PORCUPINE MARINE NATURAL HISTORY SOCIETY

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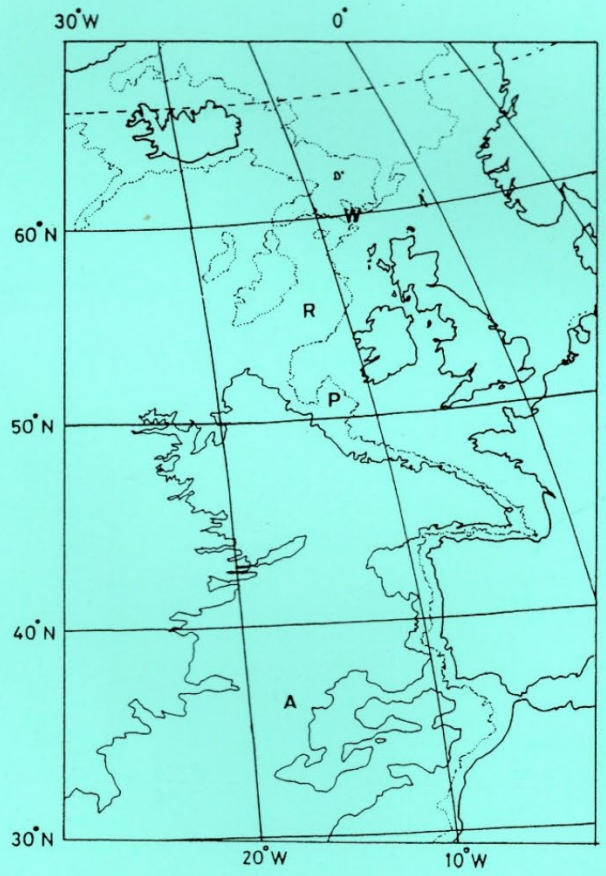

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MARINE SPECIES ECOLOGY: THE VALUE AND APPLICATION OF EXISTING KNOWLEDGE - or Making the Most of "*What We Know*"

Bob Earll
Coastal Management for Sustainability, Candle Cottage, Kempley, Gloucestershire, GL18 2BU

Jon Moore
Ti Cara, Point Lane, Cosheston, Pembroke Dock, Pembrokeshire SA72 4UN

(presented at the PMNHS meeting at Southampton Oceanography Centre in 1998)

Introduction

This paper was prompted by our attendance at a successful workshop organised by Judy Foster-Smith in Newcastle on marine species recording in January 1998. The purpose of species recording schemes was to help us better understand the biology and distribution of species. Whilst species recording schemes for marine species have been in use since the early 1970's, the translation of the results from this work into our collective understanding of the biology and distribution of individual species, has not really progressed significantly to the point where the marine biological community can easily access the current knowledge for a wide range of common marine species. It can neither do this in the traditional format of paper monographs or in ways that would be of more direct application in applied studies. Currently there seems to be an obsession with 'computer' systems' and the collection of yet more data.

The view we develop in this paper is that, as marine ecologists, we are rather too quick to go out and collect more data without making proper use of the data that we have already. More than this however, we are rather poor at converting 'raw' data into biological 'knowledge' that is needed to *interpret* the data collected for either academic or more applied studies. This view is by no means new; the joys of field work and the incentives to undertake contract funded survey and monitoring all tend to encourage data collection at the expense of considered synthesis. It is also the case that a considerable amount of marine biological survey work is still being undertaken further compounding this situation. It is put forward here that the benefits of synthesis are likely to be significant and enable us to conduct both survey and monitoring work from a sounder knowledge base that will facilitate innovative approaches to both prediction and ground truthing our knowledge base.

The point is often made that data on species and habitats from the marine environment for management decisions is often lacking. In the same breath the high expense of collecting data in comparison with the equivalent information from land is also highlighted. Both these points are true and highlight the need to take much greater care of the data we collect from our marine work. Recognition of this need to better organise the data and knowledge we have is leading to important initiatives to ensure that hard won *data* is not lost and it is used to the best effect. For example *Marlin* and the JNCC Biodiversity data base for MNCR data are good examples.

However, data on its own is not enough; it needs to be set in the context of our broader knowledge of species biology. Doody (1999) summarised this point succinctly: "*Data is the raw material from which information is produced. Information is a collection of relevance to a recipient at a given point in time. Information is data in context – it has meaning, relevance and purpose.*"

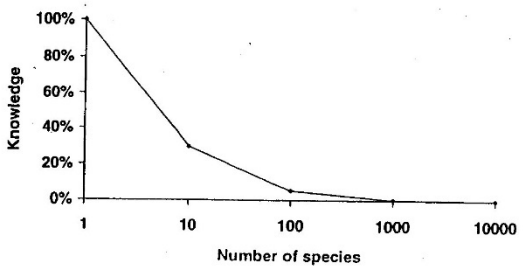
Marine biological knowledge - what we do and do not know - the challenge

The *collective* marine biological knowledge is enormous but only a fraction of this knowledge is available. For example ask yourself these questions: -

- How many years have you been studying marine biology?
- What percentage of your marine biological knowledge is published or available for other generations?
- Is this percentage high or low?

