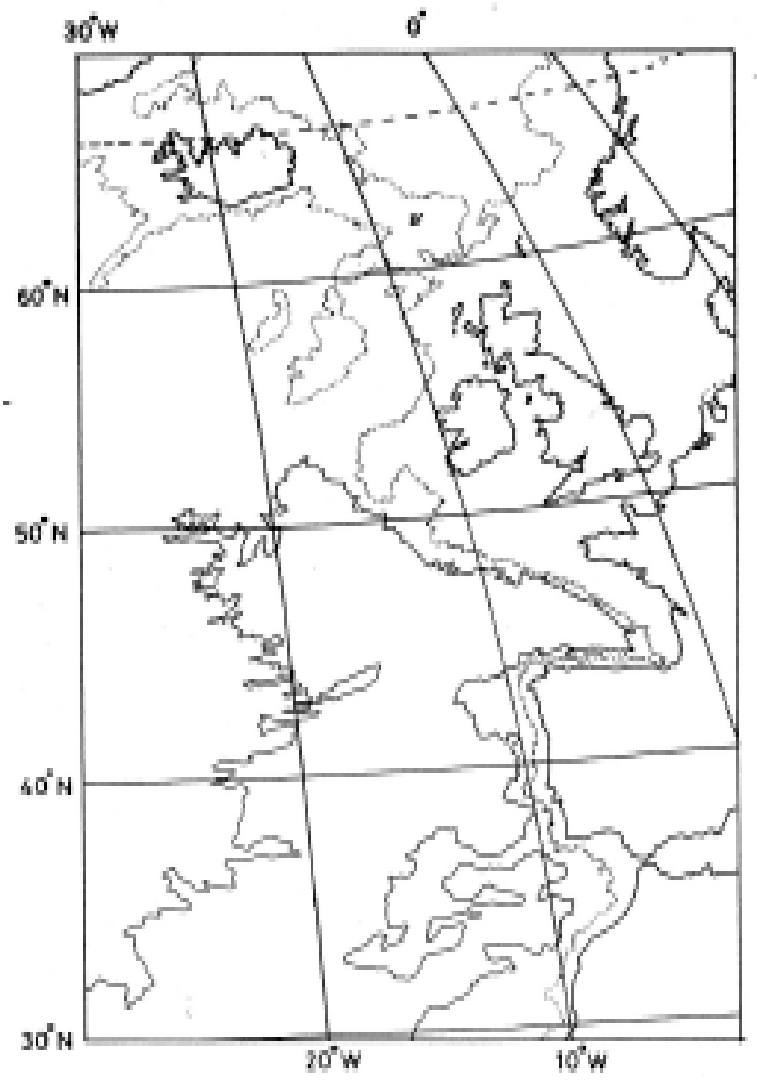
PORCUPINE MARINE NATURAL HISTORY SOCIETY

NEWSLETTER

June 2004 Number 15



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Porcupine Marine Natural History Society

Newsletter

No. 15 June 2004

Hon. Treasurer
Jon Moore
Ti Cara
Point Lane
Cosheston
Pembroke Dock
Pembrokeshire
SA72 4UN
01646 687946
jon@ticara.co.uk

Hon. Editors
Frances Dipper
The Black Bull
18 High Street
Landbeach
Cambridgeshire
CB4 8DT
01480 830507
fdipper@dial.pipex.com

Peter Tinsley
4 Elm Villas
North Street
Wareham
Dorset
BH20 4AE
01929 556653
ptinsley@dorsetwt.cix.co.uk

MEMBERSHIP
Séamus Whyte
The Cottage
Back Lane
Ingoldsby
Lincolnshire
NG33 4EW
01476 585496
seamouse@ntlworld.com

Chairman
Julia Nunn
Cherry Cottage
11 Ballyhaft Rd
Newtonards
Co. Down BT 22 2AW
porcupine@strangfjord.freeserve.co.uk

Porcupine MNHS welcomes new members- scientists, students, divers, naturalists and lay people. We are an informal society interested in marine natural history and recording particularly in the North Atlantic and 'Porcupine Bight'. Members receive 3 newsletters a year which include proceedings from scientific meetings.

Individual £10 Student £5

www.pmnhs.co.uk

Contents

EDITORIAL

The PMNHS annual meeting was held at Bournemouth University on March 20-21st 2004. This was a smaller meeting than last year - friendly and informal - the trademark of Porcupine meetings. There were some fascinating papers, several of which are published in this issue, with, hopefully, more to come in the October issue. Tim Golding's talk about black bream off the Sussex coast stuck in my mind and on a recent visit to the National Aquarium in Plymouth, what should I see but a huge tank with black bream busy excavating the sandy bottom into a series of moon crater nests, just as Tim had described. Colin Froud presented a newly released video "Beneath the Waves: the sea life of South-east England", made in collaboration with the Wildlife Trusts' South East Programme. Copies should now be available and of interest to divers, naturalists and anyone interested in the marine life of this area. Steve Trewhella gave a slide show of marine species along the English Channel coast. Wonderful slides of both familiar and unfamiliar animals from tiny to huge. Why can't I take photos like that?

Following the weekend meeting, a number of Porcupiners stayed on until the Monday to visit a local seashore at Osmingtom Mills to search for *Oslinius lineatus* (*Monodonta* to most of us). See 'Porcupine Pieces' for a report of what we got up to. Sunshine and hail combined to make an interesting day!

FREE TO GOOD HOMES -Back issues of Porcupine (old and new series). E-mail your request and then send 50p worth of stamps or a large SAE to me. Note that I am moving house on June 12th. However, my current address will work for some time after the move

OBITUARY

David Heppell, a founder and life member of Porcupine, died peacefully on Saturday 24 April 2004. He had been seriously ill for some time. Most of his working life had been with the National Museums of Scotland, as head of the Mollusca Section. In addition he was a Commissioner for ICZN. He retired several years ago to British Columbia. He leaves his Canadian wife and two teenage children. By his request no funeral or flowers."

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COPY DEADLINES
August 20th for the October issue
December 15th for February issue

COUNCIL MINUTES

MINUTES OF THE COUNCIL MEETING

Held on March 20th 2004 at Bournemouth University.

Present: Peter Barfield, Julia Nunn, Frances Dipper, Peter Tinsley, Frank Evans, Shelagh Smith, Paul Brazier, Anne Bunker, Lin Baldock, Vicki Howe, Ronni Robbins

Apologies: Sue Chambers, Séamus Whyte, Jon Moore, Andy Mackie, Roger Bamber

Matters arising

Julia Nunn has sent the letter to the CEO of Cardiff Museum to thank them for hosting the 2003 annual meeting.

There has been no progress with the History of Porcupine

Finances

The accounts to 5th March 2004 have been audited and received. The accounts to 13th March 2003, have now been audited and remain unchanged and as published in the May 2003 newsletter. In the absence of the Treasurer (birth of 2nd offspring coincided), Julia Nunn presented a short summary. The finances were discussed prior to their presentation at the AGM. They appear to be in good order. Membership remains stable with a modest increase resulting from the Cardiff meeting.

Membership

Séamus Whyte and Peter Barfield have taken over membership from Jon Moore and will follow up any remaining unpaid subscriptions. Vicki Howe is preparing an article for the Marine Conservation Society magazine that will help publicise Porcupine. We can reciprocate. Julia Nunn is maintaining an e-mail list of members and others who might be interested in attending Porcupine events. Members for whom we have no e-mail address need to be identified and a letter sent to either request their e-mail address or identify them as not having one. ACTION: Frances Dipper

Publicity

Anne Bunker holds a list of organisations to whom publicity fliers can be sent or e-mailed to advertise the annual meeting and field trips. This includes relevant universities and colleges.

Newsletter

The new system with two editors is working well. Frances Dipper said that she has collated an archive of existing past copies of newsletters from both the old and new series. She asked if she should throw away the numerous spare copies from the first series. It was agreed she should keep them until the next AGM and then any not required after this could be thrown out. Most of the new series are held in electronic form on disc. It was agreed it would be a good idea to try and make electronic copies of the old series. Peter Barfield said he would start the process and Julia also offered to help. Frances will send Peter the back copies. ACTION: Frances Dipper

It was agreed that starting from next year, authors presenting papers at the annual meeting will be asked to supply their full manuscript prior to the meeting, if they wish to have it published. Instructions to authors will be prepared and published. ACTION: Frances Dipper

The possibility of having a 'special topic' in the November issue each year was again discussed. 'Maerl' had been proposed for this year but it was generally felt that there were too few people who could be asked to contribute. Additionally a longer lead in time would be required and it is unlikely to happen this year.

Website

Anne Bunker reported that she has got a new feature for the web site and this will be posted to the site soon. She would be grateful for further contributions. It was suggested that the 'Meetings' page should be split into past events and future events. Photographs need updating. Vicki Howe will help with this. ACTION: Vicki Howe.

Possible changes and updates to the design and look will be discussed more fully at the autumn Council meeting.

Annual Meeting and AGM 2004

Lin Baldock was thanked for all her hard work and organisation. The venue at Bournemouth University was a good choice. A 'How to run the Annual Meeting' document is needed. This will save future convenors time and trouble. ACTION: Julia Nunn (Lin Baldock has since volunteered to initiate).

Frank Evans will stand down permanently at the AGM. Shelagh Smith will stand down but is available for re-election. Alison Shaw from the Royal Zoological Society will stand for election. She has also offered to convene an annual meeting in London. It was agreed this would be excellent but will have to be in the future as the 2005 meeting will be in London.

Field trip 2004

There has been little interest from Porcupine members. Conchological Society has good bookings for the dredging. The diving may have to be cancelled. When details of what is happening on each day have been agreed, this information will be put on the website. Subsidy of the boat costs by Porcupine may depend on whether any Porcupine members are involved.

ACTION: Anne Bunker and Lin Baldock

Frank Evans reported that Norwich Union had not replied re the query about field trip insurance. Julia Nunn reported that the insurance for BNFC was a special deal based in Northern Ireland and provided by Norwich Union and so could not be used. Insurance requires further discussion in the autumn. A basic risk assessment will be prepared for the May field trip. ACTION: Julia Nunn. Julia Nunn may be meeting Chris Wood at the end of March and will discuss how Porcupine might contribute to Seasearch on its field trips.

Annual meeting and AGM 2005

Ronni Robbins reported on progress with plans for the 2005 Annual meeting at the Natural History Museum. The date was agreed as 18-20th March 2005. The theme will be 'Collections, Collectors and Collecting'. Clare Valentine from the NHM has offered to give a talk. For the 'fieldwork', material from the museum collections including Discovery, Challenger and Porcupine can be made available for people to work on. Microscopes and equipment are available. Special tours of the new Darwin wing can also be organised. A discount will be arranged for delegates in the museum shop.

Field meeting 2005

May was suggested as a suitable time for the field trip. Séamus Whyte has been in touch with Eastern Sea Fisheries who have agreed in principle to a dredging trip using their boat. They will need to fit this in with their schedule. Dates need to take into account good tides (for shore working). A proposal needs to be sent to Eastern Sea Fisheries. ACTION: Frances and Seamus to discuss dates and liase with ESF.

Any Other Business

There has been no further progress with the memorial to Netty Little

(Note: Jon Moore has since reported that he has actually spoken to the developers of the potential site near Pembroke Dock, and they seem reasonably open to the idea, but they think he should wait until the design of that part of the new estate is completed, so that we can work out if an interpretive panel could be sited appropriately in the picnic area overlooking Pennar Gut).

Date of Next Meeting

To be decided. Julia will e-mail council. ACTION: Julia Nunn

AGM MINUTES

MINUTES OF THE 27TH ANNUAL GENERAL MEETING OF PORCUPINE MARINE NATURAL HISTORY SOCIETY

Held at the University of Bournemouth on Saturday March 20th 2004

Chairman: Julia Nunn

Apologies for absence

Apologies were received from Susan Chambers, Roger Bamber, Jon Moore, Andy Mackie, Séamus Whyte

Minutes of last AGM

These were published in the May 2003 issue of Porcupine newsletter and were accepted with one correction: Under 'Council members for next year', Peter Barfield was listed as co-editor instead of Peter Tinsley.

Matters arising from the minutes of the last AGM

There were no matters arising from the Minutes.

Officer's reports

Hon. Treasurer, Jon Moore

In the absence of the Hon. Treasurer, the financial report was presented by the Chairman Julia Nunn. The accounts to 5th March 2004 have been audited and received. The accounts to 13th March 2003, have now been audited and remain unchanged and as published in the May 2003 newsletter. Income from subscriptions has increased slightly as a result of new members joining at the Cardiff meeting. Total membership stands at 203. Some subscriptions remain unpaid. Seamus Whyte and Peter Barfield have undertaken to deal with membership matters. There was a small surplus for the year of £143. Therefore with this and the balance brought forward, the surplus stands at £5073 for the year ended 31 December 2003.

The report was accepted following proposal by Anne Bunker, seconded by Frank Evans.

Hon. Editor and Hon Secretary, Frances Dipper

The Hon Editor reported that there had been three issues of the newsletter since the last AGM. Future issues will be published in June, October and February. Copy deadlines are published in the newsletter. The layout and print quality of the newsletter has been greatly improved thanks to Peter Tinsley, the co-editor. Colour is still too expensive but may be used on occasion.

This year, nine papers from the Cardiff meeting were published plus 10 'Porcupine Pieces'. The latter included reports from field trips and a wide variety of articles submitted by Porcupine members, from 'Creature features' to new species records and University student field trips. Short observations and requests for information are published under 'Porcupine problems'. Recent issues have seen some fascinating dialogue concerning the distribution of the sea slug *Onchidella celtica* plus many unusual fish records from Doug Herdson at the Plymouth National Aquarium.

Papers from the Bournemouth meeting will be published in the June issue. Contributors were requested to submit their papers ASAP. Those who had already done so were thanked. In future, all contributors will be requested to submit their written papers prior to the Annual Meeting. Papers can be peer-reviewed on request.

Back issues of almost all volumes are available from the editor.

The report was accepted following proposal by Jan Light, seconded by Frank Evans.

Hon. Records Convener

In the absence of Jon Moore, Julia Nunn reported that the recording scheme was active but was still low profile. Most records are published in the newsletter. Members were encouraged to send in their observations.

The report was accepted following proposal by Peter Barfield, seconded by Vicki Howe.

Chairman, Julia Nunn

The Chairman reported that it had been a relatively quiet year. There have been two council meetings since the last AGM, on 8th November in London and 20th March in Bournemouth, where general society business was discussed. Council is still examining ways to raise awareness and attract members. Shelagh Smith was thanked for organising the 2003 field trip to Northumberland. The 2004 field trip is to Dorset, May 4-8th. The 2005 Annual meeting and AGM will be held in London at the Natural History Museum and will be convened by Roger Bamber and Roni Robbins. The 2005 field trip will be to the Wash and North Norfolk coast in May 2005.

The website remains active and will shortly have a new special feature. New photographs are needed. Members were invited to contribute to the website.

The report was accepted following proposal by Shelagh Smith, seconded by Ken Collins.

Election of officers and council members

Two council members were retiring, Shelagh Smith and Frank Evans. Shelagh Smith is available for re-election. All remaining council members and office holders expressed themselves willing to stand for re-election. Alison Shaw wished to stand for election to Council, proposed by Vicki Howe and seconded by Peter Barfield. The Chairman proposed a vote that Officers and Council members be elected en bloc and this was agreed with no objections or abstentions. Frank Evans has been a council member almost continuously since the start of Porcupine and is a founding member and Life member. He held the post of Hon. Editor for some time. Porcupine owes much to him and he was heartily thanked for all his years of service.

Officers for the next year:

Hon. Chairman, Julia Nunn; Hon. Treasurer and Hon. Records Convenor, Jon Moore; Hon. Editors, Frances Dipper and Peter Tinsley, Hon. Secretary, Frances Dipper

Council members for the next year:

Lin Baldock, Roger Bamber, Peter Barfield, Paul Brazier, Anne Bunker, Susan Chambers, Frances Dipper, Vicki Howe, Andy Mackie, Jon Moore, Julia Nunn, Roni Robbins, Shelagh Smith, Peter Tinsley, Séamus Whyte, Alison Shaw.

Any Other Business

It was proposed that records obtained from the Dorset field trip will be submitted to the Dorset Environmental Centre. There were no objections to this.

The Chairman thanked the organiser of the annual meeting, Lin baldock, for all her hard work in making the meeting so successful. Shirley, a facilitator from Bournemouth University, was also thanked for helping the event to run smoothly.

There being no other business, the Chairman declared the meeting closed.

ACCOUNTS

PORCUPINE MNHS

RECEIPTS AND PAYMENTS ACCOUNT

for the year ended 31 December 2003

Year to 31.12.02 £	£			Year to 31.12.03 £	£
		RECEIPTS			
20			2000-2001	0	
1422			2002	40	
0			2003	1456	
0			2004	10	
	1442				1506
	76	Bank Interest (net of tax)			53
	2	Sale of PN Back Number			4
	50	Donations			0
	1570	Total Receipts			1563
		PAYMENTS			
684		Newsletter-	Printing	1134	
135			Postage	431	
819		Total Newsletter Costs		1565	
0		Chairman/Treasurer expenses (printing/postage)		65	
100		Poster preparation & printing		176	
424		Web site development			0
224		Council meeting expenses (travel/catering)		181	
2		Bank charges		0	
	1569				1987
	1	**SURPLUS (DEFICIT) BEFORE MEETINGS**			(424)
	778	**Annual Conference** – Edinburgh (2002)			0
	0	**Annual Conference** – Cardiff (2003)			767
	0	**Field Meeting** – Northumberland (2003)			(200)
	779	**SURPLUS (DEFICIT) FOR THE YEAR**			143
	4151	**BALANCE BROUGHT FORWARD**			4930
		BALANCE CARRIED FORWARD			
456			Current Account	53	
4474			Deposit Account	5020	
	4930				**5073**

Jon Moore, Hon Treasurer
5th March 2004

N Lang W
Hon Secretary
16th March 2004

PORCUPINE 2005 COLLECTIONS, COLLECTORS, COLLECTING

18th - 20th March 2005

The Natural History Museum, Cromwell Road, London SW7 5BD

The meeting will follow the format of talks and presentations on Friday 18th and Saturday 19th. Delegates will be thrown upon the more-than-adequate catering and refreshment resources of nearby South Kensington for lunches. The Conference dinner will be held on the Friday night. The Annual General Meeting of the Society will occur during Saturday's proceedings.

A 'field trip' will be organized on Sunday 20th to such venues as the Porcupine Sea Bight, Rockall, etc., utilizing as yet unsorted material held at the NHM. The delegates will be based in the large laboratory in the Darwin Centre; while a number of microscopes will be available, delegates are welcome to bring their own. During the day, Museum staff will be available to give behind-the-scene tours of the Darwin Centre and the collections held there.

Options for accommodation will be circulated at a later date, particularly to those requesting them.

Offers of talks and/or posters, either on the theme or on any appropriate subject, are welcome now.

Please contact either Roger Bamber (R.Bamber@nhm.ac.uk) or Roni Robbins (ronr@nhm.ac.uk) of the Zoology Department of the Museum. Fax: 020 7942 5433.

