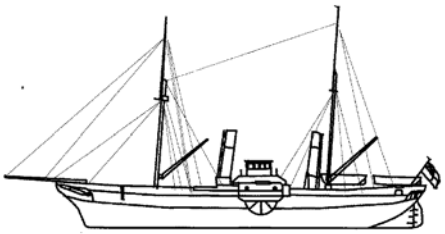
PORCUPINE MARINE NATURAL HISTORY SOCIETY

NEWSLETTER

December 1999 Number 3

ISSN 1466-0369

CONTENTS



EDITORIAL

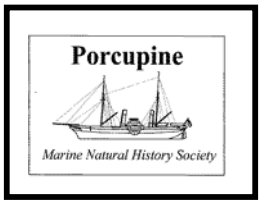
As mentioned in the previous newsletter, this, the third of the new Porcupine Marine Natural History Society newsletters, was going to be a short one with the particular aim of encouraging all Porcupines to attend our spring meeting in Plymouth on March 17th -19th 2000. Put the date in your diaries now! We already have some excellent speakers lined up for you, but more 'volunteers' and suggestions are still needed. Plymouth is a great place to visit and a trip round the new National Marine Aquarium is included - well worth a visit so bring the family.

The reason the newsletter is **not** short is that I have received many contributions from Porcupines and their friends. These are most welcome. Please keep them rolling in! I would also be interested to have some feedback on previous information requests. Did you receive any information or comments back? If so please tell me so that I can publish them and so spread the word on interesting sitings, associations (of the marine kind!) etc.

The next newsletter will again be a major one containing (we hope) any remaining papers from the Dunstaffnage meeting and the papers from the Southampton meeting as far as we have been able to persuade authors to produce them. Contributors to the Plymouth meeting in March 2000 will be asked to submit their papers for publication immediately following the meeting if at all possible.

LOGO

Porcupine Council is developing a new logo for the Society. Several ideas have been put forward including: modifying the old one of 'Scubahystrix'; using the drawing of HMS Porcupine (see below and back cover); using a symbolic animal (*e.g.* starfish, seaslug); something inanimate or symbolic (*e.g*. composite of camera, diver, shore etc). A final decision on the logo, which will be used in the newsletter, leaflet *etc*. will be taken at the Council meeting in February 2000. All the suggestions so far put forward (mostly by council members) will be considered. However, Council would be very pleased to receive YOUR suggestions. Please send logo designs to Julia Nunn or Frances Dipper by February 10th at the latest. Your design should represent the whole ethos of Porcupine - 'an informal society interested in marine natural history and recording particularly in the North Atlantic and Porcupine Bight'. The 'winner' will be acknowledged in the next newsletter and a small prize awarded (if chosen from outside Council).



COPY DEADLINES

May 1st for June/July issue

Sept 1st for Oct/Nov issue

Jan 1st for Feb/March 2001 issue

MEETINGS, MEETINGS, MEETINGS, MEETINGS, MEETINGS

PORCUPINE MEETINGS

Porcupine 2000

The marine natural history of the NE Atlantic

Approaches to Identification

(Plymouth, 17th-19th March 2000)

The Porcupine Natural History Society is pleased to announce that next year's spring meeting will be held in Plymouth and will run from Friday 17th to Sunday 19th March. Oral and poster presentations are being solicited which focus on all aspects of identification within the marine environment.

Confirmed presentations include:

- "*Identification by volunteer recorders - National Biodiversity Network developments by MarLIN*" **- Keith Hiscock (MarLIN)**
- "*Identifying marine biotopes*" **- Bob Foster-Smith (University of Newcastle)**
- *"The AQC scheme"* - **Joe Breen (IRTU)**
- "*Identifying conspicuous seabed species in-situ - a comparison of divers, cameras and ROV*" **- Jon Moore (OPRU)**
- "*The Challenges of Identification at the National Marine Aquarium*" **- Doug Herdson (National Marine Aquarium)**
- "*Quality in taxonomy*" **- Roger Bamber. (Natural History Museum)**
- "*Finding and identifying molluscs*" **- Julia Nunn & Shelagh Smith**
- "*Online exchange of electronic information*" **- Mike Kendall (CCMS - Plymouth Marine Laboratory)**
- "*Problems of Identification in the Deep Sea*" **- Gordon Patterson. (Natural History Museum)**
- "*Superseding paper keys*" **- Nigel Grist (Unicomarine)**
- "*From morphology to molecules: New methods for assessing biodiversity*" - **Alex Rogers (Southampton Oceanographic Centre)**
- *"Making the most of what we know - Life beyond 'Survey' "* **- Bob Earll**

Abstracts should be less than 1 page of A4 (12 pt type, single space) and should be submitted in Word format on diskette or preferably in electronic form via e-mail to:

Steve Widdicombe
Plymouth Marine Laboratory
Prospect Place
Plymouth
PL1 3DH

e-mail: S.WIDDICOMBE@PML.AC.UK
Phone: 01752 633423

Registration fees £40 (includes conference dinner, lunches and guided tour of National Marine Aquarium)

Registration forms are included in this issue of the Newsletter and may also be obtained directly from Steve Widdicombe.

P0RCUPINE PROBLEMS
Information requests

Unusual observations from the Eastern Solent

Jenny Mallinson
Southampton Oceanography Centre

The seabed of most of the eastern Solent is comprised largely of muds and sands with few rock outcrops. Much of the hard substrate is provided by small stones and shells, in particular the slipper limpet, *Crepidula fornicata*. This supports a varied epifauna of sponges, anemones, hydroids, bryozoa and ascidians extending throughout the Solent and, indeed, off the coasts of Sussex to the east and Dorset to the west.

South of Langstone Harbour, the Nab Channel marks the track of the ancient Solent River. On the northern edge there is a band of large (1-2m) sandstone boulders lying in mobile sand with patches of slipper limpet. The epifauna on these boulders and limpet shells is consistent with that of the area, including sponges, *Esperiopsis fucorum* and *Dysidea fragilis*, anemones, *Actinothoe sphyrodeta* and *Urticina felina*, hydroids, *Nemertesia antennina* and *Hydrallmania falcata*, bryozoa, *Flustra foliacea* and *Scrupocellaria* spp. and ascidians, *Polycarpa* sp. and *Styela clava*.

A recent dive (July 1999) on this band of sandstone boulders revealed a species that is unusual for this part of the south coast. Just how unusual or

far from its normal range could, perhaps, be determined by putting the question to Porcupine members:

Palmiskenea skenei (Ellis & Solander, 1786)
This attractive hard bryozoan, resembling a miniature staghorn coral, is known from Sandown on the Isle of Wight (NCC survey,1983). No other record of it for this area has been found although it is quite striking. Off Sandown, small colonies were found on limestone bedrock but off the Nab Channel, well grown colonies 10-12cm across were associated with the large sandstone boulders. One was on top of a rounded boulder 1m across by 0.5m high, a second was on sand attached to a chain of *Crepidula fornicata*. The latter specimen, considered to be vulnerable to inundation by shifting sand, was collected.

Identification is by Jenny Mallinson, the animal is recorded in its habitat on digital video by Ken Collins and the sample is, at time of writing, alive in the Southampton Oceanography Centres marine aquarium.. Can anyone throw more light on the range of this interesting creature?

Unusual worms

Roger Brehaut
La Canurie, Colling's Road, St.Peter Port, Guernsey GY1 1GF

In May 1999, a dealer in angling supplies in Guernsey was offered some King Rag as bait. After he had paid for it and the young boy who had brought it in had gone, he realised that it was not King Rag, and when other anglers failed to recognise it, he contacted local biologists.

The worms were *Sabella spallanzanii* (Viviani 1805). Although known from the adjacent coasts of France, as far as I know, the only reference to this worm in British waters is in the text of the Cambridge Natural History Vol.II, of 1896, where the author mentions the species and adds: "which occurs off the Channel Islands and in the Mediterranean".

Most descriptions suggest a length up to 200mm, or possibly to 300mm and imply that it occurs at extreme low water, or sub-littorally. These worms were all in excess of 300mm, some more than 350mm and were apparently collected on a neap tide. They were all very much alive when I saw them the day following their sale.

Attempts through local media, to trace the boy who sold them, failed.
I would like to know whether anyone can add to my information on size and habitat, and in particular, to know whether there have been any occurrences in more northern localities since my books were published.

WANTED!

Have you seen this worm recently?
Peacock worm Sabella pavonina (Polychaeta:Sabellidae)

Pamela E Tompsett
Awelon, Colborne Avenue, Illogan, Redruth, Cornwall, TR16 4EB
Tel & Fax: 01209 842316
e.mail: petomp@bioscope.demon.co.uk

My studies on the Helford and Fal *Sabella pavonina* populations in Cornwall would be greatly enhanced by records relating to the whole UK marine scene. Whilst more recent information is of particular interest, any observations at all would be most welcome. Minimum information needed for each sighting: Date, Location, Depth, Observer, Substrate, Associated species and where possible, an indication of Density and Size. Any records of related species such as *Megalomma vesiculum* and the larger *Sabella spallanzanii* would be of interest. I know that ***Porcupines*** are all enthusiastic observers and I

should be most grateful for your assistance.

(*Note from editor*: Pamela should contact Roger Brehaut - see 'Unusual worms' above.)

Unusual fish records

Frances Dipper
Porcupine editor (contact on inside cover of newsletter)

I am preparing a new edition of 'British Sea Fishes'. I would be very interested to hear from anyone who has records or preferably photos of unusual fish seen or caught within diving depths around UK. Since the books publication in 1984, divers have been reporting various 'rare' or 'rarely seen' fish and I would like to include information on these in the new edition. Similarly, any additional information on distribution or ecology of fish already covered in the book, would be most welcome.

OTHER SOCIETIES AND RECORDING SCHEMES

History of the Local Records Centre in Cornwall

Stella Turk

It is almost 30 years since the Cornish Biological Records Unit was instigated as one of the projects of the then new Institute of Cornish Studies. Frank Turk was asked to undertake this as part of his role as an Extra-Mural Dept tutor - so combining the University of Exeter in a double role (i.e. in relation to the Institute as well as Adult Education), together with the County Council (as sponsor of the Institute). In 1980, on his retirement, Stella Turk was appointed Honorary Academic Director, and from 1993 to 31st December 1996, Adrian Spalding became Academic Director.

From 1972 to 1988, card indices of approximately half a million records were amassed from published sources, mainly by the efforts of Brian and Elizabeth Jackson, in the later years aided by Pamela Tompsett. At the same time an index of sources was compiled, and Cornwall being a popular place for visiting naturalists over the centuries, this too grew, and encompassed national as well as international journals. Compiling sources was undertaken by Government trainees in association with the Local Studies Library.

Over the years, a network of recorders and recording groups was established in Cornwall and beyond, with much time and effort given to amassing material on marine life.

Frank Turk had conceived the Records Unit as embracing all species (marine, land and freshwater) that had lived or still live west of the Tamar so that it would be useful for a wide range of interests, including those of research and conservation. This has come to be recognized as a wise strategy in the light of the threatened extinctions of species, and conferring of Red Data and Nationally Scarce status on little-known invertebrates. The records were invaluable for the compilation of the *Red Data Book for Cornwall and the Isles of Scilly* (1997) edited by Adrian Spalding, and continue to be useful for work on Biodiversity Action Plans and long-term monitoring of Global Warming, whether the long-term outlook is waxing warmer or waning colder for the British Isles.

In May 1989 computerisation was officially started, under the control of Colin French (following an eight-month feasibility scheme and a year of

securing funding) who devised a programme called ERICA (Environmental Records in Cornwall Automated - including the Isles of Scilly by implication and in fact), designed not to exclude any of the data on the card index. With various Government manpower training schemes, a steady input of 3,000 records a week was maintained, allowing the Unit to keep up with incoming records. The millionth record (a Sailfin Dory, a fish new to British seas) was celebrated in March 1996, the number of species then being almost 22,000.

In summer 1996, there were changes in the funding, money was withdrawn from the CBRU, some staff were made redundant and on 1st January 1997 the Cornish Records Unit was merged with the Wildlife Trust. The new Environmental Records Centre for Cornwall and the Isles of Scilly has now been firmly established, hosted by the Cornwall Wildlife Trust and funded by the Trust and Cornwall County Council. It aims to provide a service to all users and providers of environmental data and is being developed under the guidance of an Advisory Board. This includes representatives of the local authorities, statutory agencies and the recording community.

The Centre is also playing a role in the development of the National Biodiversity Network through the linking Local Records Centre project and is working in collaboration with the Bristol Regional Environmental Records Centre in this respect.

The Centre, like others in the UK was committed to using Recorder 2000 devised by Stuart Ball of JNCC, and was concerned to wait for it to become available before adding further records. However, this year (1999),the centre like many other similar organisations has recently started to use various forms of Biobase which will easily relate to Recorder 2000. It is now known that NEW ERICA, which had been made available in its rewritten form to run on a PC, can also be transferred, and records of flowering plants and ferns have been added (by Colin French) as well as certain faunal groups, including marine Mollusca (SMT).

A combined initiative of the Cornwall and Devon Wildlife Trusts, called Seaquest South-West, is providing a valuable source of marine information. It was formed by a few people separately collecting data on cetaceans, sharks, seals and turtles. They believed that they could not only help each other by pooling observations, but they could encourage others living by or visiting the coast to send in records of sightings offshore as well as drift seeds and dead animals stranded on the shore. In return contributors receive an information pack and subsequent newsletters.

The scheme has become very popular, and the Trusts have received valuable information on various marine organisms and events. For instance, the recent wreck of *Physalia physalus* (Portuguese Man-of-War) resulted in a valuable assessment of numbers, similar to the result of a plea for records mounted by Dr Douglas Wilson in 1945. These have all been added to NEW ERICA, where they make a series connecting strandings of this species over the past century.

We are also able to share records with the National Marine Aquarium which is represented on the Steering Group.

Particularly important is the fact that all this information is being entered on to the Trust's web site (www.wildlifetrust.org.uk). Entries are normally brought up to date once a week bringing marine records to a wider public.

The Joint Marine Programme

Pippa Morrison

Marine Conservation Manager (Irish Sea Region), Ulster Wildlife Trust, 3 New Line, Crossgar, Co.Down BT30 9EP

In June 1997, The Wildlife Trusts and WWF-UK joined forces under a Joint Marine Programme, or JMP for short, to advance marine nature conservation in the UK. The two organisations had regularly found themselves campaigning and working on the same marine issues over a number of years, WWF-UK focussing at a national and international level and The Wildlife Trusts well placed to undertake the work at a local and regional level.

The opportunity to develop this work together allows the two organisations access to a wider base of skills and expertise, and enables both organisations to increase the effectiveness of their marine conservation work at local, regional and national level. This joint approach also means that the partners can bring more credibility to the work and maximise the marine conservation effort within the limited funding constraints that all conservation groups suffer.

The Programme is managed by Joan Edwards, Marine Conservation Policy Manager for The Wildlife Trusts and Siân Pullen Head of WWF's Living Seas Programme.

The JMP has committed the organisations to a minimum five-year partnership, with the vision "to ensure the conservation of marine wildlife and healthy seas". The JMP has identified three main phases of work, each building on the previous phase:

Phase one
- Protection of marine wildlife and habitats
- Conserving the coastline
- Reducing the risk from offshore activities

Phase two
- Fisheries
- Elements of Phase one

Phase three
- Pollution prevention and environmental monitoring
- Elements of Phases one and two

After two and a half years, the JMP is moving into phase two, and has achieved an enormous amount in this time and made significant progress towards the goal.

There are already three regional officers based in Wales, Northern Ireland and the North East of England, with plans underway for another three officers based around the rest of the UK. Each of these officers is responsible for developing marine conservation work within their region, and assisting the local Wildlife Trusts to increase the capacity of their marine conservation work.

