

PORCUPINE MARINE NATURAL HISTORY SOCIETY

NEWSLETTER



Summer 2010

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Porcupine Marine Natural History Society

Newsletter

No. 28 Summer 2010

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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 2 newsletters a year which include proceedings from scientific meetings, plus regular news bulletins

Individual £10 Student £5

 www.pmnhs.co.uk

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Editorial

Welcome to the first Porcupine newsletter in full colour. The cost of short-run digital printing is such that it is now little more to print in colour than black and white. This will make figures with complex charts and maps much easier to display and understand and it will do justice to the many colour illustrations supplied by contributors. I hope it will also persuade more people to submit articles and pieces - it can be a challenge filling these pages.

There's no stopping the march of progress - Porcupine now even has a Facebook presence - though this is hardly news, judging by the number of members. There is much lively discussion going on there and a growing collection of members photographs. If you haven't joined yet - <http://www.facebook.com/group.php?gid=190053525989>

Don't forget that you can now opt to receive your newsletter via email as a pdf attachment - this can be as well as or instead of the printed version.

Corrections:

Newsletter 27 - Winter 2009/10

The table on page 8 - labelled "Table 1 - Shore thing climate change and non-native species" belonged to the article on page 9 about the autumn field trip to St Abbs and not, as the layout suggested, to the article from page 7 about the spring field trip to Plymouth.

Peter Barfield and Evelina Capasso's article on *Serpulorbis arenarius* (page 18) was printed with an incomplete list of references. The full reference list is on page 13 of this edition.

Roger Bamber and Roni Robbins' article on *Metamunna typica* is reprinted in full on page 15 - this time with the accompanying figures.

Copy deadline for the next newsletter - 31 December

Porcupine Marine Natural History Society Minutes of the 33rd Annual General Meeting, Saturday 10 April 2010, at the University of St Andrews.

1. Apologies for absence were received from Tammy Horton, Vicky Howe and Peter Tinsley.

2. Acceptance of the Minutes of the 32nd Annual General Meeting, as published in the PMNHS Newsletter No. 26, was proposed by Séamus Whyte, seconded by Roni Robbins, and accepted by the floor with no corrections or additions.

3. There were no matters arising from the Minutes of the 32nd Annual General Meeting.

4. Officers' Reports

(a) The Hon. Treasurer's Report was presented by Jon Moore, the accounts being presented to the AGM audited. The accounts will be published in the Newsletter (see p5). We had paid £479 Corporation tax in the previous year, but we shall be recouping that this year. The 2009 Plymouth Meeting made a profit of £558. It was noted that we now receive no more income from the DCUK-Esmee Fairbairn Scheme. Acceptance of the Hon. Treasurer's Report was proposed by Anne Bunker, seconded by Peter Barfield, and carried with no votes against.

The Hon. Membership Secretary's Report was presented by Séamus Whyte. Membership stands at 269, with 229 fully paid up, including 12 student, 10 library, 4 Life Members, 9 honorary members and 5 members of unknown status. Acceptance of the Hon. Membership Secretary's Report was proposed by Jon Moore, seconded by Roger Bamber, and carried with no votes against.

The Hon. Editor's Report had been sent to the Hon. Chairman, and was presented by Andy Mackie in the absence of Peter Tinsley.

"There have been two issues of the newsletter since the last AGM, the summer issue filled out

with papers from the Plymouth meeting, the winter one with reports from field meetings and some interesting "Porcupine Pieces". Many thanks to all contributors.

I'm sorry not to be with you but I'm hoping for a good number of papers to publish in the next edition – copy deadline is 31 May. Can I encourage all presenters who wish to be published to submit their papers as soon as possible after the conference, if you don't wish to, we would be happy to publish your abstract.

The format is largely unchanged since taking over from Frances, but the newsletter is now available in electronic format as a full colour pdf (most of the illustrations supplied with articles are in colour and it seems a shame to waste them). Members can have the option of receiving the newsletter by email or by post (or both). The next printed edition could be in full colour – I've been offered a good deal by the printer.

Finally – an apology to any overseas member who had to pay a surcharge to receive the last newsletter. Please contact me or Jon for a refund."

Frances Dipper encouraged new people to contribute articles and notes to the Newsletter, especially post-graduates and other students.

Acceptance of the Hon. Editor's Report was proposed by Julia Nunn, seconded by Paul Brazier, and carried with no votes against.

The Hon. Web-site Officer's Report was presented by Andy Mackie in absence of Tammy Horton. "The website continues to be maintained and kept up-to date, providing information about the annual conferences and field trips and contact details for council (please inform TH of any changes). The peak usage of the website is in the spring months around the time of the annual conference. I have recently uploaded old Newsletters that have been made available to me in PDF format so you can now read all about Porcupine back as far as its beginning in 1976. I am happy to make any updates/changes as members require".

Acceptance of the Hon. Web-site Officer's Report was proposed by Roni Robbins, seconded by Steve Jarvis, and carried with no votes against.

The Hon. Records Convenor's Report was presented by Roni Robbins. The St Abbs field-trip data were now entered, and about to be uploaded to the NBN, but there had been no new records sent in under the Porcupine Recording Scheme. Members were, nevertheless, encouraged to do so.

Acceptance of the Hon. Records Convenor's Report was proposed by Frances Dipper, seconded by Julia Nunn, and carried with no votes against.

The Hon. Chairman's Report was presented by Andy Mackie.

The Council has held two meetings in the past year. These have been at the National Museum Wales, Cardiff on 31st October 2009, and here in Plymouth on Thursday 8th April 2010.

A successful conference was held in March 2009 at the University of Plymouth on 'Seashore to Seafloor' attended by almost 100 delegates. The Council thanks Jason Hall-Spencer, Fiona Crouch and their team for organising the meeting and fieldwork.

During the past year we held two field meetings, both of which were very successful. After the 2009 conference at Plymouth 30 attendees joined John Bishop at the marina to look at non-native species, followed by a rocky-shore visit to Wembury Voluntary Marine Conservation area. The Autumn field meeting was held at St Abbs & Eyemouth Voluntary Marine Nature Reserve: there were 15 attendees despite the poor weather conditions, indulging in shore-work and diving. Accounts have been published in latest newsletter. Thanks go to Fiona Crouch, John Bishop and the University of Plymouth for facilities and microscopes, and again to Fiona Crouch for the St Abbs trip.

Thanks to Richard Lord, Porcupine MNHS now has a Facebook presence. Members are encouraged to sign up to communicate with other Porcupines, send notices of events, ask questions, view photographs, post observations and chat about anything concerning marine natural history. Already there are photographs

from the fieldtrips at St Abbs and Plymouth. Thanks are also due to Ann Bunker for her work on this project.

A proposal had been received from Frank Evans, suggesting Porcupine might wish to offer some sort of annual prize. Options were discussed, and Council thought it would be appropriate to reward an article in the newsletter by a student or amateur, once per year. The prize will be £50 plus 1 year's membership.

Thanks were given to all the organisers for the very successful St Andrews meeting, and to the Scottish Oceans Institute for the wine reception. Everyone agreed that this had been a very enjoyable conference with wonderfully varied and interesting talks, that were of a high standard.

Acceptance of the Hon. Chairman's Report was proposed by Roger Bamber, seconded by Sue Chambers, and carried with no votes against.

5. Porcupine Grants Scheme

The second year of the Porcupine grants scheme has been a success once again. Three grants were awarded from 4 applications.

Roger Herbert: (Porcupine Grant being used as seed money to get a larger grant elsewhere) (see the article by Roger Herbert, Bill Farnham & Ian Tittley in the latest newsletter No. 27).

Roger Bamber" *Leptochelia savignyi*. A talk on this project was presented at this conference and an article will appear in this newsletter.

Annie Yunnice: (Report received 28 April 2010)

The grants scheme was established to exploit the income from the DCUK project, which income is now finished. It was decided to continue the scheme next year, looking at the sum of £2,000 for about 2 or 3 grants, and routinely to re-assess the financial viability of the scheme year by year. The deadline for applications is the end of May 2010.

6. Election of Officers and Council.

Two members of Council, Anne Bunker and Sophie Henderson, retired at the AGM; Anne Bunker was available for immediate re-election.

Angie Gall was proposed as a candidate for election to Council. The re-election of Anne Bunker was proposed by Roger Bamber and seconded by Jon Moore; the election of Angie Gall was proposed by Julie Nunn, seconded by Fiona Crouch: both proposals were carried with no votes against.

The motion was proposed (by Sue Chambers, seconded Sue Hamilton) to re-elect all the Office Bearers and the remaining ordinary members of Council en bloc, and was carried with no votes against.

The Council for 2010-2011 is as follows.

Office Bearers:

Hon. Chairman – Andy Mackie

Hon. Secretary – Roger Bamber

Hon. Treasurer – Jon Moore

Hon. Editor – Peter Tinsley

Hon. Membership Secretary – Séamus Whyte

Hon. Records Convenor – Roni Robbins

Hon. Web-site Officer – Tammy Horton

Ordinary Members of Council:

Peter Barfield

Paul Brazier

Anne Bunker

Sue Chambers

Fiona Crouch

Frances Dipper

Angie Gall

Vicki Howe

Julia Nunn

7. Future Meetings

The Autumn Field meeting will be in the Isles of Scilly; 32 members were already signed up, incl. Conchological Society members, but there is still space available if intending participants can get accommodation.

The 2011 AGM meeting is planned to be held in the Solent region.

There is a proposal from Julia Nunn for the 2011 fieldtrip in the last week of September

to be to Connemara, with the Conchological Society. Shorework is planned, and diving facilities will be available.