PORCUPINE FIELD MEETING 2005

The Wash and North Norfolk coast

This meeting is in the early planning stages. The dates will be decided once boat availability has been ascertained. It is hoped to carry out dredging within the Wash (leaving from Sutton Bridge or Kings Lynn) plus visits to various coastal sites centered around Wells. There are numerous fascinating saline lagoons, saltmarsh, seagrass and sand dune systems in the area. Contact Frances Dipper or Séamus Whyte for suggestions or questions (see inside cover for contact details). Further details will be sent by e-mail and will be in the next newsletter (October).

OTHER MEETINGS

June 23rd 2004
CIWEM Conference. Improvement Programmes for Combined Sewer Overflows and other Intermittent Discharges

Intermittent discharges are probably the biggest single issue facing the Water Companies of England and Wales in the AMP4 period covering 2005-2010, and are of similar importance in Scotland and Northern Ireland. By summer 2004 the outline capital programme will be agreed between Government, EA and OFWAT, but there will be a number of major issues concerning its implementation. The conference aims to enable policy-makers and those responsible for their implementation to discuss the issues surrounding the development of an effective programme to deal with unsatisfactory intermittent discharges

Contact: CMS on 01531 890415 or bob.earll@coastms.co.uk; CMS website www.coastms.co.uk

June 21st-23rd 2004
Molecular sytematics for taxonomists, Edinburgh

The Centre for Marine Biodiversity and Technology at Heriot-Watt University in Scotland is running its short course in again this year. The course is aimed at people who are engaged in taxonomic work but who are not familiar with techniques in molecular systematics. Participants need not have previous knowledge of the subject as the course will provide both a basic theoretical grounding together with instruction in practical techniques. The course is for anyone who needs to extend their taxonomic capability beyond traditional morphological and anatomical approaches. Contact: Dr. Paul Kingston, the course organiser P.F.Kingston@hw.ac.uk as soon as possible.

June 30th 2004
National Aquatic Litter Group Annual Supporters Meeting

The 2004 National Aquatic Litter Group Annual Supporters Meeting will be held at 10.30am June 30th at the Offices of Defra, Ashdown House, Victoria Street, London.

If you would like to attend please contact Ian Cole: ian.cole@encams.org.

July 13th 2004 CIWEM WFD Series Integrated Catchment Management - lessons for River Basin Management

Conference Programmes on the website www.coastms.co.uk

13th-17th September 2004
ECSA 38, Rouen, France. Changes in land uses: consequences on estuaries and coastal zones.

This is an international conference co-sponsored by ERF. It is organised by the Seine-Aval programme and ECSA with the principal objective of comparing the Seine-Aval results with those from other estuaries.

Contact: Dr R. Lafitte, e-mail: robert.lafite@univ-rouen.fr

20th-22nd September 2004 **Littoral 2004. Seventh International Conference & Exhibition Delivering Sustainable Coasts: Connecting Science and Policy** Aberdeen Exhibition and Conference Centre, Aberdeen, Scotland. A joint EUROCOAST and EUCC-The Coastal Union conference, supported by CoastNET, the UK's national coastal network. Littoral 2004 is a major European event attracting an international audience of coastal researchers, managers, practitioners, and industry. Those wishing to attend, exhibit at, or sponsor the conference should visit www.littoral2004.org to register their interest. E-mail: enquiries@littoral2004.org; Tel: 01223 333438.

"Darwin and the Barnacle"

by Rebecca Stott, pub. Faber and Faber, London, 309 pp., 2003. ISBN 0 -571- 20966 - 1

Reviewer: Frank Evans

This is not the book that Rebecca Stott set out to write. She planned to describe the Victorian fascination with the sea shore and with the complimentary attempts to maintain sea water aquariums in middle class Victorian drawing rooms. In the event these contraptions proved immensely difficult to maintain, requiring much attention which was all too often left to the servants. The aquarium tanks flourished for a short period at considerable expense and were then banished to be replaced by simpler interests while the aquarium suppliers turned from domestic business to providing and servicing larger municipal and national aquariums. But while it lasted the keeping of marine aquariums at home in mid-Victorian times appeared almost as a form of mania.

On its fringe, untroubled by such affairs, Charles Darwin, dabbling in a few sea water experiments, was also working at Down House on a project which he believed would soon be completed. It too concerned a marine creature, a barnacle which he had picked up in southern Chile during the "Beagle's" epic voyage. He was happily unaware that its proposed examination would take him eight years, would cost him his health and drive him almost to despair. Amid the aquarium mania Stott's interest was caught up with this, an apparently insignificant corner of the Victorian scene, but one of the most important ventures in the history of biology and her book takes its shape from this.

Few biologists have read "The Origin of Species" although many will be familiar with the more accessible "Voyage of the Beagle". But even fewer will be familiar with Darwin's second most important publication after "The Origin", his work on barnacles and will be unaware that had he never written a word about natural selection he would still have ranked as one of the world's great biologists on the strength of this work alone. The story of the production of his mighty barnacle volumes is a profound one and one well worth telling.

However, in approaching it, Stott recognises that externally it lacks drama. The course of Darwin's investigation is without the appeal of a journey such as frames Cook's explorations or his own "Beagle" voyage. There is no clear physical or mechanical progress as with Harrison's development of the chronometer, and no parallel skulduggery either. He is simply a wealthy gentleman diverting himself with natural history, no fire or shipwreck occurs such as Alfred Russell Wallace suffered, no bankruptcy, no climactic event. Yet Stott recognised that it was a real journey of immense importance and one that took place in peaceful, domestic surroundings, almost entirely in the mind of Charles Darwin.

How best to convey this towering achievement, she wonders, how to make an epic of it?

She uses as her principal sources Darwin's own notebooks and letters. Darwin kept careful notes of his own reading, rating books as good, pretty good, etc. and he also kept diaries on his health. Most informative of all were his letters, many of which have survived. In them he reveals himself rather more freely than elsewhere, joking about his barnacles and even, Victorian though he was, remarking on their astonishing male endowment. From all this she constructs detailed moments, employing a certain amount of fancy but backing it up with profuse references.

To bring the events to life Stott employs two principal devices. Over and over again she places Darwin in the context of his current situation. To achieve this she has done a great deal of research unconnected with cirripedes. For instance she describes how in 1846 Darwin carries a glass jar containing the barnacle which will prove to be the core of his work, from his overnight residence in Grosvenor Square to Kew, where he is to meet Joseph Hooker, the renowned botanist and early sharer of his secret thoughts about evolution. He travels by bus, horse-bus, of course, and we learn of its crowded condition with "six and twenty sweaty citizens jammed, crammed and squeezed into each other" as we read about the dirty straw on the floor and the method of stopping the bus by banging on the roof, all supported by an appropriate reference in the book's endnotes.

Five years after his visit to Hooker the Darwin family is visiting the Great Exhibition of 1851. We are given notes of that event, easily culled from the literature but interspersed with "they saw", "they glimpsed" and other phrases which direct us to see the scene through Darwin's own eyes. We live the day through him.

Secondly, to convey dramatic effect, her descriptions sometimes move into the present tense. A little further on in the book Darwin, in his black cloak and with his walking stick, is slipping out of his house at dawn for his usual walk. He observes the range of pear trees in his garden and we are led towards Darwin's reflections on variation within a species, a topic largely avoided until the very end of the book. But the account gains immediacy by being in the present tense, combined with Darwin's imagined speculation on the future of the trees. Through much of the book these methods of presentation give descriptive strength to Darwin's internal battles, battles with his illness, with barnacle classification, with the dualism of fact and speculation. And there is attention everywhere to small detail. For example the family takes a holiday in Eastbourne, staying in a street called Sea Houses; Stott troubles to find out and to inform us that it is now known as Marine Parade. Equally, she seeks out from the Ray Society the London address of Edwin Lankester (secretary of the Society and father of Ray Lankester) in order to give an account of Darwin's delivery there of the manuscript of his stalked barnacle book

Using these devices Stott's approach to Darwin's achievement is to set the scene for his great barnacle work and then by a series of set pieces illustrate how he gained his purpose of grasping the science of taxonomy through the classification of the cirripedes.

One criticism to be mentioned here concerning the setting of scenes in place of continuous narrative is that occasionally Stott allows characters to spring ready-made from the page. We learn suddenly that aboard the "Beagle" Darwin had a servant called Sym Covington without being told that this was a youth of sixteen who Darwin had negotiated for with FitzRoy once the voyage was under way. Covington was removed from the crew list and subsequently remained with Darwin for a number of years before emigrating to Australia. In the same way Parslow, his butler, and Miss Thorley, his children's governess, both appear without introduction. It may be that Stott did not always write her scenes in order but joined them later and in this way explanations appear in the wrong place.

As the book opens we first encounter Darwin as a young student in Edinburgh, in the company of Dr. Grant, engaged in the careful examination of the sponge *Spongia compressa* (now *Grantia compressa)* instead of devoting himself to preparing for his entry into the church. Dr. Grant's influence on him will lead to the precision with which he approaches his own barnacles later on. We next find him aboard the "Beagle" and soon to encounter the moment that will shape much of his future life. Unmentioned in the "The Voyage of the Beagle", Stott uses Darwin's diary to describe his picking up of a conch shell on the beach in the Chronos Archipelago in southern Chile in January 1835 and slipping it into his pocket. The owner animal has long departed but the shell has been bored by scores of small creatures and is pitted with holes. Under his microscope Darwin recognises them as barnacles. This is an example of Darwin's remarkable insight. The creatures are a couple of millimetres or less across and, for barnacles, very aberrant. They could, at first sight, be almost anything.

It is these curious animals that fuel Darwin's attack on the cirripedes. Stott makes them the baseline of the major part of her book, showing how on his return home Darwin at first set them aside and then after ten years or so of other work allowed himself a month or two to describe and classify them.

A question much occupying naturalists in the early part of the nineteenth century concerned the relative merits of description and philosophy, of systematics and speculation. Until Darwin took it out of their hands and solved it with "The Origin" he too was much occupied with the place of the two concepts in biology. Stott draws a picture of him doubting his authority to speculate until he can lay claim to authority in taxonomy. And what better subject for taxonomic investigation than the class of cirripedes, for

the animals, mostly at the time unclassified, are common, small, tough, easily collected and easily sent by post. At the centre of Darwin's self imposed task would be the creature in the conch shell, a creature that he refers to in all his writing as "Mr. Arthrobalanus". And around Mr. Arthrobalanus Darwin gathers other barnacles until he is able to produce two books on the subject which together amount to well over a thousand pages. So much for a month or two. We are looking at eight years.

When Darwin set sail on the "Beagle" the true systematic position of barnacles had only recently been elucidated. Barnacles are so shelly in appearance that they were long thought by biologists to be molluscs. Then in 1830 an army surgeon named John Vaughan Thompson, stationed at the hospital in Cork in Ireland, made a remarkable discovery.

Using a fine muslin net Thompson had collected creatures from the waters of the Cork estuary and among them there chanced to be the settlement stage of rock barnacles. Of course, we now know that the young of barnacles disperse from the sedentary parents as nauplii. It is often assumed that these were what Thompson saw and would clearly indicate to him a crustacean connection. But in fact what he actually saw were metamorphosing cyprids. This final larval stage, enclosed between a pair of shells, resembles a minute bivalve mollusc more than any other stage in the barnacle's life history. But under his microscope Thompson brilliantly noticed that beneath the shells was a pair of eyes and these were compound eye, found only transiently at this moment of development. Such eyes are never found in molluscs but occur freely in lobsters, crabs, shrimps and their relatives. So barnacles, he correctly concluded, could only be crustaceans.

His work, entitled "Zoological Researches, Memoir 4, On the Cirripedes, or Barnacles" was published, as Stott noted, in 1830. It is not really a book as she mistakenly states but is one of a series of six memoirs privately published by him between 1828 and 1834. All six memoirs were reissued in a single binding by the Society for the Bibliography of Natural History in 1968.

Among the publications loaded onto the Beagle in 1835 Darwin had fortunately included Thompson's work. Thus far had his barnacle knowledge advanced. And now from 1846 to 1854 he was to labour on his self imposed task. At times, as he confessed, it almost drove him mad. Half way through he wrote: "I hate a barnacle as no man ever did before." Packets of barnacles arrived by every post from every quarter of the globe and his life became circumscribed by the creatures. At first he was handicapped by inadequate equipment. Like so many modern biologists, Darwin was astonished at what he could see through someone else's superior microscope, in his case Hooker's, but he soon rectified this by purchase. In his final barnacle volume Darwin gives detailed drawings of the anatomy of Mr. Arthrobalanus but at one point presents the whole animal actual size within a circle of half an inch diameter. As Stott says and as this picture forcefully shows, the animal upon which such fine dissection was performed is hardly bigger than a pinhead. Truly, he must have been possessed of an excellent microscope and remarkable dissecting skill.

As Darwin continued to gnaw his way through barnacle anatomy and taxonomy and struggled with the philosophical questions concerning their place in the scheme of living things he was himself being gnawed at by painful ill health, made partially bearable by opium pills. That he was often unwell is commonly known but Stott devotes a chapter to the miseries of his situation, describing in the present tense his sojourn in Malvern in the care of Dr. Gully and the Bath Man. Dr. Gully's regime includes early morning visits by the Bath Man who wraps him tightly in sheets soaked in cold water and leaves him to dry out by the heat of his body. He is forbidden alcohol and snuff and prescribed cold douches. Strangely, it all makes him feel better and his digestive problems, faintness, boils, swellings and flatulence recede although he is far from cured.

The barnacles that await his return to Down House present ever more complicated problems. He has decided that all his Mr. Arthrobalanus specimens are exclusively male while in the stalked barnacle *Ibla* he has

discovered a species in which the sexes are sometime separate with a dwarf male attached to the female and sometimes, as with the majority of barnacles, hermaphrodite, but still with a dwarf male attached. While barnacles commonly bear six pairs of thoracic limbs Mr. Arthrobalanus appears to sport none of these but three pairs on its abdomen. And it has no shell plates as other barnacles but bores into dead shells for protection, there extending its limbs and feeding through the aperture in the usual way.

The first boring barnacle to be described in print was *Alcippe (=Trypetesa) lampas*, so named by Hancock in 1849. (Albany Hancock's name graces the Hancock Museum of Natural History in Newcastle on Tyne.) It is to be found in gastropod shells inhabited by hermit crabs. Darwin carried on an extensive correspondence with Hancock, discussing the means by which the cavity was excavated. Eventually, when the immense volume on sessile barnacles was nearing completion, Darwin had found that Mr. Arthrobalanus was not in fact male but female and bore a succession of parasitic males in the fashion of *Ibla*, and also, as he had discovered, *Scalpellum*. He was puzzled as to where to place Mr. Arthrobalanus, now given its formal name of *Cryptophialus minutus*, but finally erected a separate order for it and for *Alcippe* under the title Cirripedia Abdominalia. This was in respect of the abdominal limbs of the group. Darwin made few mistakes in his career but here he was in error since what he supposed were three limb-bearing abdominal segments are actually thoracic segments, in fact a more characteristic organisation for barnacles. *Cryptophialus* and *Alcippe* are now included in the Order Acrothoracica.

He erected a second order, the Apoda for an even more aberrant barnacle, *Proteolepas*, which has no trunk limbs at all. We now know that this is not even a cirripede but a parasitic isopod. But in general in his barnacle studies as elsewhere Darwin was amazingly surefooted, with hardly a stumble.

Reading Stott's book one is frequently impressed with its scholarship and with the constant feeling of proximity to Darwin. But every now and again one is jolted into the realisation that the writer is not a biologist. Professor Rebecca Stott is Head of the English Department at the Anglia Polytechnic University. She is unaware that Darwin would never, as described, have hesitated to pick up the polychaete *Aphrodite* on the shore at Leith, since it has neither stinging cells nor is it parasitic; it is a predator on smaller worms. The classic nineteenth century work on molluscs in four magnificent volumes by Forbes and Hanley is credited to Forbes and Hancock, a blunder unlikely to be made by a marine biologist. The "camera obscura" used for drawing from a microscope would surely be a camera lucida. The reference to the tropical forests of Tierra del Fuego, a country in 55°S is unfortunate as is her confusion of meteors and comets.

But all these are trivial infelicities compared with the remarkably successful presentation of her story. We read the book and live Darwin. Guided by her we walk in imagination in the company of a Victorian giant. It is a truly fine achievement.

Information requests and observations

More on Onchidella celtica distribution

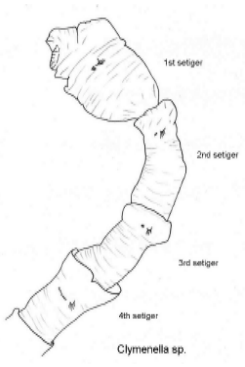
From Jim Wilson, Zoology Department, Trinity College, Dublin 2, Ireland. email: jwilson@tcd.ie

Just to muddy the waters (sorry!) I have a note from an expedition we did to loch Eriboll in 1976, and you can have this for what it's worth! My notes say ?*Onchidella celtica*? from the shallows at Fresgill Head. I remember identifying this and being extremely dubious from the records, that it could be right, mounting it on a stub and sending a scanning EM of it off to the the British Museum. The reply confirmed the ID, although with reservations about his skills and difficulties from a photo. The bad news is that I now have neither the specimen nor the photos, unless the latter are still tucked away somewhere forgotten! Given what we know now of species such as *Elminius* and *Palinurus* up the west coast of Scotland, I'm less surprised now of such records. Does this help?

Clymenella cincta and *Clymenella torquata*

From Peter Garwood, 8 Lesbury Road, Heaton, Newcastle upon Tyne, NE6 5LB. Tel. 0191 2650567

I am looking for specimens of these two species of bamboo worm, both of which are quite substantial animals, up to 15cm in length. Maldanids have a reputation for being difficult to identify, mainly because many of them fragment easily, they are capable of regenerating in both directions, and the first thing you are expected to know about them is how many segments they have. Most maldanids are made up of a head, a number of body segments with dorsal and ventral



chaetae, followed by a small number of segments without chaetae, and finally a pygidium. The head and tail end are variously developed, and it is often the case that the tail ends are easier to identify than the heads.

The two species I am particularly interested in belong to a genus which is characterised by the presence of a membranous collar on the fourth segment to bear chaetae, which projects forward and overlaps the posterior part of the segment in front of it. This makes recognition of the head end relatively easy. Of the two species, *Clymenella torquata* is recorded intertidally and in the shallow subtidal of southeast England, and is thought to be an american immigrant. *Clymenella cincta* is much less well known, and I have not yet found a description of its tail end.

So, if anybody out there has specimens which they think belong to either of these two species, and is willing to let me look at them, then I would be very grateful. Heads would be interesting, tails would be wonderful, and a complete specimen, well.....

