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STOP PRESS: Members are reminded that their 1988 annual subscriptions (£5.00) are due on January 1st 1988.

EDITORIAL

Welcome to Volume 4 of PORCUPINE NEWSLETTER, with a slightly revised layout occasioned by a variety of factors, such as different processor and the need for more 'Contents' room to accomodate the titles of Articles. Equally, the more compact pitch is a subtle (?) cost-cutting measure. I hope this does not confuse too many Members, and I will of course respond to floods of critical correspondence (not that one sees many floods of correspondence in this job!).

It is apposite to take this opportunity to inform readers and prospective contributors of the general editorial policy of PN (at present), partly in response to various queries from said contributors. To those of you kind enough to offer me versions of articles on floppy disc, etc., I am able to interpret from Apple (-writer) and Apricot (Superw.), but the only system which can feed directly into the editing is Amstrad (Locoscript 2) (I can still read bits of paper though). Publication priority is given to articles stemming from presentations at PORCUPINE Meetings, as a service to Members unable to attend the meetings. But anything else is always welcome. Editing is confined to grammatical correction and the general functions of refereeing, but not 'style'; spelling is approved by 'Prospell'; 'proofs' are only returned to authors if major revision is required; author's addresses are deemed not necessary if they are available from the Membership list; I have no desire to redraw figures, so what appears is what was sent (allowing for reduction or enlargement), if not rejected. I have not yet had complaints, but I welcome comments.

Apropos Dennis Seaward's letter of last issue (PN 3; 281), Members will be delighted to hear that Elizabeth Roberts is covering Vol.3, Numbers 6 to 10 in the next Estuaries and Coastal Waters of the British Isles bibliography, and subsequent to a most fruitful correspondence between ourselves, I shall keep Elizabeth supplied with the necessary information for future issues.

SUBSCRIPTIONS for 1988 are due in January, and have risen to £5.00 as agreed at last year's AGM (PN 3 (9), p.242). You have been reminded! Many thanks to those of you who responded to arrears reminders - we are now financially happier.

FUTURE MEETINGS; the 1988 Spring Meeting and 11th Annual General Meeting of PORCUPINE will be held on March 5th and 6th at Millport, Isle of Cumbrae, as detailed in the previous issue (apologies for date confusion). Accomodation will be available at the Marine Biological Station - for people arriving for dinner on the Friday (4th March) full board up to and including lunch on the Sunday, with a four course dinner (with wine) on the Saturday will cost around £37.00, based on shared accomodation in the Student Hostel; a supplement of £5.00 will be required for single rooms. There will be a Conference fee of £1 (Members) or £2 (non-Members). The provisional programme is enclosed.

Trains run from Glasgow to Largs, whence the ferry to Cumbrae; the last ferry on Friday night is at 1900h, and the first in the morning is believed to be at 0700h. On alighting, there is a bus service (55p) to the Marine Station. Further details and information can be obtained from Fred Woodward (Art Gallery and Museum, Kelvingrove, Glasgow G3 8AG), and Fred would like to know who plans to be going in good time to arrange accomodation, etc. with Millport (i.e. as soon as possible).

MERRY CHRISTMAS
Hon Ed.

ALIEN AMPHIPOD SPECIES IN IRELAND

by Mark J. Costello
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The colonisation of islands in historic times permits the monitoring of the distribution and assessment of the impact of immigrant species on native populations. In addition, the study of this disturbance assists the understanding of niche partitioning in the indigenous and donor communities. Terrestrial and freshwater species, which must cross the sea barrier, appear to colonise Britain before Ireland. However, the same appears to occur for marine species. Their immigration may be more a reflection of human activities than their natural dispersal ability. Amphipod Crustacea in Ireland have recently been reviewed by Costello *et al.* (in press), who list details of the distribution of the 300 recorded species, including those discussed here.

One marine, three freshwater and one terrestrial species of amphipod are believed to have colonised Ireland in recent times. The marine species may have arrived by natural means from Britain, but the others have almost certainly been introduced by human activities. Species which reach the limit of their latitudinal distribution and may not have permanent populations in Ireland are not considered as aliens. This paper reviews the origins, habitats and present distribution of the alien amphipods. Their potential impact on the native amphipod populations is discussed.

Corophium sextonae Crawford 1937. This epibenthic marine amphipod is recorded from kelp holdfasts (Moore, 1978), sponges and plastic-mesh substrata (Costello, 1987). When describing the species from Plymouth material, Crawford (1937) suspected *C. sextonae* of having recently invaded the area. Although apparently absent from the Plymouth area about the turn of the century, it was common by the 1930's, and very abundant by the 1950's (Spooner, 1957). Hurley (1954) found the species in New Zealand, and suggested that it may have been introduced to Britain amongst fouling on ships, as the barnacle *Elminius modestus* Darwin probably was. Moore (1978) studies populations in south-west Britain, and subsequently collected material in Scotland (Moore, 1980). He suggested that the species may also be transported amongst fouling during mussel culture activities. Surveys of ships hulls and aquaculture fouling before and after a journey would provide valuable information on what species may be transported as viable propagules by such means. Because many aliens and their parasites or diseases have important economic implications, it is remarkable that such a comprehensive survey has not been undertaken. *C. sextonae* is now known to occur in three localities on the south coast of Ireland, Lough Hyne (pers. obs. 27 Nov. 1982; Holmes, 1985), Cork Harbour (pers. obs.) and Carnsore Point (Keegan *et al.*, 1987) (Fig.1). Its apparent absence from relatively well studied areas, such as Dublin Bay, Galway Bay and Strangford Lough, is notable.

Crangonyx pseudogracilis Bousfield 1958. Believed to have originated in North America, this species was collected in London in the 1930's (Tattersall, 1937), and has since been spreading through the canal system and other lenitic waters in Britain (Spooner, 1951; Hynes, 1955; Gledhill *et al.*, 1976). In Ireland it is known from ponds in the Phoenix Park, Dublin at present (Holmes, 1975a) (Fig.1).