8. There being no other business, the meeting closed at 13.02.

PORCUPINE MNHS
RECEIPTS AND PAYMENTS ACCOUNT
Year to 31 December 2009

Year to 31.12.08			Year to 31.12.09
£	£		£
RECEIPTS			
1823		2004 to 2008	50
118		2009	1314
0		2010	20
<hr/>	1941		<hr/>
	34	Sales (Sweatshirts & books)	1384
	222	Bank Interest (gross, both accounts)	0
	(44)	Tax deducted	119
	<hr/>		<hr/>
	2153	Total Receipts	1480
PAYMENTS			
(856)		Newsletter- Printing	(764)
(309)		Postage	(319)
<hr/>			<hr/>
(1165)		Total Newsletter Costs	(1083)
0		Web site expenses	(151)
(402)		Council meeting expenses (travel/catering)	(136)
<hr/>	(1567)		<hr/>
	586	SURPLUS BEFORE MEETINGS & GRANTS	110
(118)		Annual Conference – Isle of Man (2006)	0
778		– Bangor (2008)	0
0		– Pembroke (field) (2008)	(60)
0		– Plymouth (2009)	558
0		– Scillies (field) (2010)	624
55,205		Deep Sea Conservation UK EFF grant received	0
(52,705)		Less grants made	0
(244)		Project expenses	0
(684)		Porcupine grants	(1699)
<hr/>	2232		<hr/>
	2818	SURPLUS/DEFICIT FOR THE YEAR (before tax)	(577)
	(353)	Corporation Tax	(467)
	<hr/>		<hr/>
	2465	SURPLUS/DEFICIT FOR THE YEAR (after tax)	(938)
	8703	BALANCE BROUGHT FORWARD	11,168
	<hr/>	BALANCE CARRIED FORWARD	
5771		Current Account	4745
5397		Deposit Account	5485
<hr/>	<u>11,168</u>		<hr/>
			<u>10,230</u>

Jon Moore, Hon Treasurer
26th February 2010

J. S. Moore

Nick Light, Hon Examiner
11th March 2010

N Light



Scavenging amphipods of the Mid-Atlantic Ridge

Tammy Horton & Grant Duffy

Investigations of the scavenging amphipod fauna of the Mid-Atlantic Ridge are currently being undertaken as part of the ECOMAR project (Ecosystems of the Mid-Atlantic Ridge). ECOMAR is a £2 million project aimed at understanding how physical and biogeochemical factors influence the distributions and structure of deep-sea communities. The project focuses on the Mid-Atlantic Ridge at four sites in different environmental settings (North and South of the Charlie Gibbs Fracture Zone and East and West of the Ridge) (Figure 1).

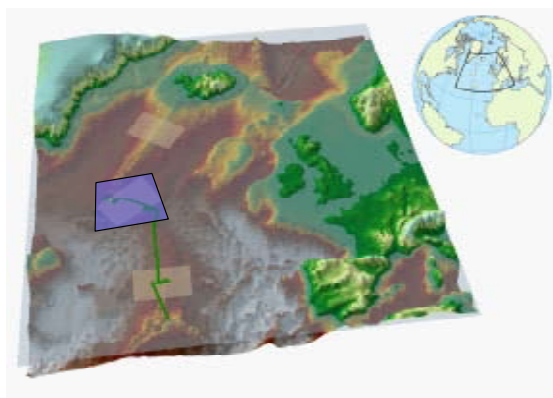


Figure 1 – Map of the study sites

The Charlie-Gibbs Fracture Zone coincides with the position of the sub-polar front in the North Atlantic Ocean, where there is warm, oligotrophic (nutrient poor) water to the south, and cold, eutrophic (nutrient rich) water to the north. The cold surface waters to the north are more productive, therefore there is a higher food supply available for organisms living on

the deep-sea floor. Using these localities we are investigating the effects of topography and currents on the distribution of the fauna, as well as the effects of varying organic input (food supply) to the deep-sea floor in two different biogeochemical settings.

Scavenging amphipods form an important part of the deep-sea fauna. Large food-falls are estimated to account for 10-30% of the annual particulate organic carbon (1, 2), and consumption of these food-falls is carried out by a specially adapted fauna comprised largely of amphipods and fish. Deep-water scavenging amphipods are highly mobile, enabling them to move easily between food-falls. They are normally constrained by depth but a few species are truly eurybathic (e.g. *Eurythenes gryllus*). Amphipods that attend food falls can easily be studied by means of baited trapping, which allows for capture of large numbers of specimens, useful for taxonomic, ecological and molecular studies.

The Amphipod Trap (figure 2) is an acoustically-released free-fall baited-trap system used to capture the mobile scavenging amphipod fauna. These free-fall systems have been used successfully in rough terrain on Atlantic Seamounts, the Faroe-Shetland channel, and Portuguese canyon systems. The trap consists of a large frame holding two or four traps – a benthic trap placed on the bottom of the lander frame and a suprabenthic trap situated 1m from the bottom. A mackerel bait is used to attract the amphipods, which enter the chambers through one-way valves, trapping them inside.



Figure 2 – Amphipod trap

Scavenging necrophagous fauna will be studied

using baited amphipod traps and lander systems.

Baited freefall amphipod traps have been deployed during three cruises (in 2007, 2009, and 2010) to the Mid-Atlantic Ridge as part of the ECOMAR project.

Analysis is based on 4 deployments of the amphipod trap (see figure 2) during cruise JC011(2007), 8 deployments during cruise JC037(2009), and 4 deployments during cruise JC048 (2010) all at ~ 2500m depth. The trap is normally deployed for about 24 hours. Good replicate samples were collected from each of the SE, NE and NW sites, however only a single sample is available from the SW (due to bad weather/trap failures). Sub-samples from each site were retained in ethanol for molecular studies.

Large samples of scavengers were recovered from both the Northern stations while very low abundances were collected from the Southern stations in 2007 and 2009. Samples are still being worked up, but so far we have identified the following species in the most of the samples.

Abyssorchomene abyssorum (present at all sites)

Abyssorchomene chevreuxi (present at all sites)

Eurythenes gryllus (present at all sites)

Centromedon sp. nov. (absent from one NE site 076)

Stephonyx biscayensis (absent from NE site 076)

Paracallisoma sp. (absent from NE site 076)

Tmetonyx sp. (absent from NW site)

Azygocypridina imperialis (an Ostracod - NW site)

Hirondellea trioculata (only SE sites)

Orchomene oxystoma (only NE site)

NE Stations

2 stations in 2007 (JC011/098, JC011/114)

2 stations in 2009 (JC037/076, JC037/083)

1 station in 2010 (JC048/020)

15+ species so far identified

Dominated by *Abyssorchomene abyssorum*, *Centromedon* sp. nov. and *Tmetonyx* sp.

At first look, one of the NE stations (JC037/076) has a lower spp diversity (only 6 spp), and some differences from the other NE sites. It is currently unclear why this is, as it is relatively close to other sites.



Figure 3 – Large *Eurythenes gryllus* specimen from mid-Atlantic ridge

NW Station

1 stations in 2007 (JC011/079)

2 stations in 2009 (JC037/052, JC037/060)

1 station in 2010 (JC048/008)

14 species (so far).

Dominated (biomass not numerically) by Ostracods (unusual) and *Centromedon* sp. nov. a very small species, new to science.

No amphipods were collected in the traps at the SE station in 2007 and very low numbers were trapped in 2009, and have yet to be fully analysed. The SE station in 2010 (JC048/046) has not yet arrived back from the cruise to be analysed, but the traps took a good catch of amphipods characterised by numerous smaller species and relatively few larger *Eurythenes*

gryllus (as compared with the SW site).

The single successful SW site (JC048/032) also has yet to be analysed but contained an unexpectedly high proportion of *Eurythenes gryllus* compared with the northern sites. Further information about the southern stations will have to wait until the return of the samples to the National Oceanography Centre for analysis.

Summary & Future Work

Clear differences are already apparent in the species compositions and abundances between the SE, NW and NE sites, indicating greater scavenger abundances at the northerly sites.

Work will continue to complete the sorting, counting and identification of the 2009 material, and to begin the process with the new material from the 2010 cruise. This will be followed by analyses of the data to compare between the sites and years. The new species is being illustrated and described for publication in *Zootaxa*.

Work is also underway in the molecular characterisation including a phylogeny and population genetic study of the species *A. abyssorum* at the 4 sites (in collaboration with Rus Høezel & Thomas White, at Durham University).

Structure, function and evolution of polychaete crotchets

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Abstract

Polychaetes may have evolved from Precambrian trochophore-like metazoans inhabiting the photic zone where the oxygen concentration was high compared with the benthos. These putative organisms probably had chaetae for buoyancy. As the benthic oxygen level increased over geological time they would have descended to the seabed to feed on accumulating organic

matter. Their chaetae would have prevented them from sinking into the detritus. Size was then no longer a limitation. By becoming larger their reproductive fitness would have increased. They budded a segmented abdomen and increased egg production. Chaetae were adapted for swimming by becoming compound. Loss of the distal article produced simple chaetae for crawling on hard surfaces and burrowing. Diversification of chaetal form appears to be a response to function rather than phylogeny. Differences in families may therefore be due to a Precambrian radiation of a trochophore-like ancestor.

Introduction

An unresolved polychaete taxonomic problem is the apparent genetic homogeneity of the polychaetes compared with marked morphological heterogeneity. Molecular biology suggests they are predominantly monophyletic whereas their general morphology suggests they are polyphyletic. An attempt to resolve polychaete evolutionary relationships was made by Dales (1963). He suggested, largely on the basis of feeding structures, that, on balance, polychaetes are polyphyletic. Fauchald & Jamars (1979) in a survey of polychaete feeding habits appears to support this approach. If polychaetes were monophyletic, as suggested by molecular biology, chaetae might be expected to show a morphological trend.

Structure & function

Chaetae

Simple chaetae, those with a single shaft, are characteristic of sedentary species, and compound chaetae, those with two components, articles, are typical of errant species. Simple chaetae are likely to have evolved from compound chaetae through the loss of the distal, outer, article. Each chaeta, irrespective of type, is formed by a chaetoblast (Hausen 2005; Gibson & Stoddart, 2005). Possibly, compound chaetae result from one chaetoblast lying immediately below the other so the innermost chaeta grows into the one above. The remnants of the outer chaetoblast, the one nearest the body surface, may form the ligament of the joint between the two articles.

The outer end of the proximal article of compound chaetae, such as spinigers, frequently has a toothed boss which appears to assist in gripping, digging into, the surface of the substratum. An example is found in *Eusyllis assimilis*. Compound chaetae of free-living benthic polychaetes appear to be largely adapted for swimming. An example is the oar-like chaetae of phyllodocids. The joint allows the outer article to rest at an angle on the substratum to aid crawling over soft surfaces and gripping the sides of tubes (Gibson, 2002b). Simple chaetae can be geniculate, bent, and these may serve the same function.