Many Porcupine members have 20, 30, and 40 years of knowledge locked up inside wise minds. This knowledge is of great value. It provides key links to previous generations and bodies of work and understanding. It is important that we do not lose this information. Whilst the value of this information is being increasingly discussed there seems little effort directed at actually securing it. This paper describes a useful way of collecting together existing expertise, which at the same time facilitates its publication.

Figure 1. What we know about the biology and distribution of UK species



The challenge we face is huge. The Species Directory shows us that there are some 9,000 species in UK seas. Our knowledge of many of these species is scant. Figure 1 shows our likely knowledge of marine species ranked in terms of how much we know about them. Species like *Mytilus edulis* about which we know a great deal would be on the left side of the graph whilst there is a large tail of species about which we know very little. One of the ongoing challenges to marine biologists and ecologists is to square off the graph.

This paper has two main aims. First, to propose both a new species recording format that has been designed to capture marine biologists' collective *knowledge* and to enable such knowledge to be published as quickly and effectively as possible. Second, to describe a trial of this species recording framework and a process of engaging the Porcupine members to record their knowledge.

Methodology

This method section describes a suggested *species recording framework* and the ideas behind this and the *information collection process* used at the Porcupine conference (March 1998).

Species Recording Framework

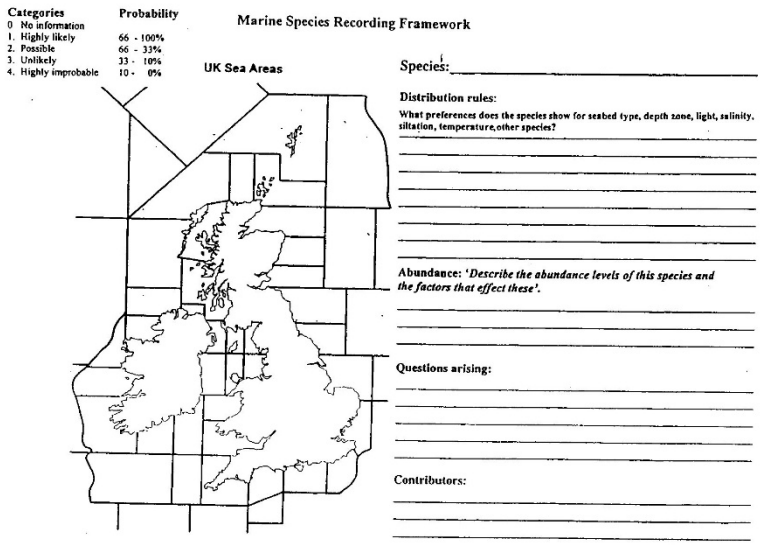
Recording forms and cards are now a recognised way of collecting information on species distribution and ecology. A single species recording form designed to capture knowledge of the distribution of species was developed to trial at the March 1998 Porcupine conference (Fig. 2). This framework is designed to enable both individuals and groups to record both biogeographic and biological knowledge ***together*** in a simple way – minimising the barriers to completion by individuals or groups. It should also be noted that the format

also lends itself directly to publication. This was the first trial of this concept and amendments are suggested, not least to include the addition of a simple abundance question.

enable others to follow-up the text in future.

The developing power of information technology should help us to marshal what we know (our existing knowledge) more effectively and

Figure 2. Marine Species Recording Framework



The provision of a map enables easy location of the information rather than the need to be absolutely precise about a particular location. This is, in effect, all that the synoptic reports of species recording schemes (especially at large scales) do anyway e.g. the Conchology Society maps for *Calliostoma* (Sheet 3 see results below).

We have added a draft number and date so that people can know at what point the information was compiled. Similarly the *author* – the last person to edit the text and the contributors will provide access to extensive bodies of information such as is published here (The Species Encyclopaedia concept - see discussion) without the need for the production of expensive monographs.

The Information Collection Process

The species recording framework was tested during two sessions at the

Southampton Porcupine conference in March 1998. In the first session delegates were encouraged to record

their knowledge of six species. Delegates were encouraged to work in groups and six co-opted co-ordinators then collated the views on these species. The results of the exercise were then presented to the conference delegates at a subsequent session. These results have since been edited and are included in the results section as ***working drafts***.