Gammarus pulex L, 1758, This is one of the most widespread freshwater amphipods in mainland Europe and Britain , In contrast, the dominant freshwater amphipod in Ireland is *G, duebeni* Lilljeborg 1852, Both species prefer running waters, but may also occur in lakes, Early work on freshwater amphipods erroneously recorded *G, pulex* in the south of Ireland, Thousands of *G, pulex* were introduced into Northern Ireland in 1958 and 1959 in an attempt to improve fisheries (Strange & Glass, 1979), This species is only recorded in Northern Ireland at present, but has been expanding its range (Fig,1), It is regarded as native to Britain but alien to Ireland,

Gammarus tigrinus Sexton, 1939, Like *C, pseudogracilis*, this species is thought to have originated in North America (Spooner, 1951; Hynes, 1955), Between 1964 and 1975 it became the dominant freshwater amphipod in the Netherlands (Pinkster, 1975); it is also known from Britain and northern Germany (Pinkster, 1978), In North America, *G, tigrinus* is considered a brackish species, and to be closely related to the freshwater *G, fasciatus* Say, 1818 (Hynes, 1954; Bousfield, 1958), It was introduced into Northern Ireland by the 1950's, and, unlike *G, pulex*, has spread southwards, into Lough Conn, Co, Mayo (O'Grady & Holmes, 1983) (Fig,1), It appears to prefer large bodies of still or slow-moving water,

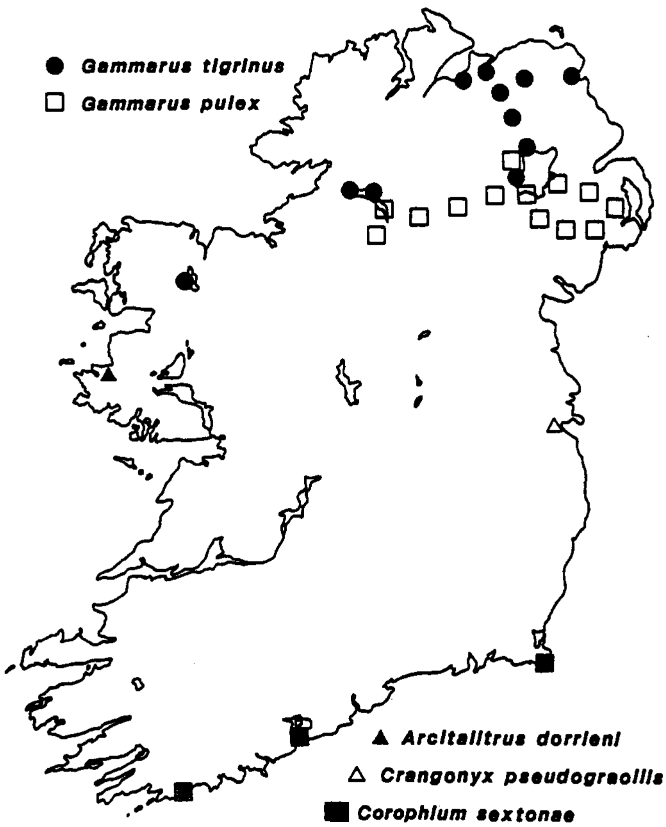

FIG.1 Distribution of alien amphipods in Ireland.

Arcitalitrus dorrieni (Hunt, 1925). This is the only fully terrestrial amphipod in the British Isles, and is believed to have been introduced with plants imported from Australasia (Richardson, 1980). In Britain it is known from the Scilly Isles, Cornwall, Devon and the Island of Colonsay (Moore & Spicer, 1986); in Ireland it is only known from Kylemore Abbey in Connemara, Co. Galway (Rawlinson, 1937) (Fig.1). Considering its abundance in this mainland habitat (pers. obs., July 1987) it is notable that this species has not expanded its range.

COMPETITION WITH IMMIGRANTS

It has been suggested that competition may occur between *Corophium sextonae* and *C. bonelli*, as both are suspension feeding, epibenthic marine corophiids, and the increase in numbers of the immigrant coincided with a decrease in numbers of *C. bonelli* in the Plymouth area (Spooner, 1957). However, Crawford (pers. comm. inMoore, 1978) believed that warmer years may have benefitted the immigrant and not *C. bonelli*, and that the species were sufficiently different to avoid direct competition. Their ecology in south west Britain was reviewed by Moore (1978). Studies in Lough Hyne found that the parthenogenic *C. bonelli* was the most abundant epibenthic amphipod (Costello, 1987; Costello & Myers, in press), even on substrates with *C. sextonae*. Their colonization of plastic mesh substrates in Lough Hyne differs, *C. bonelli* colonizing and reaching equilibrium quickly, while *C.sextonae* colonizes slowly. Despite these different rates, *C. bonelli*remained the most abundant amphipod on the substrates throughout the 14 month experiment. Their different reproductive and colonization strategies are probably sufficient to allow the coexistence of these species, although niche displacement may occur.

The most widespread freshwater amphipod in Ireland is *Gammarus duebeni calticus* Stock & Pinkster 1970; elsewhere it only occurs in Brittany, France. The subspecies *G. d. duebeni* inhabits brackish waters in northern Europe, including Ireland (Dennert, 1975; Holmes, 1975b). These subspecies have received detailed taxonomic, physiological, biogeographic and ecological attention. Current theory suggests that *G. d. celticus* is a glacial relict in Brittany and Ireland, having been displaced from other European freshwaters by *G. pulex* (Pinkster *et al.*, 1970; Dennert, 1975). The only other native freshwater amphipods in Ireland, both probably also glacial relicts, are *G. lacustris* Sars 1864 and *Niphargus kochianus irlandicus* Schellenberg 1932. The latter is subterranean and, apart from a few recently described marine species, the only endemic Irish amphipod. *G. lacustris* has a limited distribution in Ireland, being largely confined to lakes with hard waters.

Studies in Lough Neagh suggest that the two immigrant species *G. pulex* and *G. tigrinus* will displace *G. d. celticus* in rocky and sandy habitats respectively (Strange & Glass, 1979). Macan and Lund (1954) recorded only *G. lacustris* in Lough Erne, but by 1976 *G. tigrinus* was the dominant amphipod there (Strange & Glass, 1979). In 1973 *G. lacustris* and *G. duebeni* were abundant in L. Conn (Moriarty, 1973), but a decade later they had apparently been displaced by *G. tigrinus* (O'Grady & Holmes, 1983). The other introduced freshwater amphipod, *Crangonyx pseudogracilis*, inhabits dense aquatic vegetation in still and slow-moving waters. Because *G. d. celticus* and *G. lacustris* are rare in such habitats, competition with them is less likely. However, competition-induced changes in the distribution of the two introduced and two native *Gammarus* species in Ireland appear inevitable.