Chaetae for digging

Crotchets are acicular, spine-like, chaetae with the outer point forming a digging hook the crest of which frequently bears teeth. The shaft must provide leverage. A slight swelling some third of the way down the shaft from the hook persuadably acts as a fulcrum as well as helping anchor the chaeta within the body.

The distal end of the basal shaft of a compound chaeta has a shallow pit or cleft into which the outer article fits to form the joint. The loss of the outer article would produce a simple bifid chaeta as seen in the spinose chaetae of polynoids and aphroditids. The pit may have been adapted to form spooned crotchets for excavating burrows, as for example in *Dodecaceria*.

Hooded crotchets for scooping

Some crotchets have a membranous hood, a guard, which encloses the distal end and sometimes leaves only the tip of the terminal tooth projecting from it. Such hooded crotchets appear to be found only in species living in soft sediments such as mud (Table 1). The hood probably scoops up mud during burrowing much as a dredger does. There is a split along the length of the hood and as the head of the crotchet is forced into the burrow wall the membrane must open as it is pushed back. When the crotchet is withdrawn from the wall the mud is presumably squeezed out, for hoods are never seen, in preserved specimens, with mud in.

Tufted crotchets as brushes

Some crotchets have a brush of stiff processes on the distal end, the capitum. The brush is almost certainly composed of the fibres that make up the chaeta itself (Hausen, 2005; Gibson & Stoddart, 2005). The companion chaetae of the crotchets of *Polydora ligni* are similar to washing-up brushes and may be forced into the excavations produced the crotchets (Figure, a, b & c). The same function may be served by the brush on the crest of the crotchets of, for example, *Polydora polybranchia*. Brushes are also found at the ends of some acicular chaetae as for example on the fifth segment of many spionids. Brushes are found in species living in mud or other soft sediments.

Chaetae as anchors

In some tube-living species crotchets have been drastically shortened to form temporary anchors, uncini, which grip the sides of the tube (Table 1). Uncini are robust, toothed and normally arranged in lateral rows or tori. Some have an internal proximal extension, the manubrium, for the attachment of muscles. In sabellids the shape of uncini and crotchets overlap. The two types can be morphed into one another using a D'Arsey Thompson transformation (Gibson, 2002a). The change in shape is achieved through allometric growth, a process that easily accounts for the shape of all chaetae.

Comb chaetae are found in errant polychaetes (Gibson & Stoddart, 2005). They have broad heads with teeth and are apparently modified for gripping the sides of mud burrows during temporary occupation (Table 1). Again, this is probably so for lyrate or furcate chaetae (Table 1) which bear hair-like processes within a fork. The fork, as in comb chaetae, may have been derived from the bifid end of the shaft of compound chaetae.

Chaetae as spacers

In sedentary species chaetae appear to align worms within their burrows. The simple notopodial chaetae of *Spiophanes* and *Arenicola*, for example, push the worms to the ventral side of their tubes creating an upper respiratory channel (Figure, d). These chaetae are limbate. They have a flange (Figure, e) on

Family	Chaetae	Substratum	Habit	Figures
Burrowing & tube living				
Simple crotchets				
Arenicolidae	Crotchets	Sand, mud	Tubes	Fig 4.1
Cirratulidae	Crotchets	Rock, shells	Burrows, cracks in rock	F '27, Fig 36
Oweniidae	Waisted crotchets in tori	Sediments	Tubes	<i>Fig 47.2</i>
Hooded & bearded crotchets				
Capitellidae	Hooded crotchets	Mud	Tubes	Fig 51
Magelonidae	Hooded crotchets	Sand	Membranous tubes	Fig 65.1
Maldanidae	Bearded crotchets in tori	Mud	Membranous	<i>Fig 7.2</i>
Spionidae	Hooded crotchets	Rock, mud	Secreted	Fig 68.1
Uncini				
Ampharetidae	Uncini in tori	Sand	Constructed	Fig 60.1
Amphictenidae	Uncini	Sand	Constructed	F '27, Fig 77
Chaetopteridae	Uncini	Sediments	Tubes	<i>Fig 64.2</i>
Sabellidae	Uncini	Sand	Constructed	<i>Fig 49.2</i>
Serpulidae	Uncini in tori	Hard surfaces	Calcareous tubes	Fig 50.1
Terebellidae	Uncini	Mud, sand	Constructed	Fig 62.1
Lyrate chaetae				
Orbiniidae	Lyrate	Sand, silt	Burrows, free living	Fig 91
Paraonidae	Lyrate	Sand, mud	Temporary tubes	Fig 10.1
Scalibregmatidae	Lyrate	Mud	Galleries	Fig 12.1
Demersal & free living				
Compound crotchets				
Aphroditidae	Compound	Various	Epibenthic	F '23, Fig 40
Glyceridae	Compound	Various	Epibenthic, burrows	<i>Fig 24.2</i>
Hesionidae	Compound	Hard surfaces	Epibenthic	<i>Fig 18.2</i>
Nereidae	Compound	Various	Epibenthic, galleries	<i>Fig 20.2</i>
Pholoidae	Compound	Various	Epibenthic	<i>Fig 14.1</i>
Phyllodocidae	Compound	Various	Epibenthic	<i>Fig 32.2</i>
Sigalionidae	Compound	Sand, mud	Burrows	Fig 15.1
Syllidae	Compound	Mostly hard surfaces	Mostly epibenthic	Fig 22.1
Compound hooded crotchets, lyrate & comb chaetae				
Eunicidae	Compound hooded, comb	Various	Epibenthic, burrows	<i>Fig 38.2</i>
Lumbrineridae	Compound hooded	Mud, sand	Epibenthic, burrows	Fig 41.1
Nephtyidae	Lyrate	Soft sediments	Mobile burrows	F '23, Fig 147
Onuphidae	Compound hooded, comb	Various	Epibenthic, membranous tubes	Fig 43.2

Table 1. Examples of nine types of chaetae, and the relationship between species substratum and habit. Figures, unless stated otherwise, from Rouse & Pleijel (2001). The other figures from Fauvel (1923, 1927). Scanning electron micrographs shown in italics.

one or both sides of the shaft which usually consists of fine hair-like processes. The hairs may reduce friction on the wall of the burrow during positioning, like the contacts of a generator. Compound chaetae of errant species occupying burrows for short periods may also have a positioning effect (Gibson, 2002b).

The shape of the bewildering array of asymmetric simple chaetae in serpulids and sabellids may correspond to the curvature of their tubes. The same may be true for their pick-axe chaetae which appear to have loose, swivel heads. The sub-terminal beard of some crotchets in spionids and maldanids may also position the body when digging.

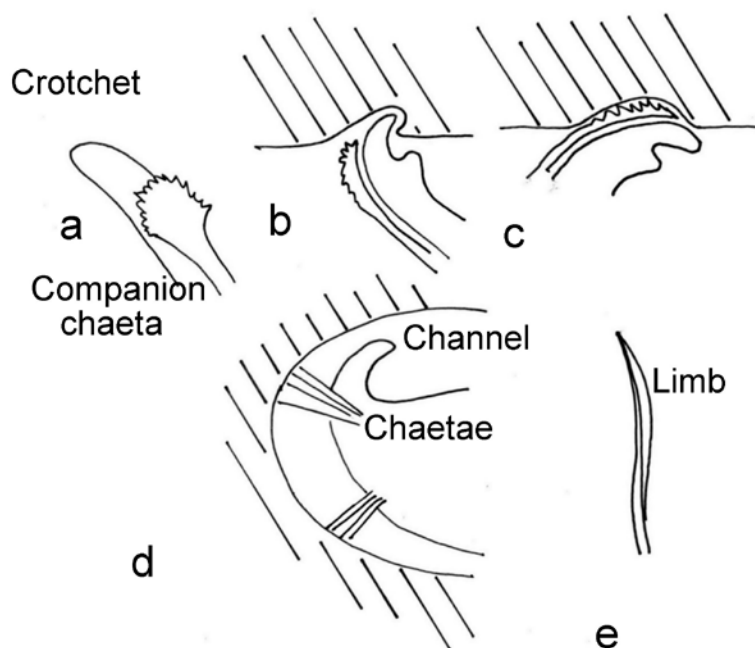
Chaetae as sensors

Sedentary polychaetes are probably unable to directly detect their position within burrows because they appear to lack specialised sensors. Chaetae may, however, relay vibrations to their attached muscles and these probably have isolated sensory endings. As suggested, the bodies of most burrowing species appear not to be in intimate contact with the burrow wall. Specialised tactile sensors are probably confined to palps and other structures of the head.

Discussion

Polychaetes can be classified using a combination of structure (Rouse & Pleijel, 2001) and molecular biology based on 18S rDNA (Bleidorn *et al.* 2003; Hall *et al.*, 2004; McHugh, 2005) (Table 2). Those families supported by molecular biology, with the exception of the Terebellida, are errant. They appear closely related: they are monophyletic. The remaining families not supported by molecular biology are, by default, unrelated: they appear to be polyphyletic. These families are all sedentary. This division may be an over simplification for it ignores many small families.

Taxonomists tend to lump taxa into ever larger and supposedly comprehensive groups. This approach is at odds with polychaete identification keys, where families are the highest taxon. Pettibone only used families and this is essentially true of Fauvel, Day and Hartmann-Shroeder. Polychaetes are most easily seen as polyphyletic. There is an uncomfortable feeling that lumpers are shoehorning polychaetes into higher taxa because they see evolution as strictly progressive. That is, organisms start from



a) Crotchet and companion chaeta of *Polydora ligni* (Jassim & Mettam, 1994) seen from the behind the hook, b) speculative position these two chaetae at the start of a digging stroke and their c) position at completion of the stroke showing, the probable brushing effect of the companion chaeta, d) cross section of burrow of a sedentary polychaete, such as *Spiophanes* and *Arenicola*, showing the probably position of the worm in relation to simple limbate chaetae, e) one of the parapodial limbate chaetae apparently used to support body of worm within its tube.