The officers also take on a specialist subject and work within a UK context as spokesperson for that subject. The three officers so far in post are: Mick Green (Wales), who specialises in offshore industry such as oil and gas; Paul Murby (North East), who is a fountain of knowledge on coast defence and erosion issues; and myself, based in Northern Ireland and acting as spokesperson on Marine Protected Areas.

Very early on in the development of the JMP, is became clear that the enormous amount of experience within the two organisations needed to be more accessible to all The Wildlife Trusts and WWF County and Regional offices. The result is an internal handbook on marine conservation. Numerous Marine Updates are publicly available on a variety of subjects (some of which are listed

below) and many fact sheets on marine species and sites.

The JMP has already had many successes, developing effective networking, securing funding for the three officers and over £50,000 towards marine projects including cetacean and basking shark projects. The JMP has presented evidence to the House of Lords Environment Inquiry on the Habitats Directive and Biodiversity; and produced reports on the wildlife and financial implications of coastal squeeze.

Future projects include the development of a 'Seaquest' survey project and a marine project for Wildlife WATCH, the young environmentalists club of The Wildlife Trusts. Work will continue to secure funding for additional JMP Officers; campaigning for the development of a Marine Act; and network and develop the work of The Wildlife Trusts involved in SAC management. A "Year of the Sea" is also being planned for 2002/2003.

The Joint Marine Programme is a unique approach to marine conservation. There is still an enormous amount of work to be done, but if the JMP continues at the rate it has been achieving its objectives so far, it will continue to be an incredibly successful and exciting initiative.

Titles of WWF Marine Updates (40 updates available from WWF-UK)

- Fisheries
- The Crown Estate Commissioners
- Coastal Zone Management
- Century of Concern Regarding the North Sea
- The Sea as a Resource
- UK's Varied Shoreline
- Review of CFP
- Pollution's Final Destination : The Ocean
- Pollution from Merchant Shipping
- The Coastal Defence and Management Retreat
- Marine Biodiversity
- Special Areas of Conservation
- Pollution and Pesticide Reduction Policies
- Precautionary Approach in Fisheries Management
- Helford Voluntary Marine Coinservaiton Area
- Integrated Coastal Management
- Integrated Coastal Management and Local Authorities
- Integrated Coastal Management and European Initiatives
- Whales and Pollution
- North Sea – Special Area
- World Oceans' Day
- Shipping and the Environment – The Risks Involved
- Barrages Within Estuaries
- Yorkshire and Lincolnshire
- Global Programme of Action
- Protected Areas, Fishery Refuges
- Particularly Sensitive Areas
- Valuable and Vulnerable – Coral Reefs
- Hormones Disrupted by Chemicals
- PAHs
- El Nino
- Pollutant Release and Transfer Register
- Ships of Shame or Vessels of Virtue
- The Sintra Statement and the OSPAR Hazardous Substances Strategy
- The Price

PORCUPINE PIECES

SEA URCHINS SET TO TOP THE MENU

Elizabeth Cook
Scottish Association for Marine Science (SAMS)

Have you ever eaten sea urchin roe? The response from most people in the UK is a look of incomprehension. This response, however, could all soon change if the commercial farming of these spikey, ball shaped sea creatures takes off in Scotland.

Travel to Japan, or countries closer to home such as France and Spain and the response is entirely different. For sea urchin roe is a valuable delicacy, particularly in Japan where it is typically consumed fresh and raw. World-wide, the demand for roe has risen substantially and to meet this rise, annual harvests have grown at an exponential rate from less than 10,000 tonnes in the 1940s to the present day figure of over 100,000 tonnes (accounting for inaccuracies in FAO Statistics). The estimated annual global market is now worth in excess of £500 million and high quality urchin roe can be found retailing at a similar price to caviar.

The Decline of the Wild Urchin

With urchin roe commanding such a high price and the fact that these creatures are relatively easy to harvest, the inevitable over-exploitation of wild populations has taken place. France and Ireland have both experienced the consequences of unsustainable sea urchin fishery practices with the collapse of their wild stocks in 1970 - 71 and the late 1980s respectively (Keesing and Hall, 1998). Other countries, including Chile, USA, Korea, Norway and Iceland, quickly recognised the signs of an unsatiated market, which had been exacerbated by the decline of wild stocks in the traditional fishing grounds and the rapid growth of the market for urchin roe. This resulted in a dramatic increase in their annual harvest of native wild stocks and as a result, the majority of these countries have imposed restrictions on the size and number of urchins that can be harvested in a given season. Critics have suggested however, that these are only poorly enforced and that it is only a matter of time before these countries also experience a collapse in their wild stocks. This rather pessimistic prediction, together with the poor or variable quality of roe obtained from wild urchins and the significant ecological importance of this creature as a grazer in kelp communities, has meant that nations involved in sea urchin fishery have now begun to search for alternative means of reducing their dependency on wild stocks and improving the quality of the roe they harvest.

Sea Urchin Cultivation

Cultivation (i.e. echinoculture) or ranching of sea urchins have both been adopted as means of reducing dependency on wild stocks and improving the quality of the roe. Japan reputedly has invested heavily in echinoculture since the 1960s, concentrating on the enhancement of natural populations through seed cultivation (Hagen, 1996). However, it has only been in the last decade, that other countries have thought seriously about the problem. In France, a capital intensive, land based system has been adopted (Grosjean *et al*., 1998). The Irish decided to develop a technically simpler approach known as ranching, in which urchins are either collected by divers or reared from seed and then transported to richer feeding grounds for on-growing. However, the industry is still without a leader, in that no country has advanced their research in

echinoculture to the point where they are able to secure a commanding commercial advantage.

This prompted a team in Scotland, co-ordinated by Dr Dougie McKenzie of SAMS, to be the first to enter the industry in the UK, with a unique method of culturing sea urchins that was designed to build upon the strong foundations of the aquaculture industry already in existence. This unique method was polyculture - the culture of two species simultaneously using the same facilities and its main advantages were that it required only a fraction of the capital investment and maintenance necessary for land based or ranching systems. The idea was formulated in January 1992, when a sea-going salmon cage was brought ashore for its annual defouling. To the surprise of the farmer, inside the cage were thousands of sea urchins (*Psammechinus miliaris*), which must have encountered the cage when in their planktonic larval stage and found that the cage netting was an ideal spot to settle. The cage had been at sea for less than eighteen months and the urchins were already of considerable size for their age, indicating rapid growth in the cage environment. The finding led to a pilot study being undertaken by Dr Maeve Kelly (SAMS), funded by Highlands and Islands Enterprise (HIE) and Ross and Cromarty District Council in association with the salmon growers, Joseph Johnston & Sons. Extremely promising results were produced from the study, with *P. miliaris* kept in salmon cages together with Atlantic Salmon (*Salmo salar*) for a period of 3 months showing significantly enhanced gonad growth compared to urchins grown in either monoculture (i.e. no salmon present) or in the wild (Kelly *et al*., 1998a). The potential for other methods of polyculture has also been highlighted, with scallop lines owned by Loch Fyne Seafarms experiencing both high natural settlement and rapid growth of *P. miliaris*.

Market studies suggested that, providing price and taste are good, there would be no resistance to cultured urchins as opposed to wild urchins. They also found that *P. miliaris* does command a high market price in France.

LINK Echinoculture Project

In response to the results obtained from the pilot study, a 3 year LINK Aquaculture grant was awarded in July 1996 to the SAMS group at the Dunstaffnage Marine Laboratory (DML) in association with Loch Fyne Seafarms, Joseph Johnston & Sons and Seafish Aquaculture, Ardtoe. The main objective of the research was to investigate the echinoculture of *P. miliaris.* This species has a number of advantages over other species in the European market (i.e. *Paracentrotus lividus*), in that it is distributed all around the British Isles and is tolerant of cooler temperatures and lower water quality. It should be stressed that this species would never be able to support a commercial 'fishery' in the UK, since in the wild it rarely achieves the size or gonad condition required for the European market. Echinoculture, however, does offer a means of exploiting this species in a sustainable manner, without the risk of depleting the wild stocks and disturbing the ecological balance of kelp communities, in which grazing by urchins often plays a major role in promoting algal species diversity.

The results of the three year study have been very encouraging. A semi-commercial hatchery is now fully operational and the sea urchins are exhibiting significant test and gonadal growth when held in cages stocked with Atlantic salmon (Kelly *et al*., 1998b) and on lines with the Queen scallop (*Chlamys opercularis*) (Cook *et al*., 1998). *P. miliaris* has also been found to tolerate stocking densities far exceeding those found in the wild which is essential if this species is to be successfully cultivated on a

economically viable scale. The French market has also responded very favourably to sea urchins, which had been on-grown on the salmon farm. It is believed, therefore, that sea urchin roe that is of a size and quality that is acceptable in the market place could be produced within 2 – 3 years. The results provided by this study, however, now need to be tested on a commercial scale to determine whether *P. miliaris* exhibits the same growth rates and tolerance levels found in the experimental trials.

References

Cook, E.J., M.S. Kelly, J.D. McKenzie (1998). Somatic and gonadal growth of the sea urchin *Psammechinus miliaris* (Gmelin) fed artificial salmon feed compared with a macroalgal diet. *J. Shell. Research* **17 (5)**: 1549 – 1555.

Grosjean, P., C. Spirlet, P. Gosselin, D. Vaitilingon and M. Jangoux (1998). Land-based, closed-cycle echiniculture of *Paracentrotus lividus* (Lamarck) (Echinoidea: Echinodermata): A long-term experiment at a pilot scale. *J. Shell. Research* **17 (5)**: 1523 – 1531.

Hagen, N.T. (1996). Echinoculture: from fishery enhancement to closed cycle cultivation. *World Aquacult*. **27 (4)**: 6 – 19.

Keesing, J. K. and K. C. Hall (1998). Review of the status of world sea urchin fisheries points to opportunities for aquaculture. *J. Shell. Research* **17 (5)**: 1597 – 1604.

Kelly, M.S., J.D. McKenzie and C.C. Brodie. (1998a). Sea urchins in polyculture: The way to enhanced gonad growth? In: R. Mooi and M. Telford (eds), *Proceedings of the 9th International Echinoderm Conference, San Francisco*. Balkema: Rotterdam. pp. 707 – 712.

Kelly, M.S., C.C. Brodie and J.D. McKenzie (1998b). Somatic and gonadal growth of the sea urchin *Psammechinus miliaris* (Gmelin) maintained in polyculture with the Atlantic salmon. *J. Shell. Research* **17 (5)**: 1557 – 1562.

Elizabeth Cook has just completed her PhD, which was supervised by Dr Maeve Kelly and Dr Dougie McKenzie at the Scottish Association of Marine Science, Dunstaffnage Marine Laboratory, Oban, Argyll PA34 4AD and sponsored by the LINK Aquaculture grant.
Tel: (01631) 567 833. e-mail: ejc@wpo.nerc.ac.uk.

REASONS FOR OCCASIONAL OUTBREAKS OF "SORE PAWS" IN OUTLYING PORCUPINES

By Ralph Robson

I was persuaded at the London meeting recently to write about the problems of attending Porcupine meetings. My first thought was to approach the subject on a purely scientific basis and produce a standard paper. Introduction, methodology, results, discussion, conclusions, references. I am sure that you all know the sort of thing, but then two problems presented themselves. Firstly, I unfortunately have little contact with other members between meetings and secondly the subject seems not to have captured the imagination of those students aspiring to attain MSc or PhD status and so published literature would appear thin or indeed absent.

It seems to me that given the above I must draw only on my own experiences and so will start back to front by citing my literature, as yet unpublished, first – Extracts from my diaries 1997-99

As many of you know it was through another founder member of Porcupine, Fred Woodward, that I became a member and in the early years we travelled to most meetings together. I have picked out a few notes from my diary which I hope you will enjoy more than I did at the time, although in retrospect they seem less traumatic.

April 1987 Lowestoft. Thursday drive to Fred's, weather mixed. Friday light snow as we leave Glasgow but nothing to worry about and not really cold. Arrive Lowestoft some nine hours later. Open car door to an easterly wind with a chill factor of around minus 20. It was warmer in snowy Glasgow. Saturday a certain hardy soul has been on the shore before breakfast, a truly enthusiastic Porcupine that one. Good meeting but we are not sorry to be heading north Sunday evening. It's warmer up there!

March 1988 Millport. Nice and close to home. Travel to Fred's on Thursday. Leave Anne my car keys and travel in Fred's car to Largs on Friday morning. No problem so far. Arrive ferry slip at around lunchtime to discover No Ferry; it would seem that Cal-Mac are on strike! Eventually someone on the slip tells us that the small launch tied up alongside the slip is acting as the ferry. We look at the boat and then the sea then each other. The waves out there look bigger than the boat. We make discrete enquiries. The "ferryman" knows about the meeting and will take us across. We park the car, lug our bags down the road and as bidden "jump in". The boat by this time is loaded with bread and cases of beer. As we pull away I notice someone on the slip with a large video camera but take little notice and spend most of the next 15 minutes looking up at the waves above me. Excellent meeting. Rough crossing back. On arriving home on Monday evening discover we are now TV personalities. My wife recorded the Grampian news on the Friday for me. An excellent shot of Fred and me in the boat surrounded by beer crates and provisions.

Several other meetings which have resulted in "sore paws" also spring to mind: Redruth in Cornwall, a drive of 800 miles each way. This will be our holiday for this year. I have family business to attend to on the way and we book a cottage near Redruth for the week. A good meeting except for the field excursion on Sunday to Marazion. We arrive at the shore where there is a cold wind blowing. Avril , my ever sensible wife, elects to sit in the car and read the paper while I join other Porcupines on the shore. When I arrive back I find that most of the sand dunes have blown over the car and the side windows and windscreen resemble ground glass and I have only had it a week! The drive home is interesting as oncoming headlights turn the screen into an opaque white glow! A sore pocket follows our arrival home.

Conclusion. I will end this discourse by saying "Thank you" to all those wonderful people who in the past have organised meetings, you have been marvellous, and lastly to those of you who are able to offer premises for future meetings please don't be shy. I know that it involves a lot of work but it is worthwhile. So please offers of venues to Julia if you live north of Watford Gap.

DYNAMICS OF MARINE POPULATIONS AND CLIMATE CHANGE: LESSONS FROM A MEDITERRANEAN FISH.

Marino VACCHI [1], Giampietro SARA [2], Carla MORRI [3], Milena MODENA [1], Gabriele LA MESA [1], Paolo GUIDETTI [4] and C. Nike BIANCHI [2]

[1] ICRAM, Via di Casalotti 300, I-00166 Roma (Italy)
[2] Marine Environment Research Centre, ENEA Santa Teresa, P O Box 316, I-19100 La Spezia (Italy)
[3] DipTeRis (Zoologia), Università di Genova, Via Balbi 5, I-16126 Genova (Italy)
[4] Laboratorio di Ecologia del Benthos, Stazione Zoologica "A. Dohrn", Punta S. Pietro, I-80077 Napoli (Italy)

Abstract
Climate change can influence marine biota by a combination of direct (survival, reproduction, recruitment, etc.) and indirect effects, mediated by biotic interactions or marine currents. Within the Mediterranean Sea, warm-water species are extending their range northward. The ornate wrasse *Thalassoma pavo* is establishing populations in the Ligurian Sea, which was formerly outside its distribution range.

Introduction
In the last decades, the natural variability of marine communities has been fully recognised and its relation with climate fluctuations hypothesised (Bianchi, 1997). However, it is often impossible to illustrate adequately this relation because of the lack of long-term data (McGowan, 1990). A striking exception are the studies in the western English Channel, continued for more than 70 years (Southward et al., 1995). They allowed detection of changes in the whole marine ecosystem that proved to be connected to long-term fluctuations in the climate called the "Russell Cycle".

