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CONTENTS

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THIS issue continues the reports from the Southampton Lagoons meeting (with fewer mentions of the Fleet), including papers stemming from the NCC surveys, and homing in on aspects of the biology of lagoonal environment species and their physiological adaptations. Please note the Corrigenda in relation to the last issue.

READERS who may notice the absence of certain regular features in this issue should know that the Editor has not received any Letters! (of publishable form), is still awaiting accounts for the Around the Marine Labs series (has your lab been covered yet?), and despite the encouraging feedback on the value of New Records (i.e. the market) none have been submitted (i.e. no product). MEMBERS are reminded that the NEWSLETTER is <u>your</u> forum for communication with other readers, particularly those unable to attend Meetings: so send in those new area records, letters, notices, advertisements, reviews, biting satirical expose's, etc.

FUTURE MEETINGS are detailed on page 181, to which announcement I should add that for members wanting info' on accomodation for the Fleet field trip, Frank Evans has a list of local 'b&b's, etc.

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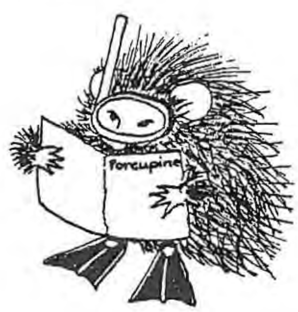


NCC SURVEY OF COASTAL SALINE LAGOONS IN DORSET, DEVON AND SOMERSET

by Dennis Seaward

My idea of a saline lagoon is the Fleet in Dorset, but I didn't find any more like it!

There are probably more definitions of saline lagoons than there are contenders for the title, but I would expect at least some of the following:

- restricted connection with the sea;
- relatively low freshwater influence;
- relatively high salinity for most of the time, with slow changes;
- sensibly constant water level;
- shallow;
- sheltered;
- presence of indicator species;

(based in part on R.S.K. Barnes' Coastal Lagoons).

For the survey, I covered Dorset (not including Poole Harbour), North and South Devon, and Somerset. From a map study of low lying areas, and discussions with local NCC offices, Water Authorities, County Councils, Naturalists' Trusts, etc., I selected 38 sites to visit. It must be said that in most of these cases a 'nil return' was expected, and a quick look was all that was necessary to prove the point. In what follows, I exclude the Fleet, which is a prime example of a saline lagoon, some aspects of which have been described in the previous issue (PN3 No.6).

In this brief review, I categorize sites - a subjective excercise which others would probably do quite differently - and give a few examples. Details are given in my Survey of Coastal Lagoons reports to the NCC: Dorset and South Devon (February, 1985), and Somerset and North Devon (January, 1986).

1. Watercourses Entering the Sea

1.1 Steep gradient with no estuary, entirely freshwater, with little or no backing up, e.g. Charmouth, Donniford Mouth. In some cases a shingle bar has developed, as at Bridemouth and Bossington Beach; where there is backing up at high tide, it is of freshwater. None of these is significant in the present survey.

1.2 Shallow gradient, with estuary e.g. rivers Axe, Otter, Teign, Taw. The only 'lagoons' found were typical saltmarsh pools, with an 'estuarine' rather than 'saline lagoon' fauna (e.g. *Hydrobia ulvae*, not *H. ventrosa*). At some sites an artificial bar with tide flaps has been constructed, forming a freshwater lake, e.g. Radipole, which has *Mercierella* near the outlet, and *Palaemonetes varians*.

2. Impeded Drainage Behind Natural or Artificial Barrier

Where at high level relative to the sea, pools are of freshwater only, although they may have been marine in their earlier stages of formation, e.g. Slapton Ley, Burton Mere.

Sites at a lower level are of more interest in the present context. At Porlock Marsh, sea water percolates through the great natural shingle bank, presumably driven by the large tidal range of the Bristol Channel, to form temporary saline pools (up to 30‰), with a restricted fauna.

3. Relict Creeks or Pools in Reclaimed Saltmarsh

One of these, at Catsford Common, Bridgewater Bay, provided the only site with Hydrobia ventrosa; it also held the amphipod Jassa falcata which is more characteristic of marine conditions. This pool is apparently isolated from the sea behind a sea wall, but in view of a salinity varying from 9‰ to 24‰ , there is presumably occasional saline percolation through the underlying shingle. The water area is small and being rapidly reduced by the spread of emergent vegetation.

4 Artificial

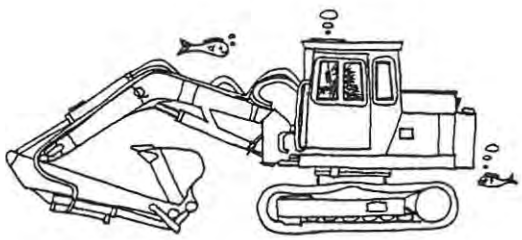
4.1 Tidal mill pond. Stoke St. Gabriel is an example of several tributary valleys of the River Dart which have been damned at their mouths to form tidal mill ponds. The dam is overtopped on spring tides, and there is a considerable freshwater inflow, so that the salinity can vary rapidly but is usually low. Flora and fauna were sparse, and the floor was of red silt from the catchment.

4.2 Weston-Super-Mare marine lake. This is an amenity lake formed by a low dam, across a tiny bay, which is overtopped by all high tides; it provides for paddling and boating when the tide retreats across the muddy Bristol Channel shore. Although in the county of Avon, and not strictly in my Somerset brief, I looked at it since it is mentioned in the Marine Invertebrate Fauna of the Severn Estuary (Boyden et al, 1977; Fld Stud.) as a site for the lagoon cockle Cerastoderma glaucum which I regard as an 'indicator species' of a saline lagoon.

The cockle is still present, but I could find only fresh but empty juvenile shells. The lake is emptied every winter to flush out the heavy silt deposition to preserve the amenity, and it is unlikely that many benthic animals survive the year.

5. Defunct

A few sites marked on maps have been destroyed for various reasons. The only one likely to have been of interest in the present context was 'The Mere' at Portland, which may have been a miniature of the Fleet; it is now buried a couple of metres deep under the Naval helicopter station.



LAGOON TYPES IN CORNWALL

by Colin Little
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I began my survey of lagoons in Cornwall by searching the Ordnancé Survey 1:25,000 maps for possible sites. Because of the large number of these, I then eliminated all sites not shown on the recent 1:50,000 series. This still left me with 42 sites to visit, and I covered all these in 4 trips: October and November 1984, and May and September 1985. The field searches identified only 18 sites that might be defined as lagoons. These are listed in Table 1, and the positions shown in Figure 1.