As the only fully terrestrial amphipod in Ireland, *Arcitalitrus dorrieni* cannot compete with other amphipods, though its effect on other litter-inhabiting invertebrates, such as woodlice, is worthy of investigation. Another talitrid amphipod, *Orchestia cavimana* Heller 1865 (associated with freshwaters), is believed to be an alien, and expanding its range in Britain (Lincoln 1979). It may be the next alien amphipod to reach Ireland.

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A BENTHIC MYODOCOPID OSTRACOD IN BRITAIN

by Roger Bamber

A potential problem with marine alien species, particularly those from obscure (?) taxonomic groups, is that their presence is unexpected; those of us indulging in general community studies or comprehensive surveys do not anticipate Brazilian / American / Japanese species to be present in addition to those listed in the accepted texts for the locality, and are unlikely to identify such specimens correctly when not some sort of expert in that group. Our only salvation is the hope that anyone discovering and identifying such a species will publicize the record, so that the rest of us may be prepared to look out for it in future. The following is an example of such a beast, from a group in which I claim no particular expertise, and of a species not presently in any British keys, synopses, etc., yet probably commoner than currently known.

Sarsiella zostericola Cushman 1906 is a large, sexually dimorphic, myodocopid ostracod. Unlike the large majority of coastal myodocopids (which are planktonic), this species is benthic, living in muds and muddy sands in shallow water. It is an annual species, showing brooding by the female, and overwintering mainly as the instar V stage; it is probably carnivorous.

S. zostericola was first described by Cushman (1906) from Massachusetts, U.S.A.; by the 1960's it was known from Chesapeake Bay in the south to Maine in the north;

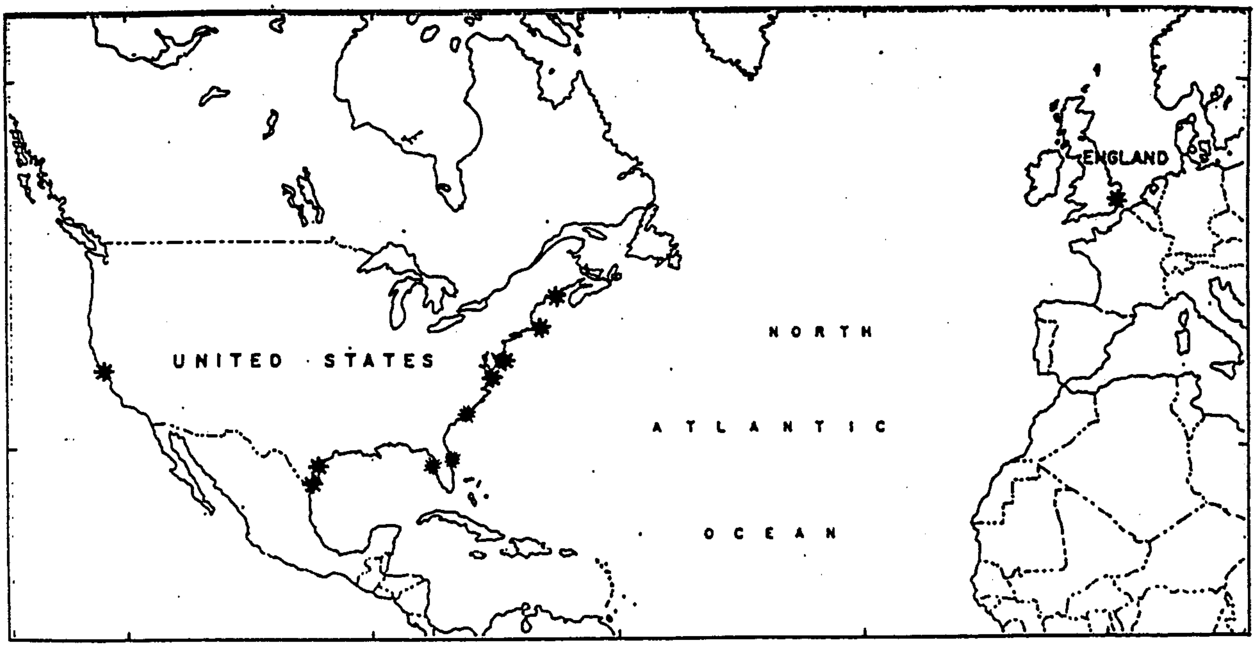

Figure 1. World distribution of *S. zostericola*, (modified from Kornicker, 1975).

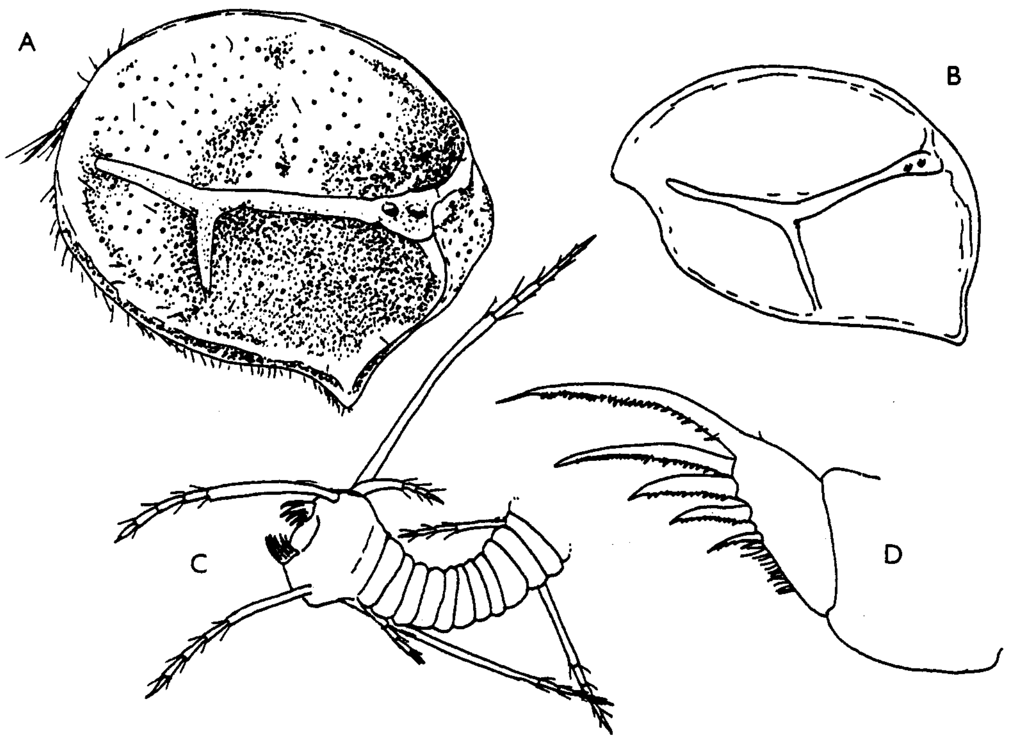

Figure 2. *Sarsiella zostericola*, A - female, entire, left side; B - male, diagrammatic; C - 7th limb of adult female; D - caudal furca. (C & D after Kornicker).