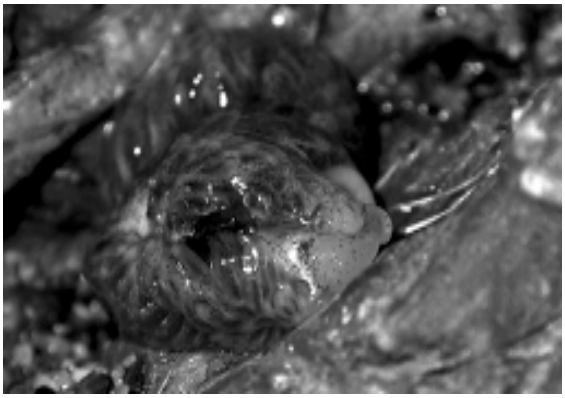
Stranded whales in Norfolk

Gayle Lister (matt.lister@zebin.co.uk) sent in some pictures to the editor, of a stranded sperm whale taken by the RSPB Titchwell Marsh site manager Adam Rowlands. The stranded whale was washed ashore at at Thornham, Norfolk, in February (around 10-15th). A few days later it moved around to Wells next Sea where it obstructed the harbour entrance. There have been a number of strandings on the Wash and Norfolk coast in the last few years.

CREATURE FEATURE

Notes on the natural history of the sea-slug, *Aeolidia papillosa* (Linnaeus, 1761)

by Peter Barfield, Sea-nature Studies
*(*website*:* www.seanature.co.uk e-mail*:* peter@seanature.co.uk*)*



Classification:

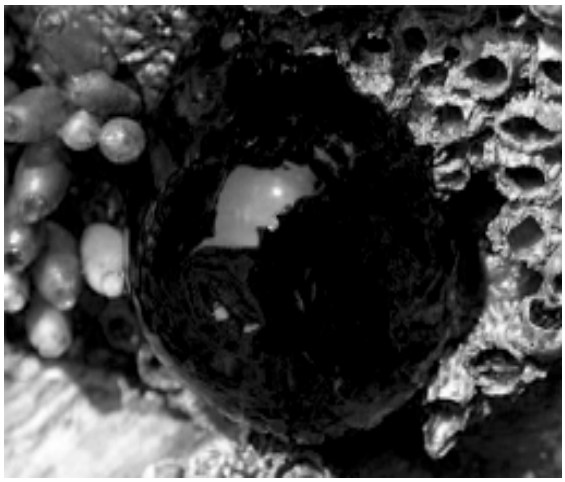
Phylum	Mollusca
Class	Gastropoda
Subclass	Opisthobranchia
Order	Nudibranchia
Family	Aeolidiidae
Genus	*Aeolidia*
Species	*papillosa*

Aeolidia papillosa (Linnæus, 1761), or the common grey sea-slug, is found on shores and in shallow water all around the UK. The animal pictured was at around the mid-shore level having been uncovered by the ebbing tide on the north coast of Cornwall on a sunny day in February 2003. As the colouration indicates the common grey sea-slug may not be grey at all and identification guides note a range of possible colour types from white to purple-brown.

Distribution:

The common grey sea-slug has a wide geographic distribution globally, occurring on most north temperate shores. It is the largest member of the aeolid family (aeolidiidae) we have and can grow up to 120mm in length, though this is the exception rather than the rule. Despite the fact that it is large, widespread and common I rarely encounter this beast on my trips to the north coast. But then *Aeolidia papillosa* is a predator, with a position higher up the food chain and therefore its abundance is inevitably less dramatic than those animals which dominate this exposed coast. It is thought to live for about one year.

Caught out of water the slug appears thoroughly unimposing. The real drama does not begin until the flood tide once again covers the shore beneath a cloak of seawater…



Food:

Aeolidia papillosa feeds on sea anemones showing a clear preference for beadlets, especially *Actinia equina*, the radially beautiful and deep-red anemones that pepper the shores of north Cornwall. *Aeolidia* will also feed on other anemones such as the strawberry anemone, *Actinia fragacea*, the snakelocks anemone *Anemonia viridis*, the Dahlia anemone *Urticina felina* and *Sagartia elegans*, though it is much less partial to these last two. Unless otherwise stated the description which follows is based on an encounter of *Aeolidia* with *Actinia equina*, its favoured prey in UK waters.

Hunting:

Aeolidia papillosa has a chemosensory ability and it uses this to hunt out its prey. Using specialised sense organs such as the dorsally prominent paired rhinophores ('rhino' is Greek for 'nose') and the oral tentacles each side of its mouth, as well as other chemo-receptors, also on its head, it will seek to get a lock onto the scent of its prey and then swivel towards it. Even weak trails can be followed as this sea-slug is skilled at detecting small increases in chemical concentrations and tracking up these invisible gradients to the source. When it finds a tell-tale trace it will swing its raised head from side-to-side, rhinophores quivering forwards and upwards, oral tentacles stretched out laterally and also searching forwards. The thread of a scent detected, *Aeolidia* begins to move rapidly towards the source.

First contact:

Its out-stretched oral tentacles may well be the first to touch the anemone. The sea-slugs reaction is too move its head back, contract the oral tentacles, whilst defensively pivoting the finger-like 'cerata', which cover its back, up and forward in the frontal region. At the same time the sensitive rhinophores are shortened and bent back and downwards to lie protected amongst the cerata. It is likely to have been stung in this brief engagement, especially if the oral tentacles happened to touch the anemones own tentacles rather than its stout column. Both of these areas on the anemone house some of the specialised stinging cells or nematocysts with which it defends itself, but they are more numerous in the tentacles. Meanwhile the anemone swings these tentacles in and back onto the oral disc.

Unperturbed the hunter re-extends its head, oral tentacles, and out through its mouth shunts a proboscis tipped with a set of jaws. This eversion heralds the imminent start of feeding. For a short while the oral tentacles and proboscis slide over the column, perhaps seeking for a suitable place for the first bite.

Actinia bends in the column where it has been touched so that the top bows over towards the aeolid.

Defence:

The sea-slug's primary defence against the stings from the anemones nematocyst cells is mucus. It secretes a thick and sticky sheath of mucus, particularly centred around the head area. The mucus is an effective barrier, into which nematocysts may discharge harmlessly, flecking this colloidal screen with little patches of lightning white in the process. This is especially useful in attacks on *Anemonia viridis*, which does not cease in its attempt to sting the attacker with its tentacles.

Remarkably *Aeolidia papillosa* can ingest the sting-cells, or nematocysts, of anemones and then transfer these to the tips of the finger-like processes, or cerata, along its back, using them in its own defence.

This gives a clue to understanding the scientific name, *Aeolidia papillosa*, for this sea-slug. In Latin 'Aeolus' means changeable (according to Homer, Aeolus was god of the winds, hence also, perhaps, the saying, 'as changeable as the wind') and *papillosa* is a nipple or teat.

Feeding:

Aeolidia maintains contact with the column of *Actinia* and the open jaws try to bite onto a part of it. It's not entirely clear if the jaws cut or rasp off tissue but when they succeed the abrasion on the column is clear.

Not surprisingly the anemone's reaction to being bitten is more dramatic than at first contact. The tentacles are violently withdrawn back onto the oral disc and covered by the closing of a sphincter. The column shortens as the anemone seeks to withdraw the area bitten from contact with the aeolid. In this semi-protective 'beadlet' state the pedal disc also begins to withdraw away from the sea-slug. This action is often followed by the anemones gradual movement away from its attacker on small waves of contraction that ripple slowly across the pedal disc.

Bites are taken at 10-20 second intervals but as feeding continues *Aeolidia* will pause for several minutes and these pauses increase in duration and may last up to several hours. If the anemone doesn't escape then *Aeolidia* feeds until satiated. Within the mouth a

chitonous cuticle protects many aeolids from being stung there.

Aeolidia can move up to 100 times faster than *Actinia* but because of the increasingly long pauses it takes during feeding the *Actinia*'s attempt to escape is not as futile as it appears. Unfortunately a damaged anemone is more easily tracked.

Moving also benefits the anemone in another way and perhaps, in terms of its evolution, this is an additional reason why locomotion is favoured in *Actinia equina*. In order to move, the anemone uses its hydrostatic skeleton, inflating itself in the process. This inflation makes it harder, in a very physical, practical sense, for the attacking *Aeolidia* to bite the anemone. When an attack stops the anemone may keep moving for several hours.

If, despite its attempts to escape, the attack continues for a long time the anemone will, as a last ditch effort to evade being further consumed (!), detach itself from the substrate under-foot. This is a drastic measure because once detached it may be swept into wholly unsuitable habitat and thus die anyway. However, once left alone a detached anemone can re-attach in 10 minutes.

Reproduction:

Sea-slugs are hermaphrodites and *Aeolidia papillosa* is no exception. Although hermaphrodites can self-fertilise this is rare in nudibranchs and most will copulate. During the reproductive period *A. papillosa* continues to direct a lot of energy to somatic growth. This may be in part because a larger body size makes it easier to prey on the available food items. Spawning adults survived until mid-July when mean water temperatures were 14.3 C°. The larvae are planktotrophic free-swimming veligers. Life in the plankton is very hazardous and mortality is high in this phase of development and dispersal. The warmer the conditions the faster the development process. By spawning during a period of increasing water temperatures *Aeolidia* decreases the time its offspring will have to spend in the plankton. To ensure successful spawning *A. papillosa* will undergo 'de-growth', using the breakdown products from this autolysis (in Greek, 'lysis' means loosening) to support reproduction. The onset of death may therefore be precipitated not least by the action of spawning.

Curiosity:

On the Canadian pacific coast *Aeolidia papillosa* feeds preferentially on *Anthopleura elegantissima*, an anemone that is not found on our own shores. *Anthopleura elegantissima* has a symbiotic relationship with two types of algae that live within its tissues. The algae photosynthesize in this protected and stable environment and the anemone receives some of the products generated by these tiny plants. The two types of algae present are collectively known as zooxanthellae and zoochlorellae. The latter is a unicellular green algae and the former are diatoms of the genus *Symbiodinium*.

When *Aeolidia* consumes *Anthopleura* the ingested algae are not digested but transferred to the sea-slugs finger-like 'cerata'. In this new environment the algae continue to live and photosynthesize to the benefit of their new host though at no time are *Aeolidia* dependent on the symbionts that they briefly house. Indeed the aeolid is unable to control these temporary tenants, by either expulsion or retention, even in starvation conditions. However by feeding frequently on *Anthopleura* the population of symbionts in the cerata can at least be maintained. There is no discernable impact on the algae during this passage from one host to another and out again. It should be noted that the zoochlorellae may behave parasitically in low light conditions and could therefore be detrimental to the host during winter.

The snakelocks anemone, *Anemonia viridis*, in our waters is also home to algae of the genus *Symbiodinium*. As *Aeolidia papillosa* can feed on *Anemonia viridis* in our own waters does it develop a similarly symbiotic relationship with the algae as a consequence of this?

References:

The following references were consulted in the production of much of the above

material, though any mistakes, musings and misapprehensions are (as ever!) entirely my own. The key paper was Edmunds *et al* (1976).

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The Farne Islands Marine Life Log, 2003

John Thompson[1] and Judy Foster-Smith[2]

1 Site manager, South Walney Nature Reserve, Cumbria Wildlife Trust, Walney Island, Barrow-in-Furness, Cumbria, LA14 3YQ (e-mail: johnt@cumbriawildlifetrust.org.uk)

2 School of Marine Science and Technology, University of Newcastle, The Dove Marine Laboratory, Cullercoats, North Shields, Tyne and Wear, NE30 4PZ (e-mail: judy.foster-smith@ncl.ac.uk)

Introduction

The Farne Islands, off the Northumberland coast (Figure 1), have been owned by the National Trust since 1925. The islands are managed by the Trust primarily to protect their internationally renowned seabird and grey seal colonies. However, in recognition of the fact that these important populations are dependent on the health of the sea around them, the 'Farne Islands Marine Monitoring' programme was established in 1996 in an attempt to provide an understanding of the state of the local marine environment and the extent to which it is being used, both commercially and for recreational purposes (Foster-Smith & Foster- Smith, 1996). The marine monitoring programme now forms part of the Farne Islands Management Plan (Walton, 2000). Much of the data for the monitoring programme has been collected by the Farnes' seasonal wardens (usually 9 in number), who reside on the islands between March and December each year. Apart from dealing with visitors to the islands, the wardens' work is primarily concerned with maintaining the seabird and seal colonies and, not surprisingly, they are selected for the post on the basis of their interest in these groups. However, since the establishment of the

marine monitoring programme, there has been a move by the Trust to employ, when possible, a warden with a particular interest in the invertebrate marine fauna.

Part of the marine monitoring programme consists of the compiling of a 'Marine Life Log' that, as the title implies, entails documenting observations of marine species as the season progresses.

The records of marine life observations compiled by Gabb (2001; 2002) as part of this scheme while working as a warden on the Farnes have proved useful as a guide to what can be expected to be found on the islands. They have been of particular use to those wardens with limited marine biological expertise. This current paper presents the marine species records that have been compiled during the 2003 season. This will not only serve to document the marine life of the Farnes for 2003, but it will also extend the catalogue of marine species recorded on the islands for the benefit of future wardens.

The records are confined to the 'Inner' group of islands (Inner Farne, the Wideopens, Knoxes Reef and the Scarcars) apart from those of seals and cetaceans. All of the sites mentioned in the text are given in Figure 1.

Most of the records have been derived from informal, intertidal surveys. These were mainly carried out in the rich, tidal-current area between Inner Farne and West Wideopens, although some occurred on the shores of neighbouring islands. Other records (mostly of large and readily identifiable species, such as fish) have been made as a result of snorkelling forays in 'The Kettle' area and other sites around Inner Farne. Further records have been obtained on an 'ad hoc' basis from observations of marine species seen being caught by their respective predators, or caught in pots or on fishing lines. In addition, the dates of the first sightings of the large planktonic species (three species of scyphozoan, *Cyanea capillata*, *C. lamarkii* and *Aurelia aurita*, and three species of ctenophore, *Pleurobrachia pileus*, *Bolinopsis infundibulum* and *Beroe cucumis*), were specifically documented.

The recording has been carried out in an opportunistic way, whenever the tides, weather and time available have been appropriate. There has been particular focus on certain animal groups, relating to those that have 'captured' the wardens' interest. Sea slugs, for example, have been of special interest to one of the 2003 wardens (John Thompson) and this is evident from the records.

The observations were compiled using 'Marine Life Log' recording sheets which prompted the '4Ws' recording procedure: What (species); When (date); Where (site) and Who (recorder). In addition, drawings of the observations were sometimes made and, where possible, photographs were taken for use in the verification process. Verification of the records was carried out by consensus identification between the wardens using standard field guides (e.g. Picton, 1993; Hayward *et al.*, 1996), reference to a specialist (Peter Garwood or Judy Foster-Smith) or, where verification was not possible, this has been noted.

Species List

The species are coded and listed in order according to Howson and Picton (1997). Higher classification is included where it is thought to be helpful in categorizing the species. Common names are included where available. While the observations were made by several of the wardens (see acknowledgements), the information for the following list was compiled by John Thompson.

Phylum Porifera

C76 Grantia compressa (Purse sponge). Found occasionally in small clusters on algae or boulders.

C651 Halichondria panicea (Breadcrumb Sponge). A locally abundant sponge, covering boulders sub-tidally and forming "walls" on steep rock faces. Frequently found washed ashore following high seas.

Phylum Cnidaria

Superclass Scyphozoa

D11 Halyclistus auricula. First recorded for the Farnes in 2002 when a few specimens

were recorded from both the 'Inner' and 'Outer' group of islands (Figure 1). One specimen was found in 2003 attached to *Laminaria* in 'The Kettle' sub-tidally when snorkelling.

D44 Cyanea capillata. First recorded on the 16th of June and present throughout the summer.

D45 Cyanea lamarcki. First recorded this season on the 22nd of May and was present throughout the summer. It was noted in very large quantities in open water along with *C. capillata* and *Aurelia aurita* (see below) during August.

D47 Aurelia aurita. First recorded 10th of June and present throughout the summer.

Superclass Hydrozoa

D66 Apolemia uvaria? (String Jelly). Three specimens of what were thought to be this species were collected, on 3 different occasions, from around the Inner Farne jetty. Unfortunately all of these were accidentally lost before identification could be verified or photographs taken. This record is of particular interest since this species has not previously been documented off the north east coast of England (Foster-Smith, 2000) and, of all the standard current field guides it could be found referred to only in (Erwin and Picton, 1995). The photograph from the latter publication helped to make this tentative identification.

D166 Tubularia indivisa. Recorded during April and May, usually associated with feeding sea slugs.

D303 Staurophora mertensis. First recorded this season in Farnes waters on 23rd of April.

D469 Plumularia setacea. Amongst boulders on shore at extreme low spring tide level and subtidally between Inner Farne and West Wideopens

Superclass Anthozoa

D675 Actinia equina (Beadlet Anemone). The most common anemone around the islands; abundant on boulders and in rock pools.

D684 Urticina felina (Dahlia Anemone). Amongst boulders between Inner Farne and West Wideopens at low spring tide.

D705 Diadumene cincta. One specimen retrieved from a laminarian holdfast on a snorkelling trip between Inner Farne and West Wideopen. This is only the second documented record of this species for the Northumberland Coast, the first having been in 1936 (Foster-Smith, 2000).

D712 Sagartia elegans. This species has been noted in small clusters confined to rock pools on Inner Farne, East Wideopen and Knocklin Ends.

D715 Sagartia troglodoytes. Recorded from Farne Haven boulder shore (Inner Farne) and from a reef just east of 'The Bridges'.

Phylum Ctenophora

E6 Pleurobrachia pileus (Sea Gooseberry). First recorded this season on 23rd of April (previously not before 12th May).

E10 Bolinopsis infundibulum. First recorded this season on 23rd of April (previously not before 8th May).

E15 Beroe cucumis. Recorded earlier in the season (27th March) than in previous years (between 9th April and 19th May).

Phylum Nemertea

G55 Lineus ruber (Red Ribbon Worm). One record of several specimens from gravel on Knoxes Reef.

Phylum Annelida

Class Polycheata

P64 Harmothoe imbricata. Common among boulders lying on sand or gravel. It is possible that it may have been confused with *H. impar* in the field.

P82 Lepidonotus squamatus. Two specimens came from the Farne Haven boulder shore (June and October). Less common than *H .imbricata* though much more distinctive and a striking metallic purple in colour.

Phylum Arthropoda

Superclass Crustacea

S935 Idotea baltica. Common on the shoreline.

S938 Idotea granulosa. First recorded amongst algae on Farne Haven boulder shore on the 2nd of April. Subsequently found to be one of the most abundant intertidal crustaceans.

S1056 Eualus sp. One specimen noted from the Farne Haven boulder shore was

carrying eggs on 17th of April.

S1342 Ligia oceanica. Abundant. Regularly found around the Inner Farne jetties.

S1400 Homarus gammarus (Common Lobster). Common subtidally around the islands and, together with other crustaceans (see below), support a local potting industry, most having been caught after August.

S1439 Lithodes maia (Stone Crab). Carapaces of this species were found on the island tops of the Wideopens near nesting gulls.

S1457 Pagarus bernhardus. Many small specimens were found in rockpools and on the lower shore occupying *Littorina littorea* and *Gibbula cineraria* shells. One very large specimen was collected from the sandy floor of 'The Kettle', with a maximum chelae width of 1.5cm occupying a *Buccinum undatum* shell 11cm long.