We chose the species on the day of the conference on the basis of the experience of the members of the audience and to ensure species from a range of different phyla were included in the trial. The six species chosen were the:

- intertidal sponge *'Ophlitaspongia seriata'*,
- leopard spotted goby *Thorogobius ephippiatus*,
- painted topshell *Calliostoma zizyphinum*,
- goose foot starfish *Anseropoda placenta*,
- burrowing anemone *Cerianthus lloydii* and
- fan worm *Sabella pavonia*

Delegates were given specimen recording forms (Fig.2). They were asked to assign the probability of finding the species in the geographic areas given by assigning them to one of five categories.

Categories	**Probability**
1. Highly likely	66 - 100%
2. Possible	66 - 33%
3. Unlikely	33 - 10%
4. Highly improbable	10 - 0%

The need for a 'no information' / insufficient information category emerged during this trial and had been raised also at the marine species recording conference in Newcastle.

Delegates were also asked to list the ***rules*** governing the distribution of the species in question for example.

- substratum preferences
- depth zone preferences
- salinity preferences
- siltation tolerance
- life cycle strategy – long lived v opportunistic colonisation

There is no doubt that illustrations of the species in question during the briefing process considerably aid participants in the information collection process. As we have found in preparing this paper *the process* forces people to dig out old records, references and to assess the biological and ecological context.

Results & Discussion

The results of this session are described in two main parts first, the sheets describing the species distributions and biology which we assembled during and after the event, and second, the general conclusions we have drawn from this trial.

Part 1

The results from the trial are presented for the following species sheets:
Sheet 1. The intertidal sponge *'Ophlitaspongia seriata'*,
Sheet 2. The leopard spotted goby *Thorogobius ephippiatus*,
Sheet 3. The painted topshell *Calliostoma zizyphinum*,
Sheet 4. The goose foot starfish *Anseropoda placenta*,
Sheet 5. The burrowing anemone *Cerianthus lloydii* and
Sheet 6. The fan worm *Sabella pavonia*

Part 2 General Conclusions

Abundance assessments

There is no doubt that a question focussed on the abundance of species would be highly productive. It is evident from the responses that people would like to include information on abundance. However, abundance clearly depends on the spatial scales of methods used to

assess it and this needs to be described in the first instance. The abundance measures and spatial scales are very species and habitat specific, for example.

- Colonies of the sponge *Ophlitaspongia* are often finite in size and cover small areas (1-10cm).
- *Cerianthus lloydii* and *Sabella* can vary in density from 1 or 2 / m^2 in sandy environments to 100's/m^2 in current swept seabeds.
- The leopard spotted goby *Thorogobius* is by and large a solitary species occupying well defined areas around small caves and underhangs in the rock, so its density may depend on the availability of this habitat.

There is no doubt that this knowledge base and information collection process would benefit from some kind of a simple abundance question such as *'describe the abundance levels of this species'.*

The importance of methodology – of knowing how and where to look

One of the interesting points to emerge from this exercise was how our understanding of species is often geared to rather specific methodology and knowledge of when and where species occur. In other words it is important to know (a) what to look for and (b) where and how to look. For example:

- *Anseropoda placenta* only tends to be observed by divers or dredge surveys that cover a relatively large area, rather than benthic grab studies which have restricted area coverage. This is perhaps not surprising for a member of the megafauna.
- The leopard spotted goby *Thorogobius* can really only be studied by divers and then with greater success diving at night because of its nocturnal behaviour.
- The sponge *'Ophlitaspongia'* is likely to be found only at *very* low water or in the shallow sublittoral zone *under* boulders on boulder beaches.

Biogeography of UK species

The theme of the March 1998 Porcupine conference was biogeography and the biogeographic descriptions resulting from this exercise are given below.

The traditional form of *'Ophlitaspongia seriata'*, which is illustrated in the classic seashore texts and guides, would appear to have a strongly western distribution. Sue Chambers at the meeting highlighted a number of difficulties with the name and authority of this species not least because of confusion with the identity of some specimens from the east coast which were actually *Halichondria panicea*. Whilst this illustrates the benefits of voucher specimens, the records for *Ophlitaspongia* from the east coast recorded by the MNCR need to be verified since Bull (1963) in his monograph of North Eastern sponges does not record this species, even though it was well know to his contemporaries. A recent detailed survey of under-boulder faunas didn't record this species either (Foster-Smith,1989). There is however one recent report from Rumbling Kern, Craster (NU263172) in a large cave with *Dendrodoa* (Holt,1994).

