved ecologists taking a boat to each location during high tide, waiting for the tide to go out before gathering data, and then waiting for the tide to return. With English Nature aiming to survey 80 locations around the harbour, such a method would prove slow to say the least. It seemed that the team from the Centre of Ecology and Hydrology (CEH), which was subcontracted by English Nature to survey the harbour, were in for a long, hard slog. Fortunately, the RNLI came to the rescue. English Nature, CEH and the RNLI agreed that an ideal (and novel) solution would be to make use of the prototype hovercraft. Each day during the survey, the trainee RNLI pilots would drop their passengers at the exact co-ordinates given, go away and practise manoeuvres, and then return to collect the 'survivors'.

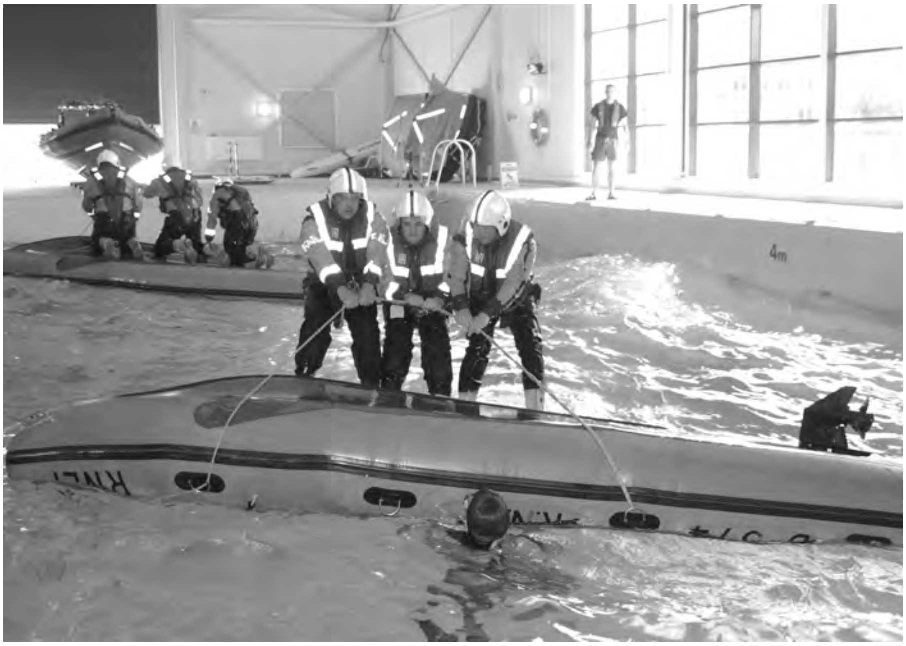
The Lifeboat College

Lifeboat and hovercraft crew training takes place at lifeboat stations and at the charity's headquarters at Poole, in Dorset. These days, there is a dedicated centre for crew training at Poole: the Lifeboat College. The Queen, the RNLI's patron, opened the College in 2004. Since then, hundreds of lifeboat crew members have trained there.

The facility has 60 bedrooms where lifeboat crews can stay during their visit, offering them a homely environment and saving the charity money in bed and breakfast bills. The training space provided by the College also saves money and is specially built for those learning to save lives at sea. Facilities include a lifeboat simulator that uses computer graphics to recreate rescue scenarios.

The College's Survival Centre houses a wave tank that recreates the conditions, sights and sounds that a lifeboat crew might experience at sea. A crane is used to capsize 'Atlantic' and 'D class' lifeboats so that crews can practise righting them (*see above*). All-weather lifeboat crews also take sea survival training in the tank, which has a variety of wave patterns and sound and lighting effects to simulate stormy seas. Visiting crews take part in exercises afloat in Poole Harbour too, launching lifeboats with instructors from the College pontoon.

The training courses that lifeboat crews take at the Lifeboat College are in addition to their regular exercises at stations around the coast. Crew members need training in everything from First Aid to boat handling. Navigation skills are especially important if a lifeboat crew is to reach a casualty quickly and safely.



Training in the Lifeboat College wave tank *Once the lifeboat has been inverted using an indoor crane system, the crew climb onto the bottom, holding the painter (the rope usually used for tying up), which is rigged so that it can be used to pull one side of the boat upwards. They then lean back, using their weight to right the boat. When she rights, the crew are plunged back into the water before they can climb back aboard. The next step is to empty the engine of water – this is done by removing the spark plugs from the engine, opening the fuel drain, and turning the engine over many times, until all of the water is dispersed. New spark plugs can then be put in. The fuel drain is then closed, the engine cover is put back on, and the engine re-started.*

On course for a rescue

While pulling on their lifejacket many lifeboat coxswains and navigators will be mentally preparing for their journey to the casualty – tides, hazards, and weather will all be considered. For example, should they pass close by the area of rocks near the harbour mouth, or should they go the long way round? Once on board, they have navigational equipment such as electronic chartplotters and radar to assist them. This

The 'Trent class' lifeboat, as used by the crew at Oban, Argyll

wheelhouse gadgetry goes hand in hand with a high standard of training.

Amongst the volunteer crew members at Oban, Argyll, is Finlo Cottier, a marine physicist with the Scottish Association for Marine Science. Finlo has been on the lifeboat crew for four years and has got to know many of the navigational hazards in the Oban 'patch'. He has been trained as navigator aboard the Oban lifeboat, an all weather 'Trent class' (see p. 3).

Each lifeboat crew around the coast faces different hazards, which they are able to deal with through a combination of training, technology and local knowledge. For Finlo and the rest of the Oban crew, it is rocks and tidal races that can make life difficult, rather than mountainous waves. 'We are less likely to encounter steep seas than some of the stations that flank us because our area of water is relatively sheltered,' Finlo points out. 'However, we do have very strong tidal waters. Trying to establish a tow to a casualty boat in a six knot tide is not easy.'

The Oban lifeboat also has to negotiate small islands, narrow channels and reefs around the local sea lochs. 'Sometimes it is just a case of using your eyes around here because some of the passages are so narrow,' says Finlo. 'There are also occasions where we have to take the lifeboat up tidal rapids which would probably worry some other lifeboat crews who are not used to it. Then again, the shifting sandbanks on the East coast of England would probably scare us,' he adds.

Train one, save many

Less than 10% of today's crew members are from professional maritime backgrounds. That means training in the operation of advanced lifeboats and equipment is more important than ever – but it is costly too. For instance, it costs £1315 to train a new volunteer to become part of an all-weather lifeboat crew, and £5185 to train a new recruit, over several years, to become a coxswain in charge of their own lifeboat and crew.

To help meet this cost, the RNLI has launched a Crew Training Campaign. The appeal, with the slogan 'Train one, save many', aims to raise £10 million over the next five years to train volunteer lifeboat crews. Robin Martin, RNLI Regional Fundraising Manager, says: 'Training is the magic ingredient that turns ordinary people into lifeboat volunteers who save lives at sea. The Crew Training Campaign will raise money to ensure we can continue to deliver consistent, high quality training to our volunteer crews; when they need it, where they need it – to help them continue to save many more lives.'

From the beach to the open sea

Lifeboat crew members are not the only RNLI lifesavers who need to be trained. The RNLI has lifeguards on beaches across the south-west of England. Lifeguard training isn't just about specialist rescue – lifeguards are also taught the importance of surveillance and preventing dangerous incidents before they happen. Lifeguards use inflatable rescue boats and personal water craft to reach casualties, who might include injured surfers, drowning swimmers, or children swept away on inflatable toys.

The RNLI's lifeboats, hovercraft and lifeguard units all help form a ring of safety around the coasts of the UK and Ireland. That ring of safety exists thanks to people's generosity: the generosity of the volunteers who give up their time to fundraise and launch to the rescue – and the generosity of the public, which helps keep the RNLI afloat.

Rory Stamp is the RNLI's in-house writer.
Email: rstamp@rnli.org.

Science in the air: reflections on the history of science broadcasting

Allan Jones

Science has featured in BBC programming since the earliest days of the organisation. For instance, in the autumn of 1926, when the BBC was four years old, there was a series of talks by Oliver Lodge on 'Atoms and world order,' another by Professor J. Arthur Thomson on 'The mind of animals', and weekly talks on meteorology. Oceanography did not figure much in those early days, but evolution, geology and natural history were well covered. But what were these science broadcasts for, and who controlled them? These may seem strange questions, but their answers tell an interesting story about the place of science in intellectual life.

Back in the 1920s, science broadcasting on the BBC was largely associated with adult education, particularly in the wake of the Haddow report, published in 1928. One of the report's conclusions was that there was no hard and fast line between recreation and education – a conclusion that nowadays would surely signal more game shows and makeovers. Back then it sanctioned the BBC's practice of unashamed pedagogy at prime time.

Serious talks were usually arranged in 'courses' of six or twelve broadcasts on a related theme, often delivered by an eminent speaker. Frequently there was accompanying paraphernalia that would be familiar to modern distance educators: pamphlets with notes to read before and after the broadcasts, illustrations, lists of further reading, and questions to test listeners' understanding or seed a discussion (for group listeners). This period saw the phrase 'university of the air' used for the first time.

There were critics, of course, such as the member of parliament who complained in the 1930s of the neglect of 'the wants of the ordinary man, who, after a hard day's work, wants some amusement and not instruction.' Maybe he meant himself. But J.G. Crowther, by his own (dubious) claim the UK's first full-time science journalist, thought the broadcasts weren't pedagogic enough. He wanted fully worked out, progressive programmes of study, rather than the odd six broadcasts here and there, and a regular science page in the *Radio Times*. And he wanted to be in charge of it all. He didn't succeed.

The 1930s were notable in Britain for a leftward shift among many scientists. Particularly associated with this trend were J.B.S. Haldane, J.D. Bernal, Hyman Levy, P.M.S. Blackett and Julian Huxley. These people were also highly regarded broadcasters. The relationship of science to society, economics and politics was something that, in their view, needed to be clarified for the general public. Hence in the 1930s we find series such as 'What is science?', 'Science and civilisation', 'Scientific research and social needs'. Some listeners detected a whiff of Marxism. In 1937, Vice Admiral Taylor asked the Postmaster General in the House of Commons whether 'his attention has been called to the continued use of the British Broadcasting Corporation for the dissemination of Communist propaganda?' Outbursts like those were not rare, to the embarrassment of the BBC's managers. The trouble was, the politically active scientists were often the best broadcasters.

The war and after

The Second World War was regarded, even at the time, as a scientific war. People with no scientific training or interest were drafted into scientific war work. Sometimes this awakened in them a latent scientific interest. Furthermore, there was a widespread view among scientists that the war would give way to a scientific peace in which only the scientifically literate would be able to cope. Many scientists therefore argued that the BBC had a duty to raise the general standard of scientific literacy as part of the war effort and as preparation for the post-war world of science.

Another popular view among scientists was that if people were more scientifically literate, their thinking would be more rigorous. The public would be more objective, and less prone to superstition, astrology, or Nazi pseudo-science. Therefore scientific broadcasting should inculcate 'scientific thinking' in ordinary people. A shaft of sense illuminated this debate when the engineer Richard Southwell pointed out at a conference in 1943 that scientists appeared to be no better equipped than anyone else for coping with life's dilemmas.

In the postwar period, the general need for scientific literacy continues to be claimed both to help people understand complex socio-scientific issues and to help them make up their mind about them. That reputable scientists are often found on both sides in these issues suggests that scientific literacy might not be the key to resolving them.

Another view of science that has frequently put forward to justify more air time, or a different kind of air time, is that science is culturally important, i.e. that a cultured person should be familiar with some basic scientific ideas, just as they should be familiar with the major events of history, or the major works of literature. This view had a strong proponent in the distinguished Australian physicist Marcus Oliphant, who lived in the UK during the 1940s. He wrote to the BBC in 1949 pleading for less of the 'science and society' type of broadcast, and for a new type that would concentrate on science's inherent interest, rather than its utility or its capacity for causing problems. (Simultaneously, a little-known Jacob Bronowski wrote in a similar vein, but was largely ignored.) A survey of broadcasts over a three-month period was undertaken, and showed that the kind of science broadcasts Oliphant favoured were already happening. He just hadn't noticed them.

Throughout scientific broadcasting's short history, scientists have often been its severest critics. It is no surprise, then, that scientists have often suggested that they should be in charge of science broadcasting. The assumption appears to be that if only professional scientists controlled scientific broadcasting, then the subject would be treated properly, and given its due importance. But how would we feel if doctors controlled medical broadcasts, or lawyers controlled legal broadcasts? Perhaps the best interests of listeners and viewers are served by broadcasters who maintain a critical detachment from the professionals.

Contemporary developments

The foregoing reflections indicate that the reasons for science broadcasting are various and changeable; and that the control of scientific broadcasting is a contested area. Anyone involved with science popularisation, in whatever medium, will not be surprised at this. The contemporary scene, however, brings new factors into play.

One potent new force is technology, which is sure to affect all kinds of broadcasting, not just scientific. There is now a bewildering array of technologies for would-be communicators. Podcasting, for instance, makes it possible for anyone with an internet connection to disseminate their own radio programmes via the internet to subscribers. For the most part, podcasting is currently akin to amateur radio, but the heavyweights are moving in. *New Scientist* and *Scientific American* issue podcasts, so becoming, in effect, science broadcasters, and most national broadcasters are at least experimenting with podcasting. There is also a video form of podcasting. What the influence of these and other technologies will be is not clear. The obvious guess is that they will lead to a fragmentation of broadcasters and audiences, as more and more special-interest groups transmit programmes to like-minded listeners throughout the world. But history shows that the obvious route is seldom the one taken.

Possibly the most influential factors will turn out to be social and economic rather than technological. For instance, virtually all areas of policy-making have been transformed by the fetishisation of the market. Public service broadcasting in the European mould does not suit the new orthodoxy. Why should the delectation of the few be financed by the many? (Enrichment of the few by the many is something competitive markets do very well, of course, but this is seen as a virtue.) For broadcasters working in expensive media such as television one strategy is to try to turn minority interests into majority interests. This laudable aim in practice seems to result in science broadcasts from which nearly all scientific content has been evacuated. Another remedy is to seek financial tie-ins with other organisations to spread the costs, but one then wonders who is really responsible for the result, and what compromises have been made along the way.

Another significant shift is in the way the public views science. For some sections of the public, high-expenditure science is not trusted because it is seen as being in the pay of vested interests. Furthermore, influential creationist lobbies claim that science is just one of several ways of interpreting the world, and has no special claim to truth. (Ironically, the same lobbies deplore the growth of relativism – crudely the notion that there are many, equally valid views of the world.) What is at stake here is science's claim to authority. Within the philosophy of science there are debates about the supportability of science's knowledge claims; and occasional scientific scandals raise questions about the practice of science. Is it as methodologically rigorous as is claimed?

Considerations like these might seem a long way from science broadcasting. Yet history shows that scientists have often seen broadcasting as a way to assert the authoritativeness of science to a mass audience. Such a lordly approach would hardly be acceptable these days. It is, in any case, questionable whether there is still a mass audience willing to give science its attention, given the proliferation of alternative entertainments. The questions about science broadcasting I posed earlier remain relevant, I think: What is it for, and who should control it?

Further reading

Several histories of broadcasting have been published, but they say next to nothing about science broadcasting. Anyone wishing to research this area has to piece together the story from primary sources in archives. Virtually all the relevant studies are in dissertations and theses. Marcel la Follette, however, has published two historical studies of the American scene: 'A survey of science content in U.S. radio broadcasting' and 'A survey of science content in U.S. television broadcasting'. Both of these are in *Science Communication*, Vol. 24, No.1, September 2002 (respectively pp. 4–33 and 34–71). My own article about early BBC broadcasts on computers, 'Five 1951 BBC broadcasts on automatic calculating machines', was published in *IEEE Annals of the History of Computing*, Vol. 26, No. 2, April–June 2004.

Allan Jones is a lecturer in the Department of Information and Communication Technologies in the Faculty of Technology of the Open University. When not producing course material he researches the history of science broadcasting in the UK. Email: a.jones@open.ac.uk

EFMS goes to Helsingborg, Sweden

The 2006 meeting of the European Federation of Marine Science and Technology Societies (EFMS) is being held in Paris in September, so it is perhaps rather late to be reporting on the 2005 event which was held in association with the annual conference of the Swedish Marine Science Society (which at the time had newly joined the EFMS; see Vol. 14, No. 2). Nevertheless, those of us who attended this most successful meeting are keen to stress the merits of attending conferences away from home.

Apart from the interesting cultural and social experiences which are part of visting other countries, it is enlightening to see what the scientific preoccupations are in marine science institutions elsewhere. In this case, the meeting was held in Helsingborg on the west coast of Sweden, from where Danish Helsingor (Hamlet's Elsinore) is just visible across the Öresund. Through this narrow gap flow waters connecting the Baltic with the Kattegat and the North Sea. Not surprisingly, much of the work presented was concerned with the Öresund and the Baltic – an interesting change from the North Sea and the North Atlantic.

Many presentations understandably dealt with biological topics, fish and shellfish being a major component of Sweden's economy. There were, however, some variations on the predominantly biological theme. These included sediment re-suspension in the Baltic Sea (where tidal currents are typically weak) – in relation to which we learnt about an intriguing consequence of Perestroika that preceded break-up of the Soviet Union: as a result of the resulting economic and agricultural downturn, less fertiliser was used on farms, and there was less eutrophication in the Baltic Sea. Also discussed was the dynamics of winter ice movement in the Baltic Sea, recorded using upward-looking ADCP measurements; the development and growth of algal mats; and a possible case of phosphorus-limitation in the Gulf of Bothnia (northen Baltic). Of relevance to patchiness of plankton and to spillages of oil, as well as to 'red tides' and the spread of algal toxins, was a study of wind-forced horizontal dispersion of tracers in surface waters, its relation to patchiness, and the way the depth of mixing correlates with wind speed (the stronger the wind the deeper the mixing, and the area covered increases in proportion to $(\text{time})^2$ after tracer release).