S1475 Galathea squamifera. One specimen was found dead floating in a rock pool on the southern shore of Inner Farne.

S1482 Pisidia longicornis.(Long-clawed Porcelain Crab). Extremely abundant under boulders, in crevices and amongst kelp holdfasts. Recorded throughout the season.

S1518 Hyas araenus (Great Spider Crab). One specimen was found amongst lobsters in a holding pot for lobsters in 'The Kettle' on 11th September.

S1536 Eurynome aspersa. Spider crab. Two specimens of this species were found on 31st August amongst coarse gravel/shingle under boulders low on the Inner Farne shore.

S1566 Cancer paragus (Edible Crab). Abundant around the islands; often caught in pots.

S1580 Liocarcinus depurator (Harbour Crab). Two small specimens were recorded on the lower shore of Inner Farne.

S1589 Necora puber (Velvet Swimming Crab). A distinctive and ferocious crab, frequently caught in pots and found on the lower shore.

S 1594 Carcinus maenas (Green Shore Crab). Common on all shores and frequently caught in pots.

Phylum Pycnogonida

Q5 Nymphon brevirostre. Found amongst hydroids on boulders or amongst kelp holdfasts A specimen carrying eggs was noted on 17th of April. Previously unrecorded for the Farnes.

Q30 Endeis spinosa. One specimen was recorded on the 3rd of April from the region between Inner Farne and West Wideopens. Previously unrecorded for the Farnes.

Q48 Phoxichilidium femoratum. One specimen of this species was noted late in the season at extreme low water on Farne Haven boulder shore (27th October). Previously unrecorded for the Farnes.

Q51 Pycnogonum littorale. Three specimens of this chunky and distinctive species were collected from inter-tidal zones on the eastern side of 'The Bridges', on Knocklin Ends and on Farne Haven boulder shore.

Phylum Mollusca

Class Polyplacophora

W79 Lepidochitona cinerea. A few specimens found amongst boulders in the low littoral zone.

W86 Acanthochitona crinita. A more distinctive species recognizable by large tufts of bristles around the girdle. Only one record (on 16th April).

Class Gastropoda

Subclass Prosobranchia

W163 Gibbula cinerarea (Grey Top Shell). Common.

W182 Calliostoma zizyphinum (Painted Top Shell). Occasional.

W234 Helcion pellucidum (Blue Rayed Limpet). A familiar and attractive species regularly observed grazing on *Laminaria*.

W296 Littorina littorea (Common edible winkle). Common.

W302 Littorina obtusata (Flat winkle). Common.

W307 Littorina saxatilis var. *rudis* (Rough winkle). Common.

W459 Trivia arctica (Arctic Cowrie). Frequently observed on rocky shores around Inner Farne.

W461 Trivia monacha (Spotted Cowrie). Regularly seen on rocky shore around Inner Farne.

W687 Nucella lapillus (Dog Whelk). Common.

W708 Buccinum undatum (Common whelk). Small specimens common intertidally.

W747Hinia incrassata (Thick-lipped Dog Whelk). Occasional.

Subclass Opisthobranchia

W1157 Pleurobranchus membranaceus. Recorded twice in 2003; two specimens were noted on the eastern side of 'The Bridges' (16th June) and two specimens on the boulder shore of Farne Haven (31st August). The latter appeared to have taken on the coloration of the bryozoan upon which it was found.

W1302 Goniodoris nodosa. One of the most common and widespread sea slugs found around the Inner group and recorded throughout the season.

W1315 Ancula gibbosa. The first specimen of this species was collected on 18th April as it drifted through tidal stream between Inner Farne and West Wideopen. One further specimen was noted on hydroids whilst snorkelling in the same area on 11th May.

W1322 Onchidoris bilamellata. One of the earliest species to be recorded and reported more frequently in the early part of the season.

W 1325 Onchidoris muricata. A common species around the islands and found higher in the littoral zone than any other nudibranch.

W1336 Adalaria proxima. Appears to be a frequent species around the islands although there may have been confusion with *O.muricata* in the field.

W1350 Polycera quadrilineata. Only one record of this species was documented in 2003 (3rd April), even though its eye-catching appearance led to many sub-tidal records in 2002. It is usually associated with *Laminaria* bearing large amounts of the bryozoan *Membranipora membranacea*.

W1354 Limacia clavigera. Recorded throughout the season from 3rd April; often found in small groups.

W1272 Doto coronata. Two specimens of this tiny and inconspicuous species were observed in a rockpool on Knocklin Ends on 10th June.

W1376 Archidoris pseudoargus (Sea Lemon). Two were found mating on 16th April on breadcrumb sponge that covered the underside of a boulder. Two large egg masses were already present.

W1417 Coryphella browni. As with the above species the only record was on a particularly productive shore search on 3rd April.

W1422 Coryphella verrucosa. The only record was from Inner Farne on 3rd April.

W1438 Cuthona nana. Two records of what were believed to be this species after scrutiny under microscope, were made from Farne Haven boulder shore and rockpools on Knocklin Ends, both in late May. This species has not been documented for the Northumberland coast since 1946 (Foster-Smith, 2000).

W1484 Aeolidia papillosa (Common Grey Sea Slug). The first record of this species in 2003 caused some confusion due to much dark pigmentation on the animal. It was later thought that this colouration may have been due to what it had been feeding on (*Actinia equina*).

Class Pelecypoda

W1695 Mytilis edulis (Common Mussel). Recorded on all rocky shores. Can be locally abundant; generally of small size (around 2cm in length) in littoral zone.

W1771 Pecten maximus (Great Scallop). Single valves were noted and collected on two occasions from the sandy areas of 'The Kettle'.

W1999 Ensis ensis (Common Razor Shell). Another species associated with sandy sediment noted on the floor of 'The Kettle'.

W2130 Dosinia exoleta (Rayed Artemis). Seemingly common; often noted on sandy areas of 'The Kettle' and occasionally found on island tops where they had been fed on by gulls.

W2166 Hiatella arctica (Wrinkled Rock Borer). Found occasionally around Inner Farne in crevices and amongst boulders.

Phylum Echinodermata

ZB20 Ophiopthrix fragilis (Common Brittlestar). Abundant under boulders and amongst gravel on the lower shore, throughout the 'Inner' group of islands

ZB51 Hippasteria phrygiana (Rigid

Cushion Star). Though the date of this record is not noted it was found dead in a Lobster pot in mid-summer and was given to the island wardens by Allan Gardiner (Skipper of 'Glad Tidings 3' from Seahouses). This is a significant record as the species is considered "rather rare" around the British Isles (Picton, 1993) and previous records for the Northumberland coast have tended to be from deep water (around 40 fathoms), the most recent dated record being 1912 (Foster-Smith, 2000).

ZB75 Crossaster pappossus (Common Sun Star). Three specimens were noted during the season. The first, a small specimen, was recorded on 5th April. One specimen, 22cm in diameter, was found on the floor of 'The Kettle' on 11th April. The third was noted beyond the low water jetty on Inner Farne.

ZB82 Henricia sp. (Bloody Henry/ Northern *Henricia*). One of two likely species (*H. sanguinolenta* or *H. oculata)*, regarded as inseparable in the field, was first recorded on 19th April and was noted on rock faces at low water twice thereafter.

ZB100 Asterias rubens (Common Starfish). Observed frequently in all inter-tidal recording sessions. One notable specimen was found on the sandy floor of 'The Kettle', measuring 29cm across, being very pale in colour and lacking the rigidity of smaller specimens.

ZB161 Amphipholis squamata Recorded from Farne Haven boulder shore on 17th April.

ZB193 Psammechius miliaris Shore Sea Urchin. Found frequently on the lower shore and in shallow sublittoral areas amongst boulders and *Laminaria* holdfasts. All specimens found around the islands have been about 20mm in diameter. Often found disguising themselves with small fragments of seaweed.

ZB198 Echinus esculentus (Edible, or Common, Sea Urchin). Abundant on kelp stems and rocks on the shore at low spring tide level and in the subtidal zone. Often taken by gulls, which have a habit of dropping them from height onto rocks.

ZB212 Echinocyamus pusillus (Green Sea Urchin). This tiny species is likely to be overlooked because of its size. The test of one specimen, found amongst gravel on Inner Farne, was the only record.

Phylum Chordata

Subphylum Tunicata

Class Ascidiacea

ZD31 Sidnyum turbinatum. Several clusters were noted on 16th June at low spring tide on a reef behind 'The Bridges' The species is regarded as 'not uncommon' in the region, under boulders at low water spring tide level (J. F-S) even though it is described as 'rare' in the North Sea in the literature (i.e. Hayward and Ryland, 1996).

ZD126 Botryllus schlosseri (Star Ascidian). This striking and distinctive species was found commonly throughout the season on algae (e.g. *Halidrys siliquosa*) and under boulders.

Subphylum Pisces

ZG17 Conger conger (Conger Eel). One specimen of just under 2m in length was caught in a lobster pot placed in 'The Kettle', 17th August.

ZG50 Salmo salar (Atlantic Salmon). One was observed being consumed by a grey seal off the North West corner of Inner Farne. Fish observed "jumping" near the Islands may have also been this species.

ZG111 Ciliata mustela (Five-bearded Rockling). One specimen, 18cm long, was recorded from a crevice draped with kelp, behind 'The Bridges' at low spring tide, 16th June.

ZG116 Gadus morhua (Cod). Several fish were caught and given to the wardens by various Seahouses boatmen.

ZG135 Pollachius pollachius (Pollack). Caught on a fishing trip south of the Inner Group during July.

ZG136 Pollachius virens (Saithe). Noted in large numbers over rocks and amongst kelp throughout the summer while snorkelling.

ZG230 Spinachia spinachia (Fifteen-spined Stickleback). One specimen was noted from a rockpool on Inner Farne, 25th October.

ZG281 Myoxocephalus scorpius (Father Lasher). Found frequently in rock pools around the Islands.

ZG283 Taurulus bubalis (Long-spined Sea Scorpion). Few records, possibly due to confusion with *Myoxocephalus scorpius*.

ZG294 Cyclopterus lumpus (Lumpsucker).

Early in the season (April – May) several specimens were captured by Seals, Cormorants, or Gulls resulting in some interesting squabbles. Specimens were also found at this time guarding egg masses at extreme low tides.

ZG297 Liparis montagui (Montagu's Sea Snail). One specimen was found clinging to *Laminaria* stipe on 17th April.

ZG395 Crenilabrus melops (Corkwing Wrasse). Some fish, believed to be of this species were in 'The Kettle' amongst *Laminaria*, 9th July.

ZG399 Labrus bergylta (Ballan Wrasse). A large and distinctive wrasse observed amongst *Laminaria* in 'The Kettle' (9h July) and around Inner Farne.

ZG412 Lipophrys pholis (Shanny). Two specimens were noted though the species is thought to be more common than this would suggest. Found in rock pools and also low on the boulder shore of Farne Haven.

ZG442 Ammodytes spp. (Sandeel). These fish are abundant around the islands, often visible in large shoals in open water. They are likely to consist of both *Ammodytes marinus* (Rait's sandeel) and *Ammodytes tobianus* (Lesser Sandeel). They form an important component of the Farne Islands marine environment as the principle food source for the majority of the breeding seabirds.

ZG448 Pholis gunnellus (Butterfish). Possibly the most common shore fish around the islands. Frequently forms a food source for Terns on low spring tides.

ZG511 Scomber scombrus (Mackerel). Abundant and easily caught on lines from July through to late September.

ZG576 Platichthys flesus (Flounder). Flatfish almost certainly of this species were observed in 'The Kettle' while snorkelling, June to November. Some specimens were very large.

Subphylum Vertebrata

Class Mammalia

Order Pinnipedia

ZK13 Phoca vitulina (Common Seal). One was on the North Wamses during seal census work on 16th October.

ZK15 Halichoerus grypus (Grey Seal). Present throughout the year. Several yearling seals were found early in the season badly caught up in netting; all were cut free. The first pup of 2003 was born on Northern Hares on 25th September.

Order Cetacea

ZK28 Tursiops truncatus (Bottle-nosed Dolphin). 6 individuals of this species were seen heading north through Inner Sound on 3rd August.

ZK31 Lagenorynchus albirostris (White Beaked Dolphin). These dolphins were reported around the islands on 7 occasions, between 24th June and the 12th August.

ZK42 Phocoena phocoena (Harbour Porpoise). A total of 47 sightings of Harbour Porpoise were reported from around the islands on 36 days throughout the season, between 29th March and 24th of November. The majority of these sightings came from Inner Sound although they occurred in Staple Sound of further east for a brief period during mid-summer. Most sightings comprised groups of up to 5 individuals, although, exceptionally, groups of 12-15 were present in late October. The first young were reported on the 13th of May.

ZK65 Balaenoptera acutorostrata (Minke Whale). 7 sightings of Minke Whale were reported in June, September and October. Interestingly, these were the same months that the Minkes were reported in 2002.

Discussion

This list amounts to approximately 105 marine species. The records of a number of these are of particular interest.

Firstly, the tentative records of the String Jelly *Apolemia uvaria*, apparently observed on three different occasions, may be the first documented sightings of this species for the north east coast of England. Although the identification is uncertain it was felt that inclusion of this record in this list might stimulate discussion as to the current status and distribution of this species.

Secondly, three other species, *Diadumene cincta*, *Cuthona nana* and *Hippasteria phrygiana*, appear to be rather rare for the region, having last been documented for the 'Cullercoats' District (Berwick to Redcar) in 1936, 1946 and 1912 respectively (Foster-

Smith, 2000).

Thirdly, a further six species (i.e. in addition to those four given above), while not uncommon for the District, are newly documented for the Farne islands: *Sagartia troglodytes*, *Lineus ruber*, *Nymphon brevirostre*, *Phoxichilidium femoratum*, *Endeis spinosa*, and *Sidnyum turbinatum*.

Fourthly, all three of the large planktonic ctenophores *Pleurobrachia pileus*, *Bolinopsis infundibulum* and *Beroe cucmis*, appeared at least two weeks earlier than in previous years (1997-2002) and this may be related to larger-scale changes in water currents.

Another interesting observation (or, rather, 'non' observation!) worthy of note was the distinct lack of the nudibranch *Dendronotus frondosus*. No records of this species were made in 2003 despite extensive searching. This is surprising in view of the fact that, in 2002, they were noted as "super-abundant" in the tide swept *Laminaria* zone between Inner Farne and West Wideopen, with estimates of 3000+ seen feeding on hydroids (J.Thompson, pers. obs.). This difference may relate to a varying availability of prey, since, in some nudibranch species, the metamorphosis of juveniles into the adult stage is apparently triggered by the presence of a particular prey species (Picton and Morrow, 1994).

Conclusion

The production of this catalogue of species for 2003 has helped to emphasise the importance of including the 'Marine Life Log' recording process in the management scheme for the Farne islands. The 'Log' not only helps to increase our fundamental knowledge of the islands' marine life, that can be built on over the years, but it also illustrates the importance of the non-specialist contribution to the documentation of marine species information. The 2003 wardens, who have had no specific marine biological training, have provided evidence of 'new' species for the site, and they have confirmed the continuing presence in the region of other species

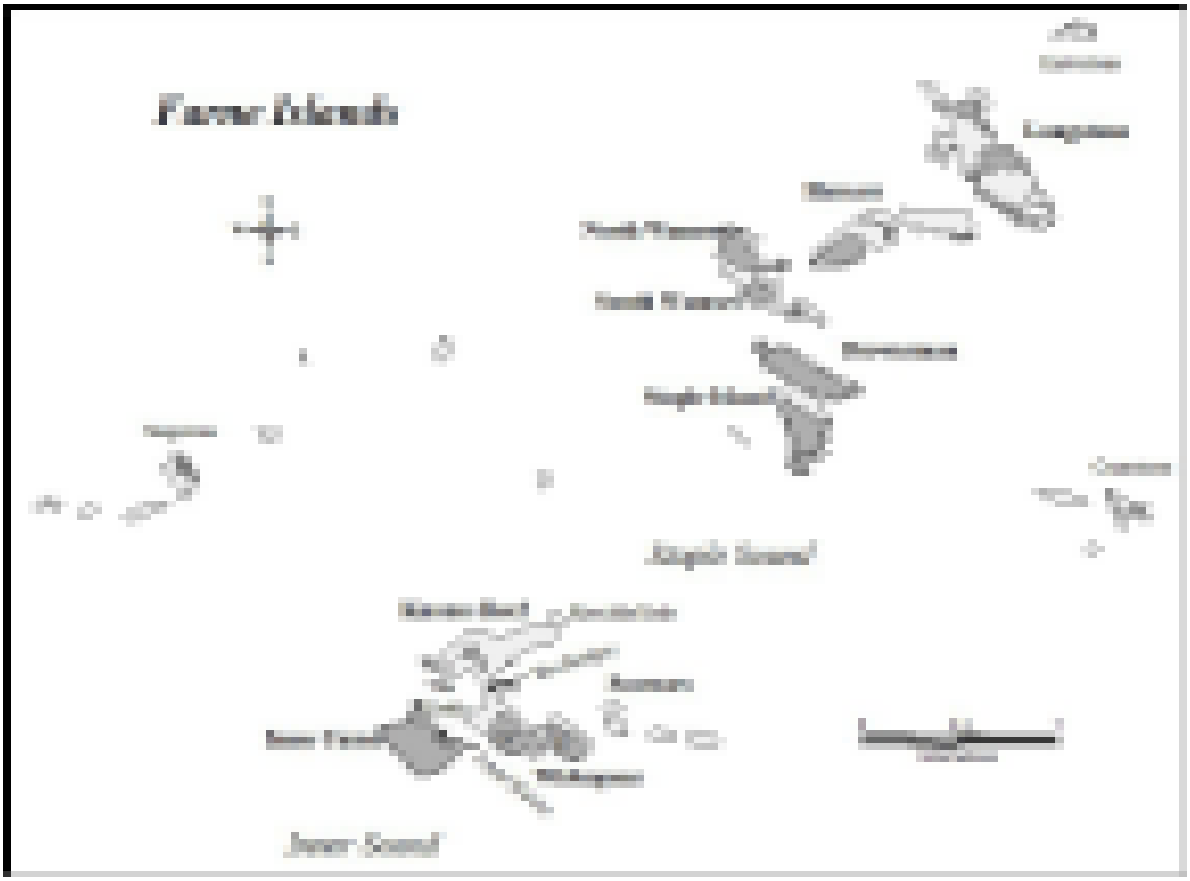

Figure 1. The Farne Islands, off the Northumberland coast.

previously regarded as 'rare' and therefore likely to be vulnerable; they have also highlighted significant changes in the seasonal timing of the appearance and in the abundance of certain species and thus may help, even in a very small way, to increase our understanding of the local effects of large-scale ecological processes (e.g. global warming). In addition, through dissemination of their observations, they are likely to stimulate discussion about the current distribution of yet other species.

Furthermore, the simple 'Log' recording process creates a heightened awareness of marine life amongst the wardens and, through their conversations with visitors to the islands (numbering about 40,000 annually), this could have a significant impact on the extent to which the general public value our marine fauna.

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Species List from Field Visit of PMNHS to Osmington Mills, Dorset on 22nd March 2004 following the Bournemouth Conference.