in 1962 it was discovered on the coast of the Gulf of Mexico (Texas), and most recently this disjunct endemic distribution has been completed by its discovery from Florida (Kornicker, 1986) (Fig 1). In 1958 Jones (1958) described *S. zostericola* (as *S. tricostata* sp. nov.) from San Francisco Bay, California, to be followed by a transatlantic leap when Dr Eric Robinson discovered it in 1967 in the River Blackwater, Essex, U.K.! This is quite an impressive move for a benthic species with non-dispersive juvenile stages.

The cause was first suggested by Kornicker (1975), and relates to that better known alien, the American or 'Eastern' oyster *Crassostrea virginica* Gmelin - a species endemic to the Atlantic and Gulf coasts of the United States. This oyster was first transplanted for commercial exploitation from Chesapeake Bay, New York and Connecticut to San Francisco Bay in 1869 or 1870, and from 1875 to 1910 some 9000 barrels of seed oyster went this was each year. From the late 1870's to 1940 young and seed *C. virginica* were transplanted from the same sources to many suitable British coasts and estuaries, to be grown on principally for the London market; sites near to London such as the R. Blackwater and R. Medway estuaries were particularly important. Brady and Robertson (no less) studied the ostracod faunas on this area pre-1870, and recorded no Sarsiellids. These transplantations are known to have been the cause of introduction of some familiar aliens, including *Crepidula fornicata* (first recorded from the R. Crouch in 1893), *Urosalpinx cinerea* (R. Blackwater, 1920) and the polychaete *Clymenella torquata* (Whitstable, 1936). Oyster shells are known to be a habitat for ostracods, and of course any bulk transported oysters will include interstitial material.

To complete the known British distribution, in 1979 I found *Sarsiella zostericola* in the R. Medway estuary, 7·5 km from a known American oyster introduction site. A study of the biology of this population (Bamber, 1987) showed that in the 40 or more years since its introduction the British 'colony' has changed somewhat in comparison to its North American ancestors, notably in all instars being larger (yes, even than the Texan individuals) and adult females more fecund.

This is a large ostracod (adult females up to 1·5 mm long), and instar IV and older will be retained in a 0·5 mm mesh sieve (i.e. standard macrofaunal samples). Thus, benthic community workers in at least the Thames and adjacent estuaries (and wherever else *C. virginica* was introduced?) will find this beast, often in large numbers in muddy substrates (up to 1110 per m² in the Medway). Hopefully, having read this, they will be able to identify it (Fig.2).

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N.B. Kornicker (1986) has transferred this species to the new genus *Eusarsiella*.

IMMIGRATION TO THE DEEP SEA

by P.A. Tyler
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There is very little direct evidence of recent immigration into the deep sea. In many deep sea taxa there is strong taxonomic evidence that species radiation took place actually in the deep sea. However, many deep sea species have close relatives in shallow water, suggesting that there may have been immigration events in the past.

Studies of the reproductive biology of deep sea echinoderms suggest that there have been at least two periods of immigration into the deep sea. In most deep sea echinoderms the reproductive pattern is for the production of a large egg, direct development omitting the larval stage, and of continuous year-round reproduction. These parameters are usually associated with environments which are biologically accommodated, and where the higher parental investment in the egg ensures successful reproduction and thus maintenance of the population.

There are, however, a number of echinoderm species in the deep sea that produce large numbers of small eggs, have planktotrophic development, and reproduce seasonally. The environmental control of this seasonal reproduction is the surface-derived organic material which sinks to the seabed and acts as a labile food source for both the vitellogenic process and for larval development. It is suggested that these species are relatively recent immigrants to the deep sea, and, owing to this annual vertical flux of organic material, have maintained their shallow-water reproductive strategy.

ALIEN SPECIES AS CANDIDATES FOR CULTIVATION

by I. Laing
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Bivalve molluscs are much favoured in aquaculture as they are readily marketable and economic to produce. They give very high yields ; for example, productivity of oysters and clams can be up to 15,000-20,000 $kg.ha^{-1}.yr^{-1}$, and as they utilize naturally occurring phytoplankton they do not need feeding. About 30% of world aquaculture and 80% of European aquaculture is devoted to bivalve mollusc production. Increasing public demand, allied to a greater public awareness of shellfish as a healthy and nutritious food source, has stimulated the aquaculture industry in Britain to diversify into new species.

There are three alien species which have some potential as candidates for cultivation in Britain, but first the native and traditional species, some of which are also aliens, are considered;

European Oyster (*Ostrea edulis*). A native species, the fishery of which has declined dramatically this century. In recent years it has been badly affected by the parasite *Bonamia* which appeared on the south coast in 1982, and has since spread to Essex and, more recently, Ireland.

Pacific Oyster (*Crassostrea gigas*). An alien, introduced from Canada in 1965 and now widely cultivated.

Since 1962 all introductions of alien bivalves for cultivation have been through the quarantine facilities at the MAFF Fisheries Laboratory at Conwy. The imported adult animals are spawned, then destroyed, and the resulting progeny reared and retained in quarantine over several months, during which time regular samples are taken and examined at the MAFF Fish Diseases Laboratory at Weymouth for freedom from all known pests and diseases. In this way, the risk of introducing alien pests and diseases is minimized. The spread of established pests and diseases is controlled by MAFF, regulated by the Molluscan Shellfish (Control of Deposit) Order 1974, as varied in 1983.

The Pacific Oyster is a favoured species owing to its rapid growth rate, but it is badly affected by tributyl tin (TBT) incorporated in marine anti-fouling paints. Although use of these paints on non-ocean-going vessels has been banned since July 1987 under the Food and Environment Protection Act, it is expected that it may be some time before TBT disappears completely from the marine environment. Until then, Pacific Oyster culture cannot achieve its full potential.

American Hard Shell Clam (*Mercenaria mercenaria*). An alien, introduced sometime in the late 19th century. Although it is slow-growing in the wild it will breed in British Waters, albeit at a low level of recruitment, and a population has become established in the Solent. There is a fishery based on this stock, which is currently in decline owing to overexploitation and poor recruitment in recent years.