According to Southward et al. (1995), climate change can influence the marine biota by a combination of: i) direct effect on the organisms (temperature causes changes in survival, reproductive success, dispersal pattern and behaviour); ii) effects mediated by biotic interactions (conferral of competitive advantage to one of a pair of overlapping species); and iii) indirect influence through ocean currents (changes in climate may alter the emphasis of water flow and the pattern of water circulation).

Several authors observed changes in species distribution related to temperature fluctuations, and Angel (1991) suggested that monitoring biogeographic boundaries would give an unambiguous signal of climate change. Grainger (1992) predicted that the foreseen global warming will probably make southern species extend their range northward.

This is apparently what is happening within the Mediterranean Sea, where warm-water species have recently increased their occurrence in the northern sectors, such as the Ligurian Sea (Bianchi & Morri, 1993, 1994; Francour et al., 1994).

Warm-water species in the Ligurian Sea
Being situated in the northernmost corner of the western Mediterranean, the Ligurian Sea (Fig. 1) is one of the coldest areas of the Mediterranean Sea. Accordingly, the fauna of this area is characterised by a strong diminution of the subtropical elements and by a more marked presence of species of cold temperate waters (Rossi, 1969). The episodic occurrence in the Ligurian Sea of warm-water species, coming from the southern and warmer Tyrrhenian Sea, was paradoxically recorded in cold years.

Astraldi et al. (1995) explained this paradox by the peculiar pattern of water and heat exchanges between

the Tyrrhenian and Ligurian basins mediated through the northward flowing Tyrrhenian Current. In response to the greater cooling of the Ligurian Sea, induced by the more intense water and temperature losses, a seasonal flux of warmer water is drawn from the Tyrrhenian Sea in order to restore the altered budget. The more intense the Ligurian Sea winter cooling, the larger the volume of the warmer flow carried northward by the Tyrrhenian Current, increasing the probability of warm-water species transport into the Ligurian Sea. Survival of warm-water species in cold years is unlikely, and this explains the rarity of findings (Bianchi & Morri, 1994). In a few cases, warm-water species have succeeded in establishing adult pseudopopulations.

This scenario, however, is changing: the occurrence of warm-water species in the Ligurian Sea has become more frequent and nearly constant after the mid-1980s, even in the presence of high winter temperatures. The air temperature time series at the Meteorological Observatory of Genoa shows a warming trend comparable to that already known for the Northern Hemisphere (Astraldi et al., 1995). Bethoux et al. (1990) and Sparnocchia et al. (1994) found evidence of a corresponding warming trend in Ligurian Sea waters. The present seawater warming may allow former sterile pseudopopulations to reproduce in the Ligurian Sea. These may thus become stable populations, getting independence from the larval supply by the Tyrrhenian Current.

The case of *Thalassoma pavo*

The ornate wrasse *Thalassoma pavo* (L.) is a small protogynous fish of the family Labridae thriving especially in shallow rocky habitats. High temperatures in summer are crucial for the sexual maturation of this species of tropical affinity. It is therefore far more common in the southern parts of the Mediterranean Sea. In the Ligurian Sea it was nearly unrecorded, notwithstanding that the Ligurian fish fauna is quite well known since the nineteenth century. Several studies on Ligurian marine biota, including fish, were carried out by both the University and the Museum of Natural History of Genoa.

The first inventories of Ligurian Sea fishes are those of Spinola (1807) and Sassi (1846), who included 113 and 218 species respectively but did not mention *Thalassoma pavo*. This fish was first cited by Parona (1898) as an infrequent species at the fishing market of Genoa. After that, it has been recorded in 1902 and 1911 (Tortonese, 1965). No other occurrence in the Ligurian sea is known until 1985 (Relini et al., 1988). Being a well-known fish, easily recognised because of its colourful livery, it is difficult to believe that it was present but overlooked during the several photographic fish-hunting competitions that have been held in Ligurian Sea since the sixties. In 1991, we found *T. pavo* to be common in several localities along both the eastern and western Rivieras and we have been observing it regularly since. Both adults and juveniles have been recorded.

This increased occurrence of *Thalassoma pavo* in the Ligurian Sea in recent years supports the hypothesis of the establishment of true populations of warm-water species in the Ligurian Sea. Thus, a systematic study of the Ligurian populations of *T. pavo* was started in 1996.

Work in progress and first results

Visual census methods have been employed to follow the dynamics of a population of *T. pavo* at “Scoglio della Croce”, a site located in the Eastern Riviera near the small town of Riva Trigoso (Fig. 1). It is an emerging rocky pinnacle connected to the shoreline by a 35 m long quay. The seabed in this small area consists of steep cliffs with algae at the base of the rocky pinnacle, and of flat grounds

covered by boulders (up to 1 m wide) on the two sides of the quay. The topographic and environmental features of the study site correspond well to the preferred habitat of *Thalassoma pavo* for both reproduction (Wernerus & Tessari 1991) and recruitment (Vacchi, unpublished data).

Visual census was performed fortnightly by snorkelling. The size (total length in cm) and livery type of each isolated or grouped *T. pavo* individuals were recorded. Fish behaviour and weather conditions were also noted, and seawater temperature measured (Fig. 2).

While monitoring of this site is still in progress, we report here on some preliminary results obtained in the first year of study, 1996-1997. Mean abundance of adults (> 10 cm) showed marked seasonal differences, maximum and minimum values being observed in summer and winter, respectively. Juveniles of 10-20 mm estimated minimum size were found from the beginning of September to the end of October, mostly on the boulder grounds in very shallow depth (0-1.5 m). Abundance of juveniles increased during autumn months, with a maximum in November.

Growth of juveniles was faster during autumn (1.2 cm·month^{-1}) and slower during winter (0.5 cm·month^{-1}). Most recruits attained 7-8 cm of total length in March. The occurrence of some specimens of small size still during autumn and winter would indicate cases of reduced growth rates. Some of the juveniles showed an unusual livery of a homogeneous bright green colour, which needs to be further investigated.

At present, populations of *T. pavo* are monitored also in the region of La Spezia, at the easternmost boundary of the Ligurian Sea (Fig. 1). La Spezia is at about 44° Latitude North and was hitherto outside the geographic range of the species. For the sake of comparison, two localities in the Tyrrhenian Sea have been also studied (Fig. 1). The Island of Ischia, at about 41° Latitude North, is close to the northern boundary of the “normal” range of the species, whereas the Island of Ustica, at about 39° Latitude North, represents a typical locality of occurrence.

First results clearly indicate that *T. pavo* is in further expansion in the Ligurian Sea and presently reproduces there, thus getting independent from the larval supply from the Tyrrhenian Sea. Between 1997 and 1998, populations of this species colonised new sites in the La Spezia region and incremented their numbers, passing from about 1 individual·100 m^{-2} to up to 5 individuals·100 m^{-2} (Sara, 1999). These figures, however, still remain much lower than in the two Tyrrhenian localities: 18-28 individuals·100 m^{-2} were counted at Ischia, and up to more than 130 individuals·100 m^{-2} at Ustica.

Acknowledgements

Studies on southern species occurrence in the Ligurian Sea are part of the research activities on marine biodiversity at the Marine Environment Research Centre (La Spezia). Change of marine ecosystems is the core topic of the ongoing national research project SINAPSI (Seasonal, INterannual and decAdal variability of the atmosPhere, oceanS and related marIne ecosystems).

References

Angel M. V., 1991. Variations in time and space: is biogeography relevant to studies of long-time scale change? J. mar. biol. Ass. U K, 71: 191-206.

Astraldi M., Bianchi C. N., Gasparini G. P. & Morri C., 1995. Climatic fluctuations, current variability and marine species distribution: a

case study in the Ligurian Sea (north-west Mediterranean). Oceanol. Acta, 18 (2): 139-149.

Bethoux J. P., Gentili B., Raunet J. & Taillez D., 1990. Warming trend in the western Mediterranean deep water. Nature, 347: 660-662.

Bianchi C. N., 1997. Climate change and biological response in the marine benthos. In: M. Piccazzo (Ed.), Atti del 12° congresso dell'associazione italiana di oceanologia e limnologia. AIOL, Genova, 1: 3-20.

Bianchi C. N. & Morri C., 1993. Range extension of warm-water species in the northern Mediterranean: evidence for climatic fluctuations? Porcupine Newsletter, 5 (7): 156-159.

Bianchi C. N. & Morri C., 1994. Southern species in the Ligurian Sea (northern Mediterranean): new records and a review. Boll. Ist. Mus. biol. Univ. Genova, 58-59 (1992-1993): 181-197.

Francour P., Boudouresque C. F., Harmelin J. G., Harmelin-Vivien M. L. & Quignard J. P., 1994. Are the Mediterranean waters becoming warmer? Information from biological indicators. Mar. Poll. Bull., 28 (9): 523-526.

Grainger J. N. R., 1992. The probable effects of climate change on invertebrate growth and reproduction with particular reference to Ireland. Invert. Reprod. Develop., 22 (1-3): 239-244.

McGowan J. A., 1990. Climate and change in oceanic ecosystems: the value of time-series data. Trends Ecol. Evol., 5: 293-299.

Parona C., 1898. La pesca marittima in Liguria. Atti Soc. ligure Sci. nat. Geogr., 9: 327-396.

Relini G., Ardizzone G. D. & Belluscio A., 1988. Le biocenosi bentoniche costiere delle Cinque Terre (Mar Ligure Orientale). Boll. Mus. Ist. biol. Univ. Genova, 52 suppl. (1986): 163-195.

Rossi L., 1969. Considerazioni zoogeografiche sul bacino N W del Mediterraneo, con particolare riguardo al Mar Ligure. Archo bot. biogeogr. ital., ser. XLV-4ª, 14 (4): 139-152.

Sara G., 1999. Demografia e comportamento riproduttivo di Thalassoma pavo (L.) (Pisces: Labridae) in Mar Ligure orientale: studio preliminare. Tesi Sperimentale, Facoltà di Scienze, Università di Pisa, a. a. 1998-99: 1-114.

Sassi A., 1846. Distribuzione dei pesci liguri. In: Descrizione di Genova e del Genovesato. Genova, 1: 111-151.

Southward A. J., Hawkins S. J. & Burrows M. T., 1995. Seventy years' observations of changes in distribution and abundance of zooplankton and intertidal organisms in the western English Channel in relation to rising sea temperature. J. therm. Biol., 20 (1/2): 127-155.

Sparnocchia S., Manzella G. M. R. & La Violette P. E., 1994. The interannual and seasonal variability of the MAW and LIW core properties in the Western Mediterranean Sea. Coast. estuar. Stud., 46: 177-194.

Spinola M., 1807. Lettre sur quelques poissons peu connus du Golfe de Gênes adressée à M. Faujas de Saint Fond. Ann. Mus. Hist. nat., Paris, 10: 366-389.

Tortonese E., 1965. Pesci e cetacei del mar Ligure. Libreria editrice Mario Bozzi, Genova: 1-216.

Wernerus F. M. & Tessari V., 1991. The influence of population density on the mating system of Thalassoma pavo, a protogynous Mediterranean labrid fish. PSZN I: Mar. Ecol., 12 (4): 361-368.

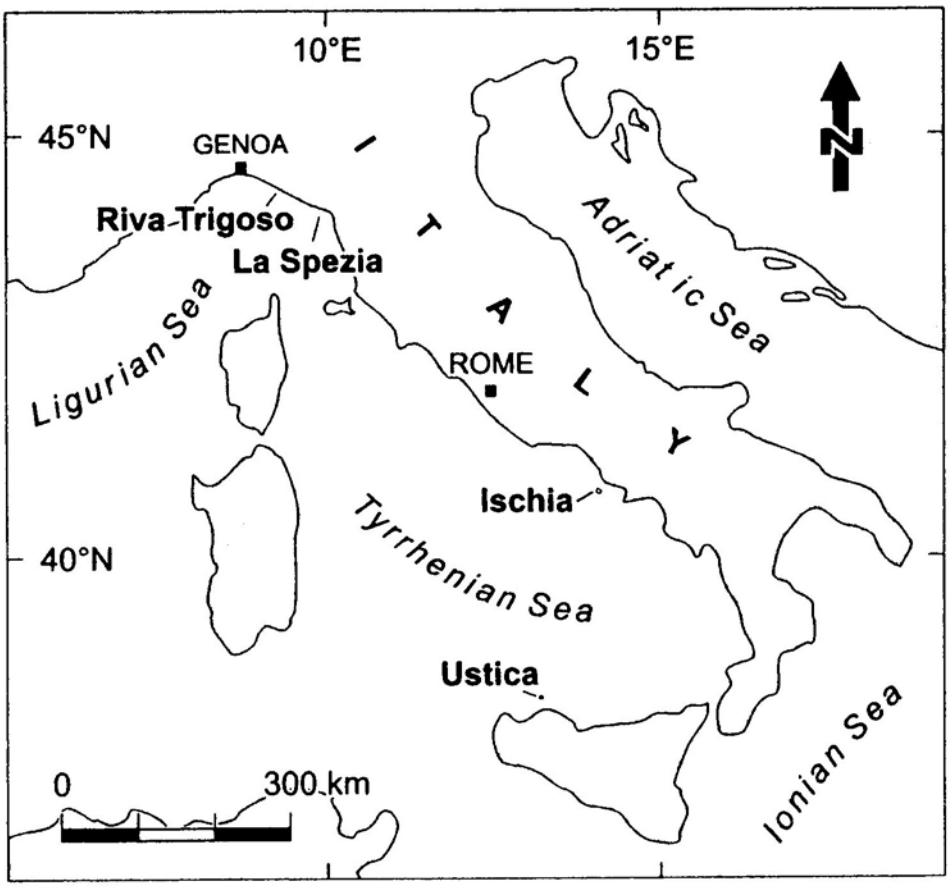


Fig. 1 – Geographical setting of the localities in Ligurian and Tyrrhenian seas where populations of *Thalassoma pavo* have been studied.

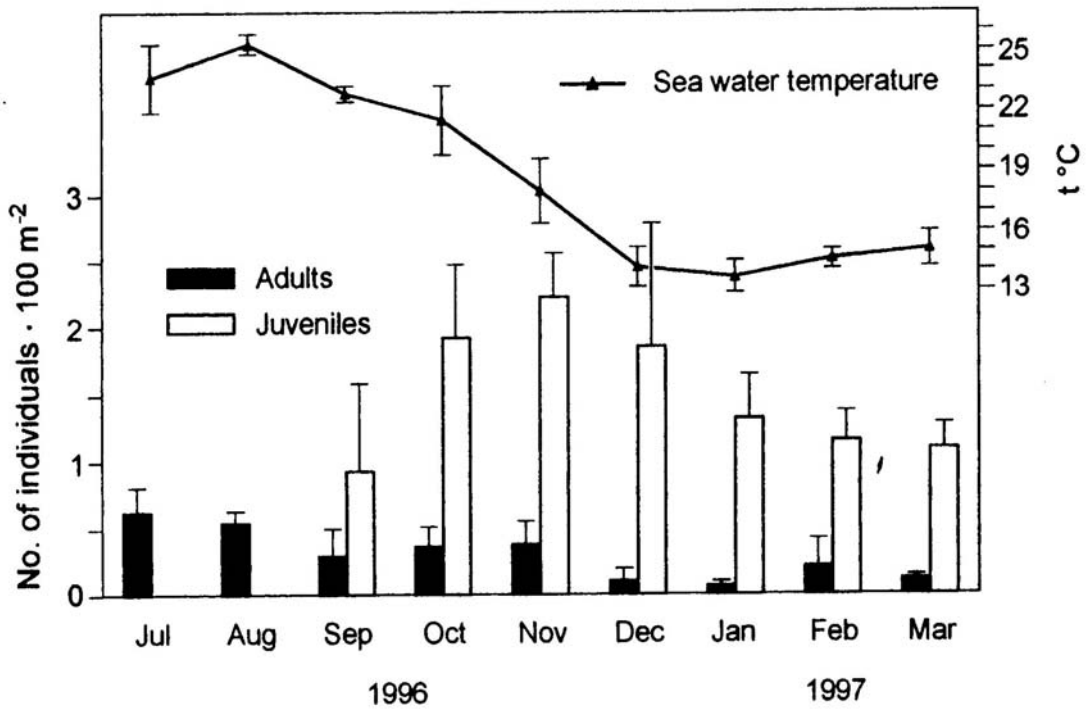


Fig. 2 – Seawater temperature and abundance of *Thalassoma pavo* at Riva Trigoso (Eastern Ligurian Sea), July 1996 to March 1997. Bars indicate standard deviations.