Sabella pavonina has a pan-UK distribution based on the MNCR findings and the contributions of members to the meeting. This is in interesting contrast to *Cerianthus lloydii* which also uses fine sediment to construct a tube but for which records are noticeably scarce on the east coast (MNCR map). This may well represent the classic south-westerly distribution pattern shown by other species.

Calliostoma zizyphinium shows a UK wide distribution although the records from the Conchological Society map and the MNCR data base suggest that it is far less common in the south-east of England. Reduced hard substrata, the preponderance of sediment habitats and reduced salinity (Mersey, Severn, Humber, and Thames) are all likely to influence its distribution. We can also see from the *Calliostoma* example why there is need to refine our descriptions, the Conchological Society map is a very crude representation of this species in areas where routine observations of this species are probably rather rare because of the prevailing physical and chemical conditions.

The leopard spotted goby, *Thorogobius ephippiatus* was one of the species whose distributions were highlighted around the coast of UK by the use of SCUBA; these distribution maps would have been blank before 1965. This is a salutary lesson with regard to knowing where and how to look for species i.e. effective methodology, and to those who would seek to use species distributions to track climate change. The gaps in the trial format and MNCR coverage still probably reflect lack of records / recording – it is highly likely to be found all around the Irish coast, Isle of Man and probably Shetland. The absence of records in the large sediment bays of the north west and below Flamborough probably reflects both lack of suitable habitat and appropriate sampling.

Anseropoda has an interesting distribution with the trial experts describing its distribution in benthic dredge tows from deep water, but the MNCR data base illustrating a high frequency of records in the Scottish sea lochs based mainly on diving studies.

Ideas to develop for the future – the use of this approach to focus on specific groups or areas

Many major synecological surveys require an autecological basis to enable results to be interpreted. This type of approach which involves the entire community engaged in the research, is a potentially powerful way of providing the autecological basis for projects on particular areas or where a particular group of species are being studied. Two possible examples: –

1. *The census of the important conservation species in Cornwall / any area.* What do we know about important species – convene a meeting inviting all the local and outside experts – what are the key species we value? Decide on these and then use a regional grid map and similar question format to generate the information base that is needed to make a start. Such a synopsis might have *Zostera*, maerl, *Sargassum*, Kelp forests, key offshore reefs, *Sabella* on the low shore areas etc. Everyone then knows what it is that is important to the experts so that a new census can work from the basis of what is known and compare existing with the new knowledge gained.

2. *New project on the molluscs / any species from the channel /any area.* Again a meeting of experts can be used to collate all the existing information in this format. Field surveys could then be directed to both 'routine' and 'key' areas to ascertain whether changes in the populations have taken place. This process could also serve to ensure that all participants in a survey were up to speed with existing knowledge and species identifications (especially for key species).

In both examples the critical driver is ownership by a body of people who can both compile the information and maintain an interest in it over time.

A new direction for Porcupine recording, publications and field activities

Porcupine has for almost 20 years been bringing marine biologists together to discuss topics of interest. It has a strong interest in marine natural history and also the distribution of species. Indeed both the founding meeting in Edinburgh and subsequent meetings, notably one in Glasgow which reviewed marine recording schemes (1984/5) as well as the Southampton conference (1998) have placed emphasis on marine biogeography and the factors that influence it. We would suggest that in the future Porcupine could target its efforts at building and publishing the marine biological knowledge base, through work on the ecology *and biology* of species using the approach described here to help develop **Species Encyclopaedias** using this type of record format to facilitate publication. This would not only engage the membership more fully, but also begin to pool the undoubted knowledge that exists in a way that is enjoyable and produces a product which has widespread benefit to those who follow.

Beyond exploratory survey - to predictive hypothesis driven survey

Much marine ecological survey work is undertaken as if no research had ever gone on before.

Survey on land has moved to much more directed methods which often *ground truth* predictions based on maps or from remotely sensed images. The survey ecologist on land is now seldom going out 'blind' to explore the 'unexplored' but instead verifies and tests reasonably well-established bodies of knowledge.

In the marine environment – with some notable exceptions of tropical reef and shallow water ecologists - benthic ecologists still tend to survey 'blind', although there are long overdue signs that this is changing. Our knowledge is just not marshalled or used in way that facilitates a ground truthing or predictive approach.

The relatively recent development of more versatile electronic means of visualising the seabed such as 'Rox Ann', and the more routine application of side scan sonar can provide the physical context to a survey area. They enable marine ecologists to describe the physical environment of the seabed. This knowledge when combined with other physico-chemical data provides a basis for starting to think about how this may be used to predict species distributions. Many benthic species are very closely distributed with the broad oceanographic features – e.g. salinity and physical seabed types and so rule- based probability distributions could provide a way of predicting likely species distributions.