The three new alien species which have potential for cultivation are:

1. Manila Clam (*Tapes phillipinarum*). (also known as *T. semidecussata*). This species was first introduced from Washington State, U.S.A., in 1980, via the Conwy quarantine facilities. It is a native of the Indo-Pacific. A very valuable species, with a high market value and good export potential as it is highly prized on the continent. It performs well under hatchery conditions; in on-growing trials at various coastal sites it performed much better than *M. mercenaria* or the native Palourde (*T. decussata*), reaching a market size of 40-50 mm shell length after only two years, with good survival. It is resistant to *Bonamia*. Manila Clams like to burrow, and so grow best on ground plots, although, as aliens as defined by the Wildlife and Countryside Act 1981 (not ordinarily resident), they must be contained in mesh bags so that they do not escape into the wild.

2. American Bluepoint Oyster (*Crassostrea virginica*). Reintroduced from Chesapeake Bay on the eastern seaboard of the U.S.A., where it is native, in 1984. Regular imports of this alien species were previously made pre-1939, when up to 6,500 tonnes of oysters were relaid around British shores for fattening prior to marketing to supply the summer trade at a time when the native oyster fishery was in decline. Other, less desirable, alien marine species were introduced with the American Oyster at this time, when no controls or quarantine procedures were in force. Some of these have survived, although the oysters themselves never established a breeding population. They are slower growing and less meaty than Pacific oysters, but have the advantages of higher tolerance to TBT and to silt loads in the water. They are well adapted to conditions in British estuaries, and

survive well. As with Manila Clams, to comply with the Wildlife and Countryside Act they must be contained, amd the usual method of culture is in trays.

3. New Zealand Oyster (*Ostrea lutaria*). Very similar in appearance to the native European oyster, this species was introduced in the early 1960's. Growth rates and survival are similar to the native oyster. The unusual feature of this animal is its life cycle; the larvae are brooded until they are almost at a size ready for settlement, so that when they are released they have a very short (1 hr to 2 days) free-swimming planktonic phase (compared with 10 - 14 days for the native oyster). A small breeding population is established in the Menai Strait. There are no plans at present for commercial exploitation of this species, as it is susceptible to *Bonamia*.

It is extremely unlikely that the Manila Clam or American Oyster will breed and establish viable populations in British Waters, but it may be possible to ensure that this does not happen by hatchery production of sterile seed. This is achieved by inducing triploidy at the post-fertilization stage by treating the embryos with a chemical, cytochalasin B. The animals, with an extra set of chromosomes, are then sterile. There is a further advantage in that the triploid animals remain in "better" condition and are thus more marketable during the summer because they do not direct energy into gonad production. Consumer trials in the U.S.A., where triploidy is routinely used in Pacific Oyster production, have shown that people prefer the taste of triploids over diploids. Triploidy is now widely used in the salmon- and trout-farming industries in this country, and research is progressing towards the production of triploid Manila Clams and American Oysters. These two alien species especially have considerable potential as candidates for cultivation.

AN ALIEN DISCUSSION

The Autumn Meeting at Pembroke covered a wide spectrum of aspects of alien marine species, ending in a constructive open discussion, led by Bill Farnham, particularly on the question "what qualifies a species as an alien?". The problem is highlighted by comparison of a species which arrives in our waters attached to the hull of a ship, with the same species arriving on a turtle, floating tree branch, or other 'natural' substrate; though the former would be cited as the introduction of an alien, and the latter as a "natural" range extension, albeit perhaps immigration, there is clearly no difference between the two.

So, what is an alien? It is undoubtedly the case that immigration ('range extension') is a commoner source of our biota than is endemic speciation. We can all cite examples of species pushing 'naturally' into British waters at the limit of their 'present range' (*Rissoides*, trigger fish), or those established in our southern fauna and moving north, or vice versa - yet we would not consider these species as aliens. What are emphasized as aliens are species introduced by man, not always by accident, and particularly when they pose a potential problem (to our 'native' fauna or flora). Generally, we are concerned with organisms "strange" to our shores, for which perhaps a more appropriate word is 'xenobionts'.

Presumably, the majority of xenobiont introductions are unsuccessful, and we hear nothing of them, Others are more famous, and are considered a potential problem by their competition with our native species (e.g. *Sargassum*, *Crepidula* and even humble *Elminius*), and it is presumably this problem of "weed" species which the relevant section of the Wildlife and Countryside Act attempts to cover. At the same time we must appreciate the successful deliberate and controlled introduction of commercial xenobionts for their maricultural exloitation (see p. 10).

A notable difficulty is the recognition of xenobiont species by non-specialist researchers and ecologists; there is a tendency for the list for an area to reflect local taxonomic expertise, while equally these species may be unrecorded elsewhere (even though present) simply owing to lack of that expertise. I include below a list of 'introductions' to the Solent area, compiled and submitted by Cliff Thorpe to accompany the following paper on *Ficopomatus*, and with one addition by myself, as an example. The onus is on the various local taxonomic experts to let the rest of us know of their findings, and to that end PORCUPINE NEWSLETTER will be glad to publish brief records or listings as appropriate, preferably with some aid to attempts at future identification (reference, figure...). The Pembroke meeting also mooted the idea of an eventual comprehensive published list of such species (having been made aware of the many already recorded in the impending Species Directory by Christine Howson).

So, to the rest of you specialists - let us know of your local xenobionts, no matter how ephemeral.

INTRODUCED SPECIES IN THE SOLENT AREA

Species	Location	Date of introduction
ANNELIDA		
Ficopomatus enigmaticus Fauvel	Chichester Harbour	1974
	Emsworth Harbour	1979
Hydroides dianthus Verrill	Southampton Water	1970
H. ezoensis Okuda	Southampton Water	?1976
	Southsea	1982
Filogranula calyculata (Costa)	Hayling Laboratory	1982
Metavermilia multicristata (Philippi)	Hayling Laboratory	1982
Pileolaria (P.) berkeleyana (Rioja)	Portsmouth Harbour	1975
Janua (D.)brasiliensis (Grube)	Portsmouth Harbour	1975
CRUSTACEA		
Acartia tonsa Dana	Southampton Water	1954
A. grani Sars	Southampton Water	1956
Limnoria tripunctata Menzies	Southampton Water	uncertain
L. quadripunctata Holthuis	Southampton Water	uncertain
Elminius modestus Darwin	Widespread	1945
	(? Chichester Harbour	1943)
PYCNOGONIDA		
Ammothea hilgendorfi (Bohm)	Southampton Water	1978
MOLLUSCA		
Mercenaria mercenaria (L.)	Southampton Water	?1925
Crepidula fornicata (L.)	Widespread	1880-90
Petricola pholadiformis Lamark	Lee-on-Solent	uncertain
TUNICATA		
Styela clava Herdman	Widespread	1960