We were introduced to the novel concept of Ecological Stoichiometry (ES) and its relation to element distributions in the marine environment; also how alelochemicals can affect species succession among phytoplankton. The concept of ES has hitherto been concerned mainly with nutrients (C, N, P), but has a much wider scope, and requires sampling and analysis of a great variety of marine organisms. The talk was presented as work in progress, and it is to be hoped that ES will become an important tool of biogeochemistryin the future.

Another intriguing presentation suggested that there may soon be a resurgence of Sweden's nuclear industry, as ing, for instance, makes it possible for anyone with an internet connection to disseminate their own radio programmes via the internet to subscribers. For the most part, podcasting is currently akin to amateur radio, but the heavyweights are moving in. *New Scientist* and *Scientific American* issue podcasts, so becoming, in effect, science broadcasters, and most national broadcasters are at least experimenting with podcasting. There is also a video form of podcasting. What the influence of these and other technologies will be is not clear. The obvious guess is that they will lead to a fragmentation of broadcasters and audiences, as more and more special-interest groups transmit programmes to like-minded listeners throughout the world. But history shows that the obvious route is seldom the one taken.

Possibly the most influential factors will turn out to be social and economic rather than technological. For instance, virtually all areas of policy-making have been transformed by the fetishisation of the market. Public service broadcasting in the European mould does not suit the new orthodoxy. Why should the delectation of the few be financed by the many? (Enrichment of the few by the many is something competitive markets do very well, of course, but this is seen as a virtue.) For broadcasters working in expensive media such as television one strategy is to try to turn minority interests into majority interests. This laudable aim in practice seems to result in science broadcasts from which nearly all scientific content has been evacuated. Another remedy is to seek financial tieins with other organisations to spread the costs, but one then wonders who is really responsible for the result, and what compromises have been made along the way.

Another significant shift is in the way the public views science. For some sections of the public, high-expenditure science is not trusted because it is seen as being in the pay of vested interests. Furthermore, influential creationist lobbies claim that science is just one of several ways of interpreting the world, and has no special claim to truth. (Ironically, the same lobbies deplore the growth of relativism – crudely the notion that there are many, equally valid views of the world.) What is at stake here is science's claim to authority. Within the philosophy of science there are debates about the supportability of science's knowledge claims; and occasional scientific scandals raise questions about the practice of science. Is it as methodologically rigorous as is claimed?

Considerations like these might seem a long way from science broadcasting. Yet history shows that scientists have often seen broadcasting as a way to assert the authoritativeness of science to a mass audience. Such a lordly approach would hardly be acceptable these days. It is, in any case, questionable whether there is still a mass audience willing to give science its attention, given the proliferation of alternative entertainments. The questions about science broadcasting I posed earlier remain relevant, I think: What is it for, and who should control it?

Further reading

Several histories of broadcasting have been published, but they say next to nothing about science broadcasting. Anyone wishing to research this area has to piece together the story from primary sources in archives. Virtually all the relevant studies are in dissertations and theses. Marcel la Follette, however, has published two historical studies of the American scene: 'A survey of science content in U.S. radio broadcasting' and 'A survey of science content in U.S. television broadcasting'. Both of these are in *Science Communication*, Vol. 24, No.1, September 2002 (respectively pp. 4–33 and 34–71). My own article about early BBC broadcasts on computers, 'Five 1951 BBC broadcasts on automatic calculating machines', was published in *IEEE Annals of the History of Computing*, Vol. 26, No. 2, April–June 2004.

Allan Jones is a lecturer in the Department of Information and Communication Technologies in the Faculty of Technology of the Open University. When not producing course material he researches the history of science broadcasting in the UK. Email: a.jones@open.ac.uk

EFMS goes to Helsingborg, Sweden

The 2006 meeting of the European Federation of Marine Science and Technology Societies (EFMS) is being held in Paris in September, so it is perhaps rather late to be reporting on the 2005 event which was held in association with the annual conference of the Swedish Marine Science Society (which at the time had newly joined the EFMS; see Vol. 14, No. 2). Nevertheless, those of us who attended this most successful meeting are keen to stress the merits of attending conferences away from home.

Apart from the interesting cultural and social experiences which are part of visting other countries, it is enlightening to see what the scientific preoccupations are in marine science institutions elsewhere. In this case, the meeting was held in Helsingborg on the west coast of Sweden, from where Danish Helsingor (Hamlet's Elsinore) is just visible across the Öresund. Through this narrow gap flow waters connecting the Baltic with the Kattegat and the North Sea. Not surprisingly, much of the work presented was concerned with the Öresund and the Baltic – an interesting change from the North Sea and the North Atlantic.

Many presentations understandably dealt with biological topics, fish and shellfish being a major component of Sweden's economy. There were, however, some variations on the predominantly biological theme. These included sediment re-suspension in the Baltic Sea (where tidal currents are typically weak) – in relation to which we learnt about an intriguing consequence of Perestroika that preceded break-up of the Soviet Union: as a result of the resulting economic and agricultural downturn, less fertiliser was used on farms, and there was less eutrophication in the Baltic Sea. Also discussed was the dynamics of winter ice movement in the Baltic Sea, recorded using upward-looking ADCP measurements; the development and growth of algal mats; and a possible case of phosphorus-limitation in the Gulf of Bothnia (northen Baltic). Of relevance to patchiness of plankton and to spillages of oil, as well as to 'red tides' and the spread of algal toxins, was a study of wind-forced horizontal dispersion of tracers in surface waters, its relation to patchiness, and the way the depth of mixing correlates with wind speed (the stronger the wind the deeper the mixing, and the area covered increases in proportion to $(\text{time})^2$ after tracer release).

We were introduced to the novel concept of Ecological Stoichiometry (ES) and its relation to element distributions in the marine environment; also how alelochemicals can affect species succession among phytoplankton. The concept of ES has hitherto been concerned mainly with nutrients (C, N, P), but has a much wider scope, and requires sampling and analysis of a great variety of marine organisms. The talk was presented as work in progress, and it is to be hoped that ES will become an important tool of biogeochemistryin the future.

Another intriguing presentation suggested that there may soon be a resurgence of Sweden's nuclear industry, as it was about modelling coastal ecosystems prior to a search for nuclear waste repositories.

Several talks referred to 'planar optodes', recently devised for 2D measurement of oxygen and pH in bioturbated sediments. The sensors that are inserted into the sediment have high spatial resolution (c. 0.1 mm) and good temporal resolution (<20 s), and they can be deployed over areas up to about 35 cm^2. They provide a useful tool for bridging the gap between the use of benthic chambers and single-point measurements using microelectrodes of the sort more commonly employed to measure oxygen and pH in sediments. Their great advantage is that they can be used both for *in situ* and for laboratory studies of oxygen dynamics within benthic habitats, ranging from macrofaunal activity (including burrow structures) and microbial biofilms, through anoxic micro-niches and root systems, to advection in permeable sediments. (For more information contact Henrik Stahl (hjstahl@bi.ku.dk.)

Among the plenary lectures that attracted special interest was one by Vicki Richards of the Western Australian Museum, who described conservation of a wreck site (the *James Matthews*, sunk in the 19th century off western Australia). She cited in particular the corrosive effect of oxygenated saline water and of biota in the sediments, also of the hazards of re-burying wrecks, which must be done carefully without too much loose material (especially sand) because both oxygen and interstitial fauna can corrode metals and consume organic material and artefacts; wood-boring worms can be especially damaging. Barriers can be erected to keep the sediment out, and there has been some success at seeding with seagrasses.

Monty Priede of Aberdeen discussed the difficulties of sampling and photographing fishes at abyssal depths (see *Ocean Challenge*, Vol. 14, No. 2). It turns out that deep sea fish have eyes, but the question is, what do they see, and by what light? It may be that bioluminescence in the deep sea provides at least part of the answer.

Perhaps the most arresting plenary speaker was Katherine Richardson of Aarhus University, Denmark, who spoke about the perils facing planet Earth, including pollution, climate change, and biodiversity loss. One of her main points was that we should regard potential shutdown of thermohaline circulation in the Atlantic as a *risk* rather than as a definite outcome of continued melting of polar ice caps. It may happen of course, and if it does, the climate of north-western Europe will become very chilly indeed.

Eds

Mary Swallow 1917–2006

John Gould

The death of Mary Swallow on 29 January 2006 brought to an end over half a century in which she and her husband, the late Dr John Swallow FRS, had a lasting influence on the worldwide community of ocean scientists.

Mary was born in Devonport on 11 July 1917, the eldest daughter of Ernest and Millicent McKenzie. She took a double First Class honours degree in geography and geology at Kings College London in 1938. After graduation she trained as a teacher and taught for a short while, but following the outbreak of war she joined the Met. Office at Stroud in Gloucestershire where she prepared oceanographic and meteorological handbooks.

After the war Mary became a lecturer in geography at the University of Exeter and in 1947 married Fred Morgan, a fellow geographer. Fred became a reader in geography at the London School of Economics and they moved to live in Haslemere, Surrey. Tragically, Fred died in 1952 only 6 months after the birth of their daughter Lucy.

In 1954 Mary joined the newly-established National Institute of Oceanography (NIO), housed in a former naval radar research building on high ground between Godalming and Haslemere. Eventually she became its librarian.

This was an exciting time for ocean exploration as technologies developed during the Second World War were given peacetime applications, and new scientists joined the NIO. One such was John Swallow, a quietly-spoken Yorkshireman, with a new doctorate in geophysics from Cambridge and oceanographic experience gained during the 1950–52 global circumnavigation of HMS *Challenger*.

John Swallow had been charged with developing a method to measure currents deep below the ocean surface – something that had not previously been possible. This he did, making the first measurements in 1955 using a device that was cleverly stabilized at mid-depth and that drifted with the currents. It became known worldwide as the 'Swallow' float.

In 1953 a journal had been founded to publish the many new oceanographic discoveries. *Deep-Sea Research* was truly international, and in 1963 Mary Swallow joined Mary Sears, an editor based in Woods Hole, Mass., USA, and between them they guided the journal to become the major outlet for ocean research publications.

In 1958, Mary had married John Swallow and together they became an oceanographic focal point, Mary editing *Deep-Sea Research* and John continuing a productive research career which gained him international honours, and during which he spent a total of seven years at sea. They spent extended periods overseas together, especially in Woods Hole where they had many friends. John and Mary's hospitality was legendary among oceanographers. In their home in Surrey, scientists from around the world enjoyed their food, wine, garden and company.

In 1977 Mary retired from the Institute and from the editorship of *Deep-Sea Research*. In 1978 John suffered a serious heart attack but he made a good recovery and continued working and going to sea until he retired from the Institute in 1983.

Following John's retirement they moved to Cornwall where John continued his research and they could entertain in their beautiful house whose front door offered spectacular views across the Tamar. Lucy moved to Cornwall shortly afterwards to take a teaching position in Falmouth.

Sadly, Lucy died in 1992 aged only 41. John and Mary's last visit to Woods Hole was in February 1994 when John was the first recipient of the gold medal instituted in memory of Henry Stommel, an eminent American scientist and longtime friend and collaborator. Further tragedy struck in December 1994 when John Swallow died suddenly.

For her remaining years Mary lived alone, coping with failing eyesight (a particular sadness for someone whose life had centred on books), supported by caring family and friends. She continued to live a full life, as instanced by the party she hosted in August 1999 so that her friends and family could view the total solar eclipse. Mary remained as an Emeritus editor of *Deep Sea Research* and still maintained close links with oceanographers around the world. As she wished, her journals have been donated to a laboratory in Africa – the Institute of Marine Research in Zanzibar.

Mary's death was keenly felt by her two surviving sisters, her other relatives and by her many friends. In the world of science Mary and John's influence continues. *Deep-Sea Research*, that Mary had done so much to shape, remains a prestigious international scientific publication, and over 2000 Swallow floats of the Argo project, operated by scientists in 23 countries, now monitor the climate of the oceans that were the focus of the Swallows' lives.

it was about modelling coastal ecosystems prior to a search for nuclear waste repositories.

Several talks referred to 'planar optodes', recently devised for 2D measurement of oxygen and pH in bioturbated sediments. The sensors that are inserted into the sediment have high spatial resolution (c. 0.1 mm) and good temporal resolution (<20 s), and they can be deployed over areas up to about 35 cm^2. They provide a useful tool for bridging the gap between the use of benthic chambers and single-point measurements using microelectrodes of the sort more commonly employed to measure oxygen and pH in sediments. Their great advantage is that they can be used both for *in situ* and for laboratory studies of oxygen dynamics within benthic habitats, ranging from macrofaunal activity (including burrow structures) and microbial biofilms, through anoxic micro-niches and root systems, to advection in permeable sediments. (For more information contact Henrik Stahl (hjstahl@bi.ku.dk.)

Among the plenary lectures that attracted special interest was one by Vicki Richards of the Western Australian Museum, who described conservation of a wreck site (the *James Matthews*, sunk in the 19th century off western Australia). She cited in particular the corrosive effect of oxygenated saline water and of biota in the sediments, also of the hazards of re-burying wrecks, which must be done carefully without too much loose material (especially sand) because both oxygen and interstitial fauna can corrode metals and consume organic material and artefacts; wood-boring worms can be especially damaging. Barriers can be erected to keep the sediment out, and there has been some success at seeding with seagrasses.

Monty Priede of Aberdeen discussed the difficulties of sampling and photographing fishes at abyssal depths (see *Ocean Challenge*, Vol. 14, No. 2). It turns out that deep sea fish have eyes, but the question is, what do they see, and by what light? It may be that bioluminescence in the deep sea provides at least part of the answer.

Perhaps the most arresting plenary speaker was Katherine Richardson of Aarhus University, Denmark, who spoke about the perils facing planet Earth, including pollution, climate change, and biodiversity loss. One of her main points was that we should regard potential shutdown of thermohaline circulation in the Atlantic as a *risk* rather than as a definite outcome of continued melting of polar ice caps. It may happen of course, and if it does, the climate of north-western Europe will become very chilly indeed.

Eds

Mary Swallow 1917–2006

John Gould

The death of Mary Swallow on 29 January 2006 brought to an end over half a century in which she and her husband, the late Dr John Swallow FRS, had a lasting influence on the worldwide community of ocean scientists.

Mary was born in Devonport on 11 July 1917, the eldest daughter of Ernest and Millicent McKenzie. She took a double First Class honours degree in geography and geology at Kings College London in 1938. After graduation she trained as a teacher and taught for a short while, but following the outbreak of war she joined the Met. Office at Stroud in Gloucestershire where she prepared oceanographic and meteorological handbooks.

After the war Mary became a lecturer in geography at the University of Exeter and in 1947 married Fred Morgan, a fellow geographer. Fred became a reader in geography at the London School of Economics and they moved to live in Haslemere, Surrey. Tragically, Fred died in 1952 only 6 months after the birth of their daughter Lucy.

In 1954 Mary joined the newly-established National Institute of Oceanography (NIO), housed in a former naval radar research building on high ground between Godalming and Haslemere. Eventually she became its librarian.

This was an exciting time for ocean exploration as technologies developed during the Second World War were given peacetime applications, and new scientists joined the NIO. One such was John Swallow, a quietly-spoken Yorkshireman, with a new doctorate in geophysics from Cambridge and oceanographic experience gained during the 1950–52 global circumnavigation of HMS *Challenger*.

John Swallow had been charged with developing a method to measure currents deep below the ocean surface – something that had not previously been possible. This he did, making the first measurements in 1955 using a device that was cleverly stabilized at mid-depth and that drifted with the currents. It became known worldwide as the 'Swallow' float.

In 1953 a journal had been founded to publish the many new oceanographic discoveries. *Deep-Sea Research* was truly international, and in 1963 Mary Swallow joined Mary Sears, an editor based in Woods Hole, Mass., USA, and between them they guided the journal to become the major outlet for ocean research publications.

In 1958, Mary had married John Swallow and together they became an oceanographic focal point, Mary editing *Deep-Sea Research* and John continuing a productive research career which gained him international honours, and during which he spent a total of seven years at sea. They spent extended periods overseas together, especially in Woods Hole where they had many friends. John and Mary's hospitality was legendary among oceanographers. In their home in Surrey, scientists from around the world enjoyed their food, wine, garden and company.

In 1977 Mary retired from the Institute and from the editorship of *Deep-Sea Research*. In 1978 John suffered a serious heart attack but he made a good recovery and continued working and going to sea until he retired from the Institute in 1983.