Taxon	Chaetal type	General habit
Families supported by 18S rDNA analysis		
Terebellida		
Ampharetidae	Uncini	Burrows
Amphictenidae	Uncini	Burrows
Cirratulidae	Crotchets	Burrows/crevices
Terebellidae	Uncini	Burrows
Phyllodocida		
Aphroditidae	Compound	Epibenthic
Glyeridae	Compound	Epibenthic/burrows
Hesionidae	Compound	Epibenthic
Nereidae	Compound	Epibenthic/burrows
Pholoidae	Compound	Epibenthic
Phyllodocidae	Compound	Epibenthic
Sigalionidae	Compound	Burrows
Syllidae	Compound	Mostly epibenthic
Eunicida		
Lumbrineridae	Compound	Epibenthic/burrows
Eunicidae	Compound	Epibenthic/burrows
Onuphidae	Compound	Epibenthic/burrows
Families not supported by 18 rDNA analysis		
Spionida		
Chaetopteridae	Uncini	Tubes
Maldanidae	Crotchets	Tubes
Megalonidae	Crotchets	Tubes
Spionidae	Crotchets	Tubes
Scolecida		
Arenicolidae	Crotchets	Tubes
Capidellidae	Crotchets	Tubes
Sabellida	Uncini	Tubes
Sabellidae	Uncini	Tubes
Serpulidae	Uncini	Tubes
Owenidae	Crotchets	Tubes

Table 2. Taxa supported and not supported using 18S rDNA families. High taxa based from Rouse & Fauchald (1997) and families from Fauvel (1923, 1927) and shown in Table 1. The correspondence of chaetae (crotchets, uncini and compound) and habitat show the environment influence on polychaete phylogeny.

being simple and inevitably become complex: an uncompromisingly Darwinian view. The unsatisfactory nature of polychaete taxonomy, therefore, requires an alternative approach. Davidson *et al.* (1995) and others, perhaps maverick zoologists, suggested that polychaetes arose from planktonic trochophore-like organisms. Hatschek (1854-1941) proposed that all invertebrates evolved from a hypothetical larva, the Trochozoon, and

this theory has been revisited by many others (Willmer, 1990).

In the Precambrian a thermocline probably existed on continental shelves. The lower levels of the sea would have been anoxic. Reduced atmospheric carbon dioxide may have led to a lower global temperature which disrupted the thermocline. At that time there was a corresponding rise in oxygen concentration in the upper layers of the sea probably due to

phytoplankton. Destruction of a thermocline would have resulted in vertical circulation of oxygen. The trochophore-like organisms would then have dropped to the seabed to take advantage of food settling there (Gibson, 2008/2009b). This migration is undertaken in extant larvae (Shanks & Carmen, 1997). The long chaetae of the trochophore-like organisms used for buoyancy would have prevented these organisms from sinking into soft detritus. They would have come to live on the seabed. Their reproductive fitness would have increased through producing greater numbers of gametes as a result of segmentation. They evolved into polychaetes which would have diverged into families due to abundant vacant niches. The sea above, in contrast, is homogeneous. Possibly fluctuations in sea levels during the Cambrian resulted in extinctions which gave rise to further episodes of speciation.

Polychaete classification based on chaetae presents a problem since chaetae are relatively similar across different families. The general morphology of the body suggests that families are polyphyletic. However, many families on the basis of molecular biology are thought to be monophyletic (Tables 1 & 2). This dichotomy may, in part, exist because the structure of chaetae is largely determined by function: same function similar shape. Chaetae may not be as homogenous as they appear: the devil may be in their detail. Resurrecting a version of Hatschek's Trochozoon avoids this taxonomic problem. Diversification of polychaetes may, as suggested, be due to numerous invasions of the seabed resulting in unrelated families: polyphyly. With the evolution of true polychaetes the trochophore-like ancestors would have been relegated to larvae for dispersion. Larvae in different families, as pointed out by Rouse (1999) and others, vary structurally. Repeated invasions and extinctions would have resulted in small populations which would have diversified as they expanded.

Fossil polychaetes first appear in the Cambrian. Their hypothetical trochophore-like ancestors would never have been found because they would not have fossilised. Polychaetes after the Cambrian show little further divergence (Eldridge *et al.* 2005) probably due to

saturation of niches. The diversity may be due to the effect of environmental changes.

Note: Genus and species names, with a couple of exceptions, are from Fauvel (1923, 1927).

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Correction:

The article:- **Some notes on an unusual mollusc, *Serpulorbis arenarius* (Linné, 1767) – The giant worm shell**, by Peter Barfield and Evelina Capasso, which appeared in the previous newsletter, was printed with an incomplete list of references. The full list is given below.

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Rediscovery, redescription and resurrection of *Metamunna typica* Tattersall, 1905 (Peracarida, Isopoda, Asellota, Paramunnidae).

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Introduction

The paramunnid isopod *Metamunna typica* Tattersall, 1905 (Figure 1) was described originally, as a representative of a new genus, from two females collected from west of Ireland as follows:

Female, 50 miles WNW of Cleggan Head, Co. Galway, 120 fthm [219 m], July 1903.

“One” Porcupine Bank, 53°20'N 13°W, 164 fthm [300 m], May 1905.

Both samples were “trawls”, and no sediment data were available. Notable characters of the species (and genus) were the distal apophysis on the antennal peduncle and the presence of eyes.

Subsequently *Metamunna* was relegated to a junior synonym of *Paramunna* G.O. Sars, 1866 (e.g. Wolff, 1962; Kusakin, 1988). The species has been listed as a deeper-water isopod, based solely on the type collection, as there had been no further records of this species. The type material is believed to be lost (e.g. Wilson, 1997).

During their recent and comprehensive revision of the *Paramunna* complex, Just and Wilson (2004) pointed out that *Metamunna typica* is “recognisable as belonging to the Paramunnidae (antennae, body form, uropods)” but the illustrations and descriptions left significant characters unresolved, and without such information a diagnosis of *Metamunna* could not be made. They considered *M. typica* as a *nomen dubium* until such time as new material was found. However, the morphology of the cephalic frontal margin precluded it from *Paramunna* as redefined.

During analysis of the benthos from the SEA5 samples from the Moray Firth, off northeastern Scotland, in 2003, a number of specimens of

Metamunna typica were found at between 50 and 110 m depth. These records are the first since the original discovery by Tattersall. One of the specimens was a mature male, allowing the redescription of the species and the resolution of this taxon in the context of the revision of Just and Wilson (2004). As the recent collections are far from the type locality, it was not appropriate to erect a neotype.

Specimens of the type species of the genus *Paramunna*, *P. bilobata* G.O. Sars, 1866, and of a third “paramunnid” species, were also found in the SEA5 material. None of the three species was common. The third species, a single female specimen similar to *Leptaspidia brevipes* Bate & Westwood, 1868 (the third paramunnid known from British waters), was in too poor a condition to allow interpretation.

Morphological terminology is as in Bamber and Shearer (2005). The term “spines” is used in the traditional (and etymologically correct) sense of rigid “thorn-like” structures to distinguish them from the flexible “hair-like” setae; non-articulating spine-shaped extensions of the cuticle are mainly considered to be apophyses.

Material is deposited at the National Museum of Scotland, Edinburgh.

Redescription

Metamunna typica Tattersall, 1905

M. typica Tattersall, 1905: 18, pl. IX, figs 1-3.

Paramunna typica Wolff, 1962: pp. 259, 274; Kusakin, 1988, pp. 332-333, fig. 283 (after Tattersall, 1905).

Material: 1 brooding female (figured), 1 male, dissected, Smiler’s Hole, Outer Moray Firth (area A), 64.87 m, muddy to clean sand, 26 September 2003; van Veen Grab sample.

1 brooding female, (NMSZ:2004.250.0001), Smith Bank station 2#1, 58°06.278'N 002°46.454'W, Inner Moray Firth, 52.33 m depth, on very fine sand with a small amount of silt and shell debris; 23 September 2003; Day Grab sample.

Further single specimens were recorded at 109.76 m (van Veen) and 110 m (megacorer) in Smiler's Hole on 22 September 2003, and 77.04 m on a rippled feature in the Outer Moray Firth (area A) on 27 September 2003.

Description:

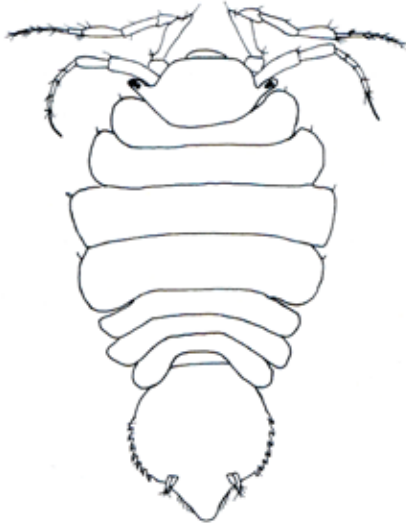


Figure 1. *Metamunna typica*, female, habitus, dorsal

Note: Just and Wilson (2004) commented that "...mouthparts, except the mandibles, and pleopods, except I (male) and II (female: operculum), hardly vary in the *Paramunna* complex and therefore are of little value in identifying genera and species." The following description reflects this.

Body (Fig. 1) width 0.52 times length in female, widest in female at pereonite 3.

Head length 0.56 times width .

Frontal margin not produced, nearly straight without lateral corners or projections, dorsoventally flattened in lateral view.

Eyestalks rounded, elongate, anterior and posterior margins nearly parallel, longitudinal axis pointing forward at approximately 33°.

Pereonite lateral margins 1 and 2 rounded, 3 quadrate, 4 to 7 rounded. Pereonite lateral margins smooth; coxae of pereonites 4 to 7 visible dorsally.

Pleon (visible, free pleonite plus pleotelson) length 1.3 times width in female.

Pleotelson (Fig. 2) lateral margins with 7

strong, posteriorly recurved denticles on each side. Dorsal setae present at base of each denticle. Posterior margin extended forming an acute, bluntly pointed angle with 6 setae on each side.

Antennule (Fig. 2) distal end of article 2 extending well beyond apex of eyestalk; article 1 longer and broader than 2, wider distally; article 2 wider distally; articles 5-6 subequal in length, longer than articles 3-4; article 6 terminating in single aesthetasc and with 2 long setae.

Antenna (Fig. 2) article 3 width 0.33 times length, with inner distal apophysis bearing a terminal seta and 1 or 2 sub-terminal setae; article 4 inserting anaxially on article 3; articles 5-6 sub-equal in length; article 5 distinctly longer than article 4; flagellum with 7 articles.