Conclusions

In this paper we seek to illustrate a number of points: -

1. Data is important, but is only *one* part of the process to develop knowledge. Data on its own, without context or a marine biological knowledge base is virtually meaningless. Similarly species distribution maps without their ecological context are virtually meaningless. It is data when combined with our marine biological understanding that provides *knowledge*. This knowledge needs to be made much more widely available and information technology has an important role to play in this.

2. As a community of scientists we collectively posses a huge amount of *knowledge* but it needs to be organised effectively so that it can

be used. In organising it we will be able to see what we *do* and *do not* know and will hopefully avoid expensive duplication of effort.

3. In this setting it should then be possible to ***use*** this knowledge to drive *hypothesis based* approaches to marine ecological studies - including predicting the distribution of species, so that surveys are in effect ground-truthing predictions.

4. In making these points we highlight:

- the challenges that still face marine biologists in understanding the ecology, including distribution, and biology of our fauna and flora,
- the great store of *knowledge* that the marine biological community from the different generations possess - *collectively*,
- the need to engage the *entire* marine biological community directly in the process,
- how a new approach to collecting single species information would be a more productive way of collating knowledge than current multi-species record cards schemes,
- how it is possible to use conferences, workshops and focussed fieldwork to help marshal such information in a way that is stimulating, enjoyable and productive,
- and the opportunities this could provide Porcupine as it develops in the future.

References

Bull, H.O. (1963) Marine Fauna of the Cullercoats District,1, Porifera. *Report of the Dove Marine Laboratory, Ser.*3 **13**, 1-22.

Doody, P. (1999) *Thematic Analysis on the Information Requirements for Integrated Coastal Zone Management (ICZM)* A report to the European Commission.

Foster-Smith, R.L. (1989) *A survey of boulder habitats on the Northumberland coast (with a discussion of survey methods for boulder habitats).* Nature Conservancy Council Report

Holt, R.H. F. (1994) *Marine biological survey of Eyemouth (Berwickshire) to Almouth (Northumberland).* Joint Nature Conservation Committee Report No.157 (MNCR/SR/24) Joint Nature Conservation Committee, Peterborough.

Howson, C. & Picton B., (1997). *The Species Directory.* Marine Conservation Society and Ulster Museum

Acknowledgements

We would like to thank the meeting organising committee for allowing us the freedom to develop this approach and to the facilitators for each of the species, Sue Chambers, Frances Dipper, Keith Hiscock, Julia Nunn, Ivor Rees and Pamela Tompsett for helping production of the trial maps and text. We would also like to thank the delegates of the Porcupine meeting that contributed to the information on the sheets. We would also like to thank Elly Murray, then of JNCC, for producing the MNCR species distribution maps of the six species. The authors would also like to thank Judy Foster-Smith and Mike Kendal for their very helpful and constructive comments on the manuscript.

Appendix 1. Species sheets resulting from the trial

The species sheets on the following pages were assembled during and after the Porcupine meeting at Southampton.

Key to Workshop Maps

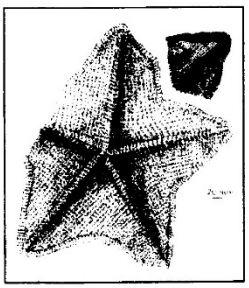
Presence of viable adult populations

1. Highly likely 66-100%
2. Possible 66-33%
3. Unlikely 33-10%
4. Highly improbably 10-0%

* Insufficient information

Anseropoda placenta (Goose Foot Starfish) Draft 1: 18/10/99

Workshop results



Distribution rules:

Full salinity.

Depth >10m.

Mixed sediment (muddy gravely sand).

West and North?

Low turbidity.

Questions arising:

Why is sediment restricted and patchy?

Contributors:

Editor: Ivor Rees
Robin Harvey

Published information

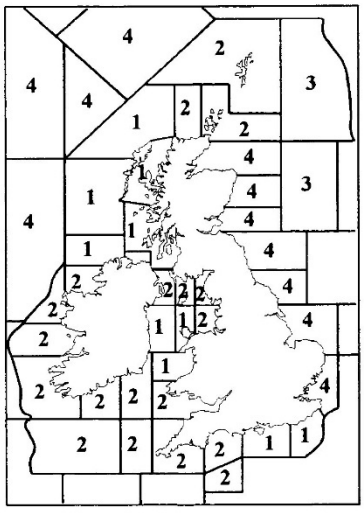
"Characteristically found on muddy sand or muddy gravel. Often covers itself with sand or gravel. Apparently feeds on small crustaceans but it is not known how these are caught. Found sporadically all round the British Isles, especially in water of 20-40m. Locally common but rarely seen by divers." Picton, 1993).