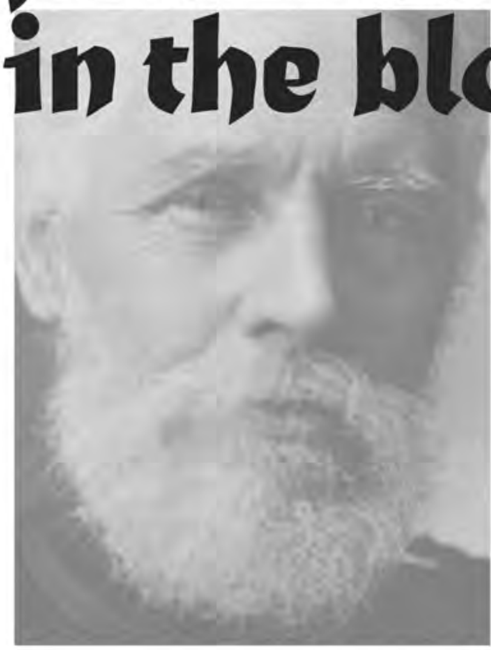
Following John's retirement they moved to Cornwall where John continued his research and they could entertain in their beautiful house whose front door offered spectacular views across the Tamar. Lucy moved to Cornwall shortly afterwards to take a teaching position in Falmouth.

Sadly, Lucy died in 1992 aged only 41. John and Mary's last visit to Woods Hole was in February 1994 when John was the first recipient of the gold medal instituted in memory of Henry Stommel, an eminent American scientist and longtime friend and collaborator. Further tragedy struck in December 1994 when John Swallow died suddenly.

For her remaining years Mary lived alone, coping with failing eyesight (a particular sadness for someone whose life had centred on books), supported by caring family and friends. She continued to live a full life, as instanced by the party she hosted in August 1999 so that her friends and family could view the total solar eclipse. Mary remained as an Emeritus editor of *Deep Sea Research* and still maintained close links with oceanographers around the world. As she wished, her journals have been donated to a laboratory in Africa – the Institute of Marine Research in Zanzibar.

Mary's death was keenly felt by her two surviving sisters, her other relatives and by her many friends. In the world of science Mary and John's influence continues. *Deep-Sea Research*, that Mary had done so much to shape, remains a prestigious international scientific publication, and over 2000 Swallow floats of the Argo project, operated by scientists in 23 countries, now monitor the climate of the oceans that were the focus of the Swallows' lives.

Sea-salts in the blood



A working life afloat: from HMS *Challenger* to the Thames

Roger Suckling ***great-grandson of the sailor***

The story of the three-and-a-half year voyage of HMS *Challenger* from 1872 to 1876, laying the foundations of modern oceanography, will be well known to most readers of *Ocean Challenge*. For the story of how this Royal Naval steam-assisted screw corvette sailed around the world on the very first circumnavigation devoted to marine scientific research has been told many times (see Further Reading). However, these accounts have been based mostly on the official expedition reports or on contemporary accounts written by the ship's officers or members of the scientific staff. Apart from the letters sent home during the voyage by a *Challenger* assistant ship's steward, Joseph Matkin, very little has been published on the influence of the expedition on men of the lower deck. One such man was my great grandfather, Henry John Lediard, who served as a seaman on the *Challenger* on the last leg of her epic voyage from Montevideo back to Portsmouth. Henry's career in the Royal Navy did not last many years – just six in fact. It was, however, eventful and memorable.

Henry John Lediard's early years

Henry was born in Chatham, Kent, on 7 February 1856. His mother, Mary was also born in the town, but his father, Edward Lediard, came from Lechlade, Gloucestershire. Edward served in the Royal Marines, and Henry attended the Royal Marine School inside Chatham Barracks. This undoubtedly had an influence on Henry's determination from a young age to go to sea. Henry attempted, in fact, to join a Royal Navy ship at Sheerness when aged just eleven years, but his brother William prevented him from signing on.

A little while later, however, Henry managed to sail aboard a collier brig, the *Elisha Kendall*. He did so until he was old enough to join the Royal Navy without family intervention. Henry was accepted into the Royal Navy on 27 August 1870, which was fortunate for him, as the *Elisha Kendall* foundered on her very next trip up the North Sea with the loss of all hands.

On Christmas Day 1872, while Henry was on-board HMS *Northumberland* anchored off Madeira, the ship dragged her anchor in heavy seas. Unfortunately, before a second anchor could be dropped, the *Northumberland* fell across the bows of HMS *Hercules*. The latter's ram penetrated the *Northumberland* on her port side, taking away boats and davits and a funnel and inflicting other damage. The *Hercules* lost masts and other gear. Pumps worked overtime and emergency repairs were undertaken in continuing stormy weather. The following day the *Northumberland* made for Gibraltar accompanied by the *Hercules* and HMS *Agincourt*. In Gibraltar, the damage sustained by *Northumberland* was more fully investigated and further repairs put in hand. The ship then sailed for Malta where she had new plates fixed to her bottom and other repair work was completed. On Good Friday 1873 the *Northumberland* arrived at Plymouth and Henry was given two weeks badly needed leave.

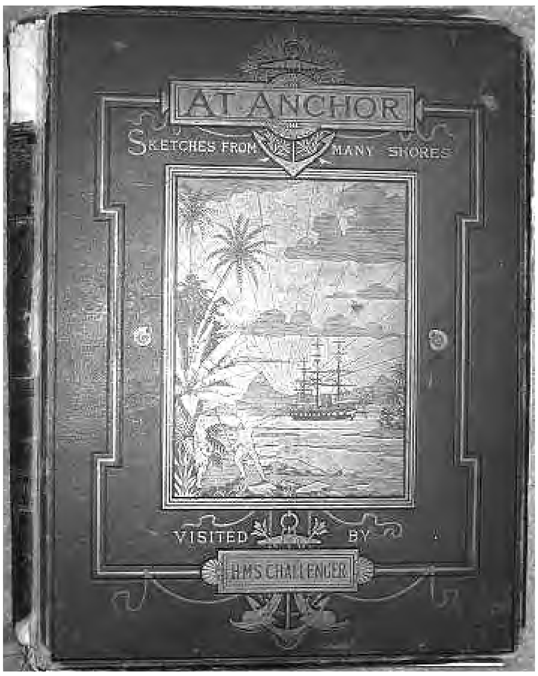
In May, Henry joined the crew of HMS *Ready*, a wooden-screw gun vessel that had been launched at Chatham the previous year. Henry's older brother William had joined the *Ready* shortly before Henry on 16 April 1873. Family memory has it that when Henry stepped onto the deck of the *Ready*, William – a bo'sun – greeted him with words to the effect: 'Now you swab, there is going to be no favouritism here; your job will be to man the topsails.' Henry recounted that several times while at sea off southern Argentina, he and colleagues up the mast were at times just a few feet above the waves and salt spray lashed their faces.

The *Ready*, on South American patrol between the River Amazon and the Straits of Magellan, was an unhappy ship. It is understood that there were three major crew desertions after Henry joined her on 16 May 1873, all of which necessitated sailors from other ships being drafted onto her. Apparently, this was due to the rather tyrannical attitude of the Captain. When the opportunity of a draft to the *Challenger* arose, Henry took it, even though it meant leaving William behind on the *Ready*.

Desertions from Naval ships were not at all uncommon at that time, and by no means always because of harsh treatment. There is no evidence that the *Challenger's* original captain during her scientific circumnavigation, George Strong Nares, nor Frank T. Thomson who took over from Nares at Hong Kong, were other than humane officers. Yet more than sixty of her men deserted at one or other of her port calls; Henry was one of the replacements.

William continued to serve with the *Ready* until 27 March 1877, and had a very successful Royal Navy career. Having joined as a Boy 2nd Class in 1858, he rose through the ranks to become an Honorary Lieutenant in 1898. He retired in 1899 and is believed to have had the longest continuous service of anyone in the Royal Navy (at the time, and possibly now) – forty-one years! He is known to have saved the lives of two able seamen from drowning by jumping overboard – once in the Gulf of Corinth while his ship was under sail, and once in Rio de Janeiro harbour. Towards the end of his career, William was appointed bo'sun of the Malta Dockyard. He retired with a pension of £147 18s 5d a year, which by 1 April 1926 had risen to £163 – not an inconsequential sum for those days!

Henry's much-read copy of WIld's account of* Challenger*'s voyage



***Henry as a young sailor in Montevideo shortly before joining* Challenger**

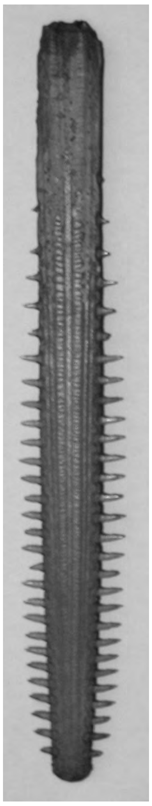
Adventures on board *Challenger*

Although Henry was part of *Challenger's* crew for only a small fraction of the almost 69 000 miles she covered in the service of science, he was very proud to have been part of the expedition. In his home, he always prominently displayed two framed pictures of *Challenger* riding a gale. Few Victorian seamen were literate, but Henry was, and he read to his children from his prized copy of John James Wild's account of *Challenger's* voyage – *At Anchor: sketches from many shores visited by HMS Challenger*, published in 1878 – and he also spoke to his children (who adored him) about his own experiences at sea.

The pictures and the book have been passed down through the family to me, as have a number of interesting anecdotes, the principal and most enthusiastic raconteur being Henry's daughter (my grandmother) Emily Ada Lediard (later to become Emily Ada Suckling on her marriage to a Metropolitan Police officer). If only some of Henry's letters home had survived, and I had paid more attention to my grandmother and her brothers and sister when they spoke about their father ...

Challenger arrived in the shallow estuary off Montevideo and anchored two miles offshore on 15 February 1876. Anchored nearby was the German frigate *Gazelle*. This ship, under the command of Captain Z.S. Freiherr von Schleinitz, was also engaged in a sounding and dredging voyage round the world. Throughout her stay off Montevideo, HMS *Challenger* experienced strong winds and rough seas, which made visits between vessels and to and from the town difficult.

On 13 March 1876, the *Challenger* crossed her outbound track near Tristan da Cunha in the mid- Atlantic. In so doing, she completed her circumnavigation of the world. Two weeks later,



The rostral saw of a sawfish (~27 cm long) which Henry acquired in the Cape Verde Islands (probably the smalltooth sawfish* Pristis pectinata*)

Challenger reached Ascension Island. Henry was taken by the volcanic nature of the island (the top of a mountain peak rising thousands of feet from the sea floor) and by the crew's luck in arriving in heavy rain, given that fresh water was normally in short supply on the island. He recalled seeing many turtles, some being taken onboard and eaten (presumably green turtles *Chelonia mydas*), and – of particular interest to me as an ornithologist – large numbers of nesting seabirds. Henry described birds with long forked tails and bright red bags under their throats (an obvious reference to male Ascension Island frigate birds *Fregata aquila*, now a globally threatened species found nowhere else in the world). According to my grandmother, Henry also enthused about the excellent fishing enjoyed by the sailors from the decks of the *Challenger*.

Challenger left Ascension Island on 3 April. Soundings and dredgings continued to be made. From 18 to 26 April the ship anchored off the Cape Verde Islands. Like Ascension Island, the islands of this archipelago are of volcanic origin. According to Henry, fish, fruit and nuts were plentiful, and limes were particularly prized by *Challenger*'s crew. More than one sailor took a parrot on-board as a pet. Henry 'acquired' the elongated snout (rostral saw) of a sawfish. This has a number of teeth running down either side and is used by sawfish when feeding. It is swung from side to side, disabling and impaling prey items (including other fish) on the teeth.

By now, many of the crew were eager to get home, but on leaving the Cape Verde Islands they encountered unfavourable winds. Progress was slow and Henry told his family that some sailors became increasingly irritable and even antagonistic towards officers. Europe was eventually reached on 20 May 1876 and *Challenger* called in briefly at Vigo in north-west Spain for provisions, mainly coal. Henry spoke of a majestic fortress high above the town. Four days later, the ship finally anchored off Spithead, Portsmouth.

Life on board *Challenger*

Henry's family gained the clear impression that – perhaps not surprisingly – he found life on-board the *Challenger* somewhat strange and uncomfortable. The layout of the ship and the equipment she carried were initially unfamiliar to all the seamen who joined her. She was, of course, quite unlike any other Royal Naval vessels, or indeed any other ship afloat. Some sailors felt vulnerable as most of *Challenger*'s guns had been removed. Living conditions were even more cramped than usual because *Challenger's* structure had been substantially modified to facilitate the provision of additional accommodation, including laboratories, workrooms, and storage for trawls, dredges, and other equipment, as well as thousands of specimens.

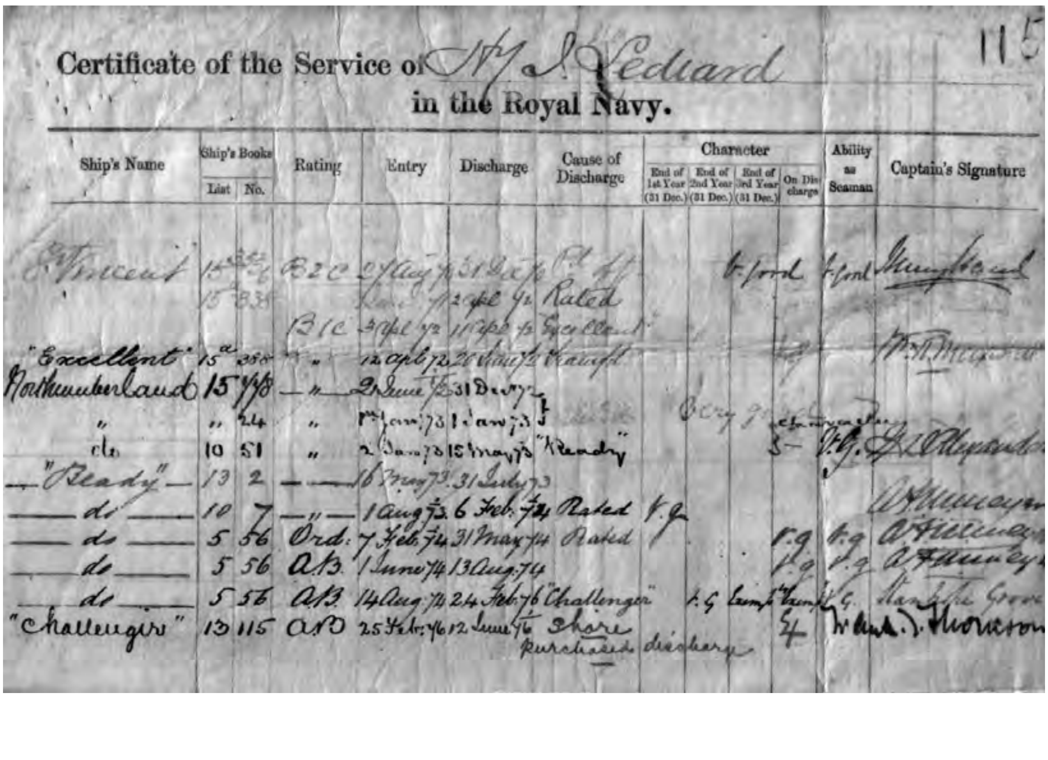
Many sailors found the scientific routines unusually arduous. The repetitive netting of fish and other sea-life, dredging through sediments, water sampling, and other tasks, had taken their toll on minds and bodies. In Henry's view, there would have been even greater crew discontentment had the ship not spent a large amount of time at anchor in harbours and ports around the world.

After HMS *Challenger* arrived back in England, her crew were paid off and Henry purchased his discharge from the Navy on 12 June 1876.

Henry's later life and career

It was not long before Henry applied to join the Metropolitan Police. He received three weeks drill at Wellington Barracks and was sworn in on 4 September 1876. Henry was posted to Woolwich Arsenal and almost straightaway applied for a transfer to the Thames Division of the Force (now known as the Marine Support Unit). He was

Henry John Lediard's Certificate of Service in the Royal Navy. Throughout his naval career, Henry's character was recorded as either 'Very good' or 'Excellent'. He spent one day in hospital and one other day sick.



Certificate of the Service of H. J. Lediard 115
in the Royal Navy.

Ship's Name	Ship's Books List	Ship's Books No.	Rating	Entry	Discharge	Cause of Discharge	Character End of 1st Year (31 Dec.)	Character End of 2nd Year (31 Dec.)	Character End of 3rd Year (31 Dec.)	Character On Discharge	Ability as Seaman	Captain's Signature
St Vincent	15	[illegible]	B2C	[illegible] Aug 71	31 Dec 71	[illegible]			V. Good		V. Good	[illegible]
	15	338		[illegible]	2 Apl 72	Rated						
			B1C	3 Apl 72	11 Apl 72	to Excellent						
"Excellent"	15a	338	"	12 Apl 72	20 June 72	[illegible]						[illegible]
Northumberland	15	478	"	21 June 72	31 Dec 72							
"	"	24	"	1 Jan 73	1 Jan 73			Very good				
do	10	51	"	2 Jan 73	15 May 73	"Ready"				3	V.G.	[illegible]
"Ready"	13	2	—	16 May 73	31 July 73							
do	10	7	"	1 Aug 73	6 Feb 74	Rated	V.G.					[illegible]
do	5	56	Ord.	7 Feb 74	31 May 74	Rated				V.G.	V.G.	[illegible]
do	5	56	AB	1 June 74	13 Aug 74					V.G.	V.G.	[illegible]
do	5	56	AB	14 Aug 74	24 Feb 76	"Challenger"	V.G.	Exemp	Exemp		V.G.	[illegible]
"Challenger"	13	115	AB	25 Feb 76	12 June 76	Shore Purchased discharge				[illegible]		[illegible]

successful and took up his new duties at Waterloo Pier Police Station in January 1877. Later that year, Henry married Emily Sarah Webb in Chatham, Kent – a step which required the permission of the Police Commissioner. Emily was born in another town with strong nautical ties – Greenwich. Henry and Emily set up home in Lambeth, London.