Mandible (Fig. 2) palp absent; molar well-developed, truncate.

Pereopod 1 (Fig. 2) carpus sub-rectangular, basis and ischium with smooth anterolateral and posterolateral margins; merus with 2 dorsodistal and 1 ventrodistal setae; carpus opposing margin with 3 flagellate spines ("robust setae" of Just and Wilson, 2004), narrowing proximally to insertion on merus, dorsodistal corner moderately produced; propodus opposing margin crenulate with several setae, propodus narrowing distally to insertion of dactylus; dactylus bifurcate.

Male pleopod 1 (Fig. 2) lateral lobes distinctly projecting from mid-lateral margin, width 0.38 times the distance to mid-line; distal projection length 0.47 times pleopod total length, forming acute angle, with pointed apices.

Uropods (Fig. 2) dorsal, well separated from lateral margin of pleotelson; protopod not exposed; with two rami, exopod fully expressed, half as long as endopod.

Female operculum ovoid, not examined in detail.

Size. Largest male 1.2 mm. Largest female 1.53 mm

The brooding female from Smiler's Hole was carrying eight eggs.

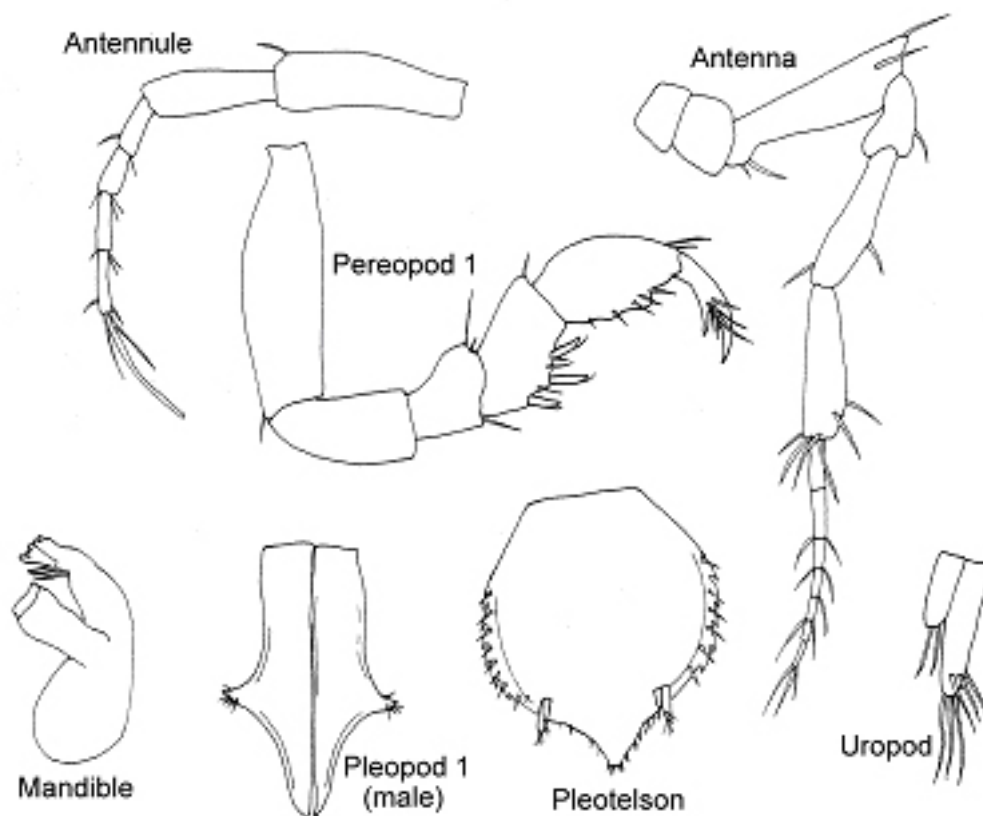


Figure 2. *Metamunna typica*, male: antennule, antenna, pereopod 1, mandible, pleopod 1, pleotelson and uropod.

Discussion and Systematics

Metamunna typica is without frontal lobes on the cephalon, so should be removed from *Paramunna* as now restricted. Among the features not apparent from Tattersall's original description but now clarified are the visibility of the coxae of pereopods 4 to 7 (only) in dorsal aspect, the well-developed and truncate molar process of the mandible, and the presence of one dorsally-visible pleonite; the first of these features distinguishes *M. typica* from the *Paramunna*-complex *sensu* Just & Wilson (2004).

These authors also define certain other features as being consistent across the *Paramunna*-complex, including two more on which *Metamunna typica* diverges, viz:

"antennule of all species with article 6 carrying a single terminal aesthetasc and one long and a few short simple setae"; *M. typica* has two longer setae.

"All species in the *Paramunna* complex invariably have two robust setae on the distal half of the posterior margin of the carpus":

M. typica has three such flagellate spines (in both sexes).

Using the key to genera of Just and Wilson (2004), the present species would identify as a member of *Omonana*; indeed, only that genus has the elongate proximal antennule articles (article 2 extending well beyond the tip of the eyestalk) shown by *M. typica*. However, species of *Omonana* have a mandibular palp (absent in *M. typica*) and have no exopod on the uropod (present in *M. typica*).

The pronounced setose distal apophysis ("spur") on article three of the antenna peduncle, emphasizing its geniculation, appears unique to *M. typica*.

We therefore re-establish Tattersall's genus *Metamunna* for *M. typica*. Note that subgenus *Metamunna* Fresi & Mazzella, 1971 (q.v.) is an invalid homonym.

Habitat and Synecology

Information on the seabed habitats is available from Eleftheriou *et al.* (2004). Information on

the community is from unpublished data from the benthic macrofaunal sample analyses.

Outer Moray Firth

Samples were retrieved from two areas in the Outer Moray Firth:

- Area A, a rectangular block extending 58°-58°29'N, 2°04'-2°11'W
- Area B, a second rectangular block extending 50°50'-58°N, 3°-1°48'W

Sediments were variable, ranging from generally coarse sediment cover to muddy, very fine to fine sands becoming finer with depth.

The macrofauna was relatively consistent, with numerically dominant taxa including species characteristic of stable fine sands (e.g. the polychaete worm *Galathowenia oculata* agg., the amphipods *Ampelisca tenuicornis* and *Harpinia antennaria*, and echinoid *Echinocyamus pusillus*). The capitellid polychaete *Peresiella clymenoides* was widely distributed in both areas.

Smith Bank

Smith Bank is an extensive sand bank located in the inner Moray Firth with a mean depth of about 40m. The sediments across the bank comprise unimodal or multimodal fine to medium sands. Occasional samples comprising shell gravel were also recorded, and these samples were also noted to display high values for carbonate and percent total carbon.

Numerically dominant infaunal taxa were characteristic fine sand species and consistent across the area, viz the amphipods *Bathyporeia elegans* and *B. guilliamsoniana*, the polychaetes *Spiophanes bombyx* and *Ophelia borealis*, the bivalve molluscs *Moerella pygmaea* and *Abra prismatica* and echinoid *Echinocardium cordatum*.

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This article was incompletely published in the last newsletter - it has been re-published here in full

Porcupine 2010 Changing Seas

University of St Andrews, Fife, Scotland

9th – 11th April 2010

Cryptic ecotypes of North Atlantic planktonic foraminiferal morphospecies complicate climate reconstructions

Kate Darling

University of Edinburgh

Planktonic foraminifera (forams) are an important group of single-celled organisms that live in the surface to sub-thermocline regions of the open ocean. Their hard shells of calcium carbonate, imprinted with a chemical record of the environment in which they grow, are preserved as microfossils in the ocean sediments where they have accumulated to great depth over millions of years. Specific

assemblages of planktonic forams are associated with each of the major hydrographic regions of the global ocean and researchers use this ecological evidence and the geochemistry of the foram shells to reconstruct ocean circulation and climate in the past. To do so, they assume that all the shells of a single morphospecies (species defined by shape) were constructed within the same environmental range and represent a single ecotype. A unique DNA marker in living forams now shows that this is not always true. Many morphospecies have several genotypes exhibiting distinct biogeographical and seasonal distributions. The genotypes of each of these morphospecies build their shells in different environments from one another and scientists are unknowingly using a mixture of different ecotypes which will introduce noise if not error into their climate reconstructions.