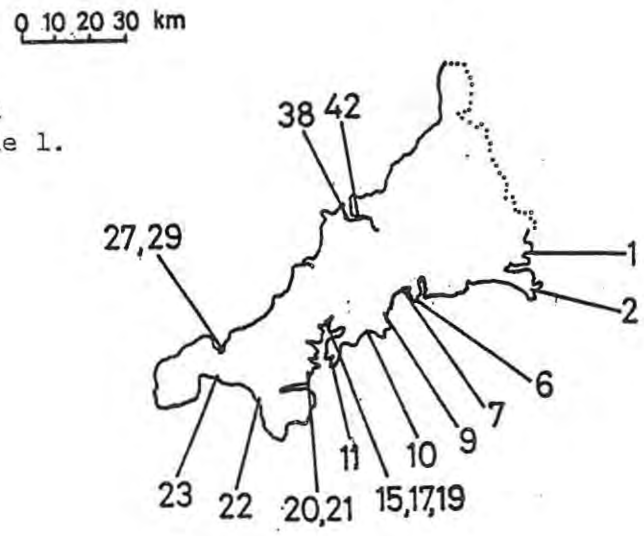


Figure 1. Lagoon sites as in Table 1.

TABLE 1. <u>List of Sites of Interest in Cornwall.</u>

1. Landulph (SX 428613)
2. Millbrook (SX 425523)
6. Polridmouth (SX 103506)
7. Par (SX 085534)
9. Pentewan (SX 019476)
10. Caerhays (SX 974415)
11. Froe (SW 867333)
15. Kiggon (SW 858455)
17. Tresemple (SW 855446)
19. Trelissick (SW 833392)
20. Swanpool (SW 802315)
21. Maenporth (SW 788297)
22. The Loe (SW 644242)
23. Marazion (SW 506314)
27. Hayle, South Quay (Carnsew Pool) (SW 551372)
29. Hayle, Phillack (SW 558377)
38. Dennis Cove (SW 921744)
42. Penquean (SW 963738)

Origins of Cornish Lagoons

Most of the lagoon sites were on the south coast of Cornwall, and were associated with drowned river valleys. Most have probably been formed behind sand or shingle bars, but only 7 of these are partly natural, while there are three that are man-made but show many parallels with the natural lagoons. The other 8 sites are all artificial additions with unique characteristics (e.g. old mill-pools, artificial enclosures, docks), and will not be discussed here.

Even within the natural lagoons, few are of any great age. Swanpool (20), Caerhays (10) and the Loe (22) may all date from the end of the last ice age, but the others, Par (7), Maenporth (21), Marazion (23) and Polridmouth (6) are probably only about 100 years old. They are therefore probably of much the same age as the artificial pools at Tresemple (17) and Trelissick (19). The most recent pool is the one at Millbrook (2), which has been created within the last few years, and should form an interesting study in the evolution of lagoonal ecosystems.

Characteristics of Cornish Lagoons

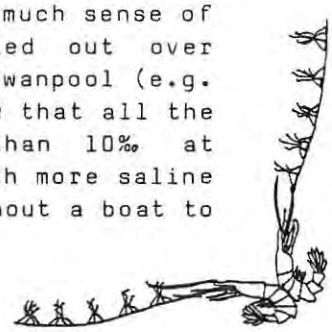
Almost all of the 10 natural and artificial lagoons to be considered are high level pools. Indeed the Loe (22) has its exit channel so high that saline water does not penetrate into it unless the shingle bar is breached. Although this happens irregularly, the fauna of the Loe is strictly freshwater, and it will not be discussed. This leaves us with 9 saline lagoons to be compared.

TABLE 2. Surface Salinities in Cornish Lagoons (‰)

Swanpool (20)	5.5-7.5*
Par (7)	4.2
Trelissick (19)	2.5
Maenporth (21)	1.0
Caerhays (10)	4-5.5
Polridmouth (6)	0.4
Tresemple (17)	8.5
Millbrook (2)	2.8-4.5
Marazion (23)	3.8

* Swanpool's annual surface range is about 0.4-13.5.

Table 2 gives the salinities of the surface of each lagoon. These figures are only spot readings, and to make much sense of the salinity regimes, studies would have to be carried out over quite long periods of time, as we have done at Swanpool (e.g. Barnes et al., 1979). Nevertheless, they do show that all the lagoons have a relatively low salinity - all less than 10‰ at the surface. I was unable to find haloclines (with more saline water at deeper levels) except at Swanpool, but without a boat to



sample properly, I may have missed deep-water salt layers.

All the lagoons are fringed with either Phragmites or Scirpus maritimus, and all have some kind of artificial channel linking them with the sea. Without these, all would have become isolated from the sea, and would have progressed to the essentially freshwater stage found in the Loe.

Fauna of the Lagoons

Because of the random timing of the sampling periods, and the short time available for sampling, I cannot claim to have exhaustive records for any lagoons except Swanpool. The distribution of the common macrofauna is shown in Figure 2. Without going into a detailed analysis, it can be seen from this

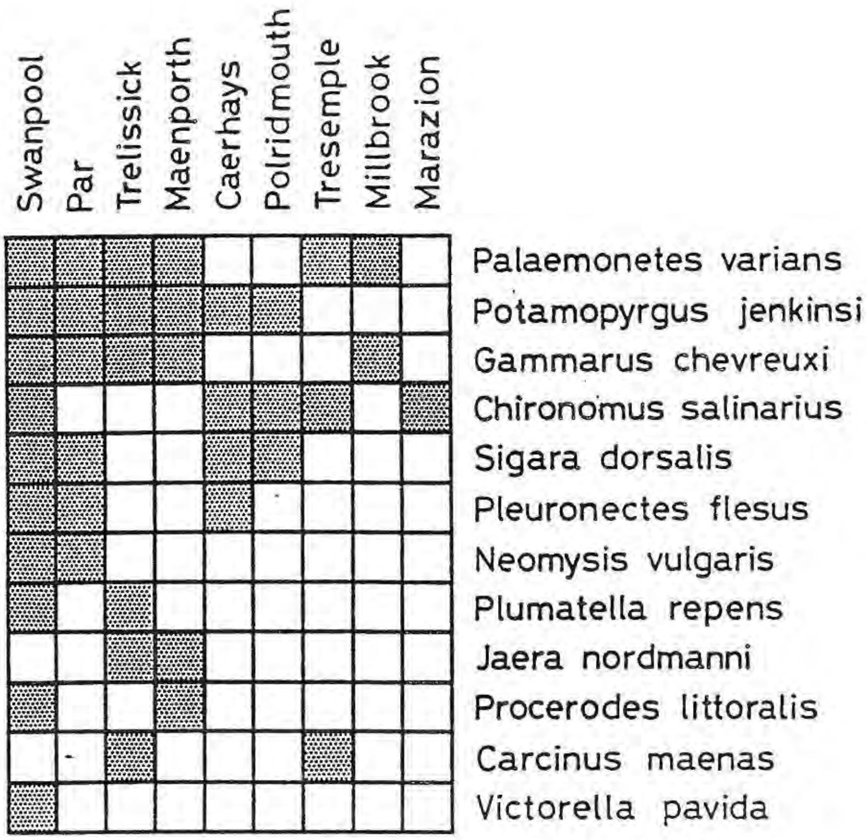


Figure 2. Distribution of macrofauna in Cornish lagoons. Stippled areas show presence of each species.

that there is quite a degree of similarity between lagoons, especially between Swanpool, Par, Trelissick, Maenporth, Caerhays and Polridmouth. Not all lagoons have the same species, however, and one of the crucial problems is to explain differences in species composition at the different sites.