Henry threw himself into his new career with considerable energy, and promotions followed. After becoming a Third Class Inspector, Henry was made a Full Inspector in 1888. In those days, Thames Division Police officers with the rank of Inspector were also customs officers (Henry's tipstaff, in which he carried his Excise Warrant, issued by the Customs and Excise Service, is shown opposite).

While at Waterloo, Henry took a rowing boat out on his own and rescued a woman from drowning. After resuscitating her, he gave her further first aid, lifted her on to a hand ambulance and then – still on his own – took her through heavy rain to Westminster Hospital. In 1882, he passed the St John Ambulance First Aid Certificate so that he could better help his fellow men.

After promotion to Inspector, Henry was based at Wapping Police Station and eventually retired from there on 9 September 1901 with a pension of £108 7s 7d a year. His conduct was described as 'Very Good'. There are many stories within the family about the strength of character shown by Henry while he was in the Thames Division of the Metropolitan Police. His Royal Navy training and experience stood him and those officers under his command in good stead. He was much loved by his men and – perhaps surprisingly for those days – respected by criminals he came across. One day when Henry was shopping with his wife in The Cut, a hardened criminal approached him with suspected malintent. On recognising Henry, the man stood back, remarking: 'If you hadn't told the truth in Court Sir, I'd have been put away for much longer. Thank you!' The rogue then made off through the street market.

Henry went on the Thames in all weathers. There were several (well-documented) severe winters during Henry's Police service. Ice was not uncommon on the river and when temperatures were low, policemen tied sacking around themselves in an effort to keep warm in the open boats. Nevertheless, frostbite proved an occupational hazard for some.

Despite the hardships, pay was not much more than 20 shillings a week. When he was on duty, Henry's meals, like those of his colleagues, would typically consist of bread and cheese and tea or soup. By today's standards, this might not be thought much – especially given the demands of making all speed in an open rowing boat in pursuit of criminals through bad weather! Until the turn of the 20th century, none of the Thames Division Police boats were power driven. Normally, Henry – as an Inspector – would use a rowing galley 'powered' by three watermen Constables. Imagine rowing after criminals and then chasing after them!

Police at Wapping Police Station, on the Thames (Henry is fourth to left of right-hand post, behind the boat crew)

Henry had clearly been able to reconcile his Christian beliefs with the theories of Charles Darwin and all he had seen and learned while on *Challenger*. He regularly attended church and was a member of the Metropolitan Police Christian Association.

When Henry retired from the Police, he secured employment as a gate-keeper at Gun Wharf, Wapping. Henry prevented the theft of a wide range of items, and on one occasion, a heavy chain was dropped on his head, apparently in retribution. According to Henry, only his hat saved him from serious injury.

Later in life, after moving to Deptford, he often undertook charity work, including in soup kitchens for the poor and the homeless. He helped provide neglected children with old clothing and shoes. He was also active in the Police Pensioners' Association, and undertook stewarding duties each year at the National Sporting Club and at Wimbledon.

Few people achieve in their lives what Henry Lediard and his older brother William did. Both made valuable contributions to Victorian Britain which were also of benefit to later generations. Henry's time aboard *Challenger* affected him greatly, and its influence remained with him over the course of his long life.

Henry's tipstaff showing the removable top in the form of a crown, which gave access to his Excise Warrant

Further Reading and Sources of Information

Unknown (?1898/1899) From Boy to Lieutenant: 41 Years in the Royal Navy. *The Daily Malta Chronicle.*

College, J.J. (1969) *Ships of the Royal Navy: an historical index. Vol. 1, Major Ships (excluding Trawlers, Drifters, Tugs etc.)*. Augustus M. Kelly, New York.

Corfield, R. (2003) *The Silent Landscape: The Scientific Voyage of HMS Challenger.* Joseph Henry Press.

Joslin, J. (1973) The Thames Police Museum Spot: The Lediard Collection. *Thames Police Association Journal*, January 1973, 81–91.

Wild, J. J. (1878) *At Anchor: Sketches from many shores visited by HMS Challenger.* Marcus Ward and Co.

Linklater, E. (1972) *The Voyage of the Challenger,* Cardinal, pp. 268–70.

Rehbock, Philip F. (1992) *At Sea with the Scientifics: The Challenger Letters of Joseph Matkin*. University of Hawaii Press.

Rice, A.L. (2001) The *Challenger* Expedition. The end of an era or a new beginning? pp. 27–48 in Deacon, M., T. Rice and C. Summerhayes (eds) *Understanding the Oceans,* UCL Press.

Rice, Tony (1990) Fame and fortune: the pay and of scientists and sailors on the *Challenger, Ocean Challenge,* Vol. 1, Autumn/Winter 1990, 45–50.

When Henry Lediard was dying he wrote his thoughts down for his children. His words, his police uniform and his and his son Edward's personal effects have been loaned to the Thames River Police Museum at Wapping. The museum may be visited by members of the public by prior arrangement. For more information, see http://www.thamespolicemuseum.org.uk/museum.html

Roger Suckling is retired from central government service. He is a passonate ornithologist with a particular interest in seabirds of the world.

Email: rogersuckling@greatbookham.demon.co.uk

The Challenger Medal Roll

Glenn M. Stein

The Challenger Society's most prestigious is the Challenger Medal, which is presented biennially to a distinguished UK marine scientist, or other person, who has made a major contribution to the development of marine science. But what of the original Challenger medals, awarded in the wake of the Challenger Expedition? Below, Glenn Stein provides some fascinating insights about the medal itself, and those who received it. Ed

Reflecting on the *Challenger* Expedition, Professor Sir Charles Wyville Thomson wrote:

> 'The objects of the Expedition have been fully and faithfully carried out. We always kept in view that to explore the conditions of the deep sea was the primary object of our mission, and throughout the voyage we took every possible opportunity of making a deep-sea observation. Between our departure from Sheerness on December 7th, 1872, and our arrival at Spithead on May 24th, 1876, we traversed a distance of 68,890 nautical miles, and at intervals as nearly uniform as possible we established 362 observing stations.'

But the work of the *Challenger* Expedition had only just begun. A group of specialists, men learned in their own subjects, would spend years describing and drawing the specimens that filled storehouses and laboratories. These specialists came from various countries across Europe, and from America, as there had been a conscious decision to invite the world's premier specialists, not only to conduct the investigations but also to write the various reports. This was done at the vigorous insistence of J.J. Thomson, who experienced considerable pressure to give a more prominent role to British scientists.

The daunting task of publishing the results fell for the most part on the shoulders of John Murray. The first of the 50 volumes of the *Challenger Report* came out in 1885, and the last two summary volumes in 1895.

The authors of the *Challenger Report,* received only a copy of the publication and a small honorarium to cover their expenses. However, in further appreciation it was resolved that a *Challenger* medal be cast. The Treasury refused to pay for it and John Murray had the medal designed and executed at his own expense, and arranged for replicas (i.e. identical medals) to be sent to those who had shared in the expedition or in preparation of the Report. He was honoured by the Royal Society when he was admitted as a Fellow in 1896. Official commendation by the Government was deferred until 1898, when the Queen conferred on John Murray the rank of Knight Commander, the Most Honourable Order of the Bath, 'in recognition of his outstanding contributions to science.'

Design and production of the medal

The medal is 3 inches (75 mm) across. The obverse (Figure 1(a)) commemorates the voyage of the *Challenger*. In the centre is Minerva, the Roman goddess of wisdom and war (one of her many roles); the owl next to her is her sacred bird). These figures are superimposed upon a globe with lines of latitude and longitude (although on at least one of the medals, only the lines of longitude appear). Partially encircling Athena and the owl is what appears to be an evergreen laurel branch; to the Greeks and Romans the laurel symbolised acquired immortality, both in battle and the arts. The whole is bordered by water, indicating the Expedition's round-the-world voyage. Figures from the sea include the Roman god of the sea, Neptune, who is grasping what appears to be a bottom sampler trawl in his right hand (disclosing treasures from the deep). He cradles his trident in the left hand. A stylized dolphin is close by, and two mermaids support a long ribbon, which tactfully conceals their charms. The ribbon bears the words: VOYAGE OF H.M.S. CHALLENGER/ 1872–76.

The reverse of the medal commemorates work on the *Challenger Report*. The central figure is a standing armoured knight, throwing the gauntlet from his right hand into the sea, presumably to Neptune, whose trident appears above the waves – this being the crest of HMS *Challenger*. The trident is partially wrapped in a long ribbon, which extends the entire circumference. The ribbon bears the wording: REPORT ON THE SCIENTIFIC RESULTS OF THE CHALLENGER EXPEDITION/1886-95 (Figure 1(b)).

The recipient's first name and surname are engraved on the edge at six o'clock, in sans serif capital letters. Sometimes, only the first and middle initials were engraved.

Corfield, R. (2003) *The Silent Landscape: The Scientific Voyage of HMS Challenger.* Joseph Henry Press.

Joslin, J. (1973) The Thames Police Museum Spot: The Lediard Collection. *Thames Police Association Journal*, January 1973, 81–91.

Wild, J. J. (1878) *At Anchor: Sketches from many shores visited by HMS Challenger.* Marcus Ward and Co.

Linklater, E. (1972) *The Voyage of the Challenger,* Cardinal, pp. 268–70.

Rehbock, Philip F. (1992) *At Sea with the Scientifics: The Challenger Letters of Joseph Matkin*. University of Hawaii Press.

Rice, A.L. (2001) The *Challenger* Expedition. The end of an era or a new beginning? pp. 27–48 in Deacon, M., T. Rice and C. Summerhayes (eds) *Understanding the Oceans,* UCL Press.

Rice, Tony (1990) Fame and fortune: the pay and of scientists and sailors on the *Challenger, Ocean Challenge,* Vol. 1, Autumn/Winter 1990, 45–50.

When Henry Lediard was dying he wrote his thoughts down for his children. His words, his police uniform and his and his son Edward's personal effects have been loaned to the Thames River Police Museum at Wapping. The museum may be visited by members of the public by prior arrangement. For more information, see http://www.thamespolicemuseum.org.uk/museum.html

Roger Suckling is retired from central government service. He is a passonate ornithologist with a particular interest in seabirds of the world.
Email: rogersuckling@greatbookham.demon.co.uk

The Challenger Medal Roll

Glenn M. Stein

The Challenger Society's most prestigious is the Challenger Medal, which is presented biennially to a distinguished UK marine scientist, or other person, who has made a major contribution to the development of marine science. But what of the original Challenger medals, awarded in the wake of the Challenger Expedition? Below, Glenn Stein provides some fascinating insights about the medal itself, and those who received it. Ed

Reflecting on the *Challenger* Expedition, Professor Sir Charles Wyville Thomson wrote:

> 'The objects of the Expedition have been fully and faithfully carried out. We always kept in view that to explore the conditions of the deep sea was the primary object of our mission, and throughout the voyage we took every possible opportunity of making a deep-sea observation. Between our departure from Sheerness on December 7th, 1872, and our arrival at Spithead on May 24th, 1876, we traversed a distance of 68,890 nautical miles, and at intervals as nearly uniform as possible we established 362 observing stations.'

But the work of the *Challenger* Expedition had only just begun. A group of specialists, men learned in their own subjects, would spend years describing and drawing the specimens that filled storehouses and laboratories. These specialists came from various countries across Europe, and from America, as there had been a conscious decision to invite the world's premier specialists, not only to conduct the investigations but also to write the various reports. This was done at the vigorous insistence of J.J. Thomson, who experienced considerable pressure to give a more prominent role to British scientists.

The daunting task of publishing the results fell for the most part on the shoulders of John Murray. The first of the 50 volumes of the *Challenger Report* came out in 1885, and the last two summary volumes in 1895.

The authors of the *Challenger Report,* received only a copy of the publication and a small honorarium to cover their expenses. However, in further appreciation it was resolved that a *Challenger* medal be cast. The Treasury refused to pay for it and John Murray had the medal designed and executed at his own expense, and arranged for replicas (i.e. identical medals) to be sent to those who had shared in the expedition or in preparation of the Report. He was honoured by the Royal Society when he was admitted as a Fellow in 1896. Official commendation by the Government was deferred until 1898, when the Queen conferred on John Murray the rank of Knight Commander, the Most Honourable Order of the Bath, 'in recognition of his outstanding contributions to science.'

Design and production of the medal

The medal is 3 inches (75 mm) across. The obverse (Figure 1(a)) commemorates the voyage of the *Challenger*. In the centre is Minerva, the Roman goddess of wisdom and war (one of her many roles); the owl next to her is her sacred bird). These figures are superimposed upon a globe with lines of latitude and longitude (although on at least one of the medals, only the lines of longitude appear). Partially encircling Athena and the owl is what appears to be an evergreen laurel branch; to the Greeks and Romans the laurel symbolised acquired immortality, both in battle and the arts. The whole is bordered by water, indicating the Expedition's round-the-world voyage. Figures from the sea include the Roman god of the sea, Neptune, who is grasping what appears to be a bottom sampler trawl in his right hand (disclosing treasures from the deep). He cradles his trident in the left hand. A stylized dolphin is close by, and two mermaids support a long ribbon, which tactfully conceals their charms. The ribbon bears the words: VOYAGE OF H.M.S. CHALLENGER/ 1872–76.

The reverse of the medal commemorates work on the *Challenger Report*. The central figure is a standing armoured knight, throwing the gauntlet from his right hand into the sea, presumably to Neptune, whose trident appears above the waves – this being the crest of HMS *Challenger*. The trident is partially wrapped in a long ribbon, which extends the entire circumference. The ribbon bears the wording: REPORT ON THE SCIENTIFIC RESULTS OF THE CHALLENGER EXPEDITION/1886-95 (Figure 1(b)).

The recipient's first name and surname are engraved on the edge at six o'clock, in sans serif capital letters. Sometimes, only the first and middle initials were engraved.

(a) ***(b)***

Figure 1 *The obverse* ***(a)*** *and reverse* ***(b)*** *of the Challenger medal sent to Alexander Buchan, shown approximately actual size. It was designed by William S. Black of Edinburgh, and sculpted by William Birnie Rhind. The recipient's first name and surname are engraved on the edge at six o'clock.*

(Courtesy of St. Columba's Hospice, Challenger Lodge, Edinburgh.)

The medal was designed by William S. Black, an Edinburgh artist who actively exhibited between 1881 and 1897, and was sculpted by William Birnie Rhind, RSA (1853-–1933) an Edinburgh sculptor. It was cast in Paris by an unknown manufacturer. I have only ever seen bronze medals, but it is possible that it was also manufactured in silver.

It is not known how many medals were manufactured, but according to the 'List of Recipients of the Challenger Medal' drawn up by staff at the Challenger Office, Edinburgh, 120 medals were sent out. They were sent out from the Challenger Office in a fitted hinged case, which had 'James Crichton & Co., 47 George St., Edinburgh' printed on the white fabric of the inside lid, and came with a simple handwritten document noting the recipient's name, and that it was a souvenir of *Challenger* work (Figure 2). Several medals were hand-delivered by John Murray, but the majority were sent by post.

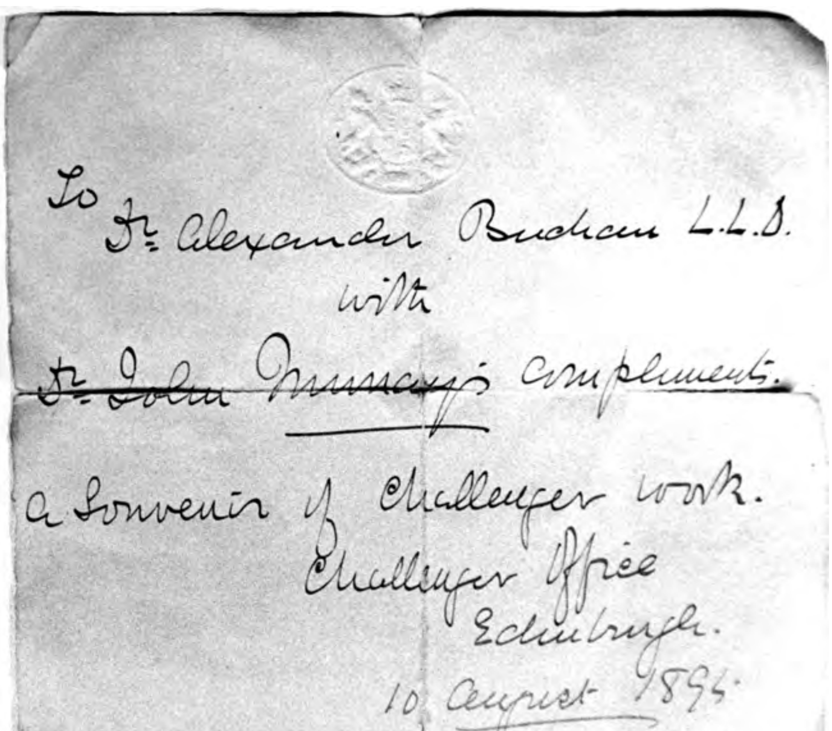

To Dr. Alexander Buchan LL.D.
with
Dr. John Murray's compliments.
A Souvenir of Challenger work.
Challenger Office
Edinburgh.
10 August 1895.

Figure 2 *The note which accompanied the medal sent to Alexander Buchan (1829–1907) who contributed to the* Report *in the area of 'Atmospheric and Oceanic Circulation'. He was Secretary of the Scottish Meteorological Society in Edinburgh, and became an FRS in 1898.*

The medal and the note are held at St Columba's Hospice, Challenger Lodge, Edinburgh.