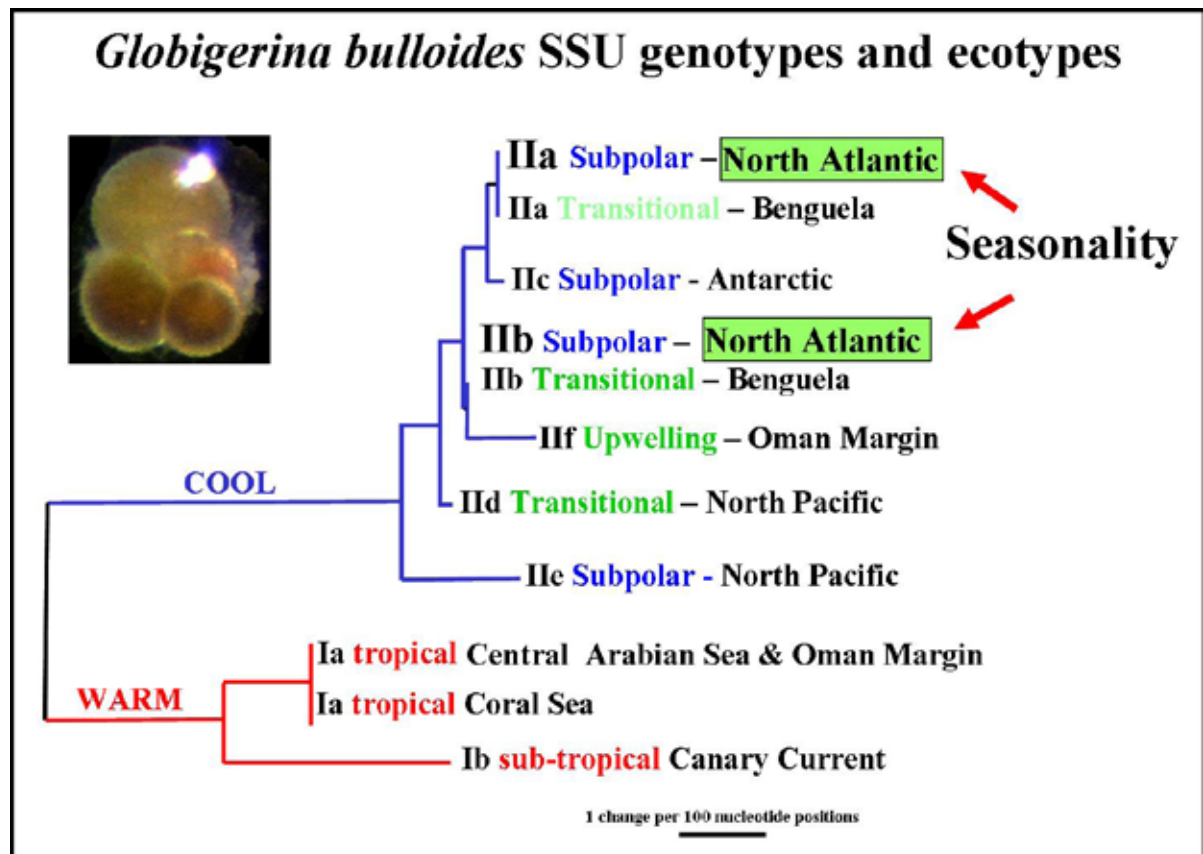


Fig.1 Phylogeny of *G. bulloides*

The sediments of the sub-polar North Atlantic are used extensively for high resolution studies of climate change. The genetic characterisation and biogeographical distribution of foram morphospecies throughout the seasonal succession has particular importance in this region. Fortunately, the present day global biogeography of planktonic forams is pristine, since they are not transported in tanker ballast water due to their pelagic habit, short sexual life cycle and lack of encystment stage. This makes it possible to use their biogeographical distribution as a potential ecological indicator. Genetic studies have identified high cryptic diversity in the palaeoceanographically important sub-polar morphospecies *G. bulloides*. Six distinct cool water genotypes have been identified within the morphospecies complex to date (Fig. 1) and the North Atlantic high latitude waters harbour Type IIa and IIb which are ecologically distinct. Seasonality studies from six different cruises indicate that Type IIa advances ahead of Type IIb as the spring plankton bloom extends north and Type IIa is the only genotype found in the most northerly subpolar/polar latitudes. The higher latitude North Atlantic sediments therefore represent seasonally overlaid assemblages of two distinct *G. bulloides* species with different ecologies and potentially distinct geochemistries. They are morphologically very similar and work is ongoing to determine potential features to differentiate them.

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Development of temperate reef monitoring methods using low-cost image mosaics: a comparison of optical techniques, quadrat sizes and measures of community structure

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With the advent of the 92/43/EEC Habitats Directive (EEC, 1992) and the 2000/60/EC Water Framework Directive (EC, 2000), a statutory need has arisen for EU member states to develop methods for monitoring programmes, from which well-informed decisions regarding the status and appropriate management of marine environments can be made (Puente and Juanes, 2008). In the hard-substratum environments of the UK this is particularly important as few standardised monitoring methods are in regular use (Whittington *et al.*, 2006; Lock *et al.*, 2009). In recognising this need, this study tested different survey methods and those that were safest, most efficient and statistically robust were recommended for use in marine temperate hard substrata monitoring programmes. A low-cost, image mosaicing method was applied to imagery collected from a macroalgae-dominated infralittoral community, located between 8 and 22 m depth off the South shore of Rathlin Island, Northern Ireland. The cost-effectiveness of different survey approaches were evaluated through the testing of four experimental factors: data collection medium, data-extraction technique, quadrat size and change detection. The significant findings from the testing of each factor are listed below.

Data collection medium

The mosaics were constructed from comparative stills and video imagery collected from the same quadrats (Fig. 1). The impression of the community differed between these media due to the inherent

Stills Image Mosaic

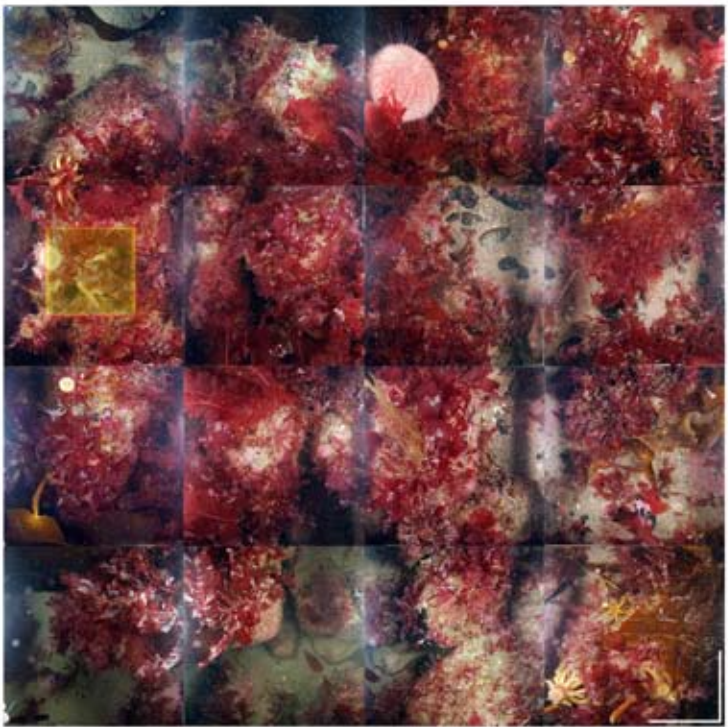
A.

Camera	Nikon D40X
Lens	Nikon Nikkor 18-55mm
Sensor	10.2 Megapixel CCD
Image resolution	300 dpi
Image storage	RAW/ JPEG format
Underwater housing	Ikelite Nikon D40
Lens port	Ikelite 8" dome port
Strobes	Ikelite DS125 X2
Total cost	£3,000

E.



C.

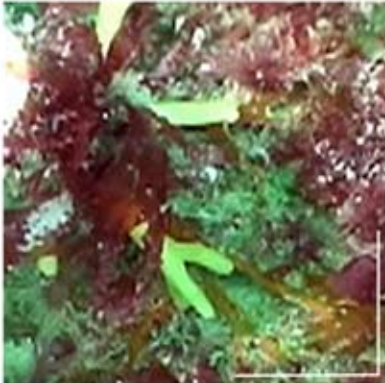


Video Image Mosaic

B.

Camera	Sony DCR-PC350E Pal
Lens	Carl Zeiss Vario-Sonnar 5.1-51mm
Sensor	3 Megapixel CCD
Image resolution	96 dpi
Image storage	MiniDV Pal format
Underwater housing	Gates Sony PC350
Lens port	Gates GP25A wide angle port
Strobes	Nightrider HID Pro X2
Total cost	£4,500

F.



D.

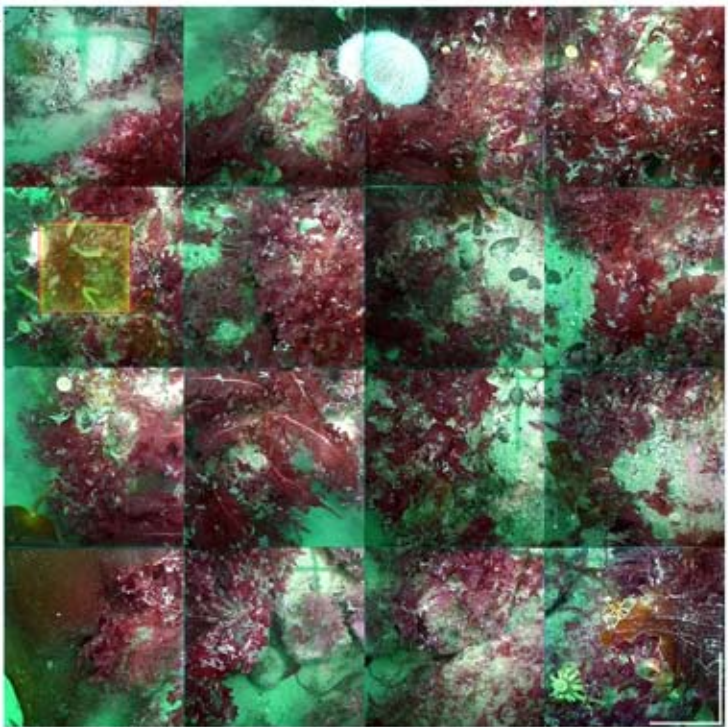


Fig. 1. Example stills and video image mosaics from the same sampling quadrat at 14 m depth. Technical comparisons and cost of field equipment to collect (a) stills and (b) video imagery. Full 100 x 100 cm (c) stills and (d) video image mosaics (yellow inserts indicate areas from which (e) stills and (f) video enlargements demonstrate differences in image resolution). Note 10 cm and 5 cm white scale bars in bottom right corners of (c) and (d), and (e) and (f), respectively.

differences in image resolution (stills 300 dots per inch (dpi), video 96 dpi). Furthermore, only a quarter of the species identified from the stills imagery were detectable in the video imagery. Surprisingly, processing and extracting data from the stills camera showed higher overall efficiency. This was likely due to the long data conversion times of the video to extract readable imagery.

Data-extraction technique

Using only stills imagery, community data were extracted using three common techniques; a visual estimation of abundance and percentage cover made by eye (ESTIM), an estimation of the frequency of occurrence extracted from an overlaid grid of 100 equal squares (FREQ) and an estimation of percentage cover extracted from 100 equally spaced dots laid over each image (POINT). The ESTIM technique was considered the most accurate technique (Dethier *et al.*, 1993; Beaumont *et al.*, 2007; Leujak and Ormond, 2007), and therefore data extracted using it served as a baseline against which data from the other techniques could be compared. The impressions of the community differed between all three techniques, with the clearest differences observed between the ESTIM and FREQ techniques. By virtue of the frequency of occurrence grid, the FREQ extracted data were over-expressed relative to the other techniques, an issue of data resolution. The POINT extracted data were more similar to those of the ESTIM technique, however, differed due to the inherently lower data density of this technique. This effect was clearly visible when the numbers of species were compared, where the POINT method detected only half of that detected by the other two techniques.