References

Picton, B. (1993) *A Field Guide to the Shallow-water Echinoderms of the British Isles.* Marine Conservation Society. London: Immel Publishing Ltd.. 96pp.

Mortensen, T.H.. (1977) *Handbook of the Echinoderms of the British Isles.* Rotterdam: Dr.W. Backhuys. 471pp.

Workshop Map



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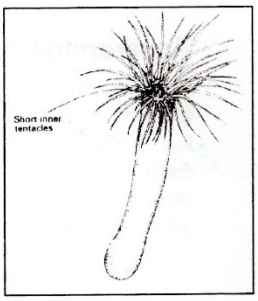
Cerianthus lloydii (burrowing anemone)



Workshop results
Distribution rules:

General: UK distribution is apparently mainly restricted to south and west coasts.

Substratum: Muddy sand to muddy gravel sediment. Not found in clean sand or gravel (i.e. dynamic sediment). Most abundant in muddy gravel's (>100/m^2) in current swept areas.

Zone: Lower shore to deep circalittoral - at least 100m deep.

Questions arising:

1. What is abundance?
2. Is it localised in distribution in the rather large areas?

Contributors:

Editor: K. Hiscock
E. Murray, R. Earll, M. Sheader, E.I.S Rees, R. Harvey.

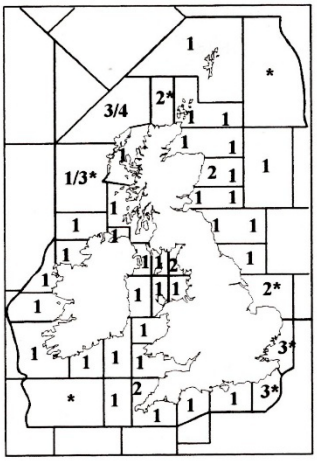
Published information

"Adults live buried in mud, sand, or gravel, from about LWST to at least 100m depth. The tube is long, up to 400mm or more, and frequently winds around stones if these are present in the substrate. Adults are locally abundant in many localities on all coasts of the British Isles and in some areas are common on the shore. This species occurs on all western coasts of Europe from Greenland and Spitzbergen south to Biscay." (from Manuel, 1988).

References

Manuel, R.L. (1988) *British Anthozoa*. Synopses of the British Fauna (New Series), No. 18 (revised). Linnean Society and EBSA: London. 241pp.

Workshop map



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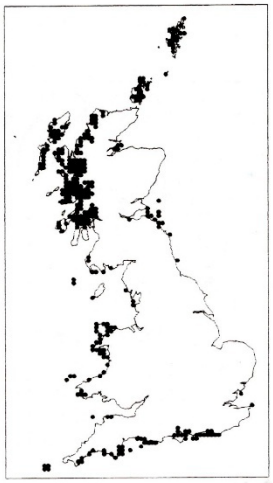


Sabella pavonina (Fan worm) Draft No 1: 18/10/99

Workshop results
Distribution rules:

General: Widespread in all coastal areas of UK

Intertidal: Fully marine, but needs considerable fine sediment and organic material to build its tube.
Wave sheltered.
Muddy sand, gravel, fairly stable substrata.
Distinct 'beds' often at ELWS
Sometimes present in very dense populations.

Subtidal: May be expected in almost any area of stable muddy sand or gravel, with high organic and sediment loading, and fully marine and fairly sheltered conditions. Sometimes found on rock or floating structures in very sheltered conditions.

Questions arising:

1. What is the status of the blank areas? (presence/abundance etc.)?
2. Does the population fluctuate?
3. What is the effect of climate or other influences?
4. Surprisingly little information on population densities, age class sizes etc.

Contributors:

Trevor Baker, Judy Foster Smith, Helgi Gudmundsson, Ian Killeen, Andy Mackie, Jenny Mallinson, Ellie Murray, Julia Nunn, Ivor Rees, Shelagh Smith, Cliff Thorpe, Pamela Tompset, Seamus Whyte.

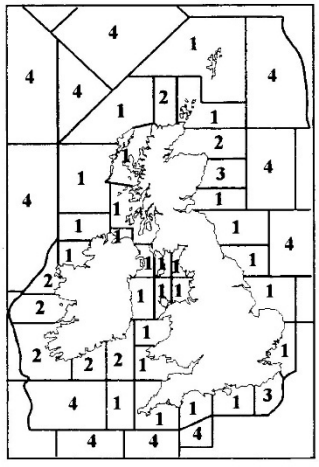
Published information

"Found on all coasts with big populations in Menai Strait, Swansea Bay, and estuaries of Essex and Plymouth rivers. On stones in sand and mud; sublittoral, locally abundant" (Hayward & Ryland, 1990).