Who was on the Challenger medal roll?

Contemporary writings in the journal *Nature* stated that the medal '... is being presented by Dr. John Murray to the naval officers of the expedition, the contributors of memoirs to the report on the scientific results of the expedition, and to members of the civilian scientific staff, as a souvenir of *Challenger* work.'

Assembling a complete medal roll presents various challenges. For one thing, not all those awarded a medal fell into the categories mentioned in *Nature*. One such person was Laurence Pullar, who had an engineering and business background, was a man of wealth, and took a broad view of public service. Pullar was also a life-long friend of Murray, and a Fellow of both the Royal Society and Royal Society of Edinburgh.

Another problem is that there are nine individuals included in Walter Crane's book of portraits of contributors to the *Report* (see Further Reading) who do not appear on the 'List of Recipients', and there seem to be no obvious reasons for their omission.

Another problem is whether or not 'contributors' included their assistants; perhaps in some cases the answer was yes, but in others no. Frederick Gordon Pearcey, who did receive the medal, had one foot in the Navy world and the other in the world of Science, as he was a Domestic 3rd Class in the Royal Navy and an Assistant to the Naturalists onboard. His shipmate, Writer Richard Wyatt, must have significantly helped in the recording of data, and was thus also rewarded with the medal. Another recipient was a certain 'Miss Sclater', who was possibly Philip L. Sclater's daughter, but this cannot be confirmed. In the case of several individuals at the end of the 'List of Recipients', I cannot find any links with the Expedition or with subsequent scientific work; more research and time will undoubtedly reveal their roles.

On the other hand, there are a number of individuals who do not appear in the 'List of Recipients' but who were evidently in every way entitled to the award, whether through participation in the voyage or through having contributed to the *Reports*. It is possible that medals were not issued to some of these men because they had died, although Busk, Carpenter and Huxley, for example, were awarded their medals posthumously. Perhaps some families could not be traced? As for the naval officers/warrant officers, with the exception of Commander Lloyd, it is possible that they had left the Service and could not be traced. But this again does not provide a definite answer to the question of why these men do not appear on the 'List'.

Murray is *not* shown on the 'List' as receiving a medal. This may well be an indication of the gentleman's modesty, as he evidently did not have a medal engraved for himself. Still, the total number of medals cast is unknown, so he more than likely kept an unnamed specimen for himself.

Acknowledgements
Clara Anderson, David C. Bossard, David M. Damkaer, Roy L. Davids, Margaret Deacon, Judith Farrington, Daniel Fearon, Dix Noonan Webb, Mark Sikes, John I. Simper, Barbara Tomlinson, Martin Wagner, Bryan Williamson.

Further Reading

Boog-Watson, W.N. (1967) *Sir John Murray, A Chronic Student*. Edinburgh: University of Edinburgh Journal, Autumn.

Brown, Laurence (1987) *A Catalogue of British Historical Medals 1837–1901*. London: Seaby.

Brunton, Eileen V. (2nd edn, 2004) *The Challenger Expedition, 1872–1876: A Visual Index*. London: The Natural History Museum.

Crane, Walter (1897) *Challenger Expedition Reports. Portraits of the Contributors, Reproduced from the Photographs Presented by Them to John Murray, etc.* London: Dulau & Co.

Kortum, Gerhard (1998) The German Challenger of Neptune: the short life and tragic death of Rudolf von Willemoes-Suhm. *Ocean Challenge,* Vol. 8, No. 2 (Special European Issue), 42–6.

Linklater, Eric (1972) *The Voyage of the Challenger*. New York: Doubleday and Company Inc.

Rehbock, P.F. (editor) (1992) *At Sea with the Scientifics: The Challenger Letters of Joseph Matkin*. Honolulu: University of Hawaii Press.

Rice, Tony (1990) Fame and fortune: the pay of scientists and sailors on the *Challenger. Ocean Challenge,* Vol. 1, Autumn/Winter 1990, 45–50.

Glenn Stein has collected and researched medals for 32 years, specialising in medals for polar exploration and research. In spring 2007, as a component of the International Polar Year 2007–2009, he will have an exhibit at the University of Central Florida on the First International Polar Year (1882–83)/ US Army's Lady Franklin Bay Expedition (1881–84).

Email: eloasis@earthlink.net

Glenn would be pleased to receive any additional information about the Challenger Medal and, in particular, would like to be made aware of existing examples of this medal. Glenn's compilation of recipients of Challenger Medals may be found on http://www.19thcenturyscience.org/HMSC/Chall-Medal/ChallengerMedal.html.

The website of the Library of 19th Century Science (19thcenturyscience.org) allows access to much else of interest, including the entire set of scientific reports produced in connection with the *Challenger* Expedition, as well as some additional contemporary books related to the voyage.

The local perspective on *Challenger*'s work off Bermuda

An idiosyncratic look at the *Challenger* Expedition my be found in a piece by Dr Edward Harris of the Bermuda Maritime Museum for the 'Heritage Matters' section of Bermuda's *Royal Gazette (*http://www.theroyalgazette.com).

Challenger visited Bermuda in April 1873. A good deal of trawling and dredging was undertaken in Bermudan waters, but time was also spent ashore. The Bermuda Maritime Museum has an album of photographs taken by men from *Challenger* while at Bermuda. The pictures in the *Challenger* album include photographs of the Dockyard, the Commissioner's House, as well as now famous rock formations, caves and 'sand glaciers'. There are also some photographs taken at other times during *Challenger's* voyage.

Putting Australia on the Map

This year marks the 400th anniversary of the first European contacts with the continent of Australia. 'Australia on the Map, 1606–2006' is the official Australian project encouraging the people of Australia to plan commemorative events. The focus is particularly on the many mariners who (by accident or design) charted the Australian coast, thereby making it known to the world.

The *Hydrographic Journal*, the publication of the International Federation of Hydrographic Societies, is running a series of feature articles written to mark this anniversary. They include an account of the voyage of the small sailing ship *Duyfken,* which in 1606 made the first historically recorded voyage to Australia. Some believe that Willem Janszoon on the *Duyfken* thought he was in fact surveying New Guinea, but this theory is strongly challenged by the article.

Other articles in this special series include 'Hydrographic Reputations: Matthew Flinders, Nicolas Baudin and Australia's Unknown Coast', and 'Finding the Figure of the Earth: the "Malaspina" Expedition 1789–1794'. This expedition was given the task of measuring the strength of gravity (using a pendulum) over the course of the voyage.

The *Hydrographic Journal* frequently includes articles with a historical flavour, as well as pieces about advances in hydrography at the present day.

Websites:
http://www.australiaonthemap.org.au;
http://www.hydrographic society.org

Sounding out sediment transport

observations and modelling of ripple-generated vortices

Peter D. Thorne and Alan G. Davies

Seven days a week, 24 hours a day, sands and muds are being carried around the world's coastlines through the actions of tides, winds and waves. The erosion, transport and deposition of these sediments continually modify the boundary between the land and the sea, changing and reshaping its form. Sometimes the changes evolve slowly over long stretches of time, at other times rapidly, due to natural episodic events or the introduction of man-made structures into the shoreline. For over half a century we have been trying to understand the physics of sediment transport processes and formulate predictive models. Although progress has been made, our capability to forecast the evolution of the shape and form of coastlines from basic principles is still relatively poor. However, innovative techniques for studying the fundamentals of sediment movement are now providing new insights, and it is expected that such observations, coupled with developing theoretical work, will allow us to take further steps towards to the elusive goal of predicting the evolution of coastlines and coastal bathymetry.

The importance of sediment studies

The mobility of sea-bed sediments, and hence of navigation channels, has been of concern to mariners over millennia. In more recent times, the appearance of supertankers and large container vessels in shallow coastal waters has brought the issue of channel mobility and predictability into even sharper focus, on account of the increasing environmental hazards posed by navigational accidents. The unpredictability of sand bars in shallow water was of vital concern during the Second World War, in connection with the use of landing craft on beaches. The laying of offshore gas and oil pipelines has raised further issues of strategic and economic importance linked to the stability of the sea-bed. Nowadays, climate change and sea-level rise are forcing us to think hard about strategies, 'green' or otherwise, for the defence of the coastline itself. All of these issues come back to the same underlying question: can we understand and then predict the movement of sea-bed sediments?

A prerequisite for the successful modelling of sediment transport is the representation of the flow itself and, in particular, the modelling of currents and waves. The nature of turbulent mixing in steady 'boundary layer' flows has been understood since the 1930s. At this time, when most interest was on river flows, key concepts such as the 'threshold' of sediment motion, and the shape of the suspended sediment concentration profile, were linked to the bed shear stress and its prediction, usually using measured logarithmic velocity profiles. The subsequent detailed measurement of turbulence became possible from the 1970s onwards. Observations of turbulence made in steady channel flows and tidal streams led to a much more detailed understanding of mixing processes, and also provided the rationale for the use of (numerical) turbulence models of increasing complexity for the prediction of sediment transport rates. The role of waves in stirring and transporting sediment in coastal waters was studied from the 1950s, and initially this research was undertaken rather separately by coastal engineers. Much work was carried out at this time in the USA in relation to the longshore drift of sediment by currents induced within the surf zone by the breaking waves themselves.

Only during the late 1970s and the 1980s were serious attempts made for the first time to bring the two strands of sediment transport research, involving currents and waves, together. Models were developed of the interaction between waves and currents in the sea-bed boundary layer, together with new formulations for predicting the shapes of the resulting bedforms (ripples etc.), in order to quantify sediment transport rates in combined wave and current flows. These transport rates can be one or two orders of magnitude greater than the transport by currents alone because of the ability of waves to stir up the bottom sediments, making this topic one of fundamental importance for coastal scientists and engineers.

Major advances followed in the 1990s, involving the enhancement of our observational capabilities with regard to sediments, both in the field and in small- and large-scale laboratory facilities. The challenges posed to existing models by these new data have led to a new generation of sophisticated, well validated modelling methods. These new models are now believed to have at least the

Coastal development can have unexpected effects on local and adjacent coastlines

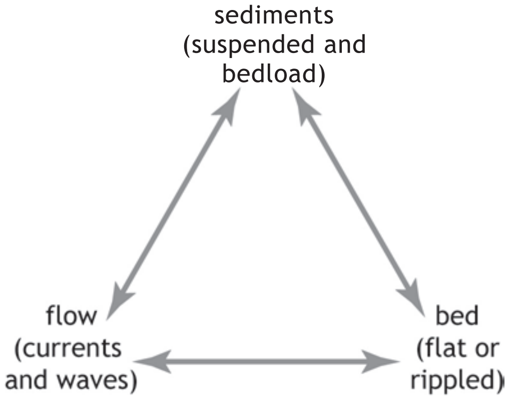
Figure 1 *Aerial view of a coastal resort in the Algarve, Portugal. This shows the impact of coastal erosion on the local coastline and the large unsightly boulders dumped onto the beach to reduce further land and beach loss.*

correct general behaviour over the wide range of wave, current and sediment conditions found in typical coastal areas. This is an important pre-requisite for successful 'morphological modelling' whereby the evolution of the sea-bed can now be predicted on medium time-scales of months, and possibly for longer, with reasonable accuracy, based on a climate of waves superimposed on tidal currents. Although this new generation of morphological models is still in its infancy, and is still constrained by computer run-times for long-term simulations, it represents the key link between local sediment process studies and larger coastal area studies, and it provides critical tests of our ability to represent detailed sediment transport processes realistically.

Figure 1 shows an example of what can happen when developments occur without a full understanding of their ramifications on the local coastal environment. It can readily be seen that the construction has impacted on the local coastline, causing the need for a significant shoreline barrier of boulders; such structures are in no way aesthetically pleasing and may in the long term generate as many problems as they try to solve.

Figure 2 *The sediment interaction triad.*

Sediment, bedforms and flow all affect one another, so if we are to understand sediment transport, we need to measure all three simultaneously



Such failures to predict the consequence of developments are not atypical. Our capability to predict the impact that man-made structures may have on the coastal environment is relatively limited, and in particular the influences that such structures have on sediment transport pathways is surprisingly difficult to forecast. On the larger scale, if modifications occur in sediment transport pathways or the wave climate changes, due for example to increased sea-level and storminess, the impact on this vital boundary between the land and the sea could be profound. Here we reflect on the problem of understanding sediment movement, its measurement in one of the world's largest man-made facilities for studying sediments, and how sound is helping to provide a clearer picture of some of the physics of sediment transport.

Sounding out sediment movement

Suspended sediment transport can be thought of as arising from three interacting components, namely the mobile sediment itself, the bedforms and the forcing hydrodynamics (currents, waves). This triad is illustrated in Figure 2.

For example, vortex generation due to flow over ripples on the sea-bed can have a significant influence on the suspension of sediment. Further, the shape of the ripples contributes to the overall flow resistance, and hence to the flow structure in the boundary layer. Yet the ripples themselves are a product of the local sediment transport. This triad of interactions and feedbacks has to be measured simultaneously, both temporally and spatially, in order to understand the fundamental processes of sediment transport. Sound can help in the making of such measurements.

As with acoustic imagery in medical ultrasound, acoustics can be used to visualise how sediments are moved around by waves and tides. The concept of using acoustics for underwater sediment transport studies is attractive and straightforward, as illustrated by the diagram in Figure 3. A pulse of high frequency sound, typically in the range 0.5–5.0 MHz and centimetric in length, is transmitted from a downward-pointing directional sound source, usually mounted at 1–2 m above the bed. As the sound pulse travels towards the bed, sediments in suspension backscatter a proportion of the sound and the bed itself generally returns a strong echo. The backscattered signal is normally sampled at about 1.0 cm range intervals. The signal backscattered from the suspended sediments can provide information on profiles of suspended sediment concentration, particle size, and the three components of flow velocity, while the bed echo provides the time history of the bed and hence, if the bed features (e.g. ripples) are moving, its form. Acoustics can therefore measure all three components of the triad, and can do this with sufficient spatial and temporal resolution to allow the fundamental intra-wave and turbulent processes to be probed non-intrusively.

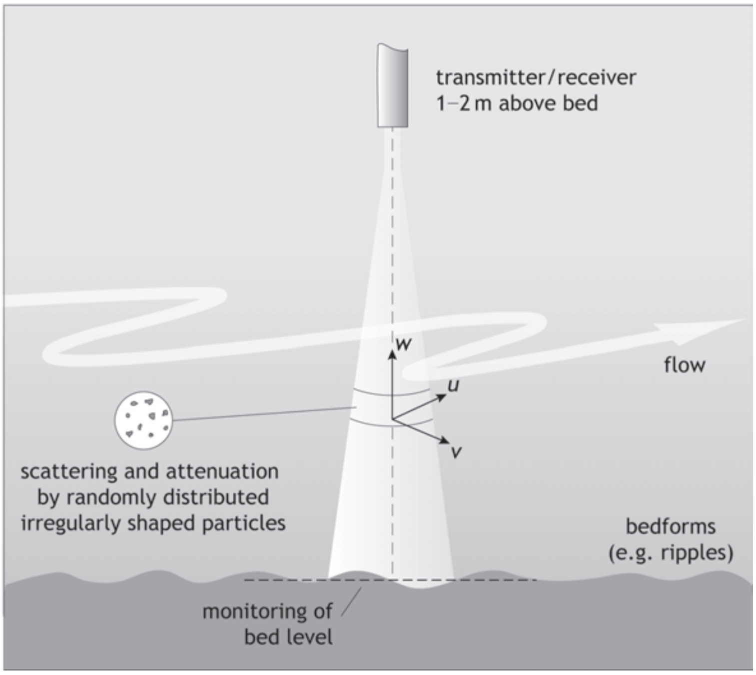


Figure 3 *Diagram summarizing the use of acoustics for sediment transport studies (*u, v *and* w *are the components of the flow velocity as obtained by reflections from particles in suspension).*

Using sound, the bed, the suspended sediment and the flow are all measured together

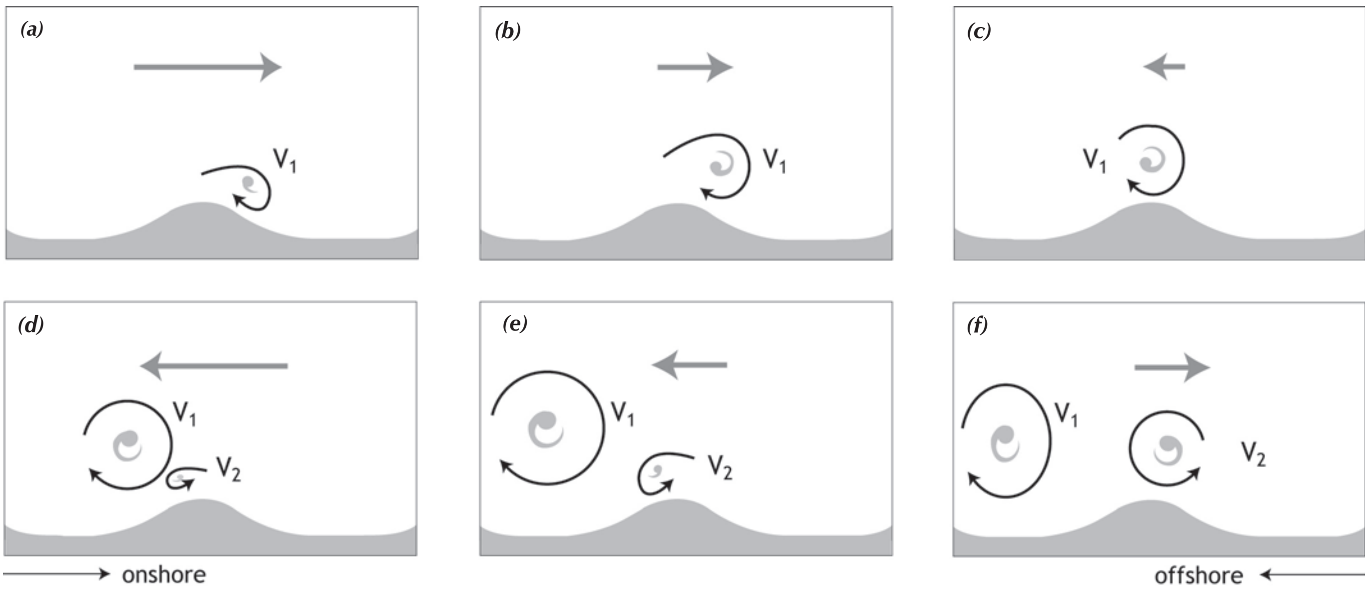
A case study: vortices over a rippled bed