Lin Baldock

Altogether 21 Porcupines made it down to the beach at Osmington Mills (Nat Grid Ref SY 735 817) for a good low spring tide in fine, bracing weather spiced up with the occasional hail shower. I would like to thank all those who sent me records. The final list will be passed on to the Dorset Environmental Records Centre for inclusion in their marine database. The list below is an amalgam of various Porcupines' records. I would like to thank Julie Hatcher, Jan Light, Shelagh Smith, Steve Trewhella and Tim Worsfold for their personal records and Anne Bunker who provided a list which included both her own records and casual observations of other Porcupines.

The beach at Osmington has a selection of habitats. A small stream runs over the beach, there are patches of sand between cobbles and huge boulders and the lower shore is made up of low rock ledges and deep intertidal pools with good growths of algae. The site is fairly exposed.

Jan Light made a specific search for *Paludinella litorina* at the top of the shore without success. This confirmed her on-site assessment of the available habitats as being unsuitable for this species. A slightly edited version of Jan's description of her search area is given below.

"The upper shore was of boulders, somewhat disturbed with small areas of bedrock exposed (Upper Corallian or Lower Kimmeridge Clay). There was some faulting in these horizons but with no exploitable cracks or crevices to investigate.

The shore search concentrated around high water mark for upper shore crevice fauna. Only occasional boulders of movable size were found to be of suitable lithology with rough surfaces allowing silt retention and a degree of embedding. An area of suitable and accessible habitat was found immediately west of the old slipway. Here, whilst some slab undersides were clean and devoid of life, others were well colonised by crevice fauna members. The 'fruitful' slabs and boulders were sitting on silted gravels whereas many of the barren slabs and boulders investigated were sitting on washed gravels and pebbles."

Jan's detailed search of sediment collected from beneath potentially suitable boulders failed to reveal any mollusc other than a single *Leucophytia bidentata*.

Continuing John Hawthorne's long-term observations at Osmington Mills on the population of *Osilinus lineatus* on their usual restricted part of the beach, Emma Liddell and Gayle Lister recorded two groups of about 25 individuals each in two places on the shore. An individual as much as eight years old was found and what was also encouraging, several 0+ specimens about 1cm in maximum diameter were recorded in the sample. The four-year class was the most common.

The nomenclature and taxonomic order for the list follows Howson C.M. & Picton, B.E. (1997) *The Species Directory of the Fauna and Flora of the British Isles and Surrounding Seas*. Ulster Museum and the Marine Conservation Society, Belfast and Ross-on-Wye.

Porifera
- Grantia compressa
- Halichondria panicea
- Hymeniacidon perleve
- Haliclona viscosa

Cnidaria
- Dynamena pumila
- Actinia equina
- Actinia fragacea
- Anemonia viridis

Nemertea
- Nemertea indet.

Nematoda
- Nematoda indet.

Platyhelminthes
- Procerodes littoralis

Annelida
- Harmothoe spinifera
- Pholoe inornata
- Eulalia viridis
- Sphaerosyllis tetralix
- Nereididae (juv)
- Lysidice ninetta
- Lanice conchilega
- Fabricia sabella
- Spirorbidae
- Protocirrineris chrysoderma

Acariformes
- Acariformes indet.

Crustacea
- Chthamalus montagui
- Chthamalus stellatus
- Elminius modestus
- Semibalanus balanoides
- Balanus perforatus
- Stenothoe monoculoides
- Hyale stebbingi
- Orchestia sp
- Orchestia gammarellus
- Amphithoe gammaroides
- Corophium sextonae
- Caprella acanthifera
- Dynamene bidentata
- Sphaeroma sp
- Sphaeroma rugicauda
- Jaera albifrons agg
- Idotea granulosa
- Ligia oceanica
- Tanais dulongi
- Palaemonidae indet.
- Athanus nitescens
- Porcellana platycheles
- Cancer pagurus
- Carcinus maenas

Mollusca - Polyplacophora
- Lepidochiton cinerea
- Acanthochitona crinita

Mollusca - Gastropoda
- Tricolia pullus
- Gibbula cineraria
- Gibbula umbilicalis
- Osilinus lineatus
- Calliostoma zizyphinum (juv)
- Patella depressa
- Patella ulyssiponensis
- Patella vulgata
- Helcion pellucidum
- Bittium reticulatum
- Lacuna pallidula
- Littorina littorea
- Littorina fabalis
- Littorina mariae
- Littorina obtusata
- Littorina saxatilis
- Littorina saxatilis
- Melarhaphe neritoides
- Melarhaphe neritoides
- Eatonina fulgida
- Rissoa guerini
- Rissoa interrupta
- Rissoa parva
- Onoba aculeus
- Hydrobia ulvae
- Nucella lapillus
- Buccinum undatum (D)
- Hinia reticulata
- Rissoella diaphana
- Odostomia plicata
- Elysia viridis
- Limapontia senestra
- Berthella plumula
- Berthella plumula
- Leucophytia bidentata
- Ovatella myosotis

Mollusca - Pelecypodia
- Mytilus edulis (D)
- Lasaea adansoni
- Irus irus
- Pholas dactylus (D)
- Barnea parva

Mollusca - Cephalopoda
- Sepia officinalis (D)

Bryozoa
- Encrusting bryozoa indet.

Insecta
- Anurida maritima
- Chironomidae

Echinodermata
- Asterina gibbosa

Tunicata
- Botrylloides leachii
- Botryllus schlosseri

Pisces
- Nerophis lumbriciformis
- Gobius paganellus
- Lipophrys pholis
- Anguilla anguilla

Algae
- Rhodophycota
- Porphyra sp.
- Gelidium latifolium
- Palmaria palmata
- Coralline crusts
- Corallina officinalis
- Titanoderma sp.
- Catenella caespitosa
- Calliblepharis jubata
- Cystoclonium purpureum
- Dumontia contorta
- Furcellaria lumbricalis
- Chondrus crispus
- Mastocarpus stellatus
- Polyides rotundus
- Plocamium cartilagineum
- Lomentaria articulata
- Ceramium spp
- Porphyra linearis
- Cryptopleura ramosa
- Hypoglossum hypoglossoides
- Membranoptera alata
- Osmundea hybrida
- Osmundea pinnatifida
- Polysiphonia sp
- Polysiphonia brodiei
- Polysiphonia lanosa

Chromophycota
- Dictyota dichotoma
- Laminaria digitata
- Laminaria saccharina
- Cystoseira sp
- Halidrys siliquosa
- Ascophyllum nodosum
- Fucus serratus
- Fucus spiralis
- Fucus vesiculosus
- Sargassum muticum

Chlorophycota
- Ectocarpales indet.
- Enteromorpha sp
- Ulva lactuca
- Chaetomorpha linum
- Cladophora rupestris

Lichens
- Verrucaria spp
- Caloplaca marina
- Grey lichens

Freshwater Fauna
- Hirudinea indet.
- Gammarus pulex
- Ephemeroptera indet.
- Ancylus fluviatilis
- Lymnaea peregra
- Lymnaea truncatula
- Potamopyrgus antipodarum

'PORCUPINE 2004. MARINE SPECIES AT THE LIMITS OF THEIR RANGE'

Papers from the PMNHS meeting held at Bournemouth University from 20th-21st March 2004

Leptopsammia pruvoti at Lundy - teetering on the brink?

Robert Irving

Abstract

In the UK, the sunset cup coral *Leptopsammia pruvoti* is a species of particular marine natural heritage importance: it is nationally rare and has its own Biodiversity Action Plan (BAP). As a Mediterranean-Atlantic species, *L. pruvoti* is at the northern extreme of its range at Lundy. In south-west Britain, it is also found in the Isles of Scilly, off Plymouth Sound, in Lyme Bay and at Portland Bill. Of concern, however, is that there seems to be very little new recruitment to the present populations in south-west Britain and the number of individuals is declining. A population of *L. pruvoti* re-photographed at Lundy on an annual basis between 1983 and 1990 was found to have lost 8% of its individual corals, and between 1984 and 1996 part of this same population had declined by 22%.

A number of possible factors affecting this decline are considered. *L. pruvoti* is thought to be slow-growing and long-lived. Recruitment (i.e. the successful production and settlement of larvae) is likely to be slow for a population at the limit of its distribution, with failure probably due to the water temperature being unsuitable for promoting gamete production and/or the synchrony of gamete release. Fertilised eggs have been found to survive for up to six weeks in aquaria, though planula larvae are likely to settle close to the adults within 24 hours. Besides the difficulties of recruitment, a number of organisms have been identified as possibly being responsible for the decline in the adult population. In particular, it is thought that certain boring organisms are capable of weakening the attachment of the adult skeleton to the substratum, increasing the likelihood of it becoming detached from the rock surface.

Introduction

The sunset cup coral *Leptopsammia pruvoti* is a Mediterranean-Atlantic species of particular marine natural heritage importance in the UK: it is nationally rare and since 1999, it has had its own Biodiversity Action Plan (UK Biodiversity Group, 1999). However, in spite of this 'important' status, there has yet to be any significant improvement in the measures required to ensure its continued presence in British waters. It remains unprotected under any UK or European legislation.

Description and habitat

Leptopsammia pruvoti is a scleractinian stony coral, typically found growing as single individuals or as 'pseudocolonies' (i.e. where a number of individuals are attached at their bases). Although the calcareous skeleton (or corallum) of the coral is described as being external, it is typically hidden from view by the bright yellow soft tissue of the polyp. The corallum is porous and grows as an inverse cone in shape, circular in young individuals though becoming more oval with age. Its distal end (from where the polyp's tentacles extend) reaches 17 mm in width, and it grows to 60 mm in height (Manuel, 1988). This is noticeably taller than the more common Devonshire cup coral *Caryophyllia smithii*, which has a maximum height of just 15 mm (Manuel, 1988). *L. pruvoti* is found on shaded, bedrock habitats, such as on the underside of overhangs, in gullies or in caves, on open coast locations preferably in the lee

of prevailing winds (Jackson, 2003). It typically occurs within the depth range of 10 to 30 m in this country, though its depth range extends to over 100 m in the Mediterranean (Goffredo *et al.*, in prep.).

Distribution

L. pruvoti is at the very northern extreme of its range at Lundy. Its distribution centres on the western Mediterranean, extending northwards along the coast of Portugal, Brittany and the Channel Islands (Sark) to the south-west peninsula of Britain. Besides occurring at Lundy, *L. pruvoti* is also found in the Isles of Scilly, off Plymouth Sound, in Lyme Bay and at Portland Bill. It has been suggested that these few, isolated populations are 'relict' populations – all that is left of an historically much wider distribution – managing to survive because of localised 'ideal' conditions (Jackson, 2003).

Leptopsammia pruvoti at Lundy

Sunset cup corals appear to be restricted to the northern half of the east coast of Lundy, wherever suitable habitat occurs between 8 - 32 m depth (below chart datum). Based on surveys undertaken by Marine Conservation Society divers in the late 1990s, the total *Leptopsammia pruvoti* population at Lundy is estimated as being in the region of 1000 to 1200 individuals (Irving & Northen, in prep.). These are mostly to be found off the island's NE coast, though recently a location off the west coast with about 100 individuals has been recorded (K. Hiscock, pers. comm.). The corals tend to occur in groups, ranging in size from a few tens to several hundred individuals. One such group on the Knoll Pins, numbering at least 250 individuals, was re-photographed on an annual basis between 1983 and 1990, as part of a long-term monitoring study (Hiscock, 1984; Irving, 1990). Over this period of time, annual counts of individual corals from the photographs revealed that 8% of them had been lost (Fowler & Pilley, 1992) (Fig. 1A); and from 1984 to 1996, part of this same population had declined by 22% (Hiscock, 2003). A similar photographic monitoring study was undertaken off the east coast of St Mary's in the Isles of Scilly over a comparable period of time (1984 - 1991). Although the density of *L. pruvoti* here is considerably less than at Lundy, it was found that numbers of *L. pruvoti* fell during this time by 17% (Fowler & Pilley, 1992) (Fig. 1B).

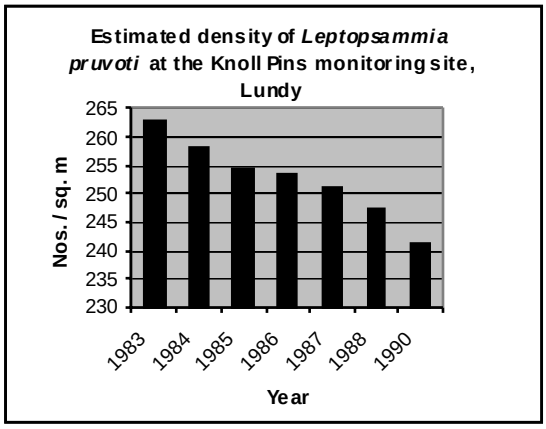

Fig. 1A

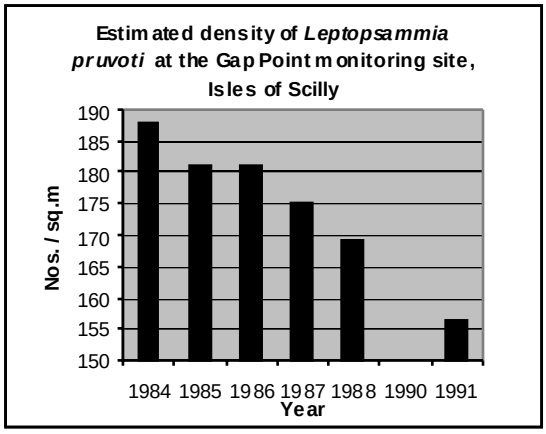

Fig.1B

Densities of *Leptopsammia pruvoti* at the Lundy and Isles of Scilly photographic monitoring sites respectively (after Fowler & Pilley, 1992).

It would appear that these findings are the result of death rates within the population far exceeding recruitment rates. The level of new recruitment to the population at Lundy since the early 1980s (and at other *L. pruvoti* sites in the south-west) appears to be very low indeed. Hiscock (2003) believes the level of recruitment over a 13 year period during the 1980s and early 1990s to be less than 1%. Fowler & Laffoley (1992) reported a new recruit to the Isles of Scilly population in 1991 (the first detected during the period of photographic monitoring), presumed to have occurred sometime between 1988 and 1991. In 1998, several very small individuals of

between 3-5 mm in diameter were reported from Lundy (Irving & Northen, in prep.). However, as is apparent in the evidence presented in this paper thus far, the numbers of new recruits to these populations are far outweighed by the loss of adult individuals. The obvious consequence of this is that overall numbers are declining.

What cause or causes might be responsible for this decline? Should this decline be expected for a population on the edge of its distribution? Is the cause (or causes) likely to be part of a natural cycle or are there anthropogenic influences at work? And can anything be done to halt the decline?

Reproduction and recruitment

There are several possible factors that may have an influence on the size of the *L. pruvoti* population at Lundy. Although the lifespan of *L. pruvoti* is as yet undetermined, individuals are thought to be slow-growing and long-lived (possibly surviving 100 years or more). However, it is not known at what age an individual reaches maturity. The species is gonochoristic – that is, the sexes are separate. The eggs take two years to develop and they are then brooded by the female (Goffredo *et al.*, 2004). In Mediterranean populations, gonad development increases significantly during December and January, fertilization takes place from February to May, and planulation (the release of the planula larvae, which have a maximum diameter of 1 mm) in June (Goffredo *et al.*, 2004).

Recruitment (i.e. the successful production and settlement of larvae) is likely to be slow and spasmodic for a population at the limit of its distribution, with failure probably due to the water temperature being too low for promoting gamete production and/or the synchrony of gamete release. Optimum water temperatures in the Mediterranean for the successful production of viable larvae are 20-21°C, whereas maximum summer temperatures of water masses affecting the Lundy populations are 17-18°C (Hiscock & Dymond, 1974; Irving & Northen, 1999). Hiscock (2003) reports that adult *L. pruvoti* brought into aquaria have produced viable larvae within a few days (at most two weeks), and he suggests that an increase in sea temperature might be a required stimulus for the production of larvae. Alternatively, it may just be a shock reaction of the adults to the translocation procedure. *In situ*, planula larvae are likely to settle close to the adult within a period of 24 hours, though observations from aquaria suggest that the larval stage may exist for up to six weeks before settling (Jackson, 2003). Apparently, mature adult corals in aquaria are very robust and cope well with extremes of temperature, starvation and slight variations in salinity (K. Hiscock, pers. comm.).

Significantly increased water temperatures in 1989 and 1990 (Fowler & Pilley, 1992) did not seem to result in higher abundances of declining species (including *L. pruvoti*) in the following years, although temperature must have some effect in triggering reproduction, especially for warmer water species (Hiscock, 2003). It may be that these isolated *L. pruvoti* populations in south-west England are reliant on viable larvae being periodically brought from populations further to the south to replenish their numbers. There is some evidence that appropriate warmer water masses move into south-west England every 25-30 years, a phenomenon known as the Russell cycle (Cushing & Dickson, 1976).

Hazards faced by recently settled larvae

As with many sessile marine organisms, the process of choosing a suitable site for settlement and then becoming properly established is full of dangers. There is a very high risk of becoming devoured by a variety of mobile animals or even other sessile organisms (particularly other anthozoans or hydrozoans). Within the circalittoral rock community of which *L. pruvoti* features, there is likely to be strong competition from fast-growing bushy bryozoans and hydroids in particular, severely reducing access to food particles suspended in the water column. There will also be periodic non-selective browsing by *Echinus esculentus* sea urchins and other grazers (see below), though for sea urchins such grazing will be reduced where the rock face is overhanging.

Possible causes of adult loss from populations

The decline in the numbers of adult *L. pruvoti* from the monitoring site at the Knoll Pins on Lundy may be due to a number of causes, several of which are discussed below.

Ballan wrasse *Labrus bergylta*. These fish are frequently observed in the same habitat and depth range of *L. pruvoti*. They are known to feed on molluscs (particularly mussels) and crustaceans, including crabs and even barnacles. As well as their 'normal' teeth, there is a set of powerful crushing teeth in the throat that enable the fish to tackle such rough fare (Dipper, 2001). Unwanted or indigestible material is passed out through the gill openings or the mouth. A diver may witness a ballan wrasse taking a mouthful of faunal turf growing on a rock face, presumably targeting a specific species of crustacean or mollusc. It seems quite likely that individual *L. pruvoti* corals may become collateral damage from such attacks from time to time. Indeed the author has photographic evidence of the crushed yellow remains of a *L. pruvoti* coral at the foot of a cliff face, likely to have been the victim of such action.

Accidental contact from inanimate objects or other organisms. Individual corals could become dislodged (albeit inadvertently) by the dropping or lifting of anchors, shot lines or fishing pots (all of these activities are prohibited in the vicinity of the Knoll Pins at Lundy, but they still occur from time to time); by the fins of divers undertaking awkward movements; or even by the fins of grey seals, though this last suggestion seems fairly unlikely.