THE MARINE MOLLUSCA OF STRANGFORD LOUGH, CO. DOWN

J. D. Nunn

Centre for Environmental Data and Recording
National Museums & Galleries of Northern Ireland

The majority of the paper given below has appeared previously in the *Bulletin of the Irish Biogeographical Society* **17**:23-214 (1994), together with a full checklist and distribution maps of Mollusca. Those requiring more detailed information should refer to this paper!

Introduction

Strangford Lough is a fully saline fjardic lough, about 24km long and 4-8km wide, linked to the Irish Sea *via* a channel known as `The Narrows'. It lies about 14km from the city of Belfast, on the east coast of Northern Ireland (Figure 1). The lough is a complex tidal estuary. The massive volume of water which flows in and out during the normal tidal cycle produces currents of up to 8 knots in the Narrows. There is complete mixing of the water in this channel. The flooding tide then goes northwards at a reduced rate (2-3 knots), with comparatively still water to the south-west, reducing to at about one knot or less in the northern half of the Lough.

Freshwater influences are not considered to be significant in Strangford Lough (Brown, 1990). The only river of any size is the Quoile, in the south-west corner, and salinity is reduced in this area only at low water. Consequently, Strangford Lough can be considered to be always fully saline (Erwin *et al*., 1986).

Strangford Lough is a very sheltered sea lough, with only the south entrance to the Narrows being exposed to significant prolonged wave action. With a fetch of only 5-10km with prevailing westerly winds, wave action mainly affects the east coast of the lough and there is little or no evidence that it affects the sublittoral below 10m depth (Erwin, 1977).

In depths less than 10m, sediments are relatively coarse, due to slight wave action - finer sediments cannot settle. However, in the sheltered west coast, there is frequently soft mud. The sublittoral substrata below 10m are laid out according to the `energy' levels within the lough, which means the current strength (Erwin, 1977;

TABLE 1: Strangford Lough MNR

	Main lough	Entire lough	Narrows
Length	24 km (N to S)		8 km
Breadth	4-8 km (E to W)		0.7-2.5 km
Maximum depth	56 m		66 m
Shoreline		240 km	
Intertidal area		50 sq km	
Current		0-350 cm/sec	
Temperature		6-16° C	
Salinity		32.65‰ -34.25% (euhaline)	
Maximum fetch		14 km	

Brown, 1990). The Narrows is dominated by bedrock, boulders and cobbles, with patches of coarse gravel and pebbles in bays. The south basin of the lough is mainly coarse sand and gravel, with boulders. In the deeper northern part of the centre channel, there is fine mud. At the sides amongst the islands and pladdies and part of the centre channel, lies the *Modiolus modiolus* (L.) community with mud and shell debris. The Quoile Estuary is dominated by soft black mud. Finally, in the far north are muddy sand flats.

Strangford Lough is now recognised to be the most diverse sea lough in the British Isles (Gubbay, 1988). More than 72% of bottom living animals and plants from Northern Ireland are present, 28% not found elsewhere in Northern Ireland. The habitat diversity is represented by a range of substrata (solid bedrock to fine silt/clay), depth (0-66m), current (0-8 knots), salinity (Narrows - Quoile Estuary), intertidal (steep bedrock to wide mud flats), and the presence of animals (e.g. *Modiolus modiolus*) which can introduce diversity by providing a substrate for other species to colonise. Strangford Lough is an ideal area for ecological studies. It is accessible, small enough to sample, relatively pollution free, temporally stable and mainly euhaline. The diversity of habitat implies a diversity of molluscan fauna, and thus Strangford Lough represented an ideal location for a detailed survey of this group.

Historical background to molluscan studies in Strangford Lough

During the late 18th and early 19th century, very little work was done on the marine fauna of Ireland. John Templeton (1776-1825) systematically dredged the Northern Ireland coast and some of his molluscan records were published in 1935 by Fisher. An account of the Irish Testacea was published in 1818 by Brown. The lack of records was remedied by the foundation of the Belfast Natural History Society in 1821 (later (1842) renamed the Belfast Natural History and Philosophical Society). Two of its members, George Hyndman (1796-1867) and William Thompson (1805-1852) were active in exploring the marine life off the coasts of Down and Antrim by dredging. Other important naturalists were members, e.g. George Dickie (1812-1882), the first Professor of Natural History at Queen's University, Belfast, and Charles Wyville-Thomson (1830-1882). These people composed a unique group, the Belfast Dredging Committee, and were all active at the same period in the mid-19th century. Many of their results were published in the Reports of the British Association (1857-59). In 1852, William Thompson died, and volume IV of his great work *The Natural History of Ireland* was edited and published by Robert Patterson (1802-72), another active member of the Society. Many of the dredged molluscan records first appeared here. However, it was Dickie (1858) who produced the first paper on a distinct geographical area, which appropriately was Strangford Lough.

Faunistic reports appeared from time to time in the *Irish Naturalist*, *Proceedings of the Belfast Naturalists' Field Club*, *Proceedings of the Royal Dublin Society* and *Proceedings of the Royal Irish Academy*. However, all the active workers had died by 1882, and little work was done in subsequent years. Their work was summarised by Praeger (1889) and further reported by Nichols (1900), in *The Marine Mollusca of Ireland*, still the most recent checklist of the marine Mollusca of Ireland. Many of these early records gave very little precise information, rarely recording whether the specimens were collected alive or dead.

In 1903, the Ulster Fisheries and Biology Association was formed under the direction of Professor G. Wilson at Larne Harbour. A fisherman's house was rented and fitted out as a marine laboratory. Representatives of the

Belfast Natural History & Philosophical Society, Belfast Naturalists' Field Club and Queen's College met there. Some work was done and a few papers published, but little further information gathered on the molluscan fauna. In 1908, the laboratory closed because of the distance from Belfast, and financial problems. During this period until the 1960's, most work was conducted intermittently, with only Nora Fisher-McMillan publishing work directly relevant to the Mollusca.

From 1937 to 1940, laboratory space was available at Ardglass at the Fish Market Building. When war broke out, the building was given up, and premises in Portaferry rented. In 1945, Queen's University purchased a house which became the Marine Biology Station. For about 10 years, many sites in Strangford Lough were dredged, and all these records, together with the earlier ones, were published by Williams (1954) in an annotated checklist. This was the most recent comprehensive checklist available prior to this study.

The expansion of Queen's University activity in marine biology, especially in the late 1960's, led to the appointment of permanent staff, with a full time director in 1971. Very little of the published work during this period concerned Mollusca.

In 1972, the Ulster Museum began a diving survey of Strangford Lough, which was extended in 1980 to become part of the Northern Ireland Sublittoral Survey (Erwin *et al*., 1986). The molluscan fauna of Strangford Lough was also surveyed by Heriot-Watt University (Wilkinson *et al*., 1988) as part of the Northern Ireland Littoral Survey, both surveys being commissioned by the D0E (NI). Many records of Mollusca were made during this period. Other workers for Queen's University (Boaden, Seed, Brown, O'Connor, Platts, Roberts, C.D., Roberts, D.) studied certain molluscan species intensively (e.g. *Modiolus modiolus*) at specific areas (e.g. Greyabbey) or specific habitats (algal epifauna at the Dorn, coarse shelly sand meiofauna).

Thus, it can be seen that no recent specific survey of Strangford Lough for Mollusca had been carried out. During the period 1989 to 1992, as research for an M.Sc., the author drew together all previous work on the Mollusca of Strangford Lough and, together with the results of further fieldwork, produced a detailed annotated checklist, distribution maps and a comprehensive bibliography (Nunn, 1994). This paper is a brief(er) updated summary of that work.

Methods

The area called `Strangford Lough' refers to the whole main body of the lough, together with the Narrows up to the south entrance line drawn between Ballyquintin Point and Killard Point (Figure 1). Beyond this line is considered to be part of the main Irish Sea.

Compilation of the checklist was achieved by: search of all previous literature; search of museum collections referring to Strangford Lough; Sea Area 28 records from the Conchological Society of GB & Ireland; notes from 1960’s & 1970’s at the Marine Biology Station Portaferry; consultation with a number of individuals for casual observations of species (Baxter, J., Boaden, P.J.S., Breen, J.; Brown, R.A., Picton, B.E., Reid, W., Roberts, D. and Smith, S.M.); and by a field work survey around the Lough and Narrows.

(a) Littoral Survey

For the present survey, sites were selected, if possible, on the following basis to include:- (i) a full range of habitats present in the area; (ii) representative sites with habitats which occur extensively; (iii) sites with restricted or unusual features; (iv) even geographic coverage; (v) high human impact areas; (vi) areas under-recorded by previous workers.

Most sites were searched for 1-1½ hours, unless several sites were being studied on the same tide. Almost all sites were examined on a good spring tide (predicted low water 0.5m or less above Chart Datum) in the early morning or late afternoon. Sites were visited at all times of the year, provided suitable spring tides were available, and weather conditions permitted. Many sites could not be reached, or reached easily, without the use of a boat.

One or two buckets full of algal samples were removed for further examination. They were soaked for a minimum of three hours (usually overnight) in fresh water. The algae were shaken and removed from the water. Detached Mollusca were collected and preserved in 70% alcohol. Additional larger molluscan species observed on the shore were identified and noted. Confirmation of identification of the most difficult species was obtained from Dr J. Baxter (chitons), B. Picton (opisthobranchs) and Dr. S. Smith (all others).

(b) Sublittoral Survey

The aim of the sublittoral survey was to dive (if possible) or dredge sites under-recorded by the Ulster Museum in the Northern Ireland Sublittoral Survey (Erwin *et al*., 1986). The dives were carried out from a hard boat, or were casual dives dictated by the diving clubs to which the author belonged (Queen's University Belfast SAC, Dolphins SAC, Portaferry Scientific Divers). This often meant repeatedly diving at the same sites. This resulted in only the south end of the lough and the north entrance to the Narrows being covered in detail. Because of the patchy nature of the survey, a full range of habitats could not be sampled.

The divers collected samples of molluscs, algae, bryozoa, hydroids etc. in plastic bags, and observed the Mollusca on each site. The samples were removed to the laboratory and left for 1-2 days in still sea water. As the water deoxygenates and warms, opisthobranchs leave the cover of their habitat, and move to the surface of the water where they can easily be seen, removed and identified. The samples were then treated in the same way as the algal samples from the shore, i.e. soaked in fresh water.

A limited dredging and grab survey was carried out from the Marine Station boat `Nerilla' in 1990. The dredge sites were designed to fill the gaps left by the diving survey, particularly in the centre of the lough. Samples were roughly sorted on board the boat, and then transported to the laboratory, where detailed identification took place.

Discussion: survey results

The shore sites are shown in Figure 2 and the dive/dredge sites in Figure 3. The total number of sites visited is shown in Table 2.

TABLE 2: Sites - this survey

	No. of sites visited	Dates of visits
Littoral sites	117	June 1986 - April 1997
Dive sites	48	July 1986 - Dec 1998
Dredged sites	15	April 1990-Oct 1990
Total sites	180	
Total visits to sites	286	

The total number of species recorded from Strangford Lough is 308. Of these, 281 were living, with 22 dead only, and 6 of unknown status (Table 3). Altogether, 253 species have been seen living in the lough since 1960, which is approximately 80% of the total molluscan fauna of Northern Ireland. Preliminary work by the author on a checklist of the marine Mollusca of Ireland suggests a minimum of 470 species recorded, which means that Strangford Lough holds perhaps 60% of the molluscan species in Ireland. This is broadly in line with the findings

of the Northern Ireland Sublittoral Survey which recorded 72% of the sublittoral fauna of Northern Ireland to be present in the lough (Erwin *et al*., 1986).

TABLE 3: Molluscan records from Strangford Lough

Records:	Numbers
Live since 1960	253
Unrecorded since 19th century	23
This survey: live	191
This survey: new since 19th century	14
This survey: new records	21
Totals:	
Live species	281
Shells only	21
Unknown status	6
Total species	**308**

A total of 23 species have not been recorded since early work in the 19th century (Table 3 & 4). It is possible that some of these species could be found in the lough. For example *Polinices catenus* (da Costa) was found north of Fairway Buoy (Marine Station notes, 1964). Several of the remaining species are associated with coarse shelly gravel, and may yet turn up (e.g. *Alvania cancellata* (da Costa), *Haedropleura septangularis* (Montagu)).

TABLE 4: Molluscan records from Strangford Lough

(A) Species of unknown status
Hanleya hanleyi; *Dikoleps nitens*; *Skenea serpuloides*; *Caecum imperforatum*; *Polinices montagui*; *Aclis gulsonae*; *Raphitoma purpurea*; *Melanella alba*; *Modiolus adriaticus*; *Pandora pinna.*

(B) Not seen since 19th century
Hanleya hanleyi; *Alvania beanii*; *A. cancellata*; *Caecum imperforatum*; *Polinices catena*; *P. fuscus*; *P. montagui*; *Epitonium turtonis*; *Haedropleura septangularis*; *Turbonilla rufescens*; *Cylichna cylindracea*; *Jupiteria minuta*; *Modiolus adriaticus*; *Limatula sulcata*; *Parvicardium minimum*; *Gari depressa*; *Glossus humanus*; *Lyonsia norvegica*; *Alloteuthis media*; *Alloteuthis subulata*; *Todaropsis eblanae* (all living); *Eulima bilineata*; *Goodallia triangularis* (all shell only).

(C) New since 19th century (author's records)
Ischnochiton albus; *Rissoa lilacina*; *Alvania punctura*; *Raphitoma linearis*; *Odostomia plicata*; *Odostomia unidentata*; *Brachystomia eulimoides*; *Chrysallida indistincta*; *Nucula nitidosa*; *Crenella decussata*; *Spisula elliptica*; *Abra prismatica*; *Thracia phaseolina*.

(D) New to Strangford Lough (author's records)
Rissoa lilacina var. *porifera*; *R. l*. var. *rufilabrum*; *Eatonina fulgida*; *Pusillina sarsi*; *P. inconspicua*; *Hyala vitrea* (dead); *Cerithiopsis tubercularis*; *Mangelia coarctata*; *Rissoella opalina*; *Odostomia turrita*; *Brachystomia carrozzai*; *Jordaniella nivosa*; *Partulida spiralis*; *Tragula fenestrata*; *Retusa truncatula*; *Onchidoris oblonga*; *Rostanga rubra*; *Geitodoris planata*; *Coryphella browni*; *Eubranchus cingulatus*; *Palliolum striatum*; *Heteranomia squamula*; *Tridonta elliptica*.

Five species, *Emarginula crassa* (J. Sowerby), *Melarhaphe neritoides* (L.), *Thesbia nana* (Lovén), *Modiolus barbatus* (L.), and *Sphenia binghami* (Turton)) are considered dubious, and possible errors of identification.

Although Strangford Lough has now been extensively surveyed for Mollusca, a number of species may yet be found in its waters that currently lie just outside the area under study. These include *Melanella alba* (da Costa) off Strangford Bar (Dickie, 1858) and *Trophonopsis barvicensis* (Johnston) north of Strangford Fairway, 1977 (C.D. Roberts, UM collections).