Quadrat size

Data were extracted using the different techniques by sampling from three quadrat sizes: 100 x 100, 50 x 50 and 25 x 25 cm quadrats. Analysis of data from these quadrat sizes highlighted the balance of accuracy and precision with efficiency present in all monitoring methods. The results showed that increases in quadrat size drove differences between the impressions of the communities extracted by the techniques. Indeed, at the two smaller quadrat sizes, the ESTIM and POINT techniques collected statistically similar data. Relative to the time taken to collect data from each quadrat size, data from the smallest quadrats had the highest numbers of species per unit effort.

Change detection

As every monitoring method must be sensitive to the detection of any changes to benthic communities,

a manipulative experiment was conducted to assess the sensitivity of the mosaics to detecting a 10 % change within the sampled communities. This change was detected in data collected by both media and in that extracted by all data extraction techniques, although replicates in excess of 17 were needed to do so. As such, the low-cost image mosaicing method proved a success and was recommended for fixed station monitoring, where collecting high-resolution imagery over large areas is advantageous.

This study has shown that further multi-method testing is needed to achieve fully standardised hard-substratum monitoring methods. The most efficient and effective approach in this study was to collect stills imagery using the 25 x 25 cm quadrat and extract the data using the ESTIM technique. As such, this approach is recommended for use in random stratified monitoring, where highly efficient methods with high precision are favourable. However, the over-estimation effect of the FREQ technique may make changes within data sets more readily detectable. As the FREQ technique also combines abundance and coverage into one measure, the usefulness of this technique should also be further explored in future methodological studies.

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Predicting impacts of climate-induced range expansion: an experimental framework and a test involving key grazers on temperate rocky shores

Firth, L.B., Crowe, T.P., Moore, P., Thompson, R.C., Hawkins S.J.

Abstract

Climate change has strong potential to modify the structure and functioning of ecosystems, but experimental field studies into its effects are rare. On rocky shores, grazing limpets strongly affect ecosystem structure and their distribution in NW Europe is changing in response to climate change. Three limpet species co-occur in SW Britain (*Patella vulgata*, *Patella ulyssiponensis* and *Patella depressa*) on open rock and in pools. Shores in Ireland are similar, but currently lack *P. depressa*. It is anticipated that *P. depressa* will expand its range into Ireland as the climate warms, but we currently lack an empirical basis to predict the consequences of this change.

Recent studies show that increasing abundance of *P. depressa* on British shores has been accompanied by a decline of *P. vulgata* suggesting interspecific competition. In this study, a new experimental framework was used to examine the potential for *P. depressa* to affect *P. vulgata* on Irish shores. *P. vulgata* was experimentally transplanted into enclosures on open rock and in pools in both Ireland and Britain. In pools, treatments also included transplanted *P. ulyssiponensis* to mimic natural assemblages. Growth and mortality of *P. vulgata* were measured over 6 months with no differences between Ireland and Britain.

In Britain, *P. vulgata* caged in pools with transplanted *P. depressa* and *P. ulyssiponensis* showed reduced growth, compared with when caged in pools with

P. ulyssiponensis alone. There was no effect of *P. depressa* on the growth rate of *P. vulgata* on open rock. Results indicate that if the range of *P. depressa* extends into Ireland, it would reduce the growth of *P. vulgata* where it co-occurs with *P. ulyssiponensis* in pools. The framework used here provides a field-based approach that could be used to examine the impacts of climate induced range expansions on the structure and functioning of other ecosystems.

Changing Seas in Northern Ireland: revisiting the sublittoral Survey 20 years on.

Claire Goodwin, Joe Breen, Hugh Edwards, Bernard Picton

Coastal waters around Britain and Ireland are warming as a result of global climate change. Annually averaged sea-surface temperatures have increased by about 0.6°C over the last 70-100 years with substantial increases over the last twenty years. Climate induced changes in marine assemblages around the British Isles have been documented in a wide variety of groups including plankton, fish, algae and intertidal marine invertebrates. However, the effect on sublittoral macrobenthos has been little studied, mainly because of the lack of comparable data. Northern Ireland is at the interface of the Boreal and Lusitanian provinces and therefore presents an ideal area to study species at the extremes of their ranges. Between 1982 and 1986 the 'Northern Ireland Sublittoral Survey' Project (NISS), a scuba diving survey of the Northern Ireland coast was conducted, providing baseline data on sublittoral species and habitats. Between 2006 and 2008 a second sublittoral survey project 'Sublittoral Survey Northern Ireland' was undertaken, resurveying five areas of Northern Ireland coast. Here we discuss the findings of this work.

The Role of Marine Citizenship in Sustainable Management of the Marine Environment

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Traditionally, governance of the marine environment has been a state driven, top-down approach. Recently, however, management has been in a transitional period, moving towards a more participatory, bottom up regime. Future management of the marine environment must take the ever increasing, diverse range of factors effecting the marine environment into consideration (Skourtas *et al.*, 2005). The role of a flexible, adaptive approach allowing for changing social values, environmental requirements and sustainable development has already been recognised (Defra, 2006). Further to this, is the increasing acknowledgement of community involvement in management of UK marine resources (Defra, 2006).

The founding rationale of this study is the suggestion that with a greater level of public involvement and responsibility, marine management could be developed at a more sustainable, long-term level. It is proposed that it will ensure successful management and protection of valuable marine and coastal ecosystems and resources, whilst prompting economic and social development and stability. Despite widespread recognition of the role of communities in marine management, currently there are no guidelines regarding promotion of public involvement. This study seeks to establish the potential role of citizenship with regard to the marine environment.

Following an extensive systematic literature review examining the role of citizenship in environmental management, and its potential applicability for the marine environment, a theoretical conceptual model of marine citizenship was generated, based on a previously developed model of environmental citizenship (Hawthorne and Alabaster, 1999). Initially, examination of the potential role of marine citizenship in marine governance and policy delivery in the UK was conducted through telephone interviews. The aim of the survey was to evaluate the views of UK marine practitioners on both the present and potential future roles of the public in marine governance and the potential role that enhanced public marine citizenship

¹ For this research, 'marine' encompasses coastal, inter-tidal and the undersea environments of the UK

could play. Analysis of the interviews identified numerous factors with the potential to influence the development and applicability of marine citizenship. These included education, proximity to the coast, personal connection with the marine environment and a high level of participation in marine environmental issues. The thematic case studies were designed to further examine the key themes of personal attachment and education. The results of the case study phase have allowed a more detailed investigation into the application of marine citizenship in marine management plans, particularly when considering them in relation to the High Level Marine Objectives. This allowed the research to develop recommendations regarding the incorporation of marine citizenship into marine management plans.

This research highlights the recognition amongst both marine practitioners and the public that the marine environment needs a change in management. Overall, a higher level of citizen involvement in the management of the marine environment was championed by both groups as having the potential to greatly benefit the marine environment, with additional benefits possible through an increased sense of marine citizenship.

The combined impacts of elevated temperature and ocean acidity on the distribution and abundance of shallow water species.

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¹ Plymouth Marine Laboratory Applications.

² Plymouth Marine Laboratory.

Over recent years there has been an increasing body of evidence that shows that as temperate waters have warmed many species have extended their geographic range polewards (north in the northern hemisphere). Each species has its own intrinsic rate of range expansion and as a consequence it is reasonable to assume that, as time passes, new patterns of biodiversity will evolve as the resulting issues of predator-prey interaction and inter-specific competition are resolved. However, at the same time as the ocean is warming it is becoming more acid. Many biological processes from calcification to metabolism are sensitive to acidification and the possibility arises that impacts on species distribution and ecology in a future ocean may well differ from those predicted on the basis of elevated temperature alone.

A series of laboratory experiments undertaken on the barnacle *Semibalanus balanoides* indicate that there is a significant interaction between the effects of changing warmth and pH. Furthermore, this work studies all stages of life history from egg to adult and showed differing patterns of sensitivity across them. It was concluded that at the species' southern limit of distribution the effects of elevated temperature would add to the effects of warming thereby increasing the probability of a range contraction. At the northern edge of the distribution the negative effects of acidification appear to be far outweighed by the positive consequences of higher temperature and will have only a small impact on range expansion.

It is concluded that in predicting the extent to which marine species distributions will change in a high carbon dioxide world, account must be taken of changes in ocean acidity as well as temperature. It is also suggested that predictions of distributional change made on the basis of adult tolerance alone are unwise as the full range of life history stages needs to be considered.



The Deep-sea Conservation for the UK projects

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Andrew Davies, Bangor University

Jason Hall-Spencer, Plymouth Marine Institute

Guy Baker, Marine Biological Association

Jon Moore, Porcupine Marine Natural History Society

Since 2005 the Esmée Fairbairn Foundation has funded two Deep-sea Conservation for the UK projects as part of its environmental theme. These projects have provided a unique opportunity to address several important practical aspects of marine conservation in the UK's deep sea environment. The projects were organised into a series of broad objectives. Work at the Scottish Association for Marine Science, Heriot-Watt University and Bangor University examined biodiversity, cold-water corals, predictive habitat mapping and ways in which the research community can expand its work to consider coral ecology, climate records and conservation at ocean basin scales. This work led to the first predictive habitat maps for

Lophelia pertusa, the most globally widespread reef framework-forming cold-water coral, and saved the first manned submersible videos to survey *L. pertusa* patches on Rockall Bank in 1973. It also developed www.lophelia.org, a website to raise awareness of cold-water corals, their biodiversity and the threats they face. Finally, the international Trans-Atlantic Coral Ecosystem Study (TRACES), produced a Science Plan and in early 2010 was awarded its first programmatic funding through EuroTRACES, a dedicated call from the European Science Foundation. At the Plymouth Marine Institute work focussed upon how the Vessel Monitoring System (VMS) can be used to inform deep-water Marine Protected Area design. Through ICES and other bodies, this work has contributed to establishing the first fishery closures to protect vulnerable cold-water coral habitats on Rockall Bank. The National Oceanography Centre in Southampton was funded to collate and disseminate their vast archive of deep-sea photographs on a searchable website, www.deepseascape.org, and to review and suggest improvements to current deep-water habitat classification schemes. The Marine Biological Association collated material from the partners to produce www.deepseaconservation.org, a website that explains key deep-sea habitats and conservation issues. The period from 2005-2010 has seen unprecedented deep-water conservation activity around the world, especially as concern over the damage caused by High Seas bottom trawling has grown. In late 2006 this reached the level of the UN General Assembly where resolution 61/105 issued specifically requires states to protect 'vulnerable marine ecosystems' from destructive fishing practices. The two DCUK projects coincided with this period and have successfully addressed not only practical ways in which to further deep-sea conservation but also worked hard raising public awareness to avoid a situation where out of sight means that deep-sea conservation remains out of mind. Finally, and perhaps most importantly, DCUK also launched the post-doctoral careers of several marine biologists with a real passion for deep-sea conservation.