It used to be fashionable to blame such distributions upon different salinity regimes. My thesis, however, is that in this kind of situation salinity is irrelevant as a controlling factor: in all these lagoons it is bound to be very variable, so that the inhabitants have, by definition, to be extremely tolerant of salinity changes. In Swanpool, for instance, we have shown that salinity varies from freshwater to over 10‰ , very irregularly, over the year. While salinity may therefore determine which species cannot be there, it does not determine which of several may be dominant in any one pool, or at any one time. Studies of one particular brackish-water organism, the oligochaete *Nais elinguis*, in Swanpool (Little, 1985) have shown that its populations peak regularly each year in spring, at the time of low salinity. When the animal's response to rising salinity is measured, however, it is found to be extremely tolerant of a great variety of combinations of salinity, temperature and pH. I suggest that we need to look much further than to salinity for explanations of the distributions of animals in lagoons.

Acknowledgements

This study was funded by the Nature Conservancy Council. I am very grateful for help in fieldwork provided by Malcolm Jones and Penny Stirling.

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FACTORS INFLUENCING SPECIES DIVERSITY IN COASTAL SALINE LAGOONS

by Martin Sheader

Recent surveys, in part sponsored by the Nature Conservancy Council, have highlighted our lack of knowledge of the many small brackish ponds or lagoons around Britain's coastline. In England they reach their highest densities on the south coast (especially in the Solent region) and along the East Anglian and Lincolnshire coastlines. Information presented in this paper uses data collected at more than forty sites between Portland (Dorset) and Eastbourne (Sussex) (Sheader & Sheader, 1985).

For the purposes of this study a lagoon is defined as any body of brackish water (salinity greater than 2‰), with or without a direct freshwater input (i.e. stream, drain or ditch), and with seawater entering through a narrow channel, or by percolation through a sand/shingle barrier, or by tidal/storm inundation over a barrier. In addition, freshwater will of course enter all lagoons by precipitation and seepage, and in many shallow lagoons this, together with evaporation, may result in seasonal and shorter term salinity changes. This definition of a lagoon is intentionally broad, and includes both naturally-formed and man-made structures.

The lagoons studied are all small (up to 18 hectares) and generally less than 1 metre in depth. Most of the sites were visited on more than one occasion and in different seasons. Sampling involved the collection of submerged macrophytes, and macrofauna (>0.5mm) associated with sediment and weed at a range of locations throughout each lagoon. Subsequent detailed studies at a number of these lagoons showed that this preliminary sampling resulted in a collecting efficiency (percentage of total species collected) of 90% or more.

Species Diversity

The species diversity within the lagoons is typically low, even by comparison with estuarine ecosystems. The biota generally has a large marine or estuarine component, a (usually small) freshwater component, together with a small group of lagoonal species, some of which also occur in sheltered estuarine environments.

A range of factors are considered as likely to determine species diversity in lagoons, and include: (a) lagoon type, (b) salinity, (c) age, (d) size, (e) proximity to other lagoons or estuaries, and (f) habitat heterogeneity. Other parameters (e.g. depth, temperature, dissolved oxygen, pH) may also be of importance but are not considered here.

(a) Lagoon Type

Preliminary attempts to categorize south coast lagoons using species data failed to produce a meaningful classification. A system of classification was therefore devised based on lagoon structure and topography. Five lagoon types were described:

- I Low salinity upper salt marsh pools (5 sites)
- II Sea inlets (6 sites)
- III Lagoons isolated from the sea (10 sites)
- IV Estuaries with constricted mouths (4 sites)
- V Lagoons having a sea connection with a sill, and a reduced or absent freshwater input.

The mean number of species in each lagoon type varied as:

Type V >> Type II > Type I = Type IV > Type III

The greatest number of species is found in lagoons having a sea connection with a sill. This ensures that the sediment surface is covered by water at all states of the tide. Conditions in these lagoons are perhaps the least stressful to the biota, with regular water exchange maintaining water quality and high salinity. Also the permanently submerged substrate permits the development of a diverse floral community, thus increasing

habitat heterogeneity. The sea connection and regular sea input allow for rapid colonisation or recolonisation.
Type III lagoons which are isolated, receiving seawater by percolation (and to a lesser extent by inundation) have the lowest species diversity. With seawater entering these lagoons through a shingle or sand barrier, it would be expected that colonisation or recolonisation rates would be low. In addition, this lagoon type was generally found to exhibit marked variation in environmental parameters (e.g. oxygen, temperature), increasing the chance of species extinction.

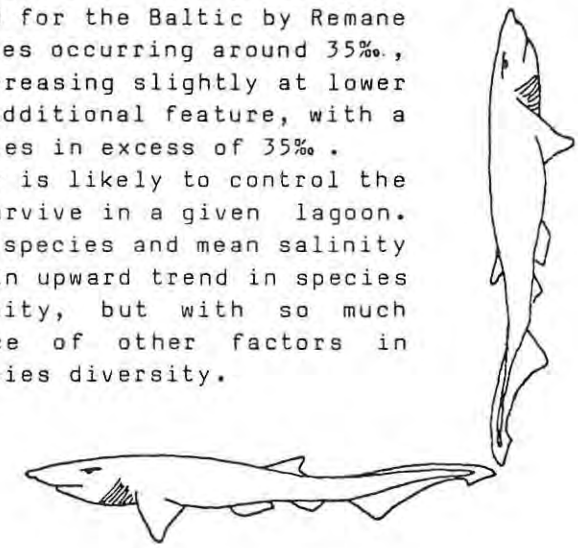
(b) Salinity

Salinity, depending on lagoon type, may vary on a tidal, spring/neap or seasonal basis, according to the frequency and quantity of direct freshwater or seawater inputs, and to the magnitudes of precipitation and evaporation. The majority of species found in lagoons occur over a wide range of salinities. However, the relative importance of the major taxa varies. Insects represent more than 60% of species in lagoons with a mean salinity of <5‰, falling in importance with increase in salinity, but continuing to account for 10% of species in lagoons at salinities between 20 and 40‰. The crustacea represent 25% of species at low salinity (<5‰) increasing to 30 to 50% of total species at higher salinities. The percentage of molluscs and annelids increases from low to high salinity, together representing 30 to 50% of species at salinities in excess of 15‰.