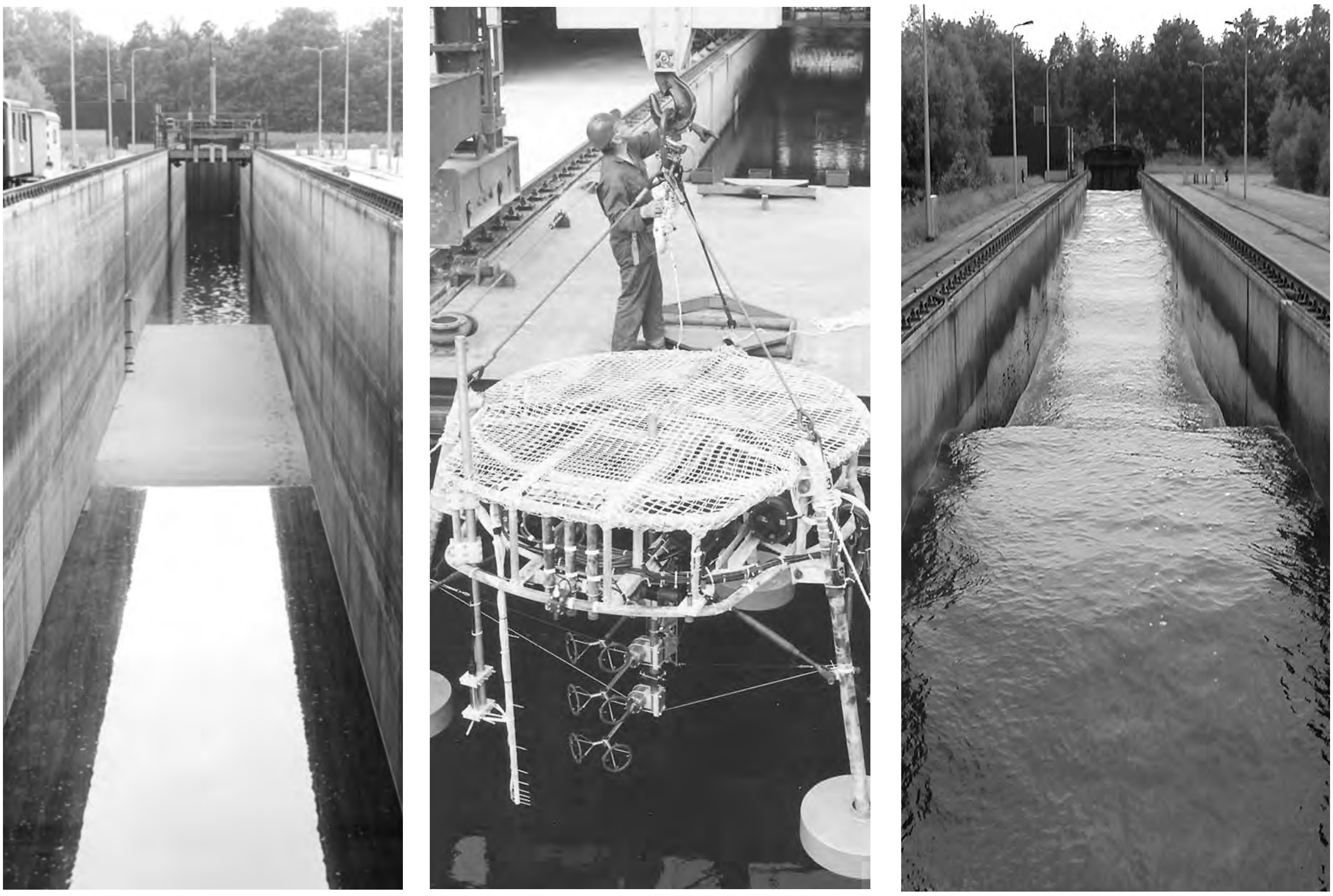
Over large areas of the continental shelf outside the surf zone, sandy sea-beds are covered with wave-formed ripples. If the ripples are steep, the entrainment of sediments into the water column as a result of waves is mainly associated with the generation of vortices. This process is illustrated in Figure 4. A spinning parcel of sediment-laden water, v_1, is formed on the lee side of the ripple at the peak positive (onshore) velocity in the wave cycle, as shown in Figure 4(a) and (b). This sediment-rich vortex is then thrown up into the water column at flow reversal (Figure 4(c) and (d)), carrying sediment well away from the bed and allowing it to be transported (offshore) by the flow. At the same time, another sediment-rich vortex, v_2, is being formed on the opposite side of the ripple due to the reversed flow. As shown in Figure 4, v_2 grows, entrains sediment, becomes detached and moves over the crest at the next flow reversal, carrying sediments into suspension. The main feature of the vortex mechanism is that sediment is carried up into the water column twice per wave cycle at flow reversal. Under steep surface waves, vortex v_1 becomes stronger than vortex v_2 giving rise to an offshore 'pumping' of the suspended sediment.

To study this fundamental process of sediment entrainment, experiments were conducted in one of the world's largest man-made channels, specifically constructed for such sediment transport studies – the 'Delta flume' at the De Voorst Laboratory of Delft Hydraulics in the Netherlands. The flume (Figure 5(a), overleaf) is 230 m in length, 5 m in width and 7 m deep and it allows waves and sediment transport to be studied at full scale. A huge paddle at one end of the flume generates waves which propagate along the flume over a sandy bed and dissipate on a beach at the opposite end. The bed in the present experiments comprised coarse sand which was located approximately halfway along the flume in a layer of thickness 0.5 m and length 30 m. In order to

Ripple-generated vortices carry sediment up into the water column twice per wave cycle

Figure 4 *Schematic representation of vortex entrainment of sediment over a rippled sandy bed. In each panel, the horizontal arrow represents the near-bed velocity resulting from the passage of the wave.*





The 230 m-long Delta flume allows waves and sediment transport to be studied at full scale

Figure 5 ***(a)*** *Photograph of the Delta flume showing the wave generator at the far end of the flume and, in the centre, the sand bed used in the study.* ***(b)*** *STABLE II, the instrumented tripod, developed at the Proudman Oceanographic Laboratory by colleague John Humphery, being placed onto the sand bed.* ***(c)*** *Waves produced for the study travelling away from the wave generator at the far end.*

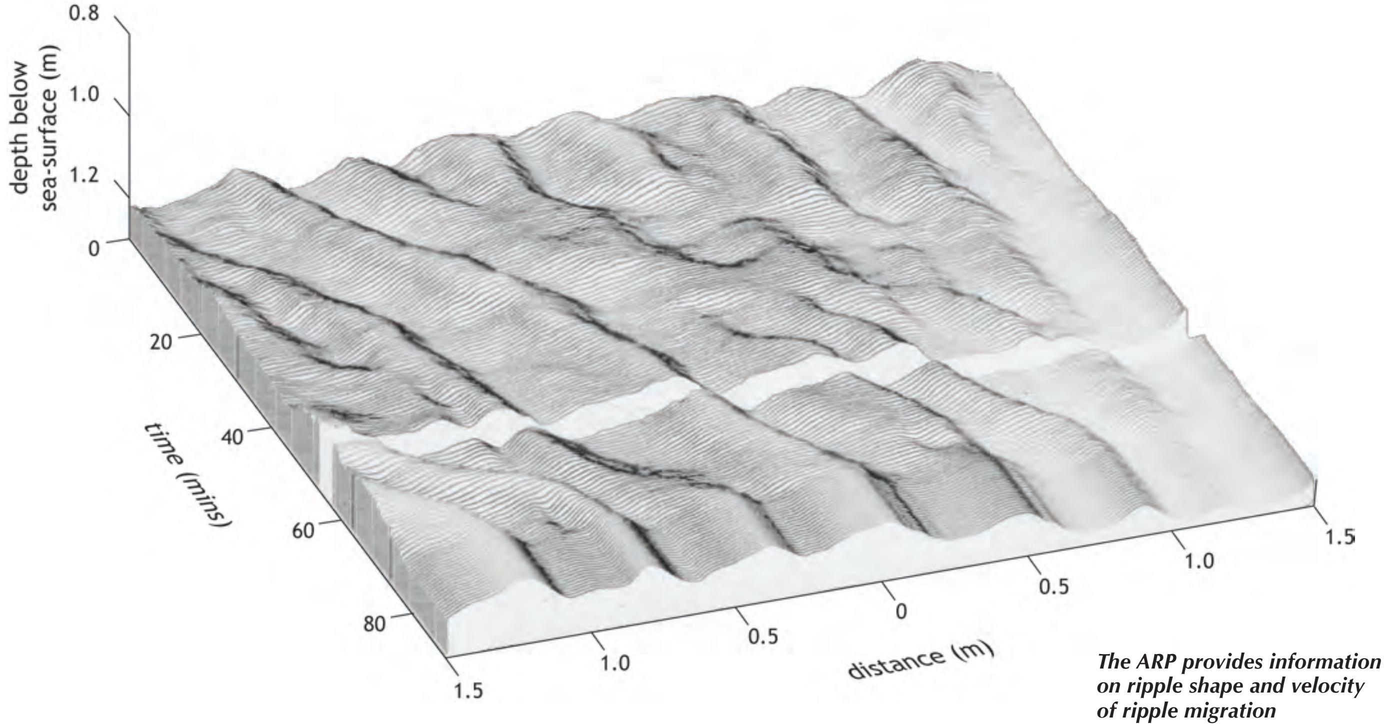
make the acoustic and other auxiliary measurements an instrumented tripod platform was developed; this is shown in Figure 5(b). The tripod STABLE II (Sediment Transport And Boundary Layer Equipment) used an acoustic backscatter system (ABS) to measure profiles of particle size and concentration, a pencil beam acoustic ripple profiler (ARP) to measure the bedforms, and electromagnetic current meters (ECMs) to measure the horizontal and vertical flow components. Figure 5(c) shows a wave propagating along the flume with STABLE II submerged in water of depth 4.5 m, typical of coastal zone conditions.

The bed, the suspended sediments and the model

To investigate and then model the vortex entrainment process it was necessary to establish at the outset whether or not the surface waves were generating ripples on the bed in the Delta flume. Using the acoustic ripple profiler, the profile of a 3 m transect of the bed was recorded over a period of time. The results of the observations over a 90-minute recording period are shown in Figure 6. Clearly, ripples were formed on the bed and the ripples were mobile. To obtain the formation of vortices requires a ripple steepness (ripple height/ripple wavelength) of the order of 0.1 or greater. An analysis of the observations showed this was indeed the case.

Using the acoustic backscatter system, some of the most detailed measurements of sediment transport ever recorded over a rippled bed at full scale were captured simultaneously. These measurements from the Delta flume were used to generate the images shown in Figure 7. The changing concentrations of suspended sediment over the ripple during the course of the wave cycle were constructed over a 20 minute period as a ripple passed in the onshore direction beneath the ABS. Comparison of Figure 7 with Figure 4 shows substantial similarities. In Figure 7(a) there can be observed the development of a high concentration event at high (onshore) flow velocity above the lee slope of the ripple (v_1). In Figure 7(b), as the forward flow reduces in strength, the near-bed sediment-laden parcel of fluid travels up the lee side of the ripple) towards the crest. As the flow reverses, this sediment-laden fluid parcel (v_1) travels over the crest and expands. As the reverse (offshore) flow increases in strength, Figure 7(d), the parcel v_1 begins to lift away from the bed and a new sediment-laden lee vortex (v_2) is initiated on the offshore-facing slope of the ripple.

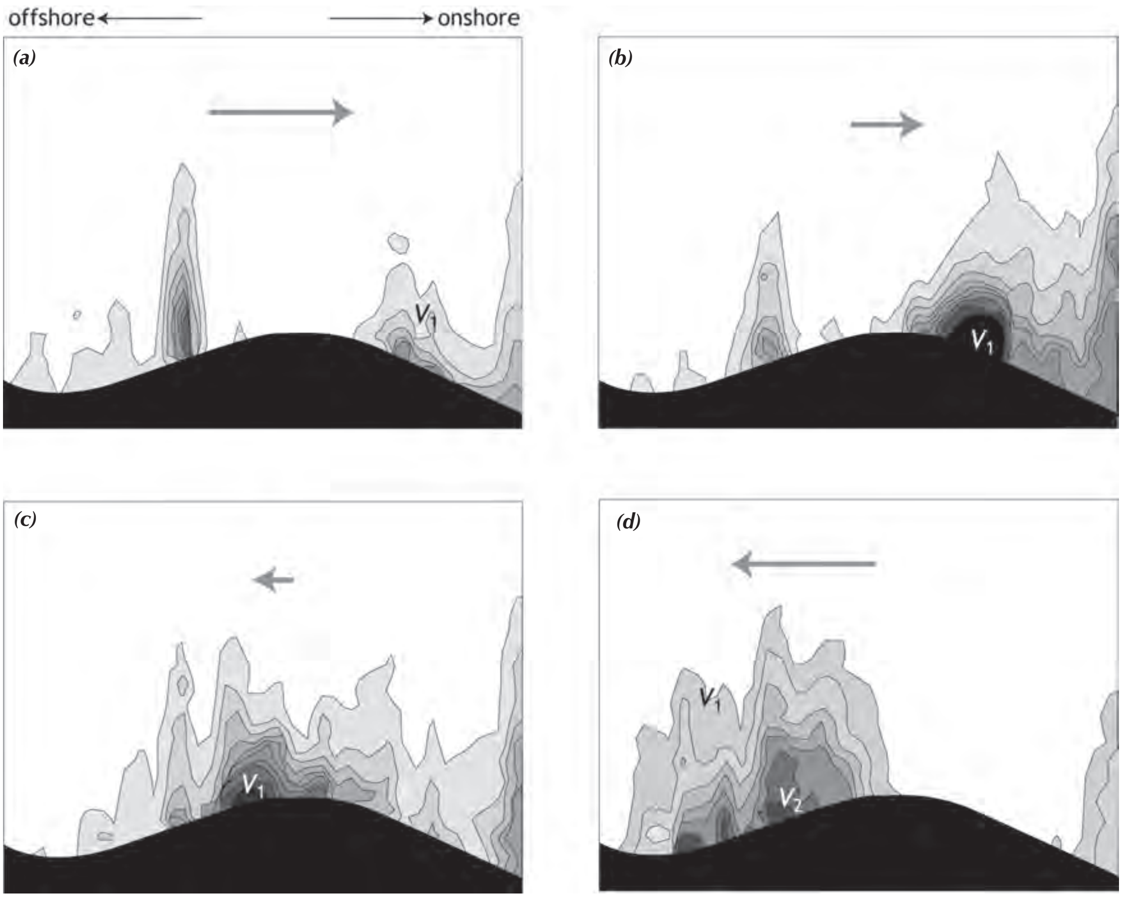
In order to capture the essential features of these data within a relatively simple (and hence practical) one-dimensional in the vertical (1 DV) model, the data have been horizontally averaged over the ripple wavelength to give the ripple-averaged variation in the concentration of suspended sediment over the wave cycle. The resulting pattern of sediment suspension contours is shown in the bottom



The ARP provides information on ripple shape and velocity of ripple migration

Figure 6 *Observations of the sand ripples on the bed in the Delta flume during a 90-minute observation period, obtained using the acoustic ripple profiler. The observations were used to assess if the ripples present fell into the vortex regime, which proved to be the case for the present work.*

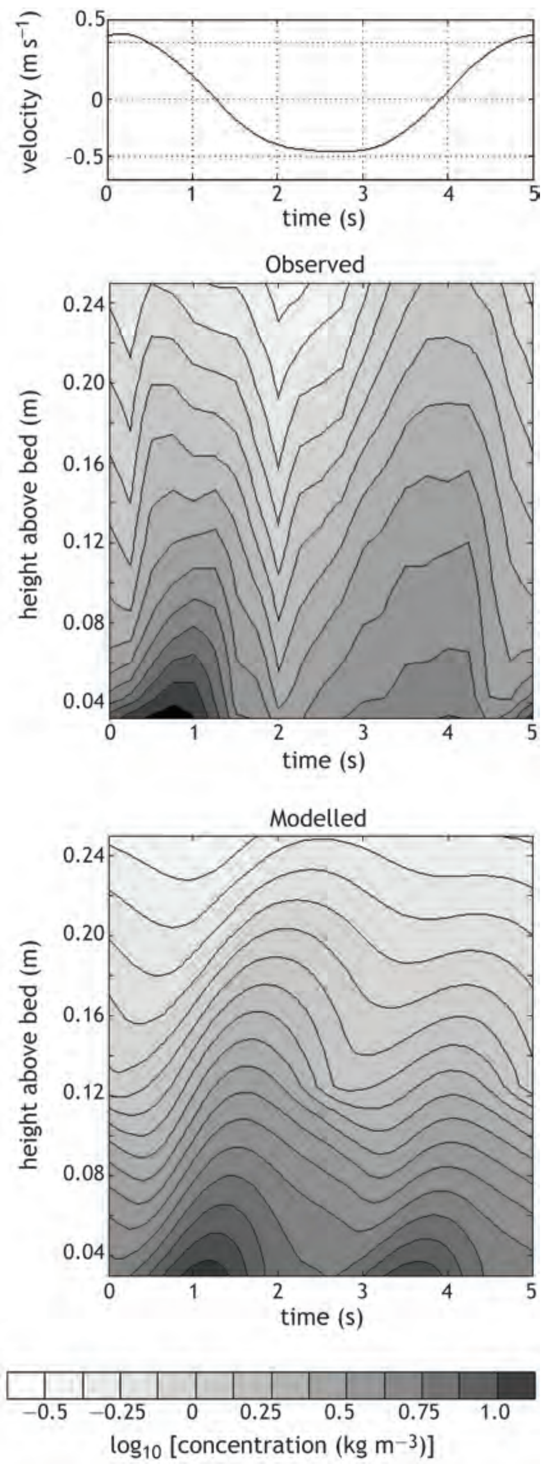
Figure 7 *Composite sound image of suspended sediment concentration above a rippled sand bed in the Delta flume, at four different times in the wave cycle. In each panel, the length and direction of the arrow represents the near-bed velocity due to passage of a wave. The vortices generated are indicated by* v_1 *and* v_2*. The grey scale represents sediment concentration, with black being the highest concentration.*



At maximum flow, a parcel of water spins up on the leeside of the ripple;
this rotating water parcel scoops up sediment
and then carries it away from the bed when the flow reverses

panel of Figure 8, while the top panel shows the oscillating velocity field measured at a height of 0.3 m above the bed. The concentration contours shown here are relative to the ripple crest level, the mean (undisturbed) bed level being at height $z = 0$. The ripple height and length were measured by the acoustic ripple profiler as 0.06 m and 0.42 m respectively.