ECOLOGICAL STUDIES ON THE SERPULID POLYCHAETE *FICOPOMATUS ENIGMATICUS* (FAUVEL) IN A BRACKISH WATER MILLPOND

by Clifford H. Thorp
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Ficopomatus enigmaticus (Fauvel), a typical filter feeding serpulid inhabiting a calcareous tube, is well known as a fouling organism and capable of forming large reef-like structures (Bianchi, 1981). *F. enigmaticus* characteristically inhabits waters of variable salinity, surviving long periods in fresh water; following the generic revision of ten Hove & Weerdenberg (1978) it is considered to be widely distributed in temperate waters of both northern and southern hemispheres. *F. enigmaticus* was first reported in Britain from the London Docks (Monro, 1924) and is recorded as an introduced species in the waters of the Solent area from both Chichester Harbour and Southampton Water (Thorp, 1980). The present paper describes populations of *F. enigmaticus* in brackish water millponds at Emsworth, West Sussex (Figs 1, 2).

The Slipper and Peter Ponds have a combined area of 2·7 ha and, apart from a meandering, deeper channel, have a depth of no more than 1·5 m. The bed of the ponds comprises soft mud with a little mixed shingle. While *F. enigmaticus* settles readily on any solid surface within the ponds, the most characteristic settlements take the form of globular mini-reefs apparently resting on the mud surface in depths of 1 - 1·5 m. In reality each mini-reef results from larval settlement on a small solid object, e.g. pebble, tin can, bottle, brick. Seawater can enter during high water of spring tides through sluice gates at the southern end of the Slipper Pond, while part of the River Ems flows into the Peter Pond from the north. The two ponds are connected by twin tunnels beneath the A27 road. A constant water level is maintained by the excess water flowing out over the sluice gates (Fig 2).

The following observations comprise weekly records of temperature, salinity and settlement intensity since May 1982. Temperatures (weekly max/min) and salinities were determined both at the water surface and close to the muddy bottom at *ca* 1·5 m depth. Larval settlement was monitored using 'Tufnol' panels (0·25 x 0·25 m) at a depth of 1 to 1·5 m.