Most of the molluscs living in Strangford Lough are not endemic to

the area. However, the Lough is the only known recent site in Ireland for *Rissoa lilacina* subsp. *porifera* Lovén, *Philinoglossa helgolandica* Hertling, *Hedylopsis brambelli* Swedmark, *Crenella decussata* (Montagu) and *Limatula subauriculata* (Montagu) (Seaward, 1991). In addition, two species, rare elsewhere in Ireland, are found here - *Doto cuspidata* Alder & Hancock and *Tragula fenestrata* (Jeffreys). *Rissoella globularis* (Jeffreys in Forbes & Hanley)(Figure 4) appears to be living at a number of sites on the north and west coasts of Ireland, but is only locally common in Strangford Lough (Nunn & McGrath, 1989). The chiton *Acanthochitona crinita* (Pennant), rare elsewhere, is present in unusually high intertidal numbers, as is *Calliostoma zizyphinum* var. *lyonsii* Leach. This is considered to be of Northern Ireland significance (Davison & Boaden, 1990).

Mollusca are the second most diverse group of animals on Earth, with prosobranch gastropods being one of the most varied groups of marine macroinvertebrates. This diversity, linked to their ability to colonise a wide range of habitats, means that the study of Mollusca in specific areas could give an index of the health and diversity of those sites. Strangford Lough, using the molluscan fauna as the criterion, can therefore be regarded as one of the richest and most diverse areas in the British Isles for marine life. The lough supports a wide range of habitats which have been exploited by at least 281 living species of mollusc over the last hundred years. Comparable inlets with strong tidal currents at their entrance, such as Mulroy Bay, Co. Donegal also have many molluscan species (232 live species, Nunn (1996)).

An overview is useful when looking at geographical distribution and selecting valuable sites for conservation purposes. A more complete understanding of the molluscan fauna of Strangford Lough can be achieved when set in the context of its position geographically within the British Isles, north-west Europe, and the Atlantic systems. The marine fauna present in any area is profoundly influenced by a broad range of factors (e.g. water temperature and direction of current flow). Strangford Lough lies, together with the majority of the British Isles, within the Eastern Atlantic Boreal Region (Briggs, 1974). The northern boundary of the warmer Lusitanian Province lies close to the western entrance to the English Channel, and influences south-west England, south-west Wales and south-west Ireland. The warm water of the Gulf Stream, one of the most important currents in the Atlantic Ocean, runs northwards to become the North Atlantic Drift. It divides in the middle of the North Atlantic, with one branch flowing north and east past the west coast of Ireland and the west coast of Scotland towards Norway. A persistent intrusion of this warmer water flows past the north coast of Northern Ireland and south into the Irish Sea close to the Co. Down coast (Irish Sea Study Group Report, 1990). The main drift of the Irish Sea, especially close to the Scottish coast, however, is northwards. This is a weak drift, averaging 2-8km per day (Irish Sea Study Group Report, 1990), although weaker currents have been reported (0.16 miles per day (Lewis, 1964)). This direction can be reversed, particularly during times of strong winds (Lewis, 1964). A typical Atlantic storm will first force water north out of the Irish Sea, and then back in a southerly direction, with flows which if persistent, would be equivalent to up to 50x the yearly average current speed. This suggests that it is possible for molluscan fauna with pelagic dispersal development phases to reach Strangford Lough from anywhere in the Irish Sea, the north and west coasts of Ireland or the west coast of Scotland.

Another potential influence upon the fauna of Strangford Lough is the

presence of stratified water outside the lough during the summer, although this mixes to some extent while flooding through the Narrows. Oceanic fronts exist off Malin Head, Co. Donegal and off the Ards Peninsula, although their exact positions can vary by up to 50 miles from year to year. The stratified water which lies off the Ards Peninsula towards the west of the Isle of Man has a surface layer of warmer water about 20-30m deep. Between April and October, this water is up to 5°C warmer than the bottom layer. Fronts are essentially offshore phenomena, so it is rather difficult to envisage how this could influence intertidal populations. However, many species on the shore are dependent on oceanic water for dispersal through pelagic larvae. There can be a close relationship between the limits of larval drift, the presence of stratified water and populations on the shore. Southern species *Osilinus lineatus* (da Costa)(Figure 4) and *Gibbula umbilicalis* (da Costa) (Figure 5), which are associated with stratified water (Crisp, 1989), are either absent from the lough (*O. lineatus*) or occur only in the Narrows (*G. umbilicalis*). Other southern species with their northern limit in the British Isles (Lewis, 1964) appear to be unaffected by the presence or absence of stratified water (*Patella ulyssiponensis* Gmelin, *Melarhaphe neritoides* (L.)) (Crisp, 1989). Their absence (*M. neritoides)* or scarcity (*P. ulyssiponensis*) in Strangford Lough is more likely to be due to lack of the appropriate exposed habitats.

A number of species that are near the northern limits of their ranges are present in Strangford Lough (e.g. *Diodora graeca* (L.), *Elysia viridis* (Montagu)) together with 33 other species which have a predominantly western coast distribution in the British Isles (Table 5) (Seaward, 1982, 1991). A further 13 species have a predominantly southern/ south-western distribution in the British Isles (e.g. *Leptochiton cancellatus* (G. B. Sowerby II), *Geitodoris planata* (Alder & Hancock)). It has been suggested that these species enter *via* St. George's Channel in the south of the Irish Sea (Williams, 1954), but it is perhaps more likely that these species enter the lough *via* the southern flow of the North Atlantic Drift from the western/north-western coast of Ireland. Many south-western species are absent from the Irish Sea, possibly due to its relatively sheltered nature, absence of exposed rocky habitats, or a requirement to avoid low temperatures in the winter (Erwin *et al*., 1986).

Table 5: Species biogeography

Species: 'western coast'	35
Species: 'south/south-western'	13
Species: 'northern'	18
Species: not on west coast Scotland	3
Species: not on north coast Ireland	86

This suggests that Strangford Lough has a large number of the `southern' warmer species (which normally have a `western' distribution). However, the molluscan fauna of the lough is predominantly **north-western** in character, rather than south-western. **All** except three of the species in Strangford Lough live on the west coast of Scotland (*Lepidomenia* sp., *P. helgolandica*, *H. brambelli*) (Smith, S.M. & Nunn, J.D., unpublished). This area must be seen as the closest in similarity. While many species which occur in the lough have also been found on the north and west coasts of Ireland, others have not. A total of 86 species with 2 varieties which occur in Strangford Lough, have not yet been found on the north coast of Northern Ireland. Ten of these have not been found anywhere living recently on the south-western/western or northern coast of Ireland (e.g. *C. decussata*, *L. subauriculata* (Seaward, 1982, 1991). This therefore suggests that these species could not have entered the lough *via* the North Atlantic Drift. Other species which commonly exist on the north and west coasts of Ireland do not

occur in Strangford Lough (32 species e.g. *Simnia patula* (Pennant)(Figure 5)). Many of them reach no further east than Malin Head, and do not appear to be able to cross the oceanic front there. On the other hand, there are many northern species in Strangford Lough. They typically occur on the west coast of Scotland, and probably extend into the North Channel reaching Rathlin Island down to the Isle of Man. As the main current in the Irish Sea is northerly, it appears that these species must spread during the temporary current reverses that occur during poor weather. These northern species include *Tonicella marmorea* (O. Fabricius), *Tectura testudinalis* (Müller), with 16 others.

Notes on selected species

There are a number of abbreviations and terms used here:- **SL**: Strangford Lough; **UM**: Ulster Museum Sublittoral Survey (Erwin *et al*., 1986); **NMI**: National Museum of Ireland, Dublin; **HW**: Heriot-Watt University; Northern Ireland Littoral Survey (Wilkinson *et al*., 1988); **BEP**: Bernard Picton; **SMS**: Shelagh Smith. All other recorders of mollusca are referred to by their full name; **Shallow sublittoral**: <10m; **det.**: `determined by', i.e. identification made, or confirmed by a particular expert. **Taxonomy** follows Howson & Picton (1997). The location of material from 19th century collections in the Ulster Museum, Belfast, and National Museum of Ireland, Dublin are given where appropriate. Maps were generated from a computerised database of records for Ireland (Table 6).

Table 6. Strangford Lough records of Mollusca on database

Total records by author	5893
Total sites on database	651
Total visits to sites on database	853
Total records on database	8620

Class CAUDOFOVEATA

***Chaetoderma nitidulum* Lovén, 1844**
A single live specimen found on Killyleagh Reefs (P.J.S. Boaden, pers. comm.) in January 1990.

Class SOLENOGASTRES

***Lepidomenia* sp.**
Recorded from Angus Rock as *Lepidomenia hystrix* Boaden (Boaden, 1966). There is some taxonomic confusion surrounding this species, and the correct identity of specimens as *L. hystrix* is doubtful (Smith & Heppell, 1991). This is the only record for the British Isles.

Class POLYPLACOPHORA

***Tonicella marmorea* (O. Fabricius, 1780)**
Widely recorded from lower shore and the sublittoral by the author, J. Baxter, UM and HW. Scattered records from Ringhaddy, 9m, 1942 (Williams, 1954), 1955 (no locality, 27mm long, Marine Biology Station notes), Greyabbey 1974 (P.J.S. Boaden, pers. comm.) and Doctors Bay 1976 (SMS). Apparently absent from the north/north-west and Quoile Estuary. This is a northern species, rarely found on the open coast in Northern Ireland. It is common only in SL.

***Acanthochitona crinita* (Pennant, 1777)**
Very widely recorded from mid to lower shore by the author, J. Baxter and HW. Abundant at sites in the north-east, but absent from the north/north-west. Found sublittorally at three sites - off Marlfield Bay (UM), west of Limestone Pladdy (10m) and off Ballyhenry Point (5m), by the author. A single specimen of an unusual red-backed form was found at North Marlfield Bay at low water by the author. This species is rare on the open coast, and is only in SL from Northern Ireland. In spite of an extensive search by J. Baxter and author, no specimens of *Acanthochitona fascicularis* have been found. All have proved to be *A. crinita.*

Class GASTROPODA

***Jujubinus montagui* (W. Wood, 1828)**
Found living in Marlfield Bay 1997 and a single shell in Castleward Bay (author).

***Gibbula umbilicalis* (da Costa, 1778) (Figure 5)**
Rare, recorded live from a few sites near the mouth of the Narrows into the Irish Sea (Mullog Point, Craigadarkin, Carrstown Point, Ballyquintin: Green Isle) by the author. Widely recorded around the whole lough by HW, which was an error of identification for juvenile *Gibbula cineraria* which also has an umbilicus. Recorded from Kilclief, Killard Point and Big Rock by Williams (1954).

***Calliostoma zizyphinum* (L., 1758)**
One of the most widely distributed species in SL. Only absent from upper reaches of the Quoile Estuary and the north-west. Found at low water, often on *Fucus serratus*, under overhangs or large stones and boulders. Can be locally extremely abundant (e.g. Inner Mahee Island, Church Point). Commonly found in the sublittoral down to 35m+, generally in smaller numbers, although can be locally as abundant as on the shore (e.g. west of Limestone Pladdy).

var. *lyonsii* (Leach)
The pure white form of species. It is abundant on the shore and in the sublittoral, particularly on the eastern shore of the main lough. The only other similar sites are Clachan Sound and Torsa Channel on the west coast of Scotland.

***Turritella communis* Risso, 1826 (Figure 5)**
Dead shells found at scattered locations on the shore. Sublittoral living in the main body of SL, especially in the south/south-west and the mouth of the Quoile (UM, author). This is consistent with its preferred habitat of stiff mud with some shell gravel and small stones.

***Littorina nigrolineata* J. E. Gray, 1839**
Found living and common at a number of sites in SL, which is the only known locality for this species in Northern Ireland (Matthews & Montgomery, 1987). The red-brown morph is present on the red sandstone stones around the lough. It is absent from the north/north-west.

***Melarhaphe neritoides* (L., 1758)**
Not recorded by author, although searched for at many potential sites. Matthews & Montgomery (1987) state that this species is only found on the Giants' Causeway and at Ardglass in Northern Ireland. Williams (1954) records *M. neritoides* from Castleward Bay, Bar Hall and Killard Point, and as common and gregarious in some localities. HW records this species from two sites: Herring Bay (on boulders) and Mahee Island. All these records are doubtful, especially as *M. neritoides* is very easy to confuse with juveniles of *L. littorea* or *L. saxatilis*.

***Capulus ungaricus* (L., 1758)**
Recorded living from a *Modiolus modiolus* bed near Black Rock (Roberts, 1975), from SL in general (Hiscock and Mitchell, 1980), and by the author from north-east of Limestone Rock where three specimens were attached to living *M. modiolus* shells.

***Vitreolina philippi* (Rayneval and Ponzi, 1854)**
One living specimen found by the author at 35m, north of Chapel Island in the south basin. Old record: as `*Vitreolina sinuosa*', live, Killyleagh (Fisher, 1933).

***Boreotrophon truncatus* (Ström, 1768)**
Recorded living from Rue Point in 2.5m, Bird Island Passage in 14m (UM), Granagh Bay (HW) and from six other sublittoral sites by author, mainly in the north entrance to the Narrows.

***Oenopota rufa* (Montagu, 1803)**
Single living specimens found on Lees Wreck (UM) and low on the shore from Dogtail Point (author). Dead shells from Castleward Bay (author) and bay north of Audley's Point (UM). Shells were taken in 13m off Killyleagh in 1939 (Williams, 1954).

***Rissoella globularis* (Jeffreys in Forbes and Hanley, 1853) (Figure 4)**
Recorded living from many sites in SL, from the shore and shallow sublittoral (author, SMS). Found generally in siltier habitats than the other two *Rissoella* spp. This is the only area in Ireland where the species is commonly found (Nunn and McGrath, 1989).

***Jordaniella nivosa* (Montagu, 1803)**
A single specimen from each of two sites recorded by the author (det. SMS) from weed washings; Angus Rock and Ballyhenry Point in 15-40m.

***Tragula fenestrata* (Jeffreys, 1848)**
Three living specimens were dredged by the author (det. SMS) from Bird Island Passage in 6-24m.

***Hedylopsis brambelli* Swedmark, 1968**
Recorded living from five sites in the Narrows: in fine shell gravel, 3m, Strangford Harbour; in coarse shell gravel, shore low water, Angus Rock; shell gravel bank low water, north and south-east sides of Black Island, Ballyquintin (Boaden, 1966); Granagh Bay (south) and Cloghy Rocks (Poizat, 1979). These are the only records for Ireland, and this species has been recorded from only two other areas in Great Britain (Seaward, 1991).

***Philinoglossa helgolandica* Hertling, 1932**
Recorded living from fine shell gravel, 3m, Strangford Harbour and Black Island (Boaden, 1966) and Cloghy Rocks (Poizat, 1979). These are the only records for Ireland. This species is only found elsewhere in the south-west of England (Seaward, 1991).

***Dendronotus frondosus* (Ascanius, 1774) (Figure 5)**
Recorded living from many sublittoral sites, but generally confined to the Narrows. Also recorded from Granagh Rocks, low water, one specimen 9.1cm long, 1948 (Williams, 1954) and from the shore, one specimen, 3cm long, Angus Rock, 1957 (Marine Biology Station). Depth range 0 - 40m+.

***Embletonia pulchra* (Alder & Hancock, 1844)**
A single specimen was found at Abbey Rock, 15m, 28.5.1985 (UM). Recorded as juvenile, *Embletonia* sp., from Angus Rock in coarse shell gravel, 12.10.1962, and on a second visit (no details) (P.J.S. Boaden, pers. comm.). Only one species of this genus is recognised to occur in north-east Europe (Smith & Heppell, 1991), so the record presumably is of this species.

***Polycera faeroensis* Lemche, 1929 (Figure 6)**
Recorded living from the sublittoral in the mid and south part of SL (UM, author). Apparently not found in the Narrows. Depth range 10-23m+.