The presence of insect species, often at very high densities, seems to be a feature of lagoons and is probably associated with the extreme degree of shelter, and to the many similarities of the lagoonal and freshwater pond environments. Crustacean species, mainly peracaridans, are in many ways pre-adapted for lagoon life, having mixed r- and K- strategies, with large yolky eggs and brood protection coupled with short generation time. Many other lagoonal species exhibit mixed strategies (Barnes, 1980).

Using the salinity range over which each species occurs in the survey, it is possible to construct a figure showing the potential number of species present in lagoons at salinities from <5‰ to >40‰. This gives a species distribution in relation to salinity, very similar to that described for the Baltic by Remane (1971), with a maximum number of species occurring around 35‰, falling to a minimum around 5‰, and increasing slightly at lower salinities. The present study shows an additional feature, with a rapid fall in species number at salinities in excess of 35‰.

It appears therefore that salinity is likely to control the number of species potentially able to survive in a given lagoon. However, the relationship between total species and mean salinity of lagoons in the present study shows an upward trend in species number with increase in mean salinity, but with so much variability as to suggest the importance of other factors in addition to salinity in determining species diversity.



(c) Age

Much interest in recent years has been directed to studies of island ecology, and in many ways lagoons may be considered as similar entities. With islands, relationships between age and number of species have been described, with, after some time, an equilibrium being reached, when colonisation balances extinction of species.

Lagoons are generally short-lived features - tens to thousands of years - with longevity often positively related to size. Without a detailed knowledge of the formation and history of each lagoon it was impossible in the present study to consider age (as a factor determining diversity) in any detail, apart from noting the obvious differences between the low number of species in newly-formed lagoons, and the higher numbers of species in older lagoons such as the Dorset Fleet.

(d) Size

In the study of island ecology relationships have been shown between the number of species and island size, with larger islands generally able to support a greater number of species than smaller islands. With data from south coast lagoons, such a relationship is found only for Type V (silled) lagoons. As suggested earlier, these lagoonal environments probably impose least stress on the biota and, with regular sea input, have the potential for rapid colonisation. It is likely, therefore, that lagoons of this type, with reduced extinction rates and increased colonisation rates, can more rapidly achieve and maintain an equilibrium number of species.

Type III (isolated) lagoons show the greatest variation in species number in relation to size, and here, where the biota is under the greatest stress, extinction rates are likely to be high and colonisation rates low.

(e) Proximity to Other Lagoons or Estuaries

The proximity to other lagoons or environments supporting species able to survive in a lagoon environment must be a major factor determining rates of colonisation or recolonisation and hence species diversity. It may therefore not be surprising to find that lagoons with the greatest number of species in the current survey occur in a region of high lagoon density in the Solent.

The probability of colonisation via the sea depends on the type of lagoon and the tidal and current regime in the adjacent coastal area. Alternatively, movement of certain species between lagoons by birds is a possible means of colonisation.

(f) Habitat Heterogeneity

The majority of lagoons in the present survey had sediments composed of an admixture of shingle and mud. Where wooden pilings or rock surfaces occurred in lagoons, increasing the spatial heterogeneity, then additional species were found.

Using data for all lagoons, a clear relationship could be demonstrated between the number of submerged macrophytes and the number of macrofaunal species. An increase in macrophyte species number increases spatial heterogeneity of the habitat and permits a greater number of macrofaunal species to exist.

This preliminary study of south coast lagoons serves to emphasize the wide variety of factors determining species diversity in lagoonal environments.

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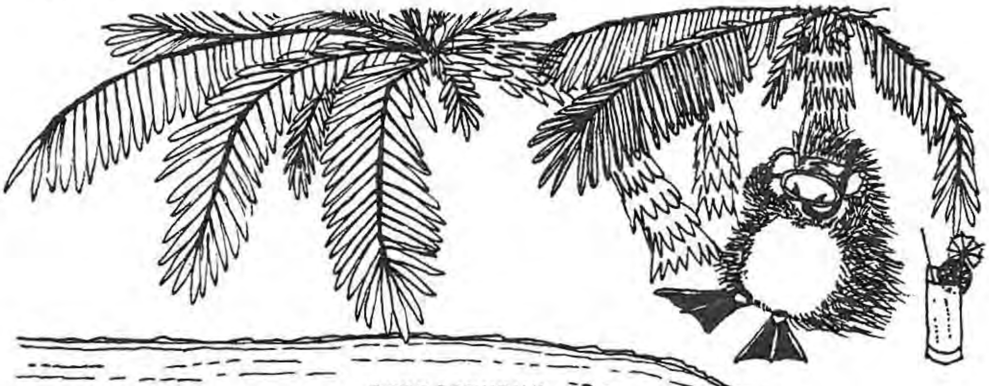

CURRIGENDUM

To Dennis Seaward, and those readers wondering about byssal production in Hydrobia, I submit my apologies for the missing lines of text in Dennis' article in the last issue (PN 3 (6), p.140-146); the section on p.141 entitled 'Sibling Species Pairs' should have read as follows:

The two hydrobiids H.ulvae and H.ventrosa overlap slightly at the lower end of the Middle Fleet. Two populations of the Littorina saxatilis agg. occur, one intertidal and the other permanently submerged, but their taxonomic status is as yet uncertain.

Both cockles Cerastoderma edule and C.glaucum are present; their populations sometimes overlap in the lower part of the Middle Fleet. (The paper by Yankson, 1986, published just after the Lagoon Symposium, describing the very different byssus threads of the spat of these two species, is of interest in regard to the discussion regarding their conspecification).

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WATER REGULATION IN A CRUSTACEAN INHABITING VARIABLE SALINITY ENVIRONMENTS

by A.P.M. Lockwood
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Introduction

In order to survive, all organisms must be able to regulate the ion and water content between certain species specific limits. Variable salinity conditions therefore pose physiological problems, and potentially one of the most stressful environments is that presented by the pools and gutters of salt marshes. Here the salinity range is not only wide but changes are sudden and unpredictable. The small pools, and gullies, on a typical estuarine raised marsh are commonly, though not invariably, flooded by a marine incursion at high water springs. The actual salinity of the incursive water tends to vary and, in a marsh such as that at Redbridge on the River Test in Hampshire, can range from virtually fresh water to some two-thirds seawater according to the river flow at the time of springs. Between the spring peaks the marsh pool salinity may (a) remain constant for extended periods, (b) be diluted by heavy rain, or (c) be concentrated by evaporation.