References

Hayward, P.J. and Ryland, J.S. (1990) *The Marine Fauna of the British Isles and North-West Europe. Volume 1*. Oxford: Oxford Science Publications. 627pp. plus index.

Workshop Map



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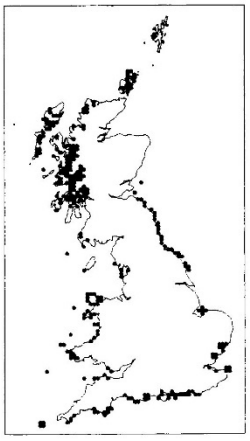


Ophlitaspongia seriata (red sponge) Draft 1 (10/10/99)

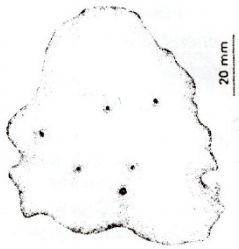
Workshop results
Distribution rules:

Substratum: usually underboulders

Zone: Lower eulittoral, shallow sublittoral

Salinity: Fully marine?

Geographic distribution: South-west and west coasts with rocky intertidal; probably not on east coast. Contributors know it from South Wales, Helford, Isle of Man, Strangford Lough and Connemara. Not seen in Orkney. Isle of Man fauna lists it from many intertidal sites.



Questions arising:

1. More accurate habitat data required
2. Where are the specimens?
3. MNCR east coast records need to be checked.

Note: this species is currently the subject of taxonomic work in progress, which may revise the name and authority (Chambers, *pers. comm.*)

Contributors:

Susan Chambers (editor),Dale Rostron, Eleanor Murray, Bob Earll.

Published information

"*Habitat*: On rock, commonly under boulders on the lower shore and also in the shallow sublittoral (to 5m BCD). "On clean rock, shells, Fucus, and Laminaria stipes in areas of strong water movement (either tidal or wave action)."

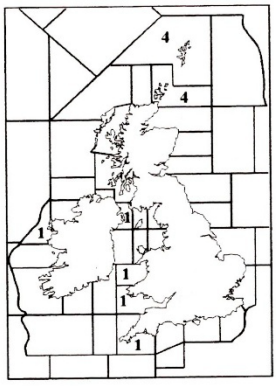
Distribution: "British Isles; France and Spain." (Ackers, et al., 1985)

References

Ackers, R.G., Moss, D., Picton, B.E. and Stone, S.M.K. (1985) *Sponges of the British Isles ("Sponge IV")*. Marine Conservation Society, Ross on Wye. 202pp.

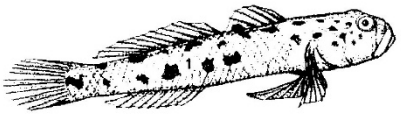
Yonge, C.M. (1949) The Sea Shore. London: Collins. New Naturalist Series. 311pp. [Drawing of *Ophlitospongia* above is copied from Plate 26]

Workshop Map



Printout from MNCR database

Thorogobius ephippiatus (leopard-spotted goby)



Workshop results

Distribution rules:

Rocky areas with ledges and crevices, often cliffs. Usually on terraces with holes/crevices to go into.

Shallow sublittoral. Often singly.

Seen in summer, by divers. Seen in holes in very soft clay cliff (piddock holes)

Doesn't like brightly lit areas.

Impression that young live in the same area/habitat as the adults.

Questions arising:

1. Are they territorial?
2. Are they in shallow water in winter?
3. Nocturnal?

Contributors:

Frances Dipper (editor), Dale Rostron, Bob Earll, Jane Lilley, Keith Hiscock, Keith Broomfield.

Published information

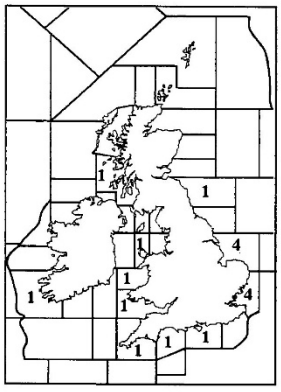
"Mediterranean; Eastern Atlantic, Canaries and Azores to Skagerrak.

Coastal, in/ near crevices associated with vertical rock faces, from low water of spring tides to 40m; rarely in deep shore pools. Breeds from May-July (Plymouth, Connemara)." (Lythgoe & Lythgoe,1988)

References

Lythgoe, J. and Lythgoe, G. (1991) *Fishes of the Sea. The North Atlantic and Mediterranean.* Blandford: London. 256pp.