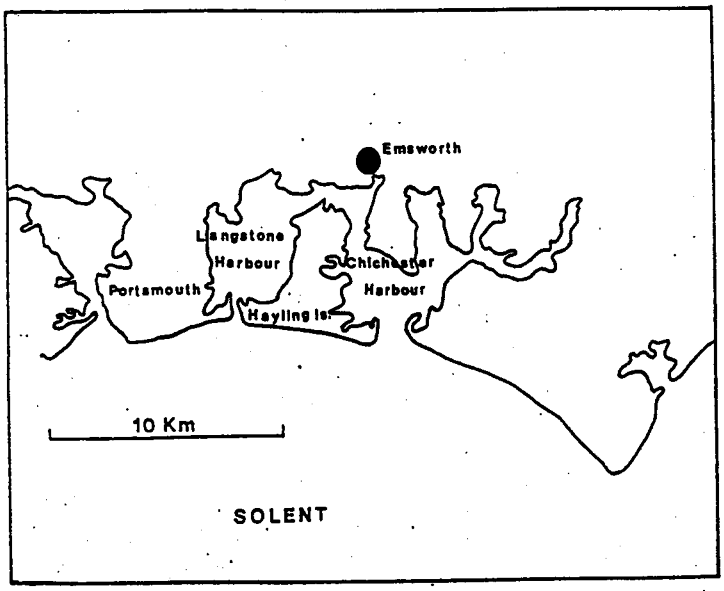

FIGURE 1. THE STUDY AREA

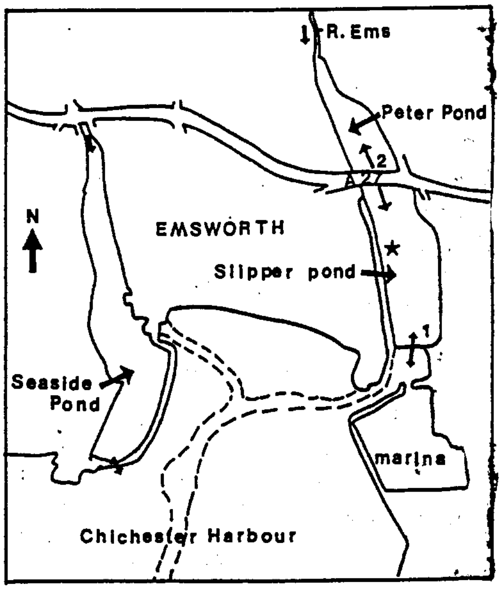

FIGURE 2. LOCATION OF EMSWORTH MILLPONDS. 1: SLUICE GATES; 2: CONNECTING TUNNELS; *: MAIN SAMPLING SITE

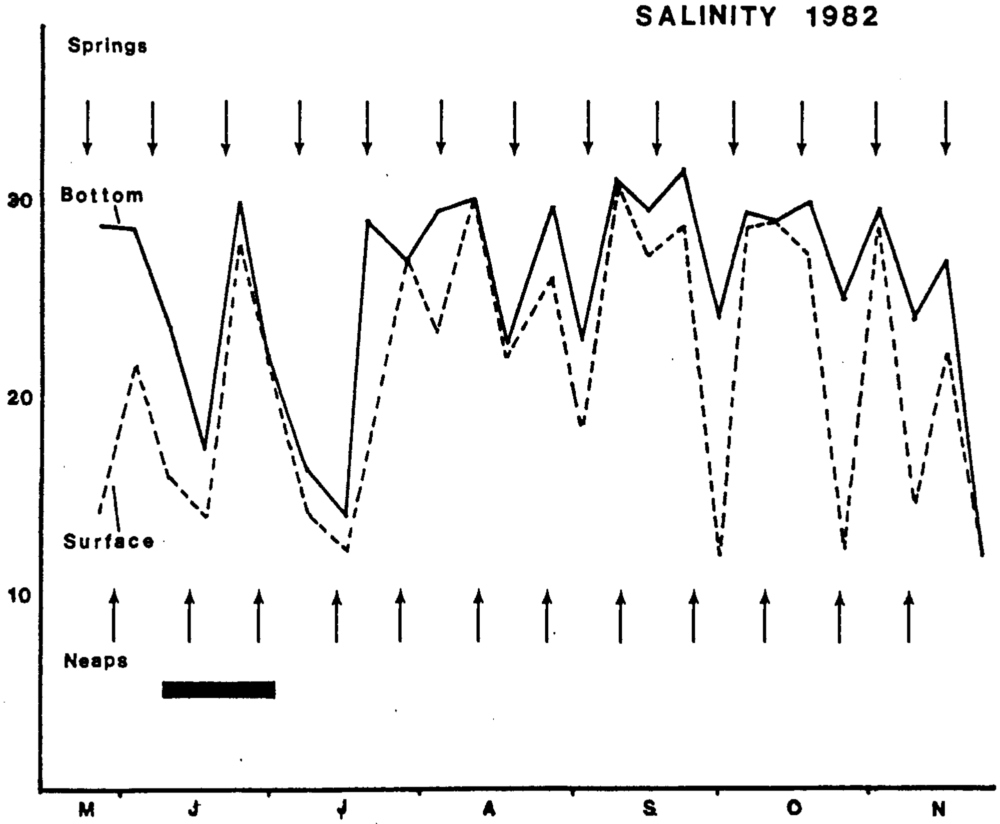

FIGURE 3. Weekly salinity records in Slipper Pond, May - November 1982. The black bar marks a period when the pond was drained at each low tide to facilitate remedial works to the pond margins.

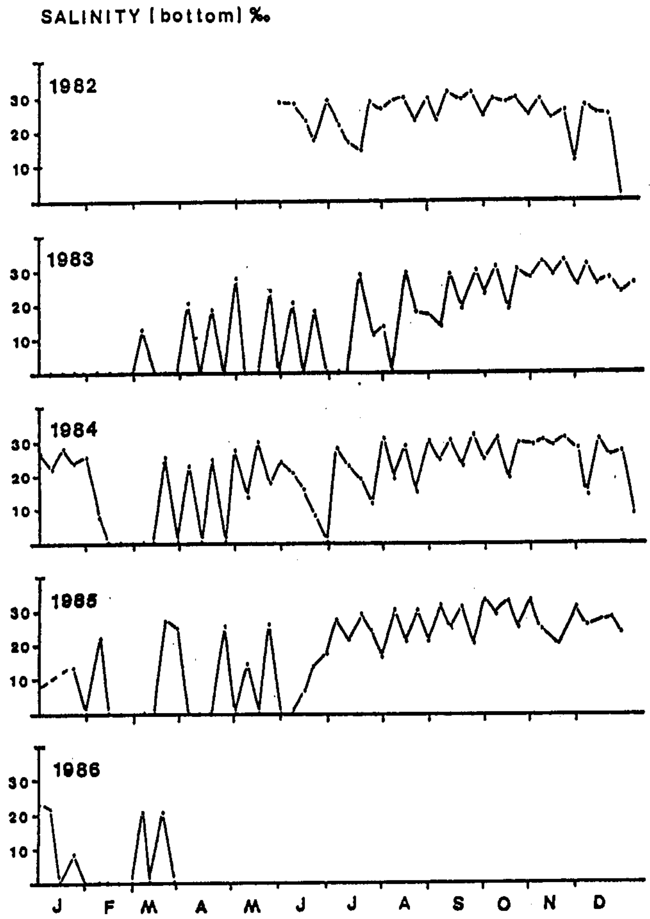

FIGURE 4. Weekly salinity records of the bottom waters of Slipper Pond.

Temperature and salinity records show that the Slipper Pond environment is very variable. While the salinity fluctuates with the spring-neap tidal cycle, such fluctuations are by no means regular (Fig. 3). Despite the shallow depth of Slipper Pond, there are also frequent and marked discontinuities in salinity betwen the surface and bottom waters. The overall salinity regime of the bottom waters (where the major settlements and growth occur) shows a lower and more variable salinity in winter and spring than in summer and autumn (Fig. 4); temperature shows a marked variation in both surface and bottom waters, though to a lesser extent at the bottom (Fig. 5).

Many records in the literature suggest that the initiation of reproductive activity may be influenced by increasing temperature. The minimum bottom water temperatures from May 1982 until March 1986 (Fig. 6) suggest that the settlement of *F. enigmaticus* larvae is largely confined to the period when the minimum temperature is >10°C. Settlement intensity appears to exhibit a lunar/tidal periodicity, with the greatest settlements occurring over the neap tide period. Settlements were recorded between May and November, regularly of $>10^6.m^{-2}$, with several $>10^7.m^{-2}$ during 1983 and 1984 (Fig. 7), but settlements in 1985 were greatly reduced, only exceeding $1 \times 10^6.m^{-2}$ on three occasions, with a maximum settlement of $2{\cdot}9 \times 10^6.m^{-2}$.

The start of the settlement season is shown in more detail in Figure 8. In 1983 and 1984 the first settlement occurred shortly after the minimum bottom water temperature exceeded 10°C and, in 1984 in particular (10 May), following an influx of higher salinity water (3 May). Though the duration of the planktonic larval stage is not known for the Emsworth population, it is tempting to suggest that it may be as short as one week, and thus spawning triggered by an influx of higher salinity water at spring tides once a bottom temperature of 10°C has been exceeded. However, it is equally possible that spawning occurs at a lower temperature, followed by a planktonic duration of 3, 5, 7 ... etc. weeks; it is hoped that identification of larvae in the plankton and histological examination of mature females will clarify this.

In 1985 the first settlement did not occur until the minimum bottom temperature had reached 12·5 - 13°C (5 June). While it is tempting to associate this delayed settlement with a drop in temperature (15 May) and/or the relatively low salinity influx of 14·5‰ (22 May), the explanation probably lies elsewhere. From late spring to early autumn the Slipper millpond is usually characterized by a dense phytoplankton 'bloom', dominated by *Achnanthes* spp. Spring 1985 was cold, wet and very cloudy with little sunshine. The waters of the millpond remained very clear, suggesting a lack of phytoplankton. The last week in May, however, was hot and sunny and the millpond became rapidly discoloured by a heavy phytoplankton bloom. Settlement of *F. enigmaticus* was observed the following week (5 June). Himmelman (1984) suggested that phytoplankton availability should be considered as an important spawning trigger for invertebrates, and, from the limited evidence available from the present investigation, it would appear that, as long as there is sufficient food available, spawning and settlement require a fairly precise minimum temperature with an influx of high salinity water to act as a trigger. In the absence of adequate food, however, spawning and/or settlement will be delayed until food availability improves. With regard to the overall low settlement densities in 1985 it is interesting to note that, after the initial build up of phytoplankton, the pond waters became relatively clear (i.e. reduced phytoplankton density) by mid-August, and remained so for the rest of the settlement season, reflecting the very poor summer that year.