Figure 8 *Measurement (Delta flume data) and modelling of suspended sediments above a rippled bed under a 5 s period wave.* ***Top*** *The flow velocity 0.3 m above the bed.* ***Middle and bottom*** *Respectively the observed and modelled concentration of suspended sediment in the suspension layer.*



How we are capturing in a simple model some of the complexity of sediment entrainment under waves over a rippled bed

The measured concentration contours presented in Figure 8 show two high-concentration peaks near the bed, which propagate rapidly upwards through a layer with a thickness corresponding to several ripple heights. The first (and strongest) of these peaks occurs slightly ahead of flow reversal, while the second peak (which is weaker and more dispersed) is centred on flow reversal. The difference in the concentrations of the two peaks reflects the fact that the positive onshore velocity beneath the wave crest (time = 0 s) is greater than the negative offshore velocity beneath the wave trough (2.5 s). Between the two concentration peaks the sediment settles rapidly to the bed. Maybe rather unexpectedly, this settling effect occurs at the times of strong forward and backward velocity at measurement levels well above the bed. The underlying mechanism of sediment entrainment by vortices shed at or near flow reversal is clearly evident in the spatially-averaged measurements shown in Figure 8.

Any conventional model that treats the bed as flat, but with enhanced roughness to account for the ripples, and attempts to represent the above sequence of events in the suspension layer, runs into immediate and severe difficulties, since such models predict maximum near-bed concentration at about the time of maximum flow velocity and not at flow reversal. Therefore, for the first time in a 1DV model, we tried to capture these effects realistically through the use of a strongly time-varying eddy viscosity that represents the timing and strength of the upward mixing events due to vortex shedding. The model initially predicts the size of the wave-induced ripples and the size of the grains found in suspension, and then goes on to solve numerically the equations governing the upward diffusion and downward settling of the suspended sediment.

The essential two-peak structure of the eddy shedding process can be seen to be represented rather well in the bottom panel of Figure 8, with the initial concentration peak being dominant. The rate of decay of the concentration peaks as they go upwards is also represented quite well, though a phase lag develops with height, which is not seen to the same extent in the data. Despite some discrepancies, the model and experiment are well matched, allowing the model to go on to be used for practical prediction purposes in the rippled regime, which is the bed form regime of most importance over wide offshore areas in coastal seas.

Reflections

Long gone are the days when coastal sediment transport predictions were commonly in error by orders of magnitude. Although this is not appreciated by some casual observers of the field of sediment transport prediction, progress has come on by leaps and bounds in the last 10 to 20 years, particularly for non-cohesive sediments (sands). The key to successful transport prediction remains our ability to estimate the 'roughness' of the sea-bed which depends, in turn, upon the heights and wavelengths of the ripples formed by waves and currents. Although many uncertainties still remain, particularly for natural mixtures of sediment sizes, we are now much more confident about predicting both the roughness of the bed and the associated and often complex mixing processes above the bed, than was the case 20 years ago.

Our understanding of the complete sediment 'triad' (Figure 2) can now be considered to be quite well advanced. In practice, net sediment transport predictions in 'blind' field tests can now, through careful work, make predictions within about a factor of two or so of the observations; this represents an enormous improvement on past uncertainties. Of course, many challenges remain for the future. What happens to our 'clean sand' predictions when a small 'cohesive fraction' is present on site? Can we successfully implement our improved understanding of the local small-scale sediment transport processes within morphological models of coastal areas? Can we provide a robust physics-based approach to predict the future of these coastal areas, and of the position of the coastline itself, as the sea-level rises inexorably around us? These are now some of the challenges that coastal marine scientists face, and that need to be answered on behalf of the 50% of the world's population that now lives within 60 km of the shoreline.

Further reading

Fredsoe, J and R. Deigaard (1992) Chapter 10 of *Mechanics of coastal sediment transport*. World Scientific Publishing Co., Singapore.

Davies, A.G. and P.D. Thorne (2005) Modelling and measurement of sediment transport by waves in the vortex ripple regime. *Journal of Geophysical Research*, **110**, C05017, doi:1029/2004JC002468, 2005. pp25.

Davies A.G., L.C. Van Rijn, J.S. Damgaard, J. van de Graaff and J.S. Ribberink (2002) Intercomparison of research and practical sand transport models. *Coastal Engineering*, **46**, 1–23.

Nielsen, P. (1992) Chapter 5 of *Coastal bottom boundary layers and sediment transport*. World Scientific Publishing Co., Singapore.

Thorne, P. D. and D.M. Hanes (2002) A review of acoustic measurements of small-scale sediment processes. *Continental Shelf Research,* **22,** 603–32.

Peter Thorne is an individual merit promotion scientist at the Proudman Oceanographic Laboratory* (POL) and has visiting professorship status at the Department of Earth and Ocean Sciences at Liverpool University. He specialises in the application of acoustics to sediment transport processes.

Alan Davies is is Professor of Physical Oceanography at the University of Wales Bangor,† and a visiting research scientist at POL. He is a modeller of detailed hydrodynamic processes and sediment transport in the sea-bed boundary layer beneath waves and currents, and is applying this knowledge to the modelling of morphological change of the sea-bed in the coastal zone.

*Proudman Oceanographic Laboratory, Joseph Proudman Building, 6 Brownlow Street, Liverpool L3 5DA, UK; Email: pdt@pol.ac.uk

†School of Ocean Sciences, University of Wales (Bangor), Menai Bridge, Anglesey, LL59 5AB, UK; Email: a.g.davies@bangor.ac.uk

***Terra firma* is not always as permanent as you might like it to be, especially near the coast**

Interested in the application of geophysics to oceanography and Earth sciences?

Issue 23 of the British Geological Survey publication *Earthwise* contains a number of short articles on this topic, including the use of sonar to map habitats in the Bristol Channel and determine the complex shapes of Scottish fjords, and the production of digital maps of the British continental margin. Ostracods (the subject of another article in this issue) also make an appearance!

A passion for ostracods

from the Arabian Sea to the world-wide web

Martin V. Angel

It all started one night in July 1963 in the Arabian Sea during the South-West Monsoon. We were treated to an awesome display of bioluminescence – the ship's bow-wave was afire. A ghostly school of blue–green dolphins created explosions of light as they broke surface. The neuston net we were towing to collect animals living in the topmost layer of the ocean left a trail of brilliant blue–green luminescence. Its catch, which would normally hardly cover the bottom of a small jar, instead filled a large bowl and glowed with an unearthly light from bioluminescent planktonic ostracods. We went slightly mad, cramming our mouths with the ostracods, and playing at vampires. These were the species *Cypridina sinuosa* which regularly forms dense swarms at the surface close inshore, in the Arabian Sea upwelling season. Ron Currie, the Principal Scientist, murmured 'Someone ought to work on these …'. At the time, I little realised that this experience would have a dominant influence on the rest of my life.

I joined the National Institute of Oceanography (NIO) full-time the next year. In those days, most new recruits were required to belong to a specialist group – this no longer happens, hence the present critical shortage of biologists who can identify more than a handful of species, let alone undertake taxonomic descriptions. Theoretically I was given a choice, but there was a strong steer to take on the ostracods – not the myodocopids that I had seen in the Indian Ocean (which are rather uncommon in the Atlantic, where they live predominantly in shallow water over the continental shelves), but the halocyprids (See Box 1).

Even in those days, the number of experts in this group of plankton could be counted on the fingers of both hands, in spite of their abundance and importance in the planktonic ecosystem. The majority of ostracodologists were, and still are, palaeontologists, who use the fossilized shells of ostracods for microstratigraphy, and so the needs of geology dominate their study. Halocyprid fossils are rare, because their carapaces (shells) are not calcified, so their taxonomic classification does not have to pay direct attention to a fossil record that is primarily based on carapace characters.

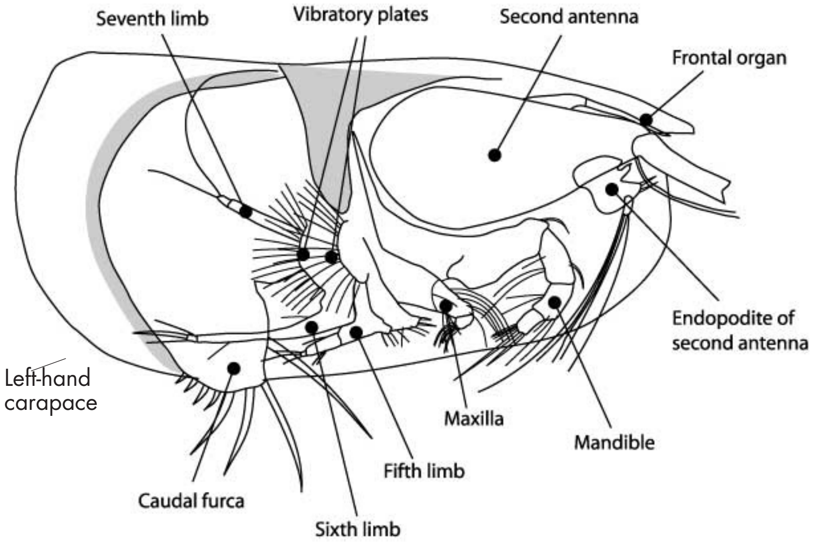
Initially I suspected this lack of interest in the living animals was because they are neither abundant nor important, so studying them would be rather esoteric pure science. I soon found this was not the case. Whereas at temperate latitudes they are seldom very common in the upper 100–200 m, everywhere else, and at all depths, they are frequently sufficiently numerous to rank second only to copepods amongst all groups collected in mesoplankton samples (plankton 0.2–20 mm long). For several years I found their identification a real struggle. This was not because they are inherently more difficult to identify than any other planktonic group – indeed they are easier than many gelatinous groups of plankton. Instead it was because the identification keys were incomplete, most original descriptions were either in obscure publications or written in difficult languages (archaic German and Russian), their systematics was in a tangled mess, and they are rather small (most adults range in length from 0.5–3 mm). Virtually nothing was known about their life histories, behaviours and distributions, nor was anything known about the role they play in oceanic food webs.

When I joined the National Institute of Oceanography (the NIO*) the sampling revolution was only just beginning. Computers at sea were unheard of, navigation was by sextant, any net-controls were mechanical, and depth measurements relied either on pressure gauges (subject to considerable hysteresis) or estimates (guesses) based on metres of wire paid out. Water sampling was by water-bottles, highly accurate but laborious and coarse in scale.

At that time 10 kHz echo-sounders were just beginning to be run routinely to compile bathymetric charts, and they were revealing an abundant backscatter from mid-water that had fine-scale heterogeneity and showed behaviour. There

*The NIO became the Institute of Oceanographic Sciences (IOS, later IOS Deacon Laboratory); after moving to Southampton, it became the Southampton Oceanography Centre (SOC). It is now the National Oceanography Centre (NOC).

Box 1 Halocyprid ostracods



The anatomy of a typical halocyprid ostracod
The animal is seen from the side with the right-hand carapace valve removed to show the arrangement of the limbs. Identification of most species is based on carapace characteristics, such as length, shape, sculpturing, and the position of some glands, as well as aspects of the frontal organ and the antennae. The animals respire by means of a flow of water through the carapace, driven by the beating of the vibratory plates. The water enters through the gap in the front and exits through a gap on the posterior margin.

Ostracods are small crustaceans whose bodies are enclosed within a bivalved carapace. There are two types of free-swimming ostracods, the myodocopids, which generally have compound eyes, usually located roughly centrally, and the halocyprids which are all eyeless. Whereas all myodocopids brood their eggs and developing embryos within their carapaces, the vast majority of halocyprids release their eggs into the surrounding water. Halocyprid ostracods are generally quite small, with adults ranging in size from 0.5 to 6.0 mm. The largest planktonic ostracod is the charismatic myodocopid *Gigantocypris* – a globular species which may be as much as 32 mm across. *Gigantocypris* lacks compound eyes but has big reflectors to its enormous naupliar eyes.

There are currently 254 species of halocyprid ostracods classified into 41 genera. However, there are about 30 novel species awaiting description, and some of the present genera are highly heterogeneous and need to be split up. They occur at all depths in all oceans except where there is a strong oxygen minimum. There is usually a zone of maximum species richness at 700–1000 m. Species richness increases again in the benthopelagic zone (1000–4000 m) which is inhabited by a large array of species, many of which await description.

The sexes are strongly dimorphic, and females generally out-number males, possibly because males do not live so long. The females store sperm after being inseminated and so may only mate once. As mentioned above, their eggs are released to float free in the water. There are six, possible seven, juvenile stages before they achieve maturation, and the life cycle takes two years to complete (developmental rates are only known in one cold-water species from the Sea of Japan, *Discoconchoecia pseudodiscophora)*.

They can achieve burst swimming speeds of 10–15 body lengths per second but normally cruise at about half such speeds. They sink at speeds of 1 cm s^{-1}, which is a little slower than their downward migration rates of 10–100 m hr^{-1} during diel vertical migrations. The ranges of these migrations are mostly about 100–200 m but one or two species migrate over depth ranges of as much as 500 m.

The limbs, together with the spines on the 'tail' (or 'caudal furca'), are used to manipulate particles of detritus (including marine snow) on which they feed. As a result of this diet, examination of the stomach contents of species living at depths of 1000 m or more has revealed remains of phytoplankton, and this has led to mistaken claims that these deep-living species are regularly carrying out undetected vertical migrations up into the photic zone.

was dynamic debate as to whether organisms in the water were causing this backscatter and giving rise to its physical properties. Were the deep scattering layers ('DSLs') artefacts or were they portraying patchiness in horizontal distributions of organisms? Some of the layers were undertaking vertical migrations around sunrise and sunset that seemed to be tracking isolumes (surfaces of equal light intensity). Were these indicating vertical migrations by organisms, and if so, which ones? A major expedition was planned to relate the movements of DSLs to the bathymetric ranges of animals within the water column.

Observations of ostracods during SOND

The SOND cruise of 1965 (now almost totally forgotten) was one of the first successful attempts to relate the bathymetric ranges of pelagic animals to deep scattering layers. The site chosen was a sheltered bay on the eastern coast of Fuerteventura (Canary Islands) where the water was deep and the island afforded some shelter from the worst of the weather. The results were so impressive that a sampling programme was initiated to examine the species composition and bathymetric distributions of the mid-water animal assemblages in the north-east Atlantic.

In successive years a long transect was sampled every 10° of latitude approximately along 20° W, from the Equator to 60° N. Gathering and compiling the data was the first problem; the second was how best to analyse the data. Mike Fasham, then working in the computer section, was inveigled into helping us, using the emerging analytical multivariate procedures of cluster and factor analysis. His career in biological oceanography was launched with spectacular success: he is now an FRS and still mathematically modelling in retirement at the National Oceanography Centre.

At sea there were unique opportunities to observe live animals, collected either near the surface at night or picked out of the samples before they were preserved. The ostracods proved not only to survive well in the laboratory, but also to be lively attractive animals to watch. They showed some unexpected behaviour. When placed in metre-long tubes, they would settle down and perform an oscillatory swimming pattern, swimming up then turning head-down and sinking. They would move almost without hesitation through temperature gradients of 10 °C (in 10 cm), and through haloclines of 1 p.p.t., showing that thermoclines and halocines in the ocean present no barrier to their movement. But what was really startling was that most of the species we observed displayed the ability to stop sinking and hang motionless in the middle of the tube. They have a mysterious ability to regulate their buoyancy rapidly; no gas bubble is involved.