***Armina loveni* (Bergh, 1860)**
Recorded living from two sites in SL; the Quoile estuary, 9m (UM) and Killyleagh Reefs, 8-12m (BEP). At the latter site, a single specimen was seen part buried in mud at the base of its prey, the sea pen *Virgularia mirabilis* (Müller) (BEP, pers. comm.).

***Hero formosa* (Lovén, 1841)**
Two large specimens (approx. 25mm long) dredged in 10m off Island Taggart, on weed, September 1954; two specimens off Killyleagh, 12m, August 1964; one specimen off Island Taggart, March 1966 (Marine Biology Station). Not seen more recently, although a specimen was seen in 1987, by the author in 30m on the wreck of the `Bangor' off the outer Ards peninsula. These are the only records for Ireland.

Class PELECYPODA

***Modiolus modiolus* (L., 1758) (Figure)**

Recorded living, common, from many sublittoral sites around SL, principally from the centre (UM, author). Also found on the shore, usually one or two specimens (e.g. Angus Rock, Ballyhenry Island, Rainey Island (author)). A scattered bed of *Modiolus modiolus* lies at low water at Islandbane Point (author). Depth range 0-42m+. This species is one of the most important in SL. Clumps support (as an `oasis') in an otherwise comparatively barren muddy substrate a huge range of other species, including acting as a nursery ground for the commercially important `queenie' (*Aequipecten opercularis*). This habitat is easily destroyed by dredging, and may take many years to regenerate, as *M. Modiolus* is slow to reach reproductive maturity (Brown, 1976).

***Crenella decussata* (Montagu, 1808)**

Recorded living from 12 sites in the south basin and north entrance to the Narrows (author). The species is normally sublittoral (to 20m+), but found on the shore at one site (Selk Rock). These are the only live records from Ireland. Dead shells were found north of Audley's Point (UM).

***Limatula subauriculata* (Montagu, 1803)**

Recorded living from off Ballyhenry Point, coarse shelly gravel, 41m, 1976, and from west of Ballywhite Bay, 34m, 1976 (UM). One live specimen in dredged *Laminaria* sp. holdfast, Chapel Island, September, 1966 (Marine Biology Station). Dead shells from Lees Wreck, Dunnyneill Island, Ballyhenry Point, north of Chapel Island, Castleward Bay (author) and Ballyquintin Point (BEP). All these records were sublittoral, 10-35m, and the only recent living ones for Ireland.

***Pecten maximus* (L., 1758)**

Recorded living, and very common in places, from many sites around SL (UM, author). Generally found in the sublittoral, but also on the shore at Church Point and Selk Rock (author). Absent from the northern part. Depth range 0-41m+. Not as abundant as formerly, due to overfishing by dredging and illegal commercial diving, and destruction of the sublittoral habitat by dredging and trawling e.g. Ballywhite Bay.

***Azorinus chamasolen* (da Costa, 1778) (Figure 6)**

Recorded living from south-east of Town Rock, 19m; north-east of Jackdaw Island, 16m; Quoile Estuary, 9m, west of Barrel Rock, 12m (UM), South Holm Bay, dredged 6-24m (author).

***Circomphalus casina* (L., 1758) (Figure 6)**

Recorded living from the shore and the sublittoral (UM, author, HW, SMS). Found generally in coarse sand, in the Narrows and the south-east part of the lough.

***Tapes decussatus* (L., 1758) (Figure 6)**

Recorded living from Greyabbey (1974, P.J.S. Boaden; Dunlop, 1980), Kircubbin (Dunlop, 1980), Doctors Bay (1970, R. Anderson) Horse Island, Black Neb, South Island (HW), Ragheries, Gransha Point (author). Farmed at Paddys Point (author). Old records: fresh looking single valves (Praeger, 1889); summer ?1919, while staying at Newtownards, plentiful at about half tide mark (Fisher, 1929). one valve + one piece of valve, dead, SL, June 1890, Praeger Collection (NMI).

Conservation status of Strangford Lough

Strangford Lough is a place which has as many designations as the legislation provides (Table 7)(Dept. of Environment (1994)!

Current research in Strangford Lough includes: Environment & Heritage

Service (EHS) funded marine biotope mapping; EHS surveying using Roxann (with Dept. Agriculture (NI); Queen's University Belfast (QUB) teaching to undergraduates with recording of species & biotopes; QUB algae research including dulse; QUB/C-Mar aquaculture - scallop trials (*Pecten maximus* & *Aequipecten opercularis*) and native oysters, whelks, mussels; studies on the numbers and behaviour of seals; EHS funded surveys of Japweed *Sargassum muticum*.

TABLE 7 : Designations for Strangford Lough

Designation	Status	Date
1. International		
Ramsar	Proposed	1998
2. European		
Special Protection Area	Designated	1998
Special Area of Conservation	Candidate	
Designated shellfish water	Designated	1983
3. Northern Ireland Designations		
Area of Special Scientific Interest (ASSI)	Designated	1988/89
Marine Nature Reserve (MNR)	Designated	1995
Statutory Nature Reserve & National Nature reserve	Designated	
Local Nature Reserve	Designated	
Nature Reserve	Designated	
Wildlife Refuge	Designated	
Area of Outstanding Natural Beauty (under review)	Designated	1972
Fisheries restrictions	Designated	1993

Acknowledgements

I would like to thank the following people for their help in making it possible for me to complete this work:- the many landowners, especially the National Trust, who gave me permission to cross their land; Shelagh Smith, John Baxter and Bernard Picton for help with identification of the more difficult species, and their encouragement; the Ulster Museum, N.I. Aquarium (now 'Exploris') and the National Museum of Ireland for access to their records and specimens; the many divers, especially Graham Day who gave diving support during the period 1986 to 1998; Queen's University, Belfast, for its financial support, March to August 1992, while much of this fieldwork was completed, and its many members of staff for helpful discussions and boat support; EHS for permission to use records, to collect Mollusca in SL, and for generously refunding part of my expenses incurred during this work; finally, my thanks go to Pat Boaden for help and support in initiating and carrying out this project.

References

Boaden, P.J.S. (1966) Interstitial fauna from Northern Ireland. *Veroffenlichungen des Instituts für Meeresforschung in Bremerhaven* **2**: 125-130.

Briggs, J.C. (1974) *Marine zoogeography*. McGraw-Hill, New York.

Brown, R.A. (1976) The ecology of *Modiolus modiolus* (L.) and *Cerastoderma* (= *Cardium edule* (L.) in Strangford Lough, N. Ireland. Unpublished Ph.D. thesis, Queen's University of Belfast

Brown, R.A. (1990) *Strangford Lough: the wildlife of an Irish Sea lough*. Institute of Irish Studies, Queen's University of Belfast.

Brown, T. (1818) Account of the Irish Testacea. *Memoirs of the Wernerian Natural History Society* **2**: 501-536.

Crisp, D.J. (1989) The influence of tidal fronts on the distribution of intertidal fauna and flora. *Topics in Marine Biology: Scient. Mar.* **53**: 283-292.

Davison, A. & Boaden, P.J.S. (1990) *The management of Strangford Lough: a study of the marine environment, its conservation and its exploitation*. A report for the Department of the Environment (NI).

Department of the Environment (NI) (1994) *Strangford Lough: proposed marine nature reserve: guide to designation.* Department of the Environment (NI).

Dickie, F. (1858) Report on the marine zoology of Strangford Lough and corresponding parts of the Irish Channel. *Rep. Brit. Assoc. Adv. Sci. for 1857*. p.p. 104-112.

Dunlop, D. (1980) A comparative study of two genera of venerid bivalves: *Venerupis* from Northern Ireland and *Katelysia* from Western Australia. Unpublished B.Sc. Hons. thesis, The Queens' University of Belfast.

Erwin, D.G. (1977) A diving survey of Strangford Lough: the benthic communities and their relation to substrate - a preliminary account. *Biology of Benthic Organisms* 11th Eur. Symp. on Mar. Biol. p.p. 215-224. Pergammon Press, Oxford.

Erwin, D.G., Picton, B.E., Connor, D., Howson, C., Gilleece, P. and Bogues, M.J. (1986) *The Northern Ireland Sublittoral Survey.* Report for Dept. of Environment (NI).

Fisher, N. (1929) Living *Tapes decussatus* (L.) in Ulster. *Ir. Nat. J.* **2**: 162.

Fisher, N. (ed.) (1935) Catalogue of Irish marine shells by John Templeton. *Ir. Nat. J.* **5**: 168-170, 235-237, 264-265, 287-288, 312-314.

Gubbay, S. (1988) *A coastal directory for marine nature conservation.* Marine Conservation Society, Ross-on-Wye.

Hiscock, K. & Mitchell, R. (1980) The description and classification of sublittoral epibenthic systems. p.p. 323-370 *In* Price, J. H., Irvine, D. E. G. and Farnham, W. E. (eds) `*The Shore Environment*' **2**: *Ecosystems*. The Systematics Association. Special volume no. 17 (a), Academic Press.

Howson, C. & Picton, B.E. (eds.) (1997) *The species directory of the marine fauna and flora of the British Isles and surrounding seas.* Ulster Museum and The Marine Conservation Society, Belfast and Ross-on-Wye.

Irish Sea Study Group Report (1990) *Part 1. Nature Conservation.Part 3. Exploitable Living Resources*. Liverpool University Press, Liverpool.

Lewis, J.R. (1964) *The ecology of rocky shores.* English Universities Press, London.

Matthews, P.M. & Montgomery, W.I. (1987) The identification and

distribution of littorinid species in Northern Ireland with particular reference to *Littorina nigrolineata* in Strangford Lough. *Ir. Nat. J.* **22**: 290-296.

Nichols, A.R. (1900) A list of the marine Mollusca of Ireland. *Proc. R. Ir. Acad.* 3rd Ser. **5**: 477-662.

Nunn, J.D. (1994) The marine Mollusca of Ireland 1. Strangford Lough, Co. Down. *Bull. Ir. Biogeog. Soc.* **17**:23-214

Nunn, J.D. (1996) The marine Mollusca of Ireland 2. Mulroy Bay, Co. Donegal. *Bull. Ir. Biogeog. Soc.* **19**:15-138

Nunn, J.D. & McGrath, D. (1989) *Rissoella globularis* (Jeffreys)(Mollusca: Gasteropoda) in Ireland. *Ir. Nat. J.* **23**: 161.

Poizat, C. (1979) Gastéropodes mésopsammiques de la Mer d'Irlande (Portaferry, Northern Ireland). Écologie et distibution. *Haliotis* **9**: 11-20.

Praeger, R.L. (1889) The marine shells of the north of Ireland. *Proc. Rep. Belf. Nat. Hist. Phil. Soc.* **2** (1887-1888). Appendix, p.p. 55-110.

Roberts, C.D. (1975) Investigations into a *Modiolus modiolus* (L.) (Mollusca: Bivalvia) community in Strangford Lough, Northern Ireland. *Rep. Underwater Assoc.* **1**: 27-49.

Seaward, D. (1982) *Sea area atlas of the marine molluscs of Britain and Ireland*. Nature Conservancy Council, Cambridge.

Seaward, D. (1991) *Distribution of the marine molluscs of NW Europe*. Nature Conservancy Council, Cambridge.

Smith, S.M. & Heppell, D. (1991) *Checklist of the British Mollusca*. Information series no. 11. Royal Museum of Scotland, Edinburgh.

Thompson, W. (1856) *The Natural History of Ireland*. **4**. Reeve, Benham and Reeve, London.

Wilkinson, M., Fuller, I. A., Telfer, T. C., Moore, C. G. and Kingston, P. F. (1988) *Northern Ireland Littoral Survey: a conservation-oriented survey of the intertidal seashore of Northern Ireland*. Report for the Department of the Environment (NI).

Williams, G. (1954) Fauna of Strangford Lough and neighbouring coasts. *Proc. R. Ir .Acad.* **56**B: 29-133.

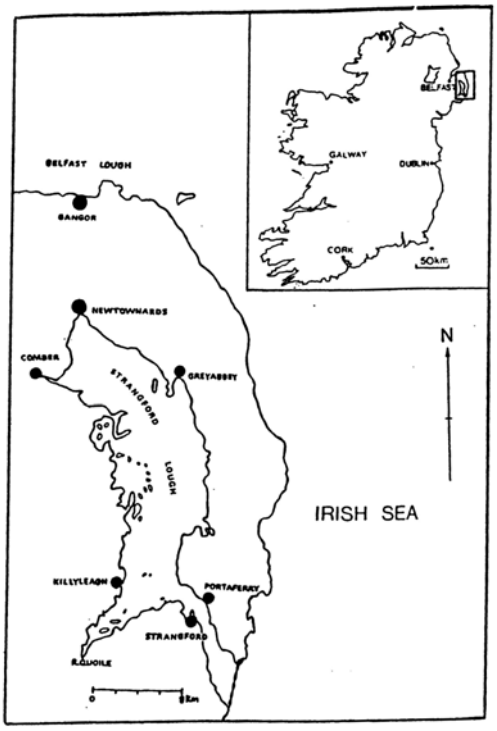


FIGURE 1: ***The location of Strangford Lough***

FIGURE 2: *Littoral sites in Strangford Lough*

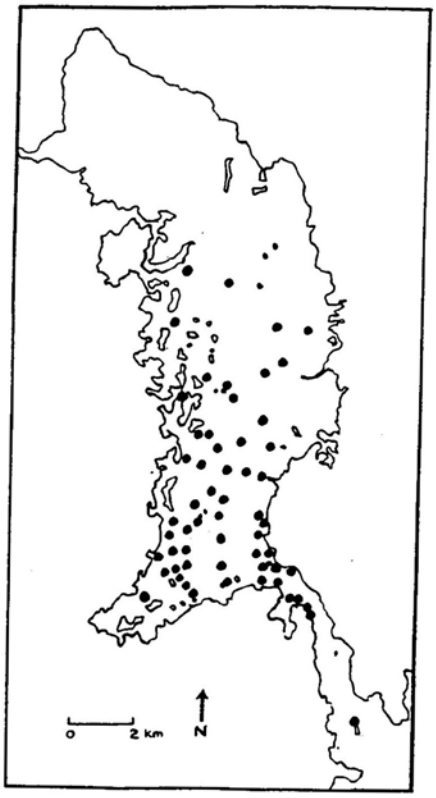
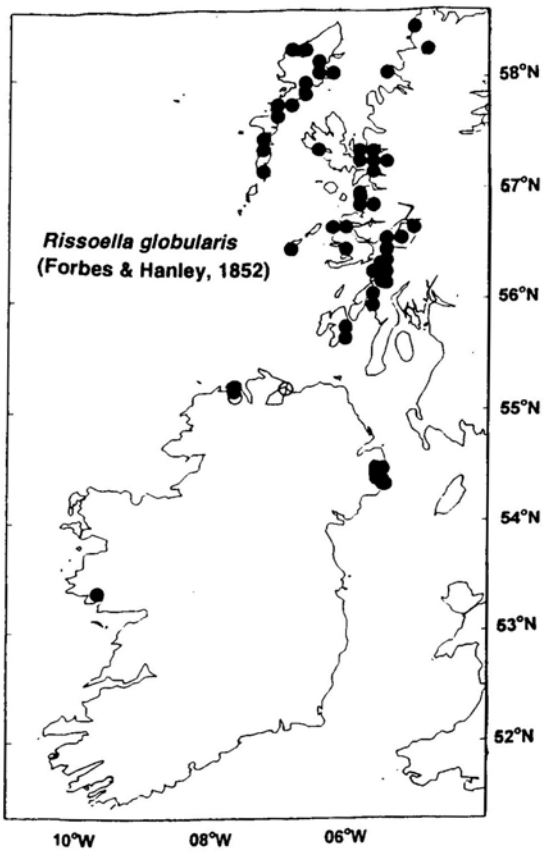