Epizooic barnacle *Boscia anglica*. This barnacle is frequently found growing on the corallum of scleractinian corals, especially the Devonshire cup coral *Caryophyllia smithii*, usually at the margin of the calyx. Hiscock & Howlett (1976) estimated 30-50% of *Caryophyllia smithii* corals in south-west Britain as having *Boscia anglica* attached. The barnacle has also been found on *L. pruvoti* at Lundy, not just around the margin of the calyx but also attached to the column. Manuel (1988) points out that the exact nature of the relationship between the barnacle and its host species is unknown – the barnacle may cause irregular septal growth of the coral, but otherwise the coral appears to suffer little inconvenience. It would seem probable, however, that with as many as eight barnacles present (the maximum number observed on one individual coral in 1999 at the Knoll Pins), there would be considerable competition for planktonic food. In 1999, of 138 *L. pruvoti* corals inspected at the Knoll Pins, 56% had one barnacle attached to them and 10% had three or more barnacles attached to them (Irving & Northen, in prep.).

Boring organisms. A number of boring organisms are capable of weakening the attachment of the adult cup coral skeleton to the substratum. The chief suspect here is the horseshoe worm *Phoronis hippocrepia*, which was first recorded at Lundy in 1995, being associated with limestone cannonballs found on the Gull Rock wreck site (Irving *et al.*, 1996). In 1998, *P. hippocrepia* was found to be present around the base of 9% of the *L. pruvoti* cup corals inspected at the Knoll Pins, and 7% of those inspected at Gannets' Rock pinnacle (Irving & Northen, in prep.). A number of dead skeletons of both *L. pruvoti* and *C. smithii* were located within the silt at the foot of walls where these corals were growing, both of which had evidence of small tunnels bored into their bases by horseshoe worms.

Although other boring organisms are reported to infest cup coral skeletons, such as the sabellid fan worm *Pseudopotamilla reniformis* or the wrinkled rock borer *Hiatella arctica* (Jackson, 2003), there is no evidence to date of these being found at Lundy.

Painted topshell *Calliostoma zizyphinum*, an algal grazer, has been observed feeding on *Balanophyllia regia*, a similar coral species to *L. pruvoti*, in an aquarium (K. Hiscock, pers. comm.). This gastropod has also been reported feeding on a snakelocks anemone *Anemonia viridis* in an aquarium (Manuel, 1988), though this observation was qualified as likely to have been an exceptional instance, possibly caused by a lack of its normal food. It is suggested here that *Calliostoma* may well become an

opportunistic feeder when unable to graze on algae, but that *L. pruvoti* would be an exceptional and unlikely prey species *in situ*.

Conclusions

It is clear that the population of *Leptopsammia pruvoti* cup corals at Lundy has recently been in decline. Numbers appear to be falling at an alarming rate. Accurate counts of the number of adult individuals, were made by contractors working for the Nature Conservancy Council, between 1984 and 1990. Subsequent photographs taken by Dr Keith Hiscock in 1996 confirmed that the downward trend in numbers was continuing (Hiscock, 2003). The same situation also appears to hold true for the *L. pruvoti* population at Gap Point in the Isles of Scilly over a similar period of time. Very little recruitment of new individuals at either site appears to have taken place during this time. More recent studies at Lundy, utilising volunteer divers, have concentrated on providing a figure for the total population size (estimated as being in the region of 1000 - 1200 individuals) and in assessing the possible causes of the decline in numbers.

The main target for the UK Biodiversity Action Plan for *Leptopsammia pruvoti* is to "maintain the distribution and the size of known viable populations" (UK Biodiversity Group, 1999). Clearly, should the decline in numbers be continuing, then maintaining the size of the populations will require some assistance if the target is to be met. Little 'hands-on management' is possible in the wild, but it may be possible to breed viable corals from individuals in aquaria under closely controlled conditions. Such *'in vitro* recruits', if they were able to survive transplantation back into wild populations, may make an important contribution to bolstering the size of existing populations or possibly establishing completely new populations. However, the costs of such a breeding programme would have to be weighed carefully against the likely success rate of transplantation. In addition, such 'management by intervention' may prove futile if the environmental conditions *in situ* are not suitable for the survival of transplanted individuals.

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The distribution limits of *Styela clava* (Tunicata, Ascidiacea) in European waters.

Martin H. Davis[1] and Mary E. Davis[2]
[1]*Nuclear Department, HMS SULTAN, Military Road, Gosport, Hampshire. PO12 3BY, UK*
[2]*Fawley Biofouling Services, 270, Burgess Road, Swaythling, Southampton, Hampshire. SO16 3BE, UK.*
E-mail: fawley.bioserve@virgin.net

Summary

The immigrant ascidian *Styela clava* is native to the northwest Pacific. It was first recorded in British waters in 1954 and has since spread along the west coast of Europe, but the distribution is patchy. The potential distribution limits can be predicted from knowledge of the temperature and salinity tolerance of *S. clava*, but the actual distribution limits are revealed only by time-consuming surveys.

The current distribution of this sessile invertebrate is reviewed with reference to the dispersal methods available. Some isolated populations can best be explained by dispersal of adults attached inside ships' sea-chests, seawater intake chambers that provide a sheltered environment for the organisms to grow to maturity and spawn in any suitable harbour visited. This dispersal method would apply equally well to any organisms that could enter the sea-chest and would explain the heterogeneous distribution found in many species. The results of some sea-chest examinations are reported, which demonstrate that this is a suitable transport mechanism for marine organisms.

A qualitative dispersal model is proposed to explain the arrival and establishment of a population of *S. clava* at a site. Consideration of dispersal methods should enable the identification of likely colonisation sites and, consequently, more selective sampling to determine the limits of distribution.

Introduction

The solitary ascidian *Styela clava* Herdman, 1882 (Plate 1) is native to the northwest Pacific (Millar, 1960). It was first found in British waters in 1953 in the estuary of the Lynher River, near Plymouth (Carlisle, 1954). It is probable that it was introduced into Plymouth Sound by military craft returning from the northwest Pacific after the Korean War in 1952 (Minchin & Duggan, 1988). It rapidly became established along the south coast, probably because the water temperature regime in the English Channel is similar to that of the northwest Pacific (Millar, 1960). But the distribution of *S. clava* is patchy. A sheltered high salinity site appears to be necessary for the initial development in any area but, with the exception of harbours in the Solent, it rarely spreads any distance to neighbouring suitable habitats. So how can the distribution limits of *S. clava* be determined?

Description of the adult

S. clava is a large solitary ascidian; adults range from 70mm to 160mm total length. The firm body is elongated, shaped like an Indian club, with two terminal openings (Millar, 1970). It is attached to the substratum by a short narrow stem-like stolon, the base of which forms an expanded membranous plate that adheres the organism to the substratum. Adults protrude from the surface and are rheophobic. They are tolerant of brief exposure. Specimens have been found attached to pebbles on exposed beach at low water spring tide, and attached to jetty supports a metre above the low water level. *S. clava* is hermaphroditic and oviparous.

Description of the eggs and larvae

The spherical eggs are negatively buoyant, but slight agitation of the water maintains them in the water column. They hatch after 12 to 15 hours at temperatures of 16 to 20°C. The pelagic lecithotrophic larvae are tadpole shaped; they range from 0.83 to 0.87 mm in

length. They are negatively geotactic (Davis, 1997) and can swim up to ten body lengths per second during short bursts, but rarely travel more than a few centimetres in sustained swimming activity. Larvae are active for approximately 12 h.

The distribution of *S. clava*

Since its initial discovery in Plymouth in 1954, *S. clava* has spread around Britain to Grimsby on the east coast and Ardrossan on the west coast. It has also been recorded in the Channel Islands, Ireland and along the coast of Europe from Denmark to Portugal (Davis & Davis, 2004).

S. clava is intolerant of wave exposure and is generally found in sheltered sites. It is also intolerant of low salinity; none have been found in water with salinity below 20‰. Gonad maturation occurs at about 16°C; for animals to reproduce, ambient water temperatures must exceed 16°C for several weeks. Thus a sheltered, mild, high salinity site is necessary to establish a population. The potential distribution limits can be predicted from knowledge of the temperature and salinity tolerance. The actual distribution limits are revealed only by time-consuming surveys and opportunistic sampling. Our ultimate aim is to develop a model to explain, and if possible to predict, the distribution of *S. clava*; but this requires substantial occurrence data. So we needed to speed up the surveying process by identifying potential settlement sites.

The majority of the sites where *S. clava* has been recorded are commercial ports and harbours, many of which have neighbouring small fishing harbours and marinas where we were unable to find any specimens. This heterogeneous distribution was difficult to explain and prompted an examination of the potential methods of dispersal. However, it should be remembered that the inability to find specimens at a site does not necessarily mean that there are no colonies present in the area.

Methods of dispersal

Four methods of dispersal have been suggested for the spread of *S. clava*, two natural and two man-aided (Lützen, 1999):

i) as planktonic eggs and larvae, carried by tidal currents;
ii) as sessile adults attached to drifting flotsam, e.g. the weed *Sargassum muticum*;
iii) as settled juveniles attached to oysters that have been transported and re-laid;
iv) as established adult animals attached to the hulls of ships.

Natural dispersion

The total time spent as planktonic egg and larva is approximately 26 hours; at the end of this period the larva must find a settlement site. A larva rarely travels more than a few centimetres in sustained swimming activity. Thus larval dispersion is mainly dependent on water movement, which in an estuary or harbour has a maximum range of little more than the tidal excursion in the time available. This method of dispersion may account for the colonisation of adjacent inlets and harbours, for example within the Solent where the majority of suitable harbours support *S. clava* populations, but cannot explain the establishment of distant colonies.

Similarly, although dispersion as settled animals attached to drifting flotsam or weed, should cover a wider area, since wind could enhance the displacement due to tidal movement, it would still probably be limited to neighbouring suitable sites. As the animals are attached juveniles or adults, the time spent drifting is not critical. Lützen (1999) thought that this dispersion method could be of local importance. However, much flotsam washes up on the strand line (high tide mark) on beaches, where it may remain drying for several days before re-immersion. So the spread of organisms by this method would be opportunistic.

Man-aided dispersal

As natural dispersal appears to be unpredictable and has a very limited range, the spread of *S. clava* has generally been attributed to the inadvertent introduction by man. It has been suggested that long distance dispersal could occur if juvenile animals

attached to oyster shells were transported with the oysters when they were re-laid. This dispersion method, favoured by Minchin & Duggan (1988), would account for the appearance of *S. clava* in oyster culturing areas such as West Mersea in the UK, and the small harbours of Brittany, France. However, this would only account for a few of the isolated populations.

An alternative hypothesis is that settled animals may be moved from one harbour to another attached to the hulls of ships. Transportation on slow moving wooden-hulled ships has been proposed as the method by which many of our apparently indigenous (cryptogenic) species were introduced over the last few thousand years (Carlton & Hodder, 1995; Carlton, 1999); but the hulls of modern operational ships are coated with anti-fouling agent to inhibit the attachment of organisms. Nevertheless, recent studies suggest that attachment to ships' hulls, particularly in areas of reduced flow, continues to be an important dispersal method for immigrant species (Gollasch, 2002). However, mature specimens of *S. clava* are rheophobic; their firm bodies protrude from the surface to which they are attached, so they are unlikely to survive sustained high-velocity movement through water when the ship is in service. In fact, the only record of *S. clava* observed attached to a ship's hull is for a ship that had been moored for almost a year in Cork Harbour (Minchin & Duggan, 1988); settlement and growth could have occurred during this time, without any ship movement. It would appear that this method of dispersal is most likely to occur when a ship is in a colonised port for sufficient time to allow breakdown of the antifouling coating and larval settlement, is then moved at low speed to a new port and remains there long enough for the animals to reach maturity and spawn. Such a series of events is unusual, but may account for the appearance of *S. clava* in Loch Ryan, which is far from the closest recorded population in Heysham Harbour.

S. clava was first observed in Loch Ryan in the late 1980s (S. Smith, pers. comm.). A survey of the Loch in May 2003 revealed that there was a small population in Stranraer Harbour and a few individuals around the ferry terminal (Cairnryan), but *S. clava* was very abundant on and around the derelict jetty further down the loch. This jetty had been the site of the breakers yard at Cairnryan; ships were moored to the jetty during dismantling. Holme (1997) documented the history of the port and its ship-breaking activities. Warships that had been paid off and de-equipped in Plymouth and Portsmouth were of particular interest to the present study, since these harbours supported populations of *S. clava* from the 1960s. The ships usually spent several years deteriorating in their final port, were towed slowly to Cairnryan, and then spent several years moored to the jetty whilst being dismantled - ideal conditions for the transfer of *S. clava*. A few examples will suffice to illustrate how transfer could have occurred. HMS EAGLE was de-equipped over eighteen months in Portsmouth, laid up in the Hamoaze (Plymouth) for six years, then towed slowly to Cairnryan over four days; demolition took over two years. HMS ARK ROYAL was de-equipped over two years at Devonport, then towed slowly to Cairnryan over six days; demolition of the ARK ROYAL took over three years. HMS BULWARK was de-equipped over three years at Portsmouth, then towed slowly to Cairnryan over seven days; demolition took over two years.

Could the animals survive such a voyage? As yet we have no evidence for *S. clava*, but a recent hull examination of HMS LONDON, in dry dock at Portsmouth, revealed that fragile *Ciona intestinalis* and *Ascidiella aspersa* could survive being towed for several miles (Plate 2). However, there is no reliable evidence that any of the ships dismantled at Cairnryan were fouled with *S. clava*, so this method of distribution must remain an intriguing hypothesis.

Other man-aided dispersal mechanisms

We propose two additional dispersal mechanisms involving operational commercial shipping to explain the spread of *S. clava* - as eggs and larvae carried in ships' ballast water or established mature adults attached to the interior surfaces of ballast tanks and sea-chests.

Transport as eggs and larvae

During August and September, the water in a harbour that supports a population of *S. clava* will contain eggs and larvae of this ascidian. Any ship taking on ballast water in such a port will inevitably take up some eggs and larvae with the water. If the ship discharges the ballast water in another port while the eggs or larvae are still viable, a new population may develop in that port, provided that the conditions are suitable for growth and reproduction.

Transport in ballast water has been proposed as the main modern-day transfer method for introduced species (see, for example, Carlton, 1985). Minchin & Duggan (1988) considered this method of dispersal unlikely for *S. clava*. However, it would be possible for voyages of less than 24 hours duration, such as the continental car ferry routes (Table 1). Using this dispersal mechanism, the original population in Plymouth could have initiated settlement in Roscoff; then, once established there, *S. clava* could have spread to Cork Harbour (Figure 1). Similarly, larvae from Portsmouth and Southampton could have colonised Cherbourg, St. Malo and Le Havre. Larvae from the Cherboug population could have settled in Poole or vice versa.

Table 1 Short duration ferry routes

Ferry Routes			Duration (h)
1	Roscoff	Cork	14
2	Plymouth	Roscoff	6
3	Portsmouth	St Malo	8.75
4	Poole	Cherbourg	4.25
5	Portsmouth	Cherbourg	5
	(Southampton	Cherbourg*	6)
6	Portsmouth	Le Havre	5.5
	(Southampton	Le Havre*	6.5)
7	Dover	Calais	1.5
8	Dover	Dunkerque	2
	Ramsgate	Dunkerque	3
9	Dover	Ostend	3.5
10	Harwich	Hook of Holland	6
11	Harwich	Hamburg	19

* Route no longer operational.

Ferries are often exchanged between Portsmouth and Dover, allowing a population of *S. clava* to become established in the Port of Dover. Larvae from the Dover colony could have been carried to Calais, Dunkerque and Ostend (Figure 1). From Dunkerque, a population could be established in Ramsgate, which is too far from Dover to be colonised by larval drift and has no local commercial oyster beds. A well-established population exists in the Dutch Naval Base of Den Helder, close to the Hook of Holland ferry port, which connects with Harwich where a thriving population has recently been recorded (Davis & Davis, 2004).

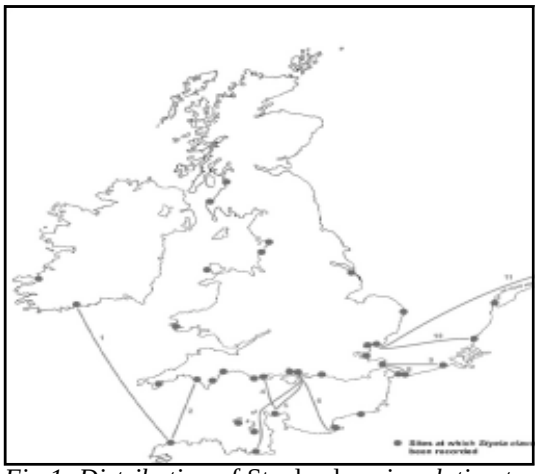

Fig 1 Distribution of Styela clava *in relation to ferry routes.*

It is difficult to prove that larvae are transported in ballast water other than by filtering the contents of the ballast tanks, which would not be permitted since it has safety implications for the vessel; moreover, it is not easy to obtain access to the ballast tanks of operating ships. Furthermore, the presence of larvae in ballast water today provides only circumstantial evidence for the source of established populations that may have arrived many years earlier. In addition, large commercial ships also use many of the harbours, so it is difficult to exclude adult transport on these ships (see below) as the means of introduction. To test the feasibility of the hypothesis of larval transport in ferry ballast water, a harbour was sought that was isolated from known populations, had no commercial oyster fishery, had a regular car ferry service of less than 24 hours duration from a colonised port, and limited commercial shipping. St Helier harbour (Jersey), which

has ferry links with Portsmouth, Poole, Weymouth and St Malo, was selected and the adjacent marinas were surveyed for populations of *S. clava*. Well-established populations were found in the St Helier and Elizabeth marinas on Jersey (Davis & Davis, 2004). The discovery of these populations is encouraging, but does not vindicate the hypothesis.

Transport as mature adults

Populations of *S. clava* have been found in most of the commercial ports surveyed although, since access to the dockside in ports is normally difficult, the search has often been restricted to adjacent marinas. Examples include Shoreham, Sheerness and Liverpool Docks, and Holyhead Harbour in the UK; the French ports of Le Havre, Calais, Cherbourg and La Rochelle and the Spanish port of Santander. Many of these ports are served by ferries or are close to other populations of *S. clava*, so the presence of the ascidian may be explained by either natural or man-aided larval transport.

However, populations of *S. clava* have also been found in isolated commercial harbours that are not served by ferries and have no commercial oyster fishery, for example Fenit (on the west coast of Ireland), Gijon (on the northwest coast of Spain), and Porto and Lisboa (Portugal). In fact, the only population found on the west coast of Ireland was in Fenit, an isolated harbour visited by commercial ships that transport locally manufactured cranes to other European ports. The Portuguese specimens of *S. clava* were found in the marinas at Leixões, Cascais and Bom Sucesso (Davis & Davis, in prep.); the marina at Leixões is adjacent to the commercial port of Porto, and the marinas at Cascais and Bom Sucesso are close to the commercial port of Lisboa. All these commercial ports are too far from the nearest populations of *S. clava* for planktonic larvae to be carried there, and any larvae transported in ballast water would probably metamorphose into sedentary juveniles long before the water was discharged.