The original aim of these observations was to observe their feeding. Examination of gut contents suggested they might be predators, but I never saw an ostracod attack another healthy animal. However, they are unhesitating about grappling with any particle, aggregate or damaged animal they encounter and they seem to be particularly fond of gelatinous debris. So their role in food webs is in recycling detritus.

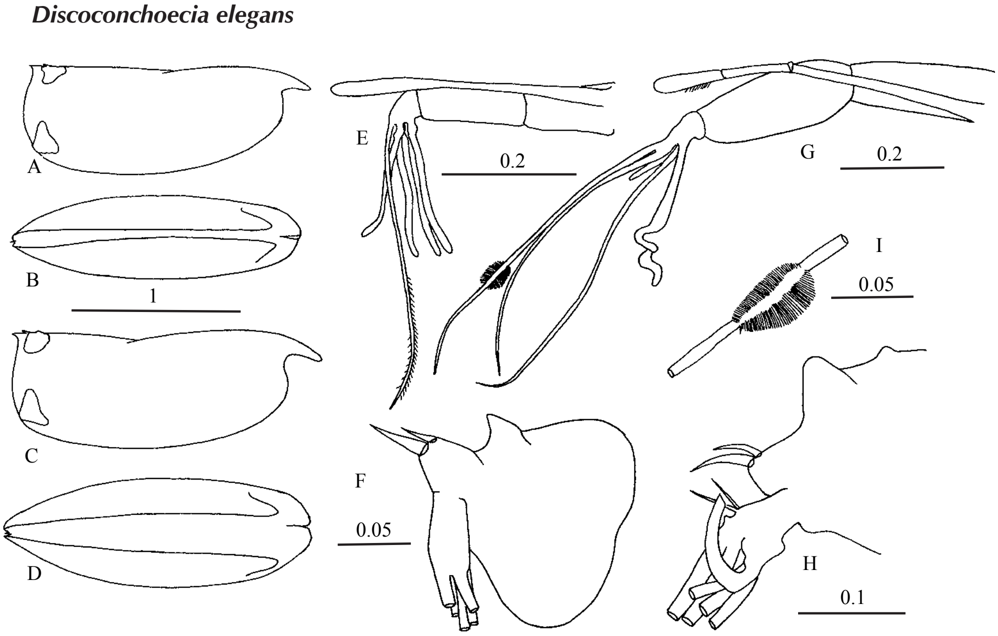
Like the *Cyprina* species in the Arabian Sea, the halocyprids produce bioluminescence, but not in such a spectacular manner. There are at least two modes of light production. In one mode, luminescent secretions are released from glands on the edge of the carapace, either into the respiratory flow of water that enters the carapace through the gap between the valves at the front of the animal, or into the exhalent flow emitted through a gap in the posterior margin. The glands are situated either anteriorly or on the posterior margin. Secretions released into the inhalant flow momentarily light up the animal and are then left behind in the wake as a phantom image – an analogy with fighter aircraft emitting fireballs to distract heat-seeking missiles is irresistible! Those secretions discharging into the exhalent flow just produce the phantom. As the secretions are released, the animal either changes direction or begins to spiral rapidly. In the other mode of light emission, glands placed at the tips of spines, or elaborations of the carapace, emit light that is retained rather than released into the surrounding water, perhaps to make the animal look bigger to potential predators. Halocyprids are blind, so they cannot be signalling between themselves.

The 'Ostracod Atlas'

The peer pressure to publish a constant flow of papers on 'new science' meant that all my data had to be cherry-picked and I never had the opportunity to generate an overall assessment of the ostracods. So on retirement I felt I had a responsibility to convert all the data in my 35 notebooks into an accessible format that could be archived. While I have some claims on the data, are they really mine to squander by committing them to obscurity?

The next decision was to compile a comprehensive database of all published records. There is a vast body of published information that is theoretically available but so dispersed it is basically unusable. I further supplemented my data and the published records with unpublished records generously provided by other halocyprid researchers like Professor V.G. Chavtur (Vladivostok). These inventories of published and unpublished data have been archived with OBIS (Ocean Biogeographic Information System; http://www.iobis.org) and with the European MARBEF network (http://www.marbef.org/). But this still left the basic problem that had bugged me at the start and must be deterring others from becoming halocyprid enthusiasts – how to make the systematics of the group more available and transparent.

I had previously published a number of 'keys' for Atlantic species but they were not readily available to researchers at sea or in developing countries with few funds. The answer seemed to lie in developing 'atlases', which would be freely available on the web. An opportunity arose through an exchange research fellowship to work with a Polish researcher, Dr Kasia Blachowiak-Samolyk from Sopot. The outcome of this collaboration was the development of the first *Atlas of Southern Ocean halocyprids* (http://ocean.iopan.gda.pl/ostracoda) which will soon be followed by a second on the Atlantic species.



One of the 140 taxonomic drawings available on the website for the Atlantic Ostracod Atlas (see opposite)

Figure 1 Disconchoecia elegans *Sars 1865 – one of the 140 taxonomic drawings available on the Atlantic website. A and B: carapace of adult female, lateral and ventral view, respectively; C and D: carapace of adult male, lateral and ventral view, respectively; E: female frontal organ and first antenna: F: female endopodite of the second antenna; G: male frontal organ and first antenna: I: male armature on the longest seta on the first antenna; and H: the endopodite of the male second antenna (left).*

This species was one of the first halocyprids to be described and is one of the most abundant and widespread species of ostracods in the world's oceans. However, the adult sizes (ranging from > 2 mm at high latitudes at 80° N off Spitsbergen down to 1 mm in equatorial waters) suggest that the species as presently understood includes a number of cryptic species, i.e. species that look almost identical but are genetically (and perhaps ecologically) distinct.

Box 2: An example of a 'species notes' page from the Southern Ocean Atlas*

Boroecia antipoda (Müller, G.W., 1906)

Records: 280

This one of the most abundant and consistently caught species in the Southern Ocean. It is predominantly a deep mesopelagic to bathypelagic species. Poulsen (1973) also recorded this species in *Dana* samples from tropical latitudes in the Indonesian Seas and in the Gulf of Panama. However, we have re-examined this material and found that it is not conspecific with typical *B. antipoda,* and will be described as a new species. Hence this species appears to be endemic to the Southern Ocean, but spreads northwards towards the Equator in the deep flows of Antarctic water, and is likely to be a good indicator of such water.

	n	Mean mm	s.d.	Range mm
Females	439	3.19	0.065	3.00–3.36
Males	270	2.94	0.054	2.80–3.08
A-1	134	2.18	0.067	2.00–2.36
A-2	131	1.44	0.030	1.38–1.50
A-3	29	0.97	0.030	0.90–1.02

****An Atlas of Southern Ocean planktonic ostracods* by Kasia Blachowiak-Samolyt and Martin Angel: http://ocean.iopan.gda.pl/**

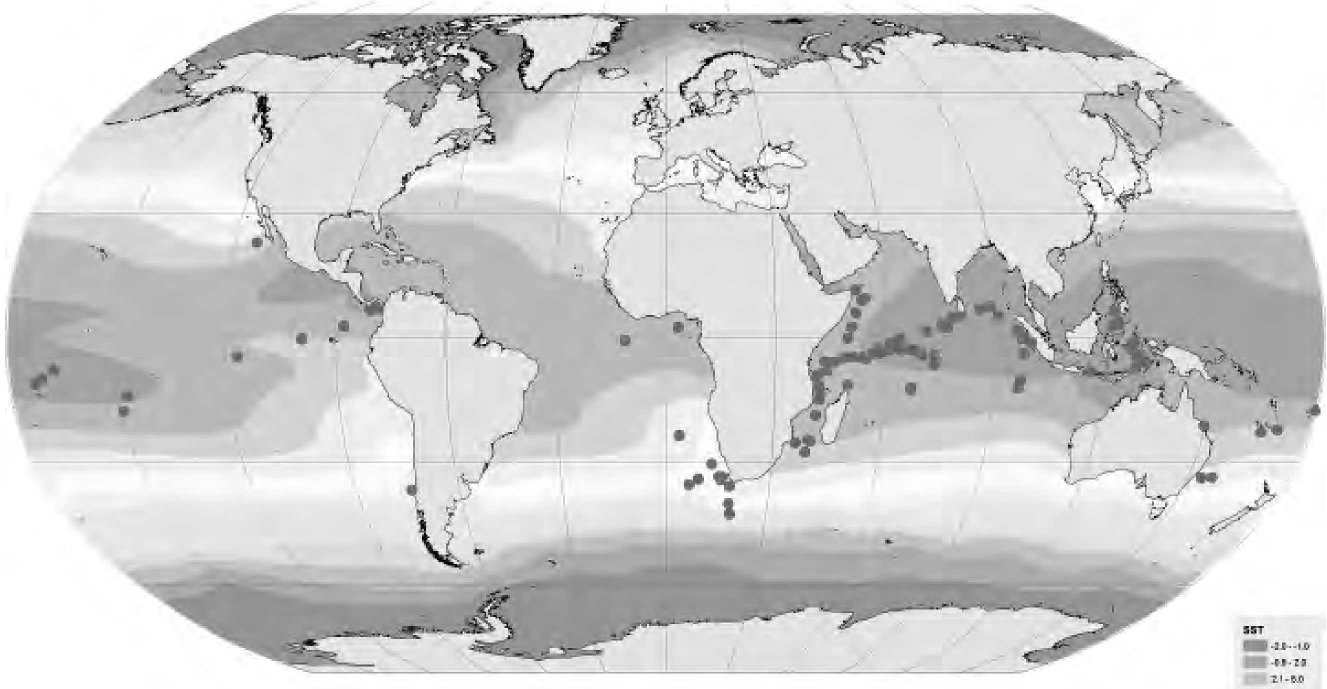
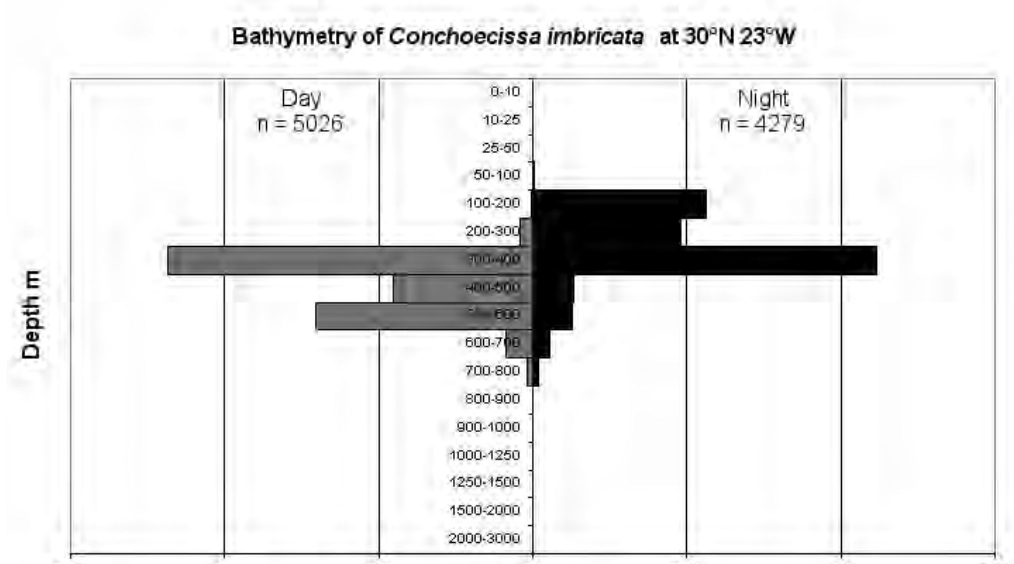


Figure 2 *The known global geographic range of* Macroconchoecia caudata*, in relation to mean sea-surface temperature. M.* caudata *is a large species with uniquely long spines on its rostrum and at the posterior dorsal corner of the carapace. Records of this species are most unlikely to be a result of misidentification. The map show that this Indo-Pacific species has been regularly, albeit intermittently, recorded from the Southern Atlantic. It seems likely that these occurrences are the result of the Agulhas retroflection, where the Agulhas current flowing westwards just south of the Cape of Good Hope dramatically loops back on itself to flow eastwards. Periodically, mesoscale eddies are spawned from the loop and these eddies track north-westwards, introducing water and plankton from the southern Indian Ocean into the southern Atlantic.*
This example shows the potential for some of the halocyprid species to be used as indicators.

An example of one of the distribution maps from the Atlantic Atlas website.

One of the many bathymetric profiles available on the Atlantic Atlas website

Figure 3 *Diagrammatic representation of diel migration by* Conchoecissa imbricata *(Brady, 1880) at 30° N 23° W. The histograms show the percentage of the total numbers in each profile (day or night) that were caught in each sampling horizon. A significant proportion of this 2.5 mm-long species undertakes a diel migration of about 200 m. This underestimates the migration of a few animals, since they are regularly caught in small numbers in neuston nets (i.e. in the upper 10 cm) at night.*



Each website includes a general description of the group and a listing of the species. The species list for each ocean provides the portal to the detailed information on each species via a page that illustrates the shape of the carapace – the majority of species can be identified from the size and shape of the carapace and the asymmetrical disposition of two large glands, one on each valve of the carapace.

In the Southern Ocean Atlas, this page offers three options – maps, drawings and notes. Each map (e.g. Figure 2) shows the known geographical range for the particular species. The drawings provide a taxonomic resource. Each species is drawn to a standardised format that shows the principal characters needed to identify the species (e.g. Figure 1). The majority of these drawings are original, but in the case of a few, we have had to rely on original sources and so these may not be complete and/or not follow the standard format. The species notes (cf. Box 2) provide an outline history of the taxonomy of each species and a summary of the carapace lengths of adult males and females, and of the juvenile stages that can be caught and identified in standard plankton nets with 0.32 mm mesh. Some of these size data suggest there may be cryptic species within the species currently identified.

A fourth option has been included in the new Atlantic website. This is day and night bathymetric profiles of all the species that occurred in reasonable numbers (>100) in each profile at each of the eight stations along the 20° W transect. These show the extent of any diel vertical migrations undertaken by the various species (Figure 3), and also how their vertical ranges change in response to changing hydrographic structure.

The maps have already generated a number of research issues. Published data showed that a species endemic to the Southern Ocean had been recorded from tropical seas, and subsequent examination of archived specimens has shown that these tropical specimens belong to a novel species. But not all the unexpected ranges are likely to be caused by misidentifications. The distribution of *Macroconchoecia caudata,* a species that is unmistakable, shows that the species is an Indo-Pacific species that occurs intermittently in the South Atlantic, and may be an indicator of water from mesoscale eddies spawned from the Agulhas retroflection and advected into the South Atlantic.

In the longer term, these distribution maps could become a baseline against which to assess changes in plankton distributions occurring in response to climatic oscillations and changes. However, rather disappointingly the maps show little coherence with the biogeochemical provinces identified by Alan Longhurst (see Further reading).

This is not entirely unexpected as the maps are based on presence and absence, and inevitably include of records of expatriate species. This blurs the evidence of the boundaries, which are probably fairly fuzzy anyway. But subsequent analyses of the transect data, which take into account the relative abundances of the species, clearly divide up the North Atlantic in good accord with Longhurst's provinces.

One of the features that emerges clearly is that the changes in species diversity and richness across the boundaries extend down from the upper water column to the deepest levels sampled (2000 m). The implication is that climate cycles that affect productivity in the upper water column will be reflected throughout the whole water column. Moreover, if these populations of planktonic recyclers change, will flows of carbon through the water column be modified? Will the changes be sufficient to render invalid models of carbon flow that ignore mid-water processes?

I am convinced that to continue to ignore the mid-water communities could lead to serious errors in predictions. But then I would hate to think the whole of my 40 years of research has been only been a curiosity-driven, esoteric exercise, initiated by a mind-bending experience in the Arabian Sea!

Further reading

Longhurst, A.R. (1998) *Ecological Geography of the Sea*, Academic Press, San Diego.

Martin Angel is retired but still works part-time at the National Oceanography Centre, Southampton.

A treat for zooplankton enthusiasts

If you are interested in marine zooplankton, take a look at the website for the Census of Marine Zooplankton (CMarZ)**:** www.cmarz.org. The project is part of the Census of Marine Life (see www.CoML.org). CMarZ is working toward a taxonomically comprehensive assessment of biodiversity of animal plankton throughout the world ocean. Its goal is to produce accurate and complete information on zooplankton species diversity, biomass, biogeographical distribution, genetic diversity and community structure by 2010.

The project will concentrate on the holoplankton, i.e. permanent members of the plankton, rather than animals that are planktonic for only part of their lives (meroplankton). There are currently ~6800 described species of holoplankton in fifteen phyla. It is thought that at least that many new species will be discovered as a result of the project. The census encompasses unique marine environments and those likely to be inhabited by endemic and undescribed zooplankton species.

The CMarZ website includes infomation about the project's cruises, including video clips and a photo gallery. The ostracod *Alacia valdiviae* shown above right comes from the 'photo gallery' for the April 2006 cruise to investigate the deep waters of the Sargasso Sea.

The halocyprid ostracod Alacia valdiviae *(which is a spectacular orange) from the CMarZ website.*

Photo: Russ Hopcraft, University of Alaska