FIGURE 3: *Dive/dredge sites in Strangford Lough*



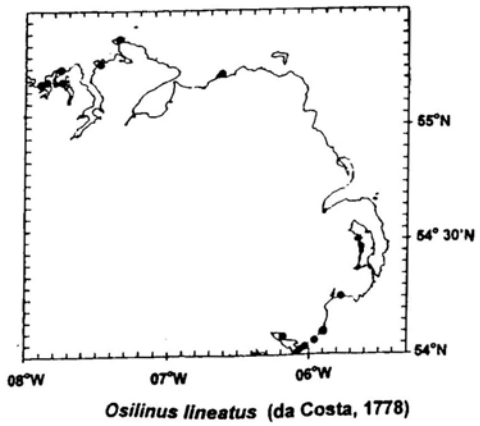


FIGURE 4: *Selected species distribution maps*

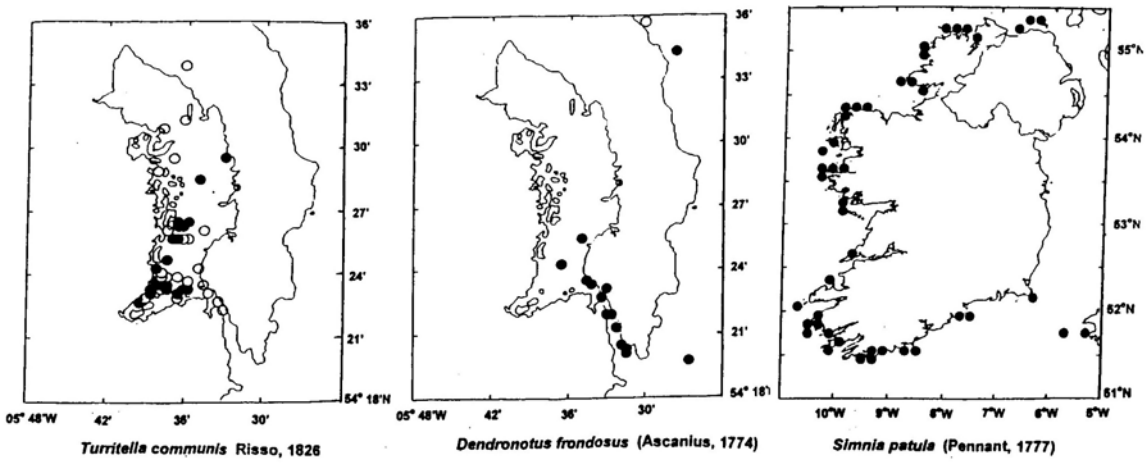
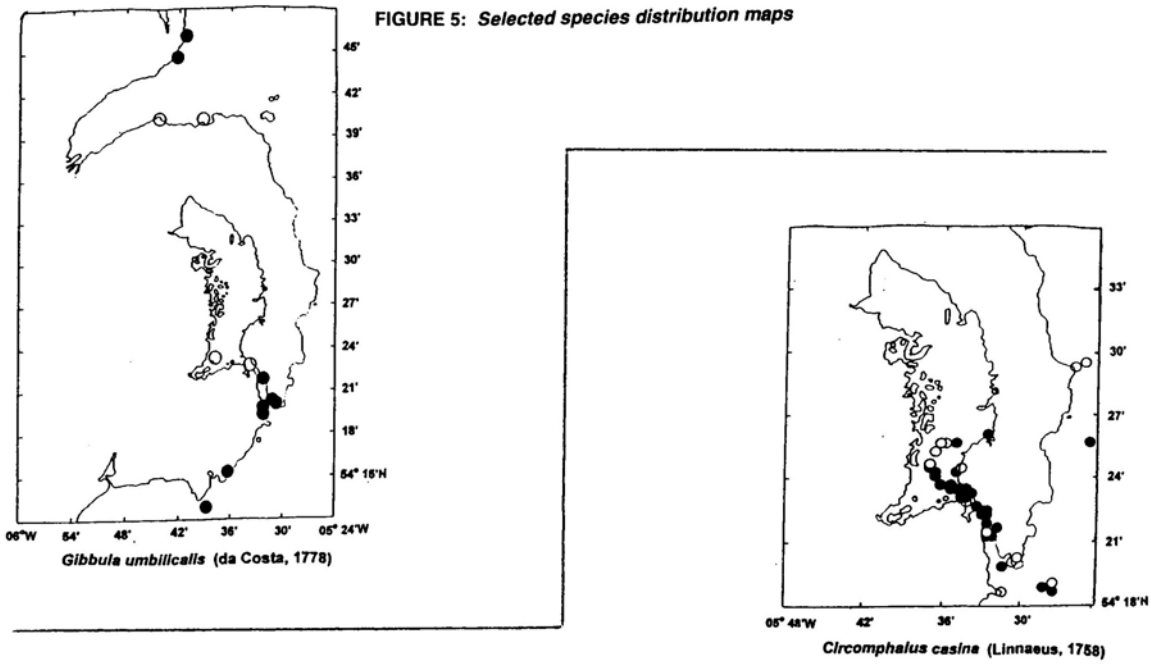


FIGURE 5: *Selected species distribution maps*



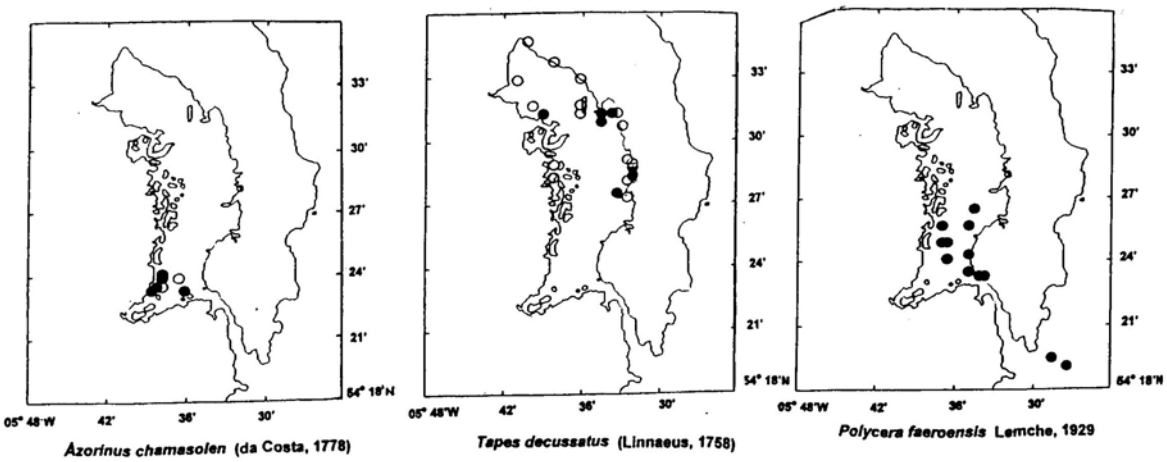


FIGURE 6: *Selected species distribution maps*

OSTRACODA RECORDS FOR NORTH-EAST ENGLAND

J. E. Phorson

5 Fellside Gardens, Belmont, Durham, DH1 1AB

Introduction to the collections

The specimens of ostracods are mounted on slides and represent species collected at a number of locations on the North-East coast from Holy Island to Sunderland. Some of the collections are represented by several slides, for example the most numerous collections are 032 (eight slides) and 035 (four slides). The 032 slides have nearly 1700 specimens representing over 100 species.

Where sufficient specimens have been available, these are arranged in growth series showing right and left valves in internal and external view; and whole carapaces with right and left sides and possibly dorsal, ventral and posterior end views.

The specimens were picked out of samples of fine, washed shell sand. Consequently most of them are empty carapaces or dis-articulated valves. A number of the specimens however, have the animal or broken soft parts *in situ*. In the lists, species are marked L (=live or recently live) in cases where the whole animal is present; or in the case of transparent species (*e.g*. *Sclerochilus* & *Paradoxostoma*), where the broken soft part debris can be seen inside closed carapaces.

The species were identified from the following monograph: Athersuch, J., Horne, D.J., and Whittaker, J.E. (1989). Marine and Brackish Water Ostracods (Superfamilies Cypridacea and Cytheracea). The authors do not include species for which they themselves have not seen the animals or soft parts. Hence there are species for which the carapaces and valves may be commonly found on British shores but which are not included. A number of such species occur consistently in the present collections and they are not listed here although the specimens are mounted on the slides. Non-marine species also occur in the beach sand and they likewise are not listed though representative specimens are on the slides; (freshwater molluscs also occur in these same shell sands).

The number of species represented on slides 037, 039, 040 and 059 is reduced because only selected species/specimens were mounted since these later collections proved largely repetitive of earlier ones, notably 032 and 035 for which the shell sand samples had proved particularly abundant in ostracods.

Table 1. Classification of Ostracoda in the collection

Phylum ARTHROPODA
Class CRUSTACEA Pennant, 1777
Subclass OSTRACODA Latreille, 1806
Order PODOCOPIDA G.W. Muller, 1894
Suborder PODOCOPINA Sars, 1866

Superfamily CYPRIDACEA Baird, 1845
Family PONTOCYPRINIDIDAE
- Pontocypris mytiloides (Norman, 1862)
- Propontocypris trigonella (Sars, 1866)

Superfamily CYTHERACEA, Baird 1850a
Family CYTHERIDAE
- Cythere lutea O.F.Muller, 1785
- Palmenella limicola (Norman, 1865)

Family EUCYTHERIDAE, Puri, 1954
- Eucythere anglica Brady, 1868b

Family LEPTOCYTHERIDAE
- Leptocythere pellucida (Baird, 1850a)
- Leptocythere baltica Klie, 1929
- Leptocythere castanea (Sars, 1866)
- Leptocythere lacertosa (Hirschmann, 1912)
- Callistocythere badia (Norman, 1862)

Family CYTHERIDEIDAE Sars, 1865
- Cyprideis torosa (Jones, 1850)
- Sarsicytheridea bradii (Norman, 1865a)

Family CUNEOCYTHERIDAE Lienenklaus, 1894
- Cuneocythere semipunctata (Brady, 1868b)

Family NEOCYTHERIDEIDAE Puri, 1957
- Sahnicythere retroflexa (Klie, 1936)

Family CUSHMANIDEIDAE Puri, 1974
- Pontocythere elongata (Bray, 1868)

Family TRACHYLEBERIDIDAE Sylvester-Bradley, 1948
- Acanthocythereis dunelmensis (Norman, 1865)
- Celtia quadridentata (Baird, 1850a)
- Hiltermannicythere emanciata (Brady, 1867)
- Pterogocythereis jonesii (Baird, 1850a)
- Robertsonites tuberculatus (Sars, 1866)

Family HEMICYTHERIDAE Puri, 1953
- Hemicythere villosa (Sars, 1866)
- Aurila convexa (Baird, 1850a)
- Heterocythereis albomaculata (Baird, 1838)

Family LOXOCONCHIDAE Sars, 1925
- Loxoconcha rhomboidea (Fischer, 1855)
- Bonnyannella robertsoni (Brady, 1868b)
- Elofsonia baltica (Hirschmann, 1909)
- Elofsonia pusilla (Brady & Robertson, 1870)
- Hirschmannia viridis (O.F. Muller, 1785)
- Palmoconcha guttata (Norman, 1865)
- Palmoconcha laevata (Norman, 1865)
- Sagmatocythere multifora (Norman, 1865)

Family PARACYTHERIDEIDAE Puri, 1957
- Paracytheridea cuneiformis (Brady, 1868b)

Family CYTHERURINAE G.W. Muller, 1894
Subfamily CYTHERURINAE G.W. Muller, 1894
- Cytherura gibba (O.F. Muller, 1785)
- Hemicytherura cellulosa (Norman, 1865b)
- Semicytherura nigrescens (Baird, 1838)
- Semicytherura acuticostata (Sars, 1866)
- Semicytherura angulata (Brady, 1868b)
- Semicytherura cornuta (Brady, 1868b)
- Semicytherura sella (Sars, 1866)
- Semicytherura simplex (Brady & Norman, 1889)
- Semicytherura striata (Sars, 1866)
- Semicytherura undata (Sars, 1866)

Subfamily CYTHEROPTERINAE
- Cytheropteron latissimum (Norman, 1865)
- Cytheropteron depressum (Brady & Norman, 1889)
- Cytheropteron nodosum Brady, 1868b)

Family XESTOLEBERIDAE Sars, 1928
- Xestoleberis aurantia (Baird, 1838)
- Xestoleberis depressa Sars, 1866

Family BYTHOCYTHERIDAE Sars, 1866
- Bythocythere bradyi Sars, 1926
- Bythocythere zetlandica Athersuch, Horne & Whittaker, 1938
- Jonesia acuminata (Sars, 1866)
- Sclerochilus contortus (Norman, 1861)
- Sclerochilus abbreviatus Brady & Robertson, 1869
- Sclerochilus bradyi Rudjakov, 1962
- Sclerochilus hicksi Athersuch & Horne, 1987
- Sclerochilus schornikovi Athersuch & Horne, 1987
- Sclerochilus rudjakovi Athersuch & Horne, 1987

Family PARADOXOSTOMATIDAE
- Paradoxostoma abbreviatum Sars, 1866
- Paradoxostoma bradyi Sars, 1928
- Paradoxostoma ensiforme brady, 1868b
- Paradoxostoma hibernicum Brady, 1868b
- Paradoxostoma normani Brady, 1868b
- Paradoxostoma porlockense Horne & Whittaker, 1985d
- Paradoxostoma robinhoodi Horne & Whittaker, 1985d
- Paradoxostoma tenuissimum (Norman, 1869)
- Paradoxostoma variabile (Baird, 1835)
- Cytherois fischeri (Sars, 1866)
- Cytherois pusilla Sars, 1928
- Paracytherois flexuosa (Brady, 1867)

Notes on Table 2.

**Callistocythere badia*. All the records listed herein refer definitely to *C.badia* (Norman, 1862) and not *C.littoralis* (Muller, 1894)

**Sahnicythere retroflexa* (Klie, 1936). Confused in the past with *Neocytherideis subulata* (Brady, 1868a). Designated as a new species by Klie in 1936. Specimens mentioned herein are clearly all *S.retroflexa*. I have never found *N.subulata* in the north-east.

**Paracytherois flexuosa*. At least two species are present at Low Newton; one is clearly *P.flexuosa* (Brady, 1867). Another has more produced extremities and may well correspond with *P.flexuosa*, *sensu* Sars (1928). See: Athersuch *et al*. (1989), p314. The latter do not, however, figure the Sars form. The taxonomy is confused and needs clarification.
**Acanthocythereis dunelmensis*. Fragments only.

Table 2. Specimens mounted on each slide

Key to the slides in Table 2.