Since larval dispersal is unrealistic, sessile adults must have established the populations of *S. clava*. There are no commercial oyster fisheries close to Fenit, Porto and Lisboa, and no *S. clava* populations that could provide flotsam with attached adults. In fact, there are four marinas (Vila Nova, Figueira da Foz, Nazaré and Peniche) with suitable conditions for *S. clava* colonisation in the 300km between Porto and Lisboa (Figure 2); but, despite exhaustive searches, no specimens of the ascidian were found in these intervening marinas, as might be expected if flotsam were a vector for adult dispersal.

Fig 2 Styela clava *sampling sites in Portugal.*

There are, however, two related man-aided methods of adult dispersal that could explain the observed distribution. The first is a natural extension of larval transport in ballast water. If larvae are taken into the ballast tank when ballast water is pumped aboard, they could settle on the walls of the tank and metamorphose into juveniles. Provided that they have sufficient resources to grow to maturity, they could spawn the following year. Discharge of the ballast water within 24 hours of the captive individuals spawning, would permit *S. clava* larvae to colonise a new site. This dispersal method would provide a mobile population capable of travelling long distances and spawning when the water temperature was suitable, usually in the shallow water of ports and harbours. The main

limitation of this method is the availability of food and dissolved oxygen in the ballast water to sustain the maturing adults; given the limited water exchange, it is probable that most of the animals would die in the ballast tank before spawning.

The other method by which adults may be transported on ships occurs when larvae settle on the internal surfaces of the ship's sea-chests (Gollasch, 2002). This method allows free access to food and dissolved oxygen. A sea-chest is a void built into the hull below the waterline, with direct connection to the surrounding seawater. It is the source of the cooling-water, fire-fighting water and ballast-water pumped aboard, and is covered with a grill (typically 13-25 mm apertures) to protect the pumps from damage by large organisms and flotsam (Plate 3). Maintaining anti-fouling protection on the internal surfaces of sea-chests is an awkward process that is often neglected. The number and size of sea-chests is in proportion to the size of the ship, e.g. a type 42 destroyer has eight sea-chests, typically 1m x 0.5m in cross section and 2m high (Plate 4), plus four small intake chambers. Since the sea-chests are located on the bottom of the hull, all will receive a flow of seawater during passage that will be considerably less than that experienced on the hull surface. Thus sea-chests provide a sheltered environment that can readily be located by negatively geotactic larvae and other organisms that are small enough to pass through the grill. Furthermore, by permitting continuous water exchange, they provide good conditions for growth and development prior to spawning. This method of transporting reproductively mature individuals would permit spawning in, and subsequent colonisation of, any port with suitable water quality visited by the ship. A recent study by Coutts *et al*. (2003) reported numerous species living in the sea-chests of a ferry that travelled between Tasmania and Australia, but there do not appear to be any similar European studies. As yet we have only examined two ships' sea-chests, and have found only hydroids, barnacles and tube worms (Plate 5). Nevertheless, this indicates that sea-chests are a suitable vector for adult organisms, and the sheltered internal ledges (Plate 6) would permit the transport of more mobile organisms. Transport of settled animals attached to the interior sea-chests could explain the presence of *S. clava* in Fenit, far from other populations, and the heterogeneous distribution around Porto and Lisboa.

Modelling the spread of *Styela clava*

We are in the early stages of developing a model, but we consider that the spread of *S. clava* from one site to another can best be modelled as an invasion. The model will initially be empirical and qualitative, seeking to explain the present distribution and identify concepts that can be transferred to other situations. It is unlikely that a quantitative model can be developed with the data available at present, other than a simplistic risk assessment; nevertheless, it should be possible to predict potential invasion sites.

Biological invasions are composed of four stages; arrival, establishment, spread and persistence. No single model can explain all four stages. Arrival and establishment are stochastic events requiring probabilistic models. Initial establishment requires that the number of invaders (adults or competent larvae) exceed a minimum determined by demographic stochasticity, e.g. births and deaths; successful establishment is a function of environmental stochasticity, e.g. variations in fertility and survivorship resulting from environmental conditions. Spread and persistence of a successfully established colony can be modelled with deterministic models incorporating stable steady-state abundances.

The probability of the arrival of *S. clava* in a new environment can be assessed by consideration of the probability of a ship visiting a colonised harbour during the spawning period, the likely time spent in that harbour, the anticipated survival of larvae or juveniles, the length of the voyage, the time spent in the receiving harbour and the suitability of the receiving environment. These factors were discussed qualitatively for the Cairnryan population, and present information

supports the hypothesis of the arrival of mature adults on decommissioned warships.

Successful establishment depends on the number of organisms arriving (inoculum) exceeding a viable minimum and the receiving habitat being suitable, with an available area exceeding the minimum area necessary to contain enough individuals to exceed the minimum inoculum size. Furthermore, it can be shown that a translocated colony has a greater probability of establishing a new population than a single cohort of larvae. It is probable that large well-established colonies, far exceeding the minimum inoculum size, arrived at Cairnryan attached to decommissioned ships; these immigrants would have had several years to establish new populations in the extensive receiving habitat while the ships were being dismantled. Consequently, we predict that *S. clava* from the south coast had a high probability of arrival and establishment in Cairnryan. Spread and persistence have yet to be addressed.

Conclusions

Since the immigrant ascidian *S. clava* was first recorded in British waters in 1954, it has spread along the coasts of the UK and Europe. The distribution is patchy and difficult to explain or model. Of the dispersal methods proposed to explain the spread of *S. clava*, natural dispersion of drifting larvae, or adults attached to drifting flotsam, has a limited range. Man-aided dispersal, as juveniles and adults attached to oysters or to the hulls of ships, is more feasible. Indeed, some *S. clava* populations have been found near commercial oyster fisheries and, although anti-fouling paint should inhibit the attachment of organisms to operational ships, one instance of possible hull transport on decommissioned ships has been identified. However, these dispersal vectors cannot readily explain the presence of many of the isolated populations. Nevertheless, man-aided dispersal appears to be the most important mechanism for extending the distribution range of *S. clava*. Therefore additional man-aided methods were proposed to explain the presence of the isolated *S. clava* colonies - as larvae carried in ships' ballast water, or as adults attached to the interior surfaces of ballast tanks and ships' sea-chests.

Transport of planktonic eggs and larvae in ballast water, and their subsequent discharge prior to settlement, was considered to be feasible only when passage times are less than 24 hours. On longer voyages, the larvae would settle on the sides of the ballast tank, metamorphose and, given sufficient resources, develop into reproductively mature adults capable of spawning prior to ballast water discharge. The area receiving the discharge could thus be colonised, provided that the quality of the receiving water was suitable for growth and reproduction. However, the limitations to successful growth in the ballast tank make this an unlikely method of colonising new sites, so transport of mature adults in ships' sea-chests is considered to be the more feasible mechanism. These chambers provide a relatively sheltered environment for the organisms to grow to maturity. When suitable conditions are encountered, the animals may spawn and the negatively buoyant eggs would sink through the grill to hatch in the new site; the larvae would then initiate settlement if conditions were suitable. However, at present there is no evidence that this occurs.

The potential distribution limits of *S. clava* can be predicted from knowledge of its temperature and salinity tolerance. We believe that the actual distribution limits can best be revealed by surveys focused around commercial ports with shipping links to ports with established populations.

We would appreciate any information concerning the distribution of *S. clava*. A detailed description of the animal was given in Davis & Davis (2004). Please report any sightings to: martinh.davis@virgin.net

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Plate 1 ***Styela clava*** **Herdman, 1882**

Plate 4 **Sea-chest on a type 42 destroyer.**

Plate 2 ***Ciona intestinalis*** **and** ***Ascidiella aspersa*** **on HMS LONDON**

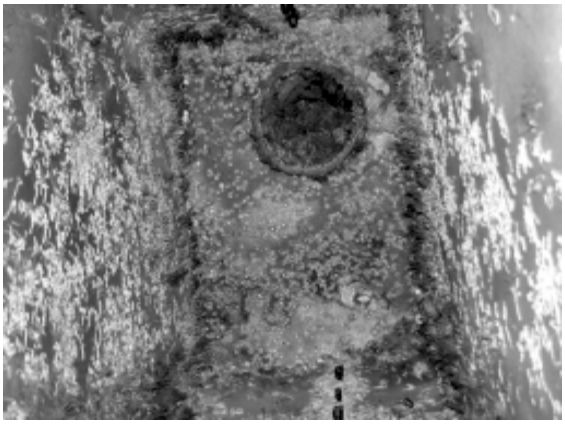


Plate 5 **Sea-chest with hydroids, barnacles and tube worms.**

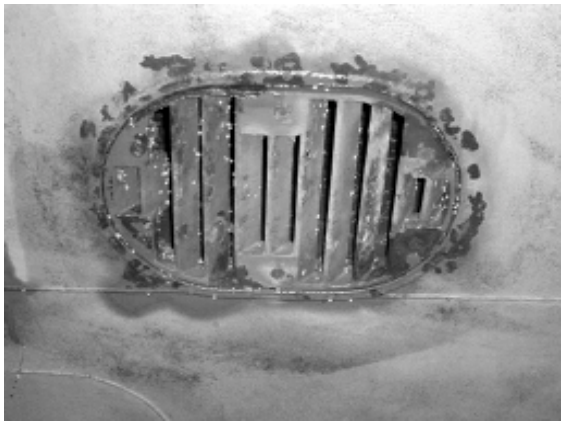


Plate 3 **A sea-chest grill.**

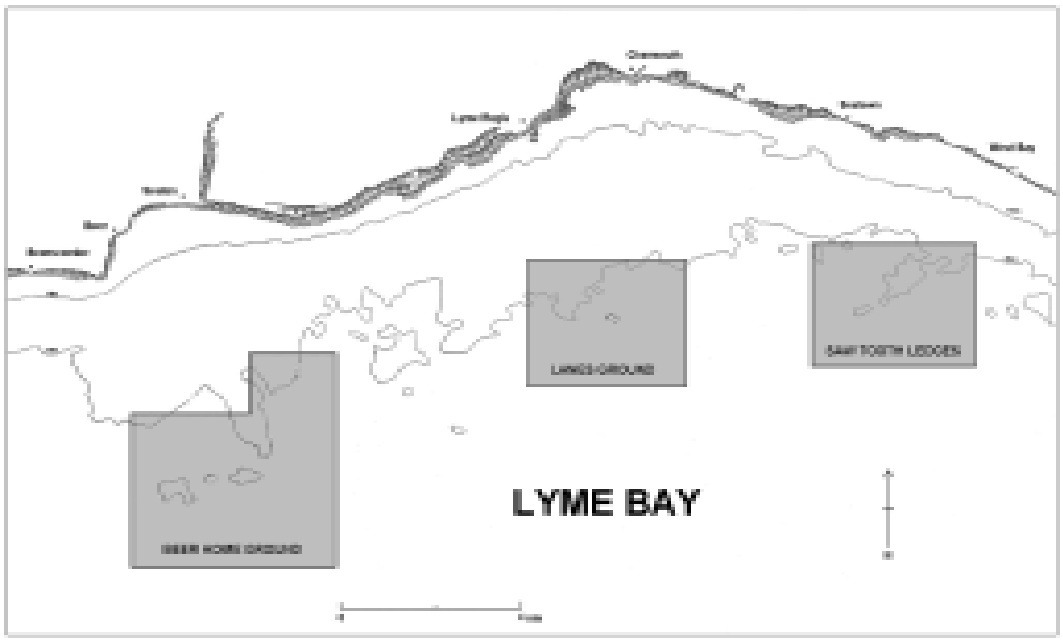
Plate 6 **Sheltered internal ledge of a sea-chest.**

'Reefunding' fishermen - Marine Conservation in Lyme Bay

Richard Stanford - Devon Wildlife Trust

Introduction

One of the greatest threats to marine sessile species at, or near, the edge of their range in Lyme Bay, is fishing activity. Whether that is line snagging on species like the pink sea fan leading to fouling, smothering caused by mobile gear or physical removal of communities by dredging, fishing activity poses a significant hazard that could have significant impacts on the wider population to the East by disrupting dispersal and reducing recruitment. One of the biggest concerns in Lyme Bay is that the soft mudstone reefs will be damaged by dredging to such an extent that physically the seabed will change shape and habitat complexity will be lost, reducing the potential for recolonisation in the future.



Location of Lme Bay Reefs

The purpose of my work is to encourage fishermen to fish away from the reefs and I hope that this short paper will provide an insight of how we are attempting to manage activity on these sensitive habitats.

Approximately 10 years ago local divers expressed concern to Devon Wildlife Trust that damage was being caused to reef communities, apparently from dredging. DWT got involved and conducted several surveys, firstly to see if scallop dredging was indeed causing a problem and secondly to identify the most vulnerable reef habitats. Our before-after dredge survey provided strong evidence that scallop dredging was the primary culprit and of the 8 or so main reefs between Exmouth and West Bay, 3 of them were particularly vulnerable to dredging, Saw Tooth Ledges, Lanes Ground and Beer Home Ground.

The main issues

Pots have been set on the reefs for centuries. Many of the boats from small villages such as Beer have a limited range and are dependent on the reefs for edible crab and lobster. They also set nets to benefit from the high quantities of finfish that congregate around the reefs and take angling trips during the summer. While some inshore trawling does

occur, the majority of mobile activity around the reefs is scallop dredging. Scallop dredging is a relatively new activity, having been practised heavily for the last 30 years or so, primarily because scallops are such a lucrative species. In recent years the market has been flooded from vessels fishing offshore with 20 dredges aside. This has lowered the price and increased the pressure on the stock as fishermen have had to fish harder to maintain catches. With the introduction of spring loaded dredges fishermen have ventured on to harder ground (the reefs) and habitat damage and gear conflict with local potters have become major problems. Enforcement at sea is a constant problem and local potters have lost much gear from rogue boats not prepared to abide by the gentlemen's agreements that have been established. One major issue is uncertainty in the fishing industry. Days-at-Sea legislation has been brought into the North Sea limiting the amount of days that fishermen can fish and South West fishermen have been concerned that the same will be brought in here. They are consequently reluctant to enter into agreements with organisations like ourselves because they do not want to shoot themselves in the foot. Finally, the absence of property rights in the fishery means that even if fishermen do enter into an agreement to see an area closed to fishing, it may not be them that benefits from the increase in the stocks. They are concerned that nomadic vessels will arrive, make the most of the booming stocks and then move elsewhere.

Success!

Despite all of these difficulties, in 2001 we had some tremendous success by securing two areas that were closed to dredging in Dorset, Saw Tooth Ledges and Lanes Ground. We started monitoring these and each summer send down a team of divers who, using a quadrat, measure the abundance of 5 indicator species. In 2003, for the first time they also measured the size and abundance of scallops to assess if the closed areas were having direct benefits for the fishery.

To date results have been encouraging with a significant difference in the abundance of pink sea fan, erect sponges and dead mans fingers between the closed and open areas. Pink sea fans seem to have shown a recovery each year although there needs to be a note of caution with these data: because the pink sea fan is such a slow growing species we cannot expect to see instant recovery. The scallop abundance at Lanes Ground was higher in the closed areas than in the dredged areas but the difference, although encouraging, was not significant. In Saw Tooth Ledges there were actually less scallops in the closed area than in the open area. This may have been caused by a high concentration of commercial diving for scallops or simply that the substrate that was sampled was bare rock and unsuitable habitat for scallops.

It is important to stress that these results do not fully indicate that the differences are due to the recovery of the reefs as the original areas were selected on the basis that they were the best sites and most worth protecting. This probably also coincides with the areas that were the most difficult to dredge.

When comparing open with closed sites there is also the assumption that those that are open to dredging will actually be dredged and this may not actually be the case. The patchiness of fishing effort and the variation in prices may mean that fishermen trawl rather than dredge.

Finally, substrate plays an important part in determining what grows there. Much of Lyme Bay around the reefs is a mixed substrate of boulders, cobbles and gravel but there are also patches of mud. In this year's survey the differences in substrate between open and closed areas were obvious to the dive team, who took a lot of notes. Some of the quadrats in the open areas landed on ground that was predominantly silt that would not be expected to support sea fans. This could positively bias the results and is something that needs to be considered for 2004's survey.

Moving on to Beer Home Ground

The areas that were closed in 2001 were the areas of most diversity but least importance for fishermen. There is considerably more at stake economically on Beer Home Ground. Initially when entering

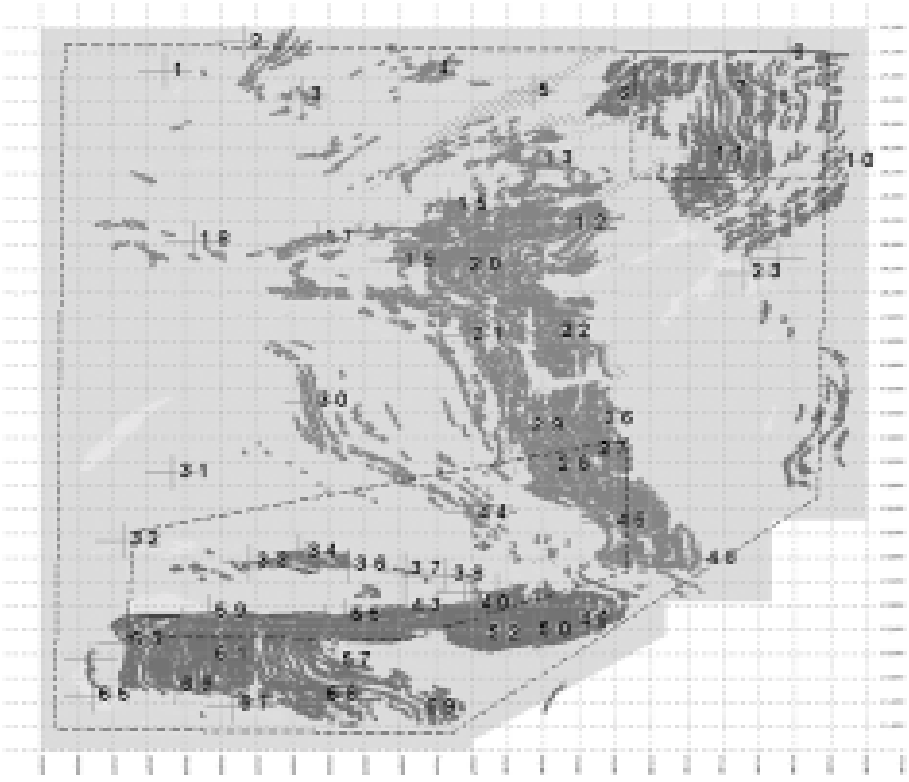
into discussion with fishermen about Beer Home Ground, the response we received was that there was not an inch of the area that had not been heavily dredged and that there would be nothing worth protecting anyway. So DWT agreed to conduct an extensive survey of the reef prior to doing anything else. We also agreed to investigate ways of enhancing the scallop fishery and guaranteeing a higher market price for fishermen.

Underwater survey

With our limited budget, I spent a lot of time investigating the possible options for surveying the reef. Our aim was: a) to identify where the reefs were and b) to identify at a broad biotope level what was living there.