Organisms such as the amphipod Gammarus duebeni which are non-burrowing components in the fauna of such pools must therefore have the capacity to tolerate salinity variations from nearly fresh water to concentrations in excess of normal seawater. They must also be able to respond effectively to virtually instantaneous salinity change in either direction. The gullies intersecting a raised marsh provide yet another regime. Here the salinity can vary on a semi-regular basis from near fresh water (1‰) at low tide to some 22‰ at high tide (Ralph, 1965). Some other forms living in such environments like Corophium volutator and Paragnathia avoid the most severe aspects of sudden salinity change by burrowing into the mud. By contrast G.duebeni does not normally burrow, and appropriately deploys a complex of physiological responses to cyclical salinity change.

Typically G.duebeni tolerates a salinity range from fresh water to about 150% seawater, though, by gradual acclimation, a proportion of the population can be got to survive in about 70‰. The body fluids are maintained strongly hypertonic to the medium in low salinities, a sodium concentration in the haemolymph of some 250-260 $mM.l^{-1}$ being normal when the animals are in circa 0.5-1‰ water (Lockwood, 1961). This haemolymph sodium concentration is nearly twice as high as that of the typical freshwater congenor G.pulex, and hence the water intake by osmosis when the animals are in dilute media is substantial.

Excess water is removed as urine and, despite the ability to produce urine more dilute than the blood, this results in ion loss. Replacement of lost ions is an energy demanding process and consequently it would seem logical that G.duebeni should restrict water inflow when in dilute media. Water lost by osmosis during any period when the animal is hypotonic to high salinities cannot readily be replaced. Consequently decreased permeability at such times too would appear an appropriate response.

There are hypothetical reasons therefore for supposing that a good osmoregulator like G.duebeni should derive advantage from being able to adjust the permeability of the body surface to water.

Effect of Acclimation to Different Media in Apparent Permeability to Water

Determination of water flux across the surface using THO indicates an apparent change in permeability to water as the salinity is changed. The half time for total body water exchange is about two and a half times faster for individuals acclimated to 100% seawater than for those in 2% seawater (Lockwood et al., 1973). This feature, if reflected in terms of hydraulic permeability change, would be expected to limit water uptake when the animals are hypertonic to the medium.

Effect of Sudden Dilution of the Medium in Apparent Permeability

The change from one level of apparent permeability to another on dilution occurs with such rapidity (<5 min) as to suggest the involvement of a physical rather than biological process, though the biological structure determines the nature of the response. The observed flux change is presumed to reflect an alteration in hydraulic permeability since, on transfer from seawater to fresh water, the rate of loss of ions from the body is slower than would be expected if the water permeability observed in 100% seawater remained unchanged (Lockwood & Inman, 1979).

Rapid Transference from Dilute to Concentrated Media

On sudden transference of individuals from 2% to 100% seawater the apparent permeability initially declines still further (Lockwood et al., 1973; Lockwood & Inman, 1979; Bolt, 1982). Then, some hours later, at about the time the blood once more reaches isotonicity with the medium, the typical permeability for seawater-adapted animals is re-established.

Structural Changes in the Gills

Dawson (1982) has shown that following transference of G.duebeni from dilute media to seawater the pattern of haemolymph circulation in the gill changes. On exposure to the higher salinity the transverse channels across the laminar face of the gill are closed to a degree such that haemocytes are no longer observed moving. Only the peripheral vessel remains open, and in this the haemocytes move but sluggishly. Such a change in circulation past the most permeable region of the body surface may well contribute significantly to the observed decrease in apparent permeability on transfer from dilute to concentrated media.

No such change in circulation is observed on transference of the animals from 100% seawater to 2%, despite the reduction in apparent permeability which accompanies such a change (Dawson, 1982). Examination of electron micrographs of animals acclimated to 100% and 2% seawater suggest however that gill cells in the two media differ in their fine structure (Lockwood et al., 1973). Epithelial cells from gills of animals in 2% seawater have the apical border thrown into a series of folds so that extra-cellular fluid is trapped between the cuticle and the cell surface. Gills from animals in 100% seawater have the apical border of the epithelium closely abutting the cuticle and, though the lamellar spaces can just be seen, they are in a compressed and reduced form. Whether these micromorphological changes are important in determining the observed permeability differences remains unresolved; however, comparable differences have also been observed in a variety of other species (Copeland & Fitzjarrel, 1968).

Response to Cycling Salinities

Acclimation of G.duebeni to a range of media results in a significant change in blood concentration. By contrast, exposure to a cycle of salinity change is accompanied by haemolymph concentration fluctuation by only about 20-30 $mM.l^{-1}$ (Lockwood & Inman, 1979; Bolt, 1982; Dawson, 1982). Large changes in apparent permeability and in sodium influx occur during the salinity cycle, however, suggesting that both processes are involved in the control being exercised over body fluid concentration (Bolt, 1982; Dawson, 1982; Bolt et al., 1983).

Long term acclimation (40 plus days) to 100% seawater has little effect on the apparent permeability (Morris et al., 1982; Dawson et al., 1984). By contrast, long-term acclimation to dilute media is followed by a well defined shift in the half time for water exchange, suggesting that the surface has become still less permeable to water. Determination of the fatty acid composition of the triglycerids and phospholipids of the gills and body residues indicates that changes occur in the gill phospholipids. These changes are not reflected in the composition of the general body phospholipids on such long term acclimation to dilute media. The most obvious effects in the gills are a decrease in the 16:0 saturated fatty acid (palmitic) and increase in the oleic acid (18.1 mono-unsaturated acid) component. Variations in other fatty acids also occur but these are attributable to the processes associated with temperature compensation, as has been found in other crustaceans.

It has not been observed directly that the observed changes in phospholipid fatty acid are responsible for the adjustments occurring in water permeability on long term acclimation but the results suggest that further work on the apparent correlation may be justified.

In summary, the habitat occupied by the amphipod Gammarus duebeni can be subject to both wide-ranging salinity regimes and to sudden changes of salinity in either direction. There is also a stock living permanently in fresh water in Eire. The ability to respond to the demands generated by such salinity variation is found to be dependent upon tolerance of some degree of change in haemolymph concentration, the capacity to vary urine flow and concentration, the ability to vary the rate of active uptake of inorganic ions and a surface permeability to water which varies with the gradient between haemolymph and medium. Factors possibly associated with changes in the permeability to water have been discussed.