Publications from the DCUK projects

Davies A & Roberts JM (2005) Preserving our deep-sea heritage. *Marine Conservation* 6: 10-11

Davies AJ, Roberts JM, Hall-Spencer J (2007) Preserving deep-sea natural heritage: emerging issues in offshore conservation and management. *Biological Conservation* 138: 299-312

Davies AJ, Wisshak M, Orr JC, Roberts JM (2008) Predicting suitable habitat for the cold-water

coral *Lophelia pertusa* (Scleractinia). Deep-Sea Research Part I 55: 1048-1062

Hall-Spencer JM, Tasker M, Soffker M, Christiansen S, Rogers S, Campbell M, Hoydal K (2009) Design of Marine Protected Areas on high seas and territorial waters of Rockall Bank. Marine Ecology Progress Series 397: 305-308

Roberts JM (2008) Cold coral. Planet Earth (Natural Environment Research Council, article describing TRACES programme.), Winter 2008 edition, pp 20-21

The Search for *Leptochelia savignyi* (Tanaidacea) from its Type-Locality, Madeira

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Background

In 1842, Henrik Nikolaj Krøyer described two new species of Tanaidacean from his collecting from Madeira – *Tanais savignyi* (based ostensibly on a female) and *Tanais edwardsii* (based on a male of *L. savignyi*); in the same paper (Krøyer, 1842) he described a further and similar species – *Tanais dubia* – collected in Brazil, and distinguished simply on the number of segments in the uropod and the antennule (but see below). Note that *Tanais* was the only genus of tanaidomorph tanaidacean available at that time. Dana (1849) erected a new genus of tanaidacean – *Leptochelia* – for his species from Polynesia – *L. minuta*, and it was rapidly apparent that Krøyer's species were members of this genus.

Leptochelia was characterized in particular by having two distal spines on the second antennal article, one dorsodistal spine on the third antennal article, a multisegmented uropod endopod (more than three segments), and highly dimorphic males, which had grossly enlarged chelipeds, multisegmented antennular flagella, and no functional mouthparts (Fig. 1). Males of the *L. minuta* type have very long and slender chelipeds, much longer than the body length (from the Greek, *leptos* – thin, delicate, and *chele* – claw), while those of the *L. savignyi/dubia* type have more robust chelae, about as long as the body length.

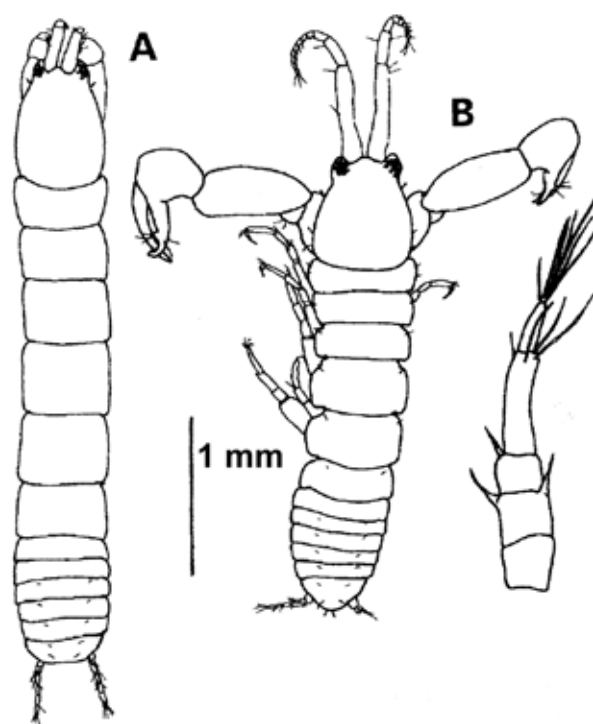


Figure 1. Typical female (A) and male (B) *Leptochelia*, with details of antenna and uropod.

We thus had *Leptochelia savignyi* (including *L. edwardsii*) from Madeira, *L. dubia* from Brazil, and *L. minuta* from Polynesia.

Over the next century, a number of new “species” were described in the genus, based largely on the gross morphology of the dimorphic males (number of uropod endopod articles; number of antennular segments; number of teeth on the fingers of the chela), such that by 1970 there were at least eight species in the *L. minuta* group and twenty in the *L. savignyi/dubia* group. It is to this latter group that the rest of this paper is addressed.

There are problems with basing these taxa on the males, as the number of uropod and antennular flagellum segments is ontogenetically variable. Secondly, some species show progynous hermaphroditism, in some cases having two forms of male. Further, as the mature males do not feed, they die shortly after breeding. A result of these last two is that sex ratios are heavily biased, between 3:1 to 100:1 during the breeding season, while at other times adult males are absent in the population.

Lang (1973) analyzed the morphology of a number of the described males, and concluded that those of the *L. savignyi/dubia* group were all examples of intraspecific variation in a single species, which he attributed to *Leptochelia savignyi* (Krøyer, 1842). Sieg (1983), in his world catalogue of the Tanaidacea, maintained this world-wide synonymy, although he attributed the species to *Leptochelia dubia* (Krøyer, 1842), engendering a protracted debate on nomenclatural priority.

There are, however, clear problems with this assumed cosmopolitan taxon.

Tanaidaceans do not have a dispersive phase, so, other than passive transport by ship-hull-fouling or algae such as *Sargassum*, they have to walk everywhere. This biology, in animals breeding at least once a year, will inevitably lead to allopatric speciation, while the chances of the species present in Madeira being the same as that in Brazil (not to mention those taxa described from the Indian Ocean and the Pacific) are entirely unlikely. A further apparent problem with the presumed synonymy of *L. savignyi* and *L. dubia* is that the former was described as having four longer articles in the antennule of the female, while *L. dubia* has the more normal three longer articles (all have a minute distal article).

Subsequently to Sieg, a number of researchers began to look more closely at the morphology of *Leptochelia* taxa, notably at the females, and including the structure of the mouthparts, of the female antennule, of the walking legs, and of the uropod exopod, *inter alia*, resulting in some more credible descriptions of distinct species (e.g. Ishimaru, 1985; Bamber & Bird, 1997; Bird & Bamber, 2000; Larsen & Rayment, 2002), to the point that Bamber (2008) described five new species occurring sympatrically (although in distinct habitats) in Moreton Bay, Brisbane, Australia.

It is therefore evident that there are numerous species of *Leptochelia* around the World, almost certainly largely with restricted distributions. Indeed, Larsen and Rayment (*loc. cit.*) considered *Leptochelia* as 'probably the most numerically abundant shallow-water genus worldwide', with co-occurrence of cryptic species.

Leptochelia species have been recorded from waters of the British Isles since Bate and Westwood (1868, as *L. edwardsii*), and the "British species" is listed in Holdich and Jones (1983) as *Leptochelia savignyi*, with *L. dubia* as a junior synonym (now regarded as an erroneous synonymy). Current confirmed records are around the western end of the English Channel, from the Scilly Isles to 2°W, on both English and French Coasts. The question approached remains – is the British species indeed *L. savignyi*, or perhaps even an undescribed species.

The only way to be sure was deemed to be to try to rediscover *Leptochelia savignyi sensu stricto*, which required sampling in Madeira.

Rediscovery

During the Porcupine Annual Meeting in Plymouth in March 2009, and subsequently on a further visit in June 2009, *Leptochelia* material was collected from the shore at Wembury, living amongst *Audouinella purpurea*-bedded sand on low-littoral rock surfaces. This material allowed the analysis of the detailed morphology of, and the intraspecific variation in the British species.

Analysis of this material found that the "four-longer-article" form of the antennule was in fact a feature of pre-adult males, and that the females (and neuters) had the "normal" antennular structure of three longer articles.

With the support of a Porcupine Grant, a visit was made to Madeira in October 2009. A number of shores was visited, and, in particular, samples of epilithic algae were collected the shores at Caniço de Baixo, Madeira, and Campo de Baixo, Porto Santo, in both of which single female specimens of *Leptochelia savignyi* were present.

While the perhaps-disappointingly-low number of specimens has precluded designating a neotype, both specimens having been completely dissected, comparisons of the morphology of those specimens has confirmed that they fall within the variation of form shown by the Wembury material, and thus that the British species is indeed *Leptochelia savignyi*.

It is now believed that *Leptochelia savignyi* is distributed from Madeira and the Azores (but not the Canary Islands) to the Atlantic coast of Spain, northwestern France and the southwest of England.



Figure 2. Female *Leptochelia savignyi*.

Prognosis

From the success of the Madeira visit, a paper is now in press redescribing *Leptochelia savignyi sensu stricto*, and comparing in detail not just the Wembury population, but also available material from Falmouth, from the Isles of Scilly, from Brittany and from north-western Spain.

Records of *Leptochelia* also exist for western Ireland, which are perhaps likely also to be *L. savignyi*, but with the sympatric occurrence of five species in Brisbane (see above) and the presence of two species of *Leptochelia*, *L. savignyi* and *L. caldera*, in the Azores (Bamber & Costa, 2009), it will be necessary to examine Irish material in order to confirm this.

Further, the results of this work will lead on to an analysis of intraspecific variation in characterizing features of the morphology of a number of *Leptochelia* species from around the World (fortunately, populations are commonly numerous – other than Madeira apparently), from which a global reanalysis of the genus will be undertaken.

As an additional spin-off from the Madeira visit, records of two further tanaidacean species from those shores (*Tanais dulongii* and *Zeuxo exsargasso*) will contribute to an ongoing study of the tanaidaceans of Macaronesia.

All of these planned publications will acknowledge the assistance of the Porcupine MNHS Grant.

Acknowledgements

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