Several people initially suggested that we would be able to achieve this with the acoustic ground discrimination systems QTC-view or Roxann, but the size of the corals we were interested in would be too small to create a strong signal. Dive surveys were prohibitively expensive and so we opted to map the seabed using side scan sonar. The advantage of this was that we already had a broad scale side scan sonar map of the whole of Lyme Bay from the Hydrographic Office that we could validate with the new tracks. We then sent down a video camera at different locations to drift with the tide and record what we saw. Combining the side scan map with nearly 70 tracks of underwater filming, we have been able to get a comprehensive understanding of the reefs that has amazed both us and the fishermen.

The extremely positive part of the survey was that there were pockets of soft corals and sponges that seemed to have remained fairly untouched. Although the fishermen persisted in their view that they had fished every inch of ground, they eventually conceded that the evidence of large pink sea fans on the rockiest ground was proof that they must have missed some areas. Interestingly, these pockets coincided with the highest densities of pots. Because of the gentlemen's agreement for dredgers not to fish on the pots, the pots had acted to provide protection for those areas. The combination of map and video has allowed all of the members of the working party to see for the first time what Beer Home Ground looks like. We have been able to

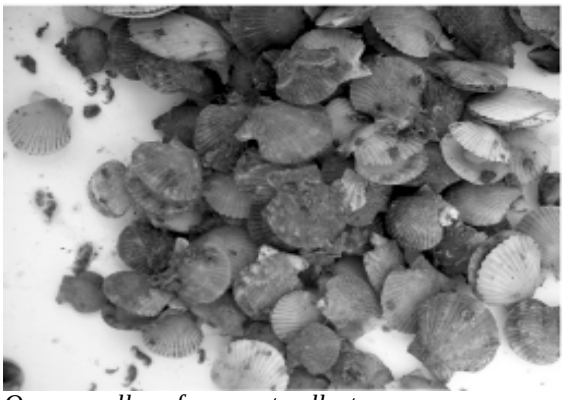


Location of reefs on Beer Home Ground from sidescan survey

prioritise areas that require further protection and discussions are ongoing with fishermen about further voluntary closed areas.

Scallop enhancement

A large slice of our funding comes from the EU through the Financial Instrument for Fisheries Guidance. This money has been provided to move Lyme Bay towards a sustainable fishing industry and one of the key areas we wanted to investigate was scallop enhancement. Working along with Devon Sea Fisheries Committee we have been making and deploying scallop spat collectors. These are designed to provide an artificial substrate that the planktonic stage of scallops can settle on to. Doing this project has been of tremendous benefit for our relationships with the fishermen. It has provided clear evidence that what we are interested in is a sustainable thriving industry and not just putting them out of business.



Queen scallops from spat collectors

In 2003 we had hundreds of queen scallops (*Aequipecten opercularis*) per bag and this year we are repeating the trials but changing the timing to try and catch more king scallops (*Pecten maximus*). The aim is to grow on the scallops in Brixham harbour and then relay them on the seabed when they are large enough to avoid predation.

Marketing

The final area that we committed to investigate, was the marketing side of the industry. Having secured funding from Seafish, the project office has been conducting an investigation into where the catch goes once it has been landed. By tracing it from the fishermen to the fork we hope to see if adding market value somewhere in the chain is possible. If the consumer is being provided with a premium product that is wildlife friendly will they be prepared to pay more? Early indications from this work and many examples from the farming industry is that they are. The problem for Lyme Bay is that currently the majority of the scallops get exported to the continent. This investigation is ongoing and we are hopeful that by using marketing we can move towards a sustainable fishery.

Trust is crucial

Although my job is composed of conducting some research, trialling scallop collection, giving presentations etc., all of that work will be futile unless I have positive relationships with the fishermen. I have already mentioned that there is tremendous suspicion about environmental groups and from a fishermen's perspective they have mostly done more harm than good. Fisheries management is a complex business and the U.S. Secretary of Commerce once remarked that fisheries took up more time than any other industry. Part of the problem is indeed that because no one owns it, no one looks after it and there is a race to maximise profits first. Over and above everything else trust is vitally important. If the fishermen don't trust you then the project will quickly stagnate.

The great news from our point of view is that the trust is there. Fishermen do want to work with us although they certainly retain that wariness about the "Greenies". The video of the seabed has had a tremendous impact in enabling all sides of the working party to see what the seabed really looks like. From this viewpoint we have been able to have positive discussions about the way forward. Fishermen are as aware as anyone that closing areas will naturally "reefund" them as habitat and stocks recover. The added incentives that we are seeking to provide go that extra step to further encourage them to look to the future of the industry.

Note: *Short video clips from the survey are available on: www.devonwildlifetrust.org*

Boats as a vector for the introduction and spread of a fouling alga, *Undaria pinnatifida* in the UK

Paul Farrell & Robert Fletcher
The Institute of Marine Sciences, School of Biological Sciences, University of Portsmouth, Ferry Road, Eastney, Portsmouth, Hampshire PO4 9LY, U.K.

Abstract

The large, adventive, fouling kelp *Undaria pinnatifida*, (Harvey) Suringar was first reported for the British Isles in June 1994, growing in the Hamble Estuary on the south coast of England. As a result of a monitoring programme, *Undaria* is now known to have spread to nine other south coast marina sites, from Torquay to Brighton. The main vector for the spread of *Undaria* was found to be boat hulls.

Introduction

The large, adventive, kelp *Undaria pinnatifida* (Harvey) Suringar (Phaeophyceae, Laminariales) was found attached in the Hamble Estuary, England, in June 1994 (Fletcher and Manfredi 1995). Originally a native to Japan, Korea and parts of China, this was the first record of its occurrence in the British Isles. *Undaria* is thought to have arrived in the British Isles via the hull of a small boat, probably from France, either as microscopic gametophytes or as young sporophytes (Figure 1.1) Hay (1990) predicted such a pattern of spread via boats using ports in the English Channel.

This adventive seaweed has considerably extended its world-wide distribution over the past 3 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 (Casa and Piriz 1994), Italy (Curiel *et al*. 1994), the Channel Islands (personal observation), mainland Australia (Campbell and Burridge 1998), Spain (Santiago Caamano *et al*. 1990) and California (Silva *et al*. 2002). 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.

Preliminary observations on the established populations in the Hamble Estuary have also revealed *Undaria* to be a major fouling organism. As a likely important contributor to the fouling communities on a wide range of immersed structures, the introduction of *Undaria* into the British Isles will, therefore, have considerable economic consequences.

Methods and Results

Concerning the introduction of *Undaria* into the BI, it was hypothesised that boat hulls were the vector, (Fletcher and Manfredi 1995, Hay 1990, Farrell and Fletcher 2000). In nearly all previous accidental introductions of *Undaria* around the world, the primary sites of infection have been ports of some description. The above hypothesis is supported by observations of boats in the Hamble and elsewhere having mature, attached sporophytes (Figures 1 and 2). Therefore, the search for *Undaria* around the British Isles was initially focused on ports and marinas. At each location where *Undaria* was reported, the surrounding sublittoral was also investigated.

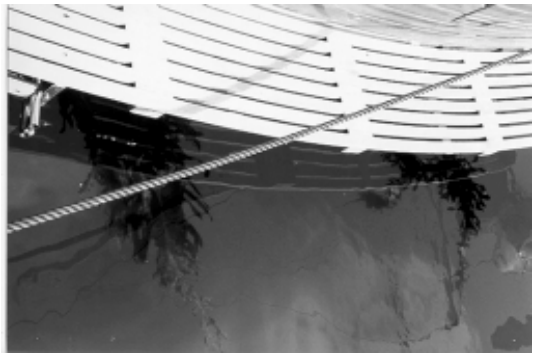


Figure 1. Undaria *sporophytes attached to the outdrive legs of a motor cruiser.*

Figure 1 clearly shows large (approximately 1 m), mature *Undaria* sporophytes attached to the stern of a motor cruiser moored at Hamble Point Marina. Closer inspection revealed the sporophytes were attached to the outdrive legs of the vessel. Attempts to contact the owner of the above vessel proved unsuccessful. However, owners of other boats that were fouled with *Undaria*, e.g. the 'Coralendo' shown in Figure 2 with an *Undaria* sporophyte attached to the hull, were successfully contacted and interviewed about the movements of their boats.

Figure 2. Undaria *sporophyte attached to the hull of a yacht.*

The Hamble is an estuary containing four large marinas, with 1310 berths in total and many smaller areas for mooring vessels, such as small boatyards, and private pontoons. The Hamble is situated centrally in the Solent, on the south coast of England (Figure 3).

Enquiries made to the offices of the Hamble marinas, as well as first hand knowledge from my own extensive boating experience in the Solent, showed that a substantial amount of the leisure boating activity in the Solent involves trips between marinas within the Solent. It was, therefore, important to establish which, if any, other marinas and ports in the Solent were affected, before looking around at the rest of the British Isles. Because of the extensive boat traffic, the infection of other locations in the Solent was likely to occur fairly rapidly. Therefore, it needed to be quickly established which locations were infected and which were not, in order to be able to monitor the 'epidemiology' of the introduction. Therefore, all of the marinas and ports in the Solent region were visited at the start of this research.

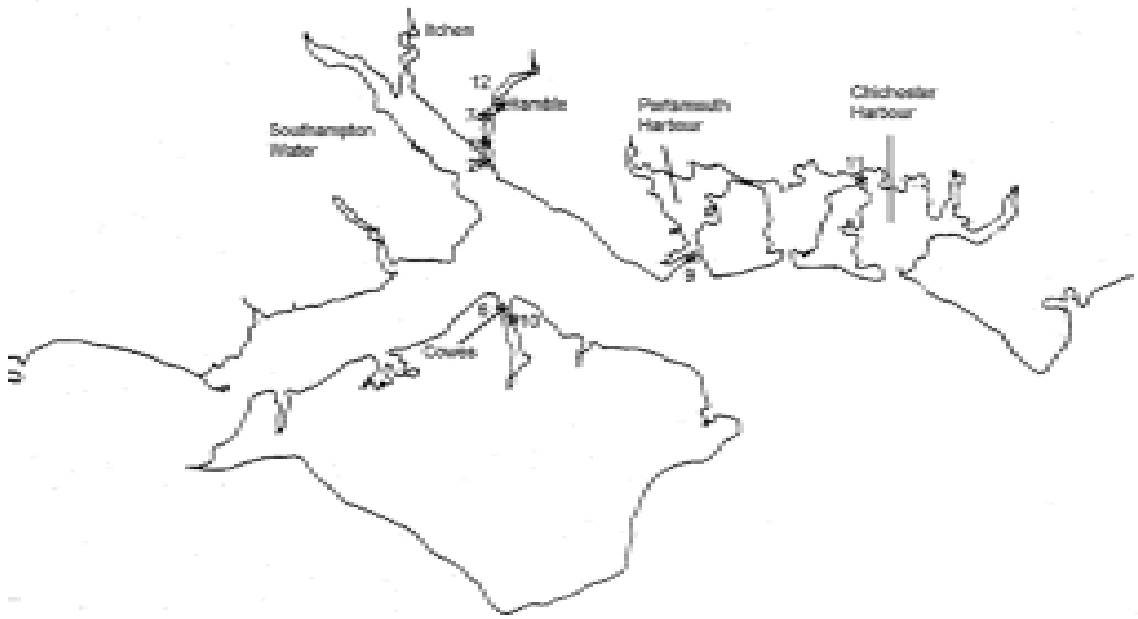


Figure 3. Map of Solent area. The numbers refer to the order of the discovery of the British Isles introductions referred to in Table 1.

Table 1. Chronology of *Undaria* discoveries in the British Isles.

1. Port Hamble Marina, Hamble Estuary	June 1994
2. Hamble Point Marina, Hamble Estuary	March 1996
3. Jersey Yacht Basin, Jersey	April 1996
4. QE2 Marina, Guernsey	June 1996
5. Torquay Marina, Devon	June 1996
6. West 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	April 1998
10. East Cowes Marina, Isle of Wight	April 1998
11. Northney Marina, Chichester Harbour	April 1998
12. Swanwick Marina, Hamble Estuary	June 1998
13.Camper & Nichols Marina, Portsmouth Harbour	October 2000
14. Ramsgate Marina, Kent	June 2002
15. Salterns Marina, Poole Harbour	March 2003

A total of 25 locations were visited during March, April and May 1996 (Table 1). A thorough search was carried out for *Undaria* at each location, thus establishing a baseline for the distribution of *Undaria* in the Solent. The next step was to expand the search for *Undaria* around the coast of the British Isles. There was not sufficient time to search many other marinas further away, so it was decided to mail a descriptive poster and introductory letter, to marinas at all main ports around the country.

The initial search for *Undaria* in the Solent area, during the first 3 months (March-May 1996) of the research, established that *Undaria* was present only in 2 out of the 25 sites identified as likely sites for *Undaria* introduction. All of the above sites were checked at least every spring until 1998. After this period, sites were visited as time permitted, or information was received about possible *Undaria* introductions. By October 2000, a total of 9 out the 25 identified sites in the Solent had been colonised by *Undaria* (Table 1).

It is probable that small boats were the vector for the Channel Islands introduction, and that these plants also originated from nearby Brittany in France, where the species has been cultivated since 1983 (Fletcher and Manfredi 1995). The population was restricted to a small area of the marina, and this was recorded, along with associated flora and fauna. The above results are presented in section two, along with additional data from subsequent visits.

The next response from the poster distribution that proved to be a correct sighting for *Undaria* was from Torquay. This population was discovered, in June 1996, after following up a response from W. Latham of the Torquay Marina Office. Torquay marina is situated within Torquay Harbour, which is located at Torbay, approximately 180 km west of the Solent, on the South Coast of England. Discussions with the Marina office revealed that there was a regular movement of leisure craft between the Solent and Torbay.

The next location to report *Undaria* was the Marina office at Cowes Yacht Haven, West Cowes. (Figure 3, number 6). Cowes Yacht Haven is situated approximately 8 km South of the Hamble, on the Isle of Wight. The above marina was visited in August 1996, and the presence *Undaria* was confirmed. The sporophytes here, as at all sites where the introduction was known to be a recent one, were restricted to a small area of the marina. The population was mapped and sampled, and the results are presented in section two along with later results. The nearby East Cowes Marina (1 km) was also visited, and found to be free of *Undaria* at that time. Regular visits were made to East Cowes Marina, and it was eventually discovered here in April 1998.

Dr. Bob Fletcher discovered the Brighton introduction in June of 1997. The alga was found in Brighton Marina, Sussex, situated approximately 80 km east of the Hamble. Again, the *Undaria* plants here were very localised in their distribution within the marina, being restricted to floating structures in the Outer Basin. Portsmouth Harbour (Figure 3, number 9) was the next location where *Undaria* was discovered, in December 1997, at Haslar Marina. The nearest marina to the above is Camper and Nichols Marina, a distance of only 250 m. Camper and Nichols Marina was regularly searched for *Undaria*, which did not become established here until October 2000. Data collected from the above locations are used in part two. The Chichester Harbour discovery was reported to me by Dr. Bob Fletcher. The sporophytes were first observed attached to the hull of boat, the

8m Fisher ketch "Antares" moored in Northney Marina. The sporophytes were reported attached to the hull of Antares in April 1998, and by July of 1998 there were sporophytes observed attached to the adjacent pontoons.

Discussion.

The plants in the British Isles, including Jersey, are likely to have come from Brittany attached to small boats, as the initial sites of infection were the floating pontoons of Marinas. On the south coast of England, for example, plants were first discovered at Port Hamble Marina in the Hamble Estuary, Southampton Water (see Figure 3). This Marina is one of 4 large Marinas in the Hamble estuary, and there are over 25 similar Marinas in this mid south coast region alone. Also, in the Hamble Estuary, there are 1,310 permanent moorings for Hamble based leisure craft, and the estuary receives over 14,000 visiting boats per year. It is also noteworthy that more than 50% of departures of Hamble-based boats leave directly for France.

With such a large volume of cross-channel traffic, it is most probable that a boat introduced *Undaria* into the Solent region, either in the form of gametophytes or small sporophytes. Certainly there is evidence that both these stages can survive long journeys on the hulls of boats (Hay 1990). Support for boats as the most likely vector for the introduction of *Undaria* into the British Isles is also provided by the occasional observation of plants on the hulls of leisure craft moored at the marinas. With the alga's known preference for artificial substrata, and especially floating structures such as buoys, floats, landing stages etc. (Hay 1990, Floc'h *et al.* 1991, 1996, Castric-Fey *et al.* 1993, Brown and Lamare 1994), it seems most probable that a small boat became infected with *Undaria* at one of the many Ports and Marinas on the Brittany coast. After the initial discovery of the south coast of England population, all the plants were removed. However, this attempt at eradication proved futile as some of the plants were already fertile and further plants were subsequently discovered at the marina. Indeed, *Undaria* has now considerably extended its distribution, both in the Hamble Estuary and along the south coast of England.

Whilst it is most likely that the majority of these new infestations are due to inter-marina traffic on the south coast of England, some undoubtedly represent independent transfers from the Brittany coast. This certainly seems to be the case in respect to the 8 m Fisher ketch Antares, which was probably responsible for introducing *Undaria* into Northney Marina. Plants were first observed attached to the hull in April 1998, and then later, in July 1998, they were observed attached to adjacent floating pontoons (Dr Bob Fletcher, pers. comm.). Prior to being moored at Northney Marina at the end of August 1997, where she has since stayed, Antares spent the preceding three weeks visiting the Brittany coast, with the following itinerary: Cherbourg Marina, St. Helier Marina (Jersey), St. Malo Marina, up the Ranch Estuary (Dijon), La Collette Marina, La Place Marina, back to St Malo Marina, Grandville Marina, St Helier Marina, Cherbourg Marina and then straight back to Northney Marina. Before she sailed south, her hull was cleaned at Northney Marina. It is likely that *Undaria* was introduced onto the hull during her stay at one of the Brittany marinas. Although *Undaria* is present in St. Helier Harbour, Jersey, the relatively small population is at La Collette Yacht Basin, and no plants were found at the adjacent St. Helier Marina during a recent visit (July 1998). This makes it unlikely that *Undaria* was introduced onto the hull during Antare's stay in Jersey.

It is apparent from Table 1 and Figure 3 that all new sightings of *Undaria* on the south coast are quite well geographically isolated and are all at Marinas. Clearly, small leisure boats are playing a major role in the "assisted" spread of *Undaria* along the south coast, as reported by Hay (1990) for Wellington Harbour, New Zealand. Certainly some examples were found of boats, colonised by *Undaria*, moving from one marina site to another. For example, the sailing sloop Coralendo that was moored at Port Hamble Marina from March 1997 to May 1998 was moved directly to Hythe Marina, situated

further up on the other side of Southampton Water, where she remained for 4 days prior to being cleaned. During the cleaning process she was observed to have a large fertile *Undaria* plant attached to the hull (Figure 2). If conditions are suitable there is, therefore, a very good chance that *Undaria* has now been introduced into Hythe Marina. It is by this mechanism that *Undaria* is likely to quite rapidly extend its geographical range both around the British Isles and on the European mainland coast. In this respect, its long-range passage is independent of current movements that by contrast have played a major role in the dissemination of *Sargassum muticum* in European waters. *Undaria* now extends between Ramsgate and Torquay, a distance of approximately 400 km.

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