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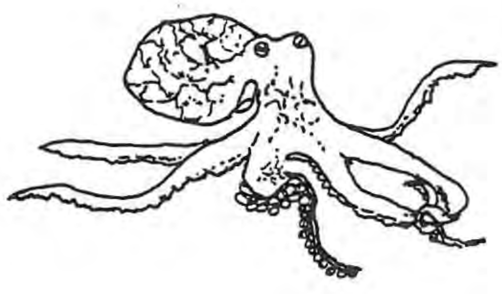

VARIATION OF WATER PERMEABILITY IN SELECTED EURYHALINE AMPHIPODS

by Stephen R.L. Bolt
Department of Oceanography, University of Southampton, SO9 5NH

Amphipods have colonised a wide range of habitats varying from the abyssal depths to a fully terrestrial environment. Many species are found in or around the shoreline, estuaries or lagoonal systems where environmental conditions can be less than stable. In oarticular, the salinity of these localities often varies causing the animals osmotic problems which must be faced in order to survive successfully in these rich habitats.

Amphipods living in these conditions show a range of osmoregulatory mechanisms which can be related to their habitat. Thus _Gammarus duebeni_, an extremely euryhaline amphipod, is capable of rapid changes in water permeability (Bolt _et al._, 1980) while the less euryhaline shoreline species _Gammarus locusta_ is not. Changes in water permeability in crustacea have been noted many times (Smith, 1967; Bolt, 1982; Dawson, 1982; Lockwood & Inman, 1973), and suspected as an important osmoregulatory mechanism (Bolt, 1983, 1985a).

Five species of amphipod with varying degrees of tolerance to salinity change have been studied by the author. The water permeability of these species was measured in a variety of salinity regimes and the results related to their habitats.

Gammarus duebeni collected from Totton Marsh, Southampton, has previously been reported to exhibit large and rapid changes in water permeability as measured using tritiated water as a marker (Lockwood _et al._, 1973; Bolt, 1982; Dawson, 1982), and is tolerant of large changes in the salinity of the external medium. However, the subspecies _Gammarus duebeni celticus_ is found in freshwater streams in Ireland where it has been isolated from the sea for many generations. Morphologically, the subspecies can only be distinguished with difficulty (Stock & Pinkster, 1970). Physiologically, however, the _celticus_ form appears to have lost the ability to alter its permeability to water, maintaining a low permeability in all salinities. In contrast _G. duebeni duebeni_ becomes more permeable when acclimated to full strength seawater. Possibly as a result of the inability to alter its permeability to water, _G. d. celticus_ cannot survive sudden increases in external salinity. It can, however, survive a stepped salinity increase up to 100% seawater over a period of days. Further work is needed to determine if these differences in physiology between two subspecies are phenotypic or genotypic.

Another euryhaline amphipod capable of changes in water permeability is the arctic species, _Gammarus setosus_ (see Bolt, 1985b). This species is found under the sea ice, feeding on ice associated algae. During the spring melt there is a layer of fresh water under the ice, and the animals can be observed freely crossing from this fresh water layer into the full strength seawater (32‰). It has been suggested that the animals drop down into the salt water to "top up" their body salts periodically. Changes in water permeability would facilitate this process, as the animals become more permeable to water and hence ions if transferred from 2% seawater (SW) to 100% SW. This contrasts with G. duebeni which reduces its permeability to water on sudden increase of the concentration of the external medium. These results are summarised in Figure 1, which shows the half-time of exchange of tritiated water ($t\frac{1}{2}$) of the animals before, immediately after and 24 hours after a transfer from 2% to 100% SW. The increase in permeability (indicated by a decrease in the $t\frac{1}{2}$) allows Gammarus setosus to "refill" with salts in 3 to 4 hours compared to the 16 hours required for G. duebeni.

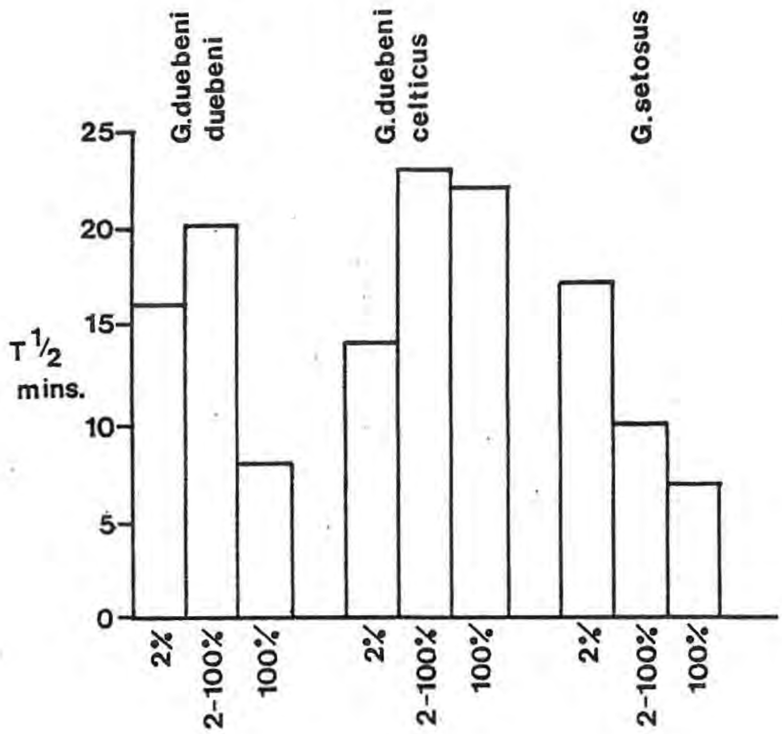

Figure 1. Half-times of exchange of three forms of amphipod before, immediately after and 24 hours after a sudden increase in medium concentration.

In contrast to the highly euryhaline species, species inhabiting areas with relatively small salinity changes do not exhibit water permeability changes. Chaetogammarus marinus, Gammarus locusta and G. insensibilis are all incapable of significant permeability changes, and this is reflected in the high mortality when exposed to rapid changes in their external salinity (e.g. Bolt, 1983).

In conclusion, all the amphipod species so far studied which are capable of living in areas of large salinity changes have shown variation in their permeability to water related to the osmotic gradient between their haemolymph and the external medium. However, the response shown by different species is not necessarily the same, and varies in different species depending on the habitat. None of the less euryhaline species which have been studied appear to have this ability to change water permeability, and this has been related to their inability to survive large salinity changes. Thus water permeability changes would seem to be an important characteristic of euryhaline amphipods, allowing the animals access to otherwise osmotically embarrassing environments.

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FUTURE MEETINGS

PORCUPINE 1986 FIELD MEETING

The Dorset Fleet

The 1986 PORCUPINE field meeting will take place at that now famous lagoon, the Fleet, Dorset (see PN3 no.6), on 19-21 September. The meeting will be an informal gathering, but, through the good offices of Dr John Whittaker of the Fleet Study Group, we hope to have use of a boat and access permission at various places. Non-members are also welcome to attend.