03 Low Newton. Jan.1984 (NU242246, 55°31'N 01°37'W)
05a Sandham Bay, Holy Island. Oct.1985 (NU136436, 55°41'N 01°47'W)
05b Bamburgh. Oct.1987 (NU179357, 55°37'N 01°43'W)
09 Whitburn Steel, Sunderland. Jan.1987 (NZ412613, 54°56.5'N 01°21.5'W)
011 Sandham Bay. May & Sept. 1988
012 Low Newton. Dec.1989
015 Low Newton. Jan.1988
016 Low Newton. 20 Oct.1990
031 Ross Back Sands. 10th & 14th Nov.1992 (*Ca*.NU150375, 55°38'N 01°46'W)
032 Low Newton. 6 Jan.1993
035 Low Newton. 15 Jan. 1994
037 Low Newton. July 1994
039 Low Newton. 5 Oct.1994
040 Low Newton. 15 Jan.1995
059 Low Newton. 1 Feb.1998

Slide No.:	03	05a	05b	09	011	012	015	016	031	032	035	037	039	040	059
Pontocypris mytiloides	x				x		x	x	x	xL	x		xL	xL	x
Propontocypris trigonella							x	x	x	xL	xL		xL		
Cythere lutea	x	x		xL	x	x	x	xL	x	xL	xL				
Palmenella limicola						x	x			x	x	x	x	x	
Eucythere anglica								x		x	x	x	x	x	x
Leptocythere pellucida	x	x				x	xL	xL	xL	xL	xL			xL	x
L. baltica									xL	x	x			x	x
L. castanea	x								x	x	x				x
L. lacertosa					?x		x	?x	x	x	x				x
Callistocythere badia*										x	x	x	x		
Cyprideis torosa			x		x	x	x	x	x	x	x				x
Sarsicytheridea bradii										x					
Cuneocythere semipunctata	x	x			x			xL		x	x	x			
Sahnicythere retroflexa*	x	x			x	x	xL	xL		xL	xL				x
Pontocythere elongata	x	x	x	x	x	x	x	x	x	xL	x				
Krithe praetexta											x				
Acanthocythereis dunelmensis*											x	x			
Celtia quadridentata						x	x			x	x				
Hiltermannicythere emaciata						x		x							
Pterygocythereis jonesii	x	x			x	x	x	x	x	x	x	x		x	
Robertsonites tuberculatus		x		x	x	x			x	x	x	x	x		x
Hemicythere villosa	x	x			x	x	x	x	x	xL	xL				
Aurila convexa	x	x			xL	x	x	x	x	x	x			xL	
Heterocythereis albomaculata	x	x		xL	xL	xL	xL	xL	x	xL	xL	x	x	xL	
Loxoconcha rhomboidea							x								
Bonnyannella robertsoni	x					x	x	xL	x	x	x			xL	x
Elofsonia baltica										x	x	x			
E. pusilla								x		x	x	x	x		
Hirschmannia viridis							x	xL		xL	x				x
Palmoconcha guttata								x		x	x		x		x
P. laevata	x	x		x	x	x	x	x	x	x	x				x
Sagmatocythere multifora										x	x	x		x	x
Paracytheridea cuneiformis	x				x	x	x	x		x	x	x			
Cytherura gibba										x	x	x	x	x	
Hemicytherura cellulosa					x	x	x	xL		xL	xL				
Semicytherura nigrescens		x		x	x		x	x		xL	x			x	
S. acuticostata					x		x	x		x	x		x	x	
S. angulata					x	x	x	x		x	x		x		
S. cornuta					x		x	x	x	x	x		x	x	x
S. sella						x	x	x		x	x				x
S. simplex													x		
S. striata	x			x	x		x	x		x	x				
S. undata					x	x	x	x	x	x	x				x
Cytheropteron latissimum	x				x		x	x		x	x			x	x
C. depressum											x	x	x		
C. nodosum				x	x	x	x	x	x	x	x	x	x	x	x
Xestoleberis aurantia							x	xL		xL	x	x			
X. depressa	x	x			x	x	x	x	x	x	xL				
Bythocythere bradyi							x	x		x	x				x
B. zetlandica	x	x			x	x	x	x	x	x	x				x
Jonesia acuminata										x	x				
Sclerochilus contortus						x									
S. abbreviatus										xL					
S. bradyi											x				x
S. hicksi								x		xL	x		xL		
S. schornikovi		x			x		x	xL		xL	xL	xL	x	x	xL
S. rudjakovi															xL
Paradoxostoma abbreviatum		x			xL	x	xL	xL		xL	xL		xL		xL
P. bradyi			x	x	x	x	x	x		xL	x		x		x
P. ensiforme	x			x	x		x	x		xL	xL		xL		x
P. hibernicum								xL		xL			x		
P. normani		x		x				xL		xL	xL	xL	xL	x	x
P. porlockense						?x									
P. robinhoodi	x					x	xL	x		xL	xL	xL	xL		
P. tenuissimum										xL	xL		x		
P. variabile	x	x	x	xL			x	xL		xL	xL		xL		
Cytherois fischeri							x			x			x		
C. pusilla								x	x	x					
Paracytherois flexuosa s.s.*					x	x				xL			xL	x	x
P. flexuosa sensu Sars*							xL	xL		xL			x	xL	x
(Also some unidentified non-marine spp.)															

UNDARIA PINNATIFIDA IN THE UK

Paul Farrell

Insititute of Marine Sciences, Ferry Road, Portsmouth
paul.farrell@port.ac.uk

The large, adventive, *kelp Undaria pinnatifida* (Harvey) Suringar (Phaeophyceae, Laminariales) was found attached in the Hamble estuary in June 1994 (Fletcher and Manfredi, 1995). A native to Japan, Korea and parts of China, this was the first record of its occurrence in the British Isles. *Undaria* is though to have arrived in the UK via the hull of a small boat, probably from France, either as microscopic gametophytes or as young sporophytes. Hay (1990) predicted such a pattern of spread via boats using ports in the English Channel. This is supported by the observation that boats in the Hamble have attached, mature, fertile sporophyes (Figure 1). Attempts at eradication proved unsuccessful and the plants have recently spread to new localities in the UK (Table 1). The presence of many mature plants in the Hamble locality, each capable of releasing millions of spores, with reported motile periods of up to five hours (Saito, 1975; Akiyama & Kurogi, 1982; Hay & Luckens, 1987), the elusiveness of the gametophyte stages, and the proximity of the mature plants and spores to the tidal waters of the Solent, all suggest that an eradication programme would have been futile. It would also be impossible to control future introductions.

This is not the first report of *Undaria* being introduced into a new region. This adventive seaweed has considerably extended its world-wide distribution over the past three decades with reports of its introduction into regions as far apart as the Mediterranean coast of France, the Adriatic, the Atlantic coast of France (Brittany), New Zealand, Tasmania and, more recently Argentina, the Venice Lagoon, the Channel Islands (unpublished) and mainland Australia (Campbell & Burridge, 1998).
In the majority of these introductions, the seaweed arrived accidentally, with imported shellfish or shipping usually identified as the most likely vectors; its introduction into Brittany was, however, deliberate and made for commercial reasons.

Figure 1. Mature *Undaria* sporophyte from the Hamble

The arrival of *Undaria* into the British Isles could be a cause for concern. Around the coast *Undaria* will compete with the native kelp species occupying the shallow sublittoral/infralittoral zone. Kelps are major primary producers in neritic ecosystems ultimately providing a rich food source for organisms at several trophic levels, and as such, play an important role in fisheries and marine ecology in general. Also kelps are effective as habitats, nursery areas etc. and provide protective cover for many species. Algae most likely to be affected are other annuals occupying the same ecological niche (Sanderson & Barret, 1989) and it has been

suggested that the large kelp *Sacchoriza polyschides* (Lightfoot) Batters, might be particularly vulnerable.

However, *Undaria* has so far failed to colonise any rocky shoreline that supports kelps, where it has colonised adjacent protected areas, such as marinas. *Undaria* can tolerate a lowered salinity and grows well in estuarine conditions, where many native species cannot. Estuaries are crucially important areas for many reasons, *e.g*. for fish and shellfish fisheries, wildlife and nature reserves and as nursery areas for many commercially important species of fish and invertebrates. Any effect, positive or negative, upon the productivity of the latter areas could have environmental and commercial impacts. Macroalgae are the major food source for many species, either directly for grazers, or indirectly, via the detrital food chain.

Table 1. Chronology of *Undaria* introductions to the UK

Locality	Date of discovery
1. Port Hamble Marina, Hamble Estuary	June 1994
2. Hamble Point Marina, Hamble Estuary	March 1996
3. Jersey Yacht Basin, Jersey	April 1996
4. Torquay Marina, Devon	June 1996
5. QE2 Marina, Guernsey	June 1996
6. W Cowes Marina, Isle of Wight	August 1996
7. Mercury Yacht Harbour, Hamble Estuary	March 1997
8. Brighton Marina, Sussex	June 1997
9. Haslar Marina, Portsmouth Harbour	December 1997
10. E Cowes Marina, Isle of Wight	April 1998
11. Northney Marina, Chichester Harbour	April 1998
12. Swanwick Marina, Hamble Estuary	June 1998

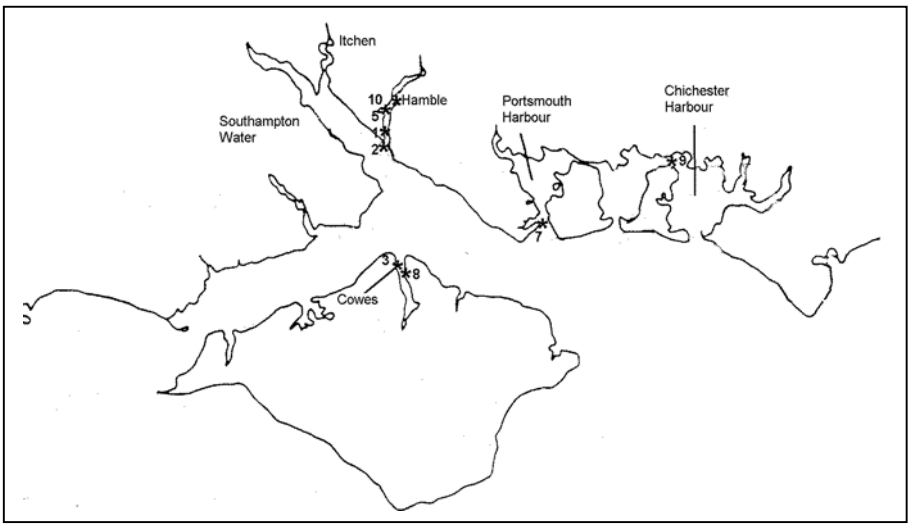
Grazing has been shown to be a major factor in determining limits of distribution of seaweed (Breen & Mann, 1976; Watson & Norton, 1985). From the study of associated flora and fauna, several species have been shown to graze *Undaria* in the laboratory; these include amphipods, isopods and gastropods.

In addition to the grazers found to be eating *Undaria* in the field, other important subtidal grazers such as the urchin *Paracentrotus lividus* and the ormer, *Haliotis tuberculata* will be used for grazing experiments. The selection and consumption of *Undaria* against native kelps and other algae are to be tested using native kelps; *Laminaria saccharina* (L.) Lamour., *L.digitata* (Huds.) Lamour and *Sacchoriza polyschides* (Lightf.) Batt.. These studies will help assess the role of grazing pressure in limiting the distribution of *Undaria* in the English Channel.

The research so far has shown that *Undaria* grows well, reproduces very successfully and has the potential to become well established around the UK coastline. Populations of *Undaria* are now well established in the Hamble Estuary (Solent), the Isle of Wight (Solent) and in Torbay (Devon). The seaweed is now locally widespread and abundant, having considerably extended its distribution in the Hamble Estuary, occurring just below the water line on the sides of a large number of the marina pontoons.

Legend for Figure 3. Figure 3 shows the locations in the Solent (south coast of England), where *Undaria* has been discovered. The numbers are in chronological order of introduction. Numbers 4 & 6 are outside the Solent and are mentioned in the following key. **1**. Port Hamble Marine, Hamble Estuary, June 1994; **2**. Hamble Point Marina, Hamble Estuary, March 1996; **3**. W Cowes Marina, I.O.W, Aug. 1996; **4**. Torquay marina, Devon, June 1996; **5**. Mercury Yacht Harbour, Hamble Estuary, March 1997; **6**. Brighton Marina, Sussex, June 1997; **7**. Haslar marina, Portsmouth Harbour, Dec. 1997; **8**. E Cowes Marina, I.O.W., April 1998; **9**. Northney Marina, Chichester Harbour, April 1998 (boat), July 1998 (pontoons); **10**. Swanwick Marina, Hamble Estuary, June 1998.

Figure 3. Introductions of *Undaria* in the Solent



HISTORY & BIOGEOGRAPHY OF PORCUPINE MNHS MEETINGS
Compiled by Julia Nunn

DATE	LOCATION	TOPIC	ATTENDANCE
Feb 1977	Edinburgh (RSM)	A forum for marine recording	74
Jun 1977	South Shields	Preservation & photographic techniques	23
Aug 1977	*Orkneys*	*Field meeting with BRISC*	9
Oct 1977	Cardiff	Parasites, commensals & symbionts	24
Feb 1978	Manchester	The species problem	44
Jun 1978	*Portaferry*	*Workshop: marine meiofauna*	9
Sep 1978	Portsmouth	The ecological impact of seaweeds	40
Apr 1979	Edinburgh	Biological frontiers	40
Oct 1979	Leeds	Developmental stages of marine organisms	35
Mar 1980	Edinburgh	Predation & survival	38
Sep 1980	*Channel Islands*	*Field meeting*	8
Feb 1981	Plymouth	Ecology from underwater photography	70+
Sep 1981	*Rhossili, Gower*	*Field meeting with Conch. Soc.*	8
Sep 1981	Portsmouth unknown	Biology of coelenterates (with Coelenterate Group)	
Mar 1982	Glasgow	Biological recording in the marine environment	66
Aug 1982	*Sherkin Island*	*Field meeting*	10
Dec 1982	*Reading*	*Workshop: identification of sessile groups*	48
Feb 1983	Menai Bridge	Biogeographic boundaries - the role of marine recording	70
Feb 1983	*Anglesey*	*Field Meeting*	
Aug 1983	*Eyemouth*	*Field meeting*	9
Oct 1983	Newcastle	Marine invertebrates	unknown

Feb 1984	Edinburgh	Sampling of the benthos - methods and rationale	70+
Sep 1984	*Falmouth*	*Field meeting*	unknown
Feb 1985	Manchester	Predators & feeding strategies	('low')
June 1985	*Skye*	*Field meeting*	1
Apr 1986	Southampton	Coastal lagoons	unknown
Sep 1986	*The Fleet, Weymouth*	*Field meeting*	8
Apr 1987	Lowestoft	Criteria for Sites of Special Status	unknown
Sep 1987	Pembroke (OPRU)	Alien species	unknown
Mar 1988	Millport	Marine biology in West Scotland	unknown
Oct 1988	*Shingle Street, Suffolk*	*Field meeting*	11
Apr 1989	Lancaster	The Irish Sea	unknown
Jul 1989	*The Trink*	*Field meeting*	13
Oct 1989	Guildford	Islands	unknown
Mar 1990	Dundee	Marine recording	unknown
Autumn 1990	Fawley	Plankton	unknown
Oct 1990	*Anglesey*	*Field meeting with Conch. Soc.*	unknown
Apr 1991	Swansea	Change & adaptation (with Coelenterate Group)	unknown
Sep 1991	*Isle of Wight*	*Field meeting*	8
Dec 1991	Dublin (TCD)	Biogeography of Ireland (with Irish Biogeographical Society)	unknown
Apr 1992	Dunstaffnage	From loch to abyss	38
Apr 1992	*Dunstaffnage*	*Field meeting*	unknown
Oct 1992	CBRU	Southern species	25
Oct 1992	*Cornwall*	*Field meeting*	15
Mar 1993	Peterborough	Coastal & inshore marine communities	120
Oct 1993	Port Erin	Experimental marine ecology	13 + staff
Mar 1994	Edinburgh (NMS)	Braer oil spill & marine environmental monitoring	unknown
Sep 1994	*Channel Islands*	*Field meeting with Conch. Soc.*	13
Mar 1995	Millport	Marine biotopes	unknown
Mar 1995	*Millport*	*Field meeting*	unknown
Oct 1995	Cardiff (NMW)	Marine surveying	40
Mar 1996	Scarborough (UC)	The North Sea - past, present & future	unknown
Sep 1996	London (Royal Holloway)	Animal & sediment interactions in the marine environment	30+
Apr 1997	Portaferry	Marine-protected areas	35+
Apr 1997	*Connemara*	*Field meeting*	8
Apr 1998	Southampton	The biogeography of the NE Atlantic	60+
Mar 1999	Dunstaffnage	Marine biodiversity: current research & conservation measures	30+
Mar 1999	*Dunstaffnage*	*Field meeting*	8+

PORCUPINE MEMBERSHIP 1977 TO 1998
Compiled by Julia Nunn