Workshop Map



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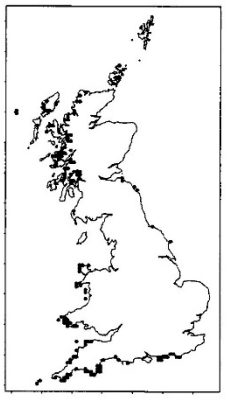


Calliostoma zizyphinum (Painted top shell)

Workshop results

Distribution rules:

1. Fully saline water.
2. Differences in requirements: littoral/sublittoral.
   (a) Sublittoral - found anywhere, but needs some kind of hard surface, not necessarily bedrock e.g. beds of stones or bivalves.
   (b) Littoral - shelter from wave action.
   - low on shore? restricted temperature/tolerance.
   - time of low (Spring) tides may be important.
   - prefers sites close to, but not in strong current.
   - mainly hard substrates.
   (c) No special food preferences, will eat many phyla!
   - tests show a love for Devonshire cup corals!

Questions arising:

1. Why uncommon SE coast of England? Lack of habitat? Reduced salinity?
2. Why are specimens 'pale' at sites near strong current?
3. Why is there a white form 'lyonsii', and what predicts its distribution?
4. Time of year for breeding?

Contributors:

Julia Nunn (Editor)
Andy Horton, Ian Kileen, Seamus Whyte, Shelagh Smith, Christina Vina Hebron.

Published information

"Occurs, fairly commonly, amongst weeds and under stones on rocky shores a little above L.W.S.T. and to 300m depth. It has been found on all suitable British and Irish shores, in the Mediterranean, and on western European shores north to the Lofoten Islands. It is said to eat small coelenterates but also takes vegetable matter." (Graham, 1988)

References

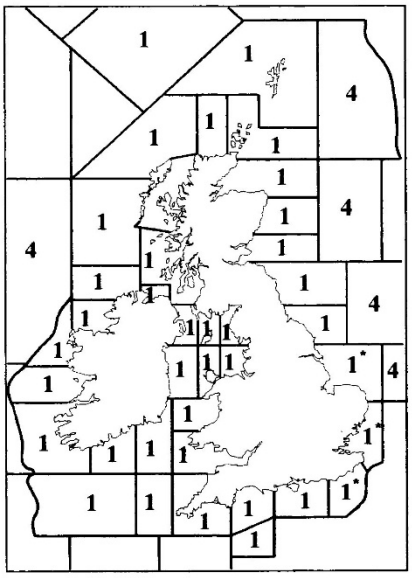
Graham, A. (1988) *Molluscs: Prosobranch and Pyramidellid Gastropods.* Synopses of the British Fauna (New Series). Linnean Society and EBSA: London. 662pp.

Seaward, D.R. (1982) *Sea Area Atlas of the Marine Molluscs of Britain and Ireland.* Peterborough, Nature Conservancy Council for Conchological Society of Great Britain and Ireland.

Seaward, D.R. (1990) *Distribution of the marine molluscs of north west Europe.* Peterborough, Nature Conservancy Council for Conchological Society of Great Britain and Ireland.

Distribution maps for *Calliostoma ziziphinum*

Workshop Map



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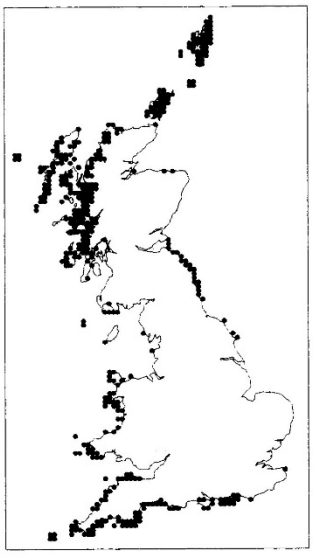
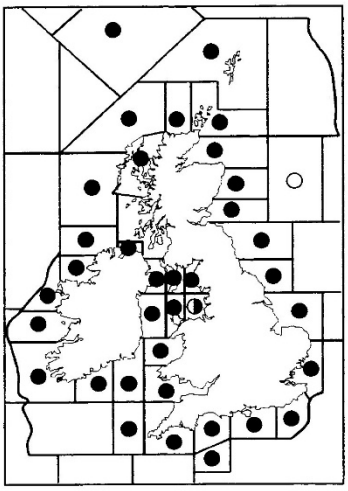


Marine Mollusc Atlas (Seaward, 1982)



Key to Workshop Map:

Presence of viable adult populations

1. Highly likely 66-100%
2. Possible 66-33%
3. Unlikely 33-10%
4. Highly improbable 10-0%

* Insufficient information

Key to Mollusc Atlas:

Recorded live, post-1950 ●

Recorded live, pre-1951 ◑

Recorded as shell only, any date ○

Additional notes from Seaward (1990) :
All sea areas except S4W, S8, S52, S40, S44