Intending participants should:

(a) contact Frank Evans, Dove Marine Laboratory, Cullercoats, North Shields, NE30 4PZ (Tel. 091 252 4850)

(b) arrange your own accomodation - guest houses, hotels, etc. are abundant in the Weymouth area, reducing to occasional at Abbotsbury.

(c) congregate at the Ilchester Arms, Main Street, Abbotsbury at around 7pm (19.00 hrs) on Friday 19th.

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PORCUPINE AUTUMN MEETING

Peterborough

The autumn meeting will be held on 11-12 October at Peterborough, on the subject of Immigrants and Aliens (marine of course).

It has become timely to bring knowledge of the distribution of immigrant species up to date, from old favourites like Elminius and Sargassum to the oddly distributed, like Styela, the introduced, like Mercenaria, and recent invaders such as Hydroides ezoensis. And how have they adapted to life in our welfare state? And what aliens should we be looking out for in community ecology studies? Representatives of the NCC will present the legal side on immigrants, and we hope for a presentation from MAFF on their policy for licensing introductions. This topic also relates to a proposed M.C.S. project for 1987.

+++++++++ Call for Papers +++++++++

Contributions are invited on the topics of the ecology and distribution of immigrants. Please contact Roger Mitchell, Nature Conservancy Council, Northminster House, Peterborough PE1 1AU.

A detailed notice with final arrangements will be circulated to all members in good time.

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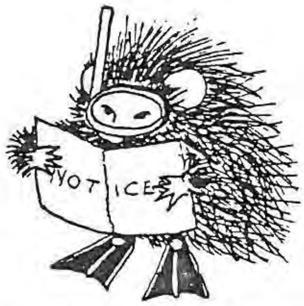
SEE YOU THERE!

NOTICES



1. The Nature Conservancy Council's COASTWATCH

In order to prepare a comprehensive conservation strategy for an area it is essential to have an adequate knowledge of the biological resource and any actual or potentially damaging activities. Although a good deal of such information is available for the coast, coverage is patchy and the records of variable quality. As part of a programme to improve this information base, the Nature Conservancy Council have decided to launch a new coastal survey. This national project, known as COASTWATCH, will provide the focus for the collection and analysis of data on the major habitats and communities occurring in a coastal strip all around Britain from cliff top to low water mark. Once the resource information has been assessed, a second stage will concentrate on identifying and measuring habitat loss or change and record those activities which are responsible.

Resource data included will include a physical description of the shore in terms of the beach material (e.g. rock, sand and mud) with information on plant communities (e.g. salt marsh, dune grass, eel grass and intertidal algae) and key species (e.g. limpets, barnacles and mussels). All this information will be recorded on large scale maps of the area and a simple recording card. The area covered by major habitat and community types will be measured from the maps, which will also be used to indicate large changes in the resource through reclamation and other engineering works, as well as natural erosion and accretion. Other sporadic activities such as bait digging, sea angling, algal collection and oil pollution will be recorded against a check list.

The Nature Conservancy Council will manage the project and provide facilities for the collection and analysis of the records and ensure feedback to the recording groups. Thanks to a generous donation from British Petroleum, NCC has been able to appoint a full-time project coordinator. However, in order to collect the information required over a reasonable timescale, the success of this project will ultimately depend on a large input from voluntary conservation bodies and other groups organised on a county basis. Support and help with the project has already been pledged by MCS, RSNC, WATCH, WWF, FSC and several County Wildlife Trusts and representatives from these bodies form an advisory coordinating committee.

Some pilot projects have been completed and others are in progress with a view to launching COASTWATCH as a national scheme in early summer 1986. Recording cards and instructions are at present being refined and a general explanatory leaflet prepared. If you wish to participate and would like further details as they become available, please send your name and address to:

Teresa Bennett, Coastwatch Co-ordinator, Nature Conservancy Council, Northminster House, Peterborough, PE1 1UA.

2. BACK ISSUES -
Members / readers are reminded that back issues of PORCUPINE NEWSLETTER are available, at £2 per issue. Recent issues are usually available at meetings.

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3. YOUNG MULLET -
are not a new pop group, rather a taxonomic problem. Member Peter Reay would be most interested in samples of younger, summertime mullet of the Thin-lipped and Golden kind, from which to sort out the thorny problem of their distinction, etc. - and we certainly wish him luck. Peter can be found at the Dept. of Biological Sciences, Plymouth Polytechnic, Drake Circus, Plymouth PL4 8AA.

4. SAND EEL EGGS -
and on the subject of fish, any information on sand eel spawn (where, when, what, how) would be much appreciated by the Hon. Ed., to help clarify a recent find of presumed Ammodytes tobianus eggs in a sandy Northumberland beach near high water mark! All offers to Box 13.

ODDMENTS FROM FAIR ISLE

by Nora McMillan
Dept. of Invertebrate Zoology, Liverpool Museum.

Just to be "different" I went to Fair Isle, that Mecca of bird-watchers, not to see birds! And I found much of interest. The following pelagic barnacles were all taken about the north end of the island during my September 1982 visit.

Lepas anatifera (L.) - a plastic float covered with beautiful living specimens was found after a gale. The colouring was quite startling: the valves were greyish-white, tinged pale blue, the margins vivid mustard-yellow; all the soft parts were a rich purple-brown.

L. fascicularis Ellis

L. pectinata Spengler - on a scrap of Ascophyllum.

Other pelagic strays were numerous floats of the siphonophore Velella velella (L.), all dead but fresh and retaining the bluish tinge. A student whom I met at Fair Isle told me that she had seen half-a-dozen floats on the island of West Burra, further north in Shetland, also in September.

Also on the little bit of sandy shore at the North Haven were numerous examples of the hydromedusa Eutonina indicans (Romanes), resembling transparent glass buttons. These were identified with the help of Dr Cornelius of the British Museum (Natural History) and Prof. Bouillon of Brussels, to both of whom I am grateful. The species is illustrated on Plate 3 of 'The Open Sea' (New Naturalist) by Sir Alistair Hardy, but my specimens were slightly flatter than that illustrated.

BRACHIOPOD DISTRIBUTION SURVEY, 1986-1987

Bernard Cohen, Moyra Cohen, Peter Balfe & Gordon Curry
Departments of Genetics and Geology, Glasgow University

Our research, which has been supported by the Natural Environment Research Council, aims to discover more about the evolution and genetics of brachiopods, animals that are important as fossils, but whose natural history has been rather neglected in recent times. An important aspect of our work is to obtain and publish an improved account of brachiopod distribution.

In general, the distribution of brachiopods is known from the results of dredging and trawling by marine rersearch vessels; the results of careful searching by divers can be expected to give a quite different picture, especially in near-shore and rocky localities.

The Different Kinds of Brachiopods

Some 20 different brachiopods have been reported from waters around the U.K.. Setting aside those that are very small (less than 1 cm) or have been found only in very deep water, we are concerned with only 5 or 6 species (see below).

Where Brachiopods Live

All the brachiopods that interest us at present look rather like small cockles, except that they live attached by a short fleshy stalk to a solid substratum. This may be cliff or boulder (usually well away from wave-action and light), cobble, gravel, shell (intact or broken), sponge or (occasionaly) fine sandy sediment. They are not usually found in silty environments, although some fossil brachiopods specialised in living in silt. Brachiopods flourish in moderate currents as well as in still water and are exclusively subtidal.

Where brachiopods do occur, they may be solitary or numerous (up to 400 per square metre) and we are equally interested in both sparse and dense populations, though obviously dense ones have the best chance of being noticed and recorded.

What Brachiopods Look Like

The four species most likely to be found are illustrated in Figure 1. Shells usually bear encrusting animals and plants, giving a brownish or darker colouration. Young brachiopods often settle on older ones too.

What To Do If You Find Brachiopods - And If You Fail To Find Them (Having Looked Carefully).

1. Collect a shell or two
2. Complete a report form (Fig.2) or give the same information on a plain piece of paper

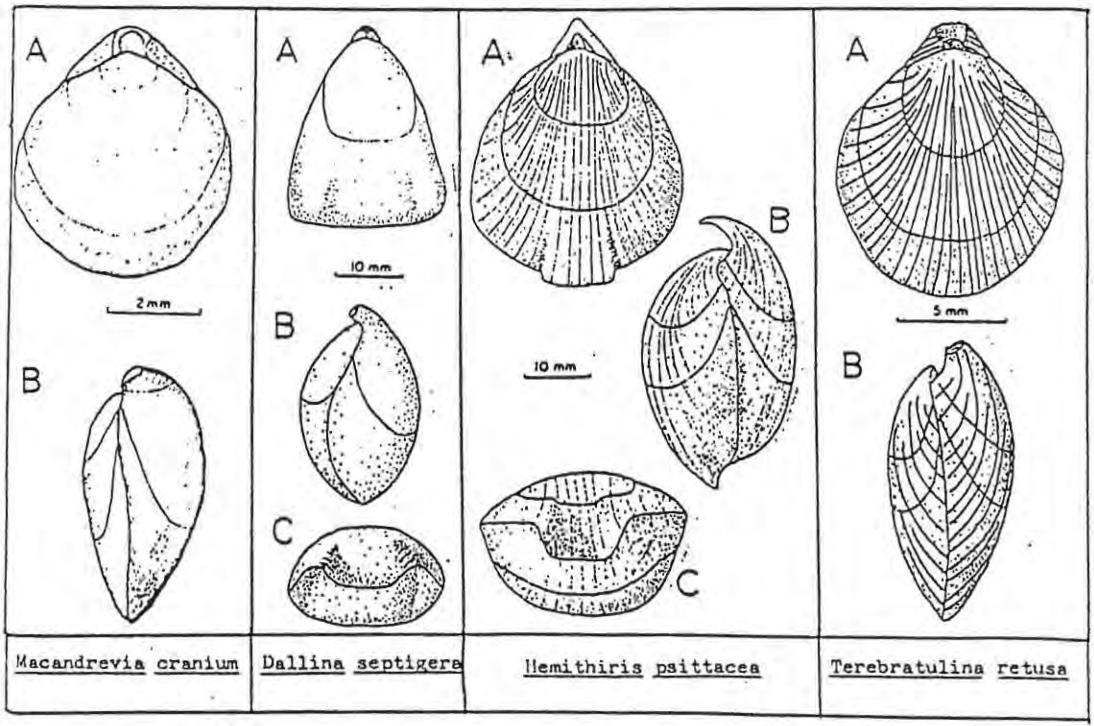

FIGURE 1. Representatives of the species of brachiopod most likely to be found around the U.K.. A - dorsal, B - lateral, C - anterior.

FIGURE 2. Format of report form.

BRACHIOPOD REPORT

Please return, with sample shells to Dr B L Cohen
Department of Genetics
University of Glasgow,
FREEPOST
Glasgow, G11 5BR

Name and address of reporter

National Grid reference of locality

Nearest town

Distance offshore

Depth

Substrate (*Rock, Cliff, Cobble, Shingle, Gravel, Shell, Other (describe)*)

Extent of population (*very localised, spread out over a distance, very widespread, etc.*)

Population density (*animals per square metre*)

Associated fauna

Would the reporter be willing and able to collect up to 50 animals from the reported locality? Divers willing to collect will be contacted separately

3. mail shell and report to us - no stamp needed - at this address:

Dr B.L.Cohen
Dept. of Genetics
University of Glasgow
FREEPOST
Glasgow, G11 5BR

4. N.B. Reports that brachiopods are <u>absent</u> when carefully searched for can give very valuable information. For example, we have dredged at many stations around Arran but have found none (except <u>Crania</u>, which we do not mention here because it cannot be collected, being cemented like a limpet). Will diving confirm the absence of brachiopods from around Arran? This is important because there are plenty in Upper Loch Fyne!

What To Do If You Find Living Brachiopods In A Remote Locality At Home Or Abroad To Which Neither You Nor Other Divers Are Likely To Return

1. Collect up to 50 animals without damage to the fleshy stalk (slide a very sharp knife along the rock or lift the whole specimen).

2. Trim the specimens to leave the minimum of rock, shell or other organisms and seal them in a stout polythene bag with plenty of seawater and a good air-space. Pack around in a stout box with ice/water and mail FREEPOST (inland only) or - after prior arrangement - by air to arrive within 1-5 days. Shipping costs will be refunded.

What Not To Do!

Please DO NOT DISTURB the Upper Loch Fyne, Easdale or Insh Island populations of <u>Terebratulina retusa</u>. These diver-accessible populations are well-known to us and are under careful study.

Your co-operation is greatly valued; without it this aspect of our work could not proceed.

CORRIGENDUM 2 - Transatlantic Asteroids

Readers wondering about the 'transatlantic' inference in Robin Harvey's 'hopping asteroid' paper in the last issue (PN 3 no6; p.158-9) are asked to bear with the Editor's word processing. The text should have included a sentence stating that "<u>Mediaster bairdi</u> (sic) was previously known only from the northeast coast of America in 360-915 m."
This is <u>not</u> the Hon.Ed's subtle way of padding out the summer issue!