Further work is necessary to expand and confirm these observations. In particular, it is necessary to strengthen the observations of settlement in relation to the spring/neap cycle; to obtain evidence of the initiation of spawning

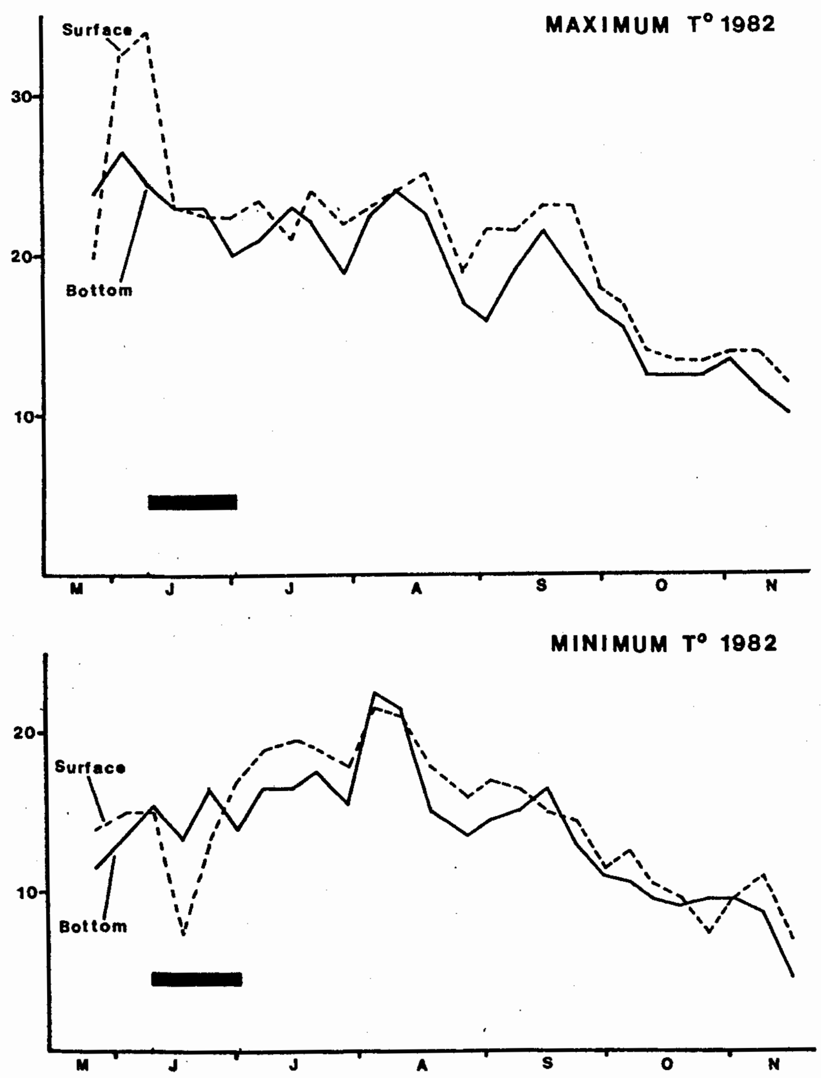

FIGURE 5. Weekly maximum and minimum temperature records in the Slipper pond, May - November 1982. (Black bar -see Fig. 3)

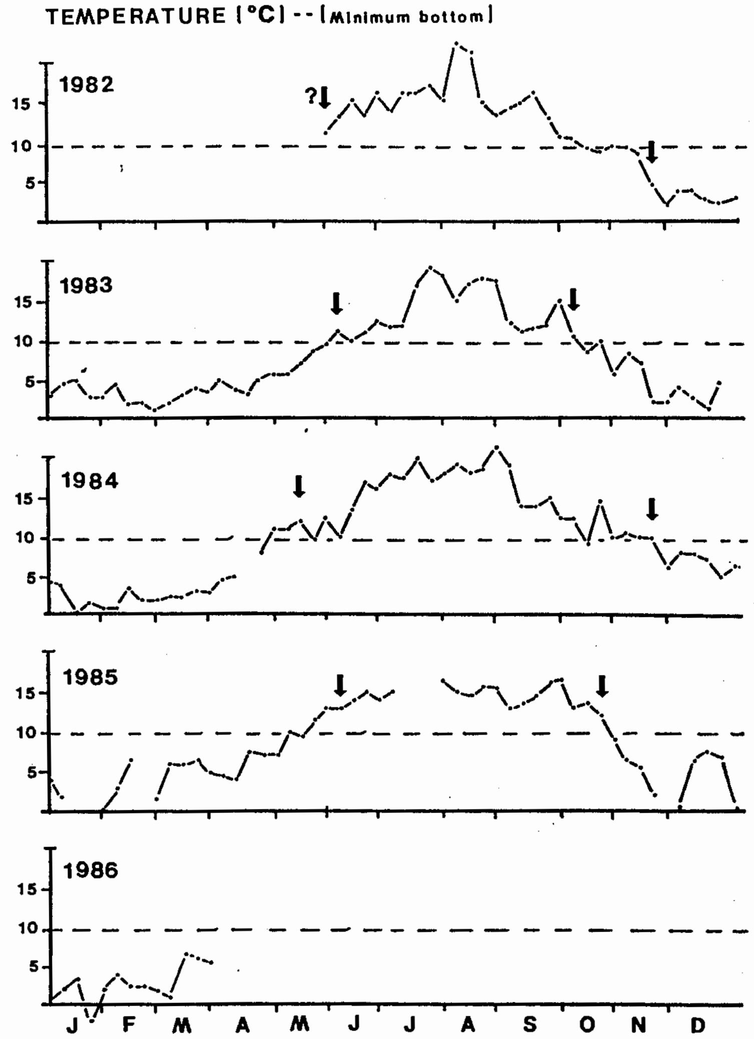

FIGURE 6. Weekly records of minimum bottom water temperature in the Slipper pond; arrows show start and finish of the larval settlement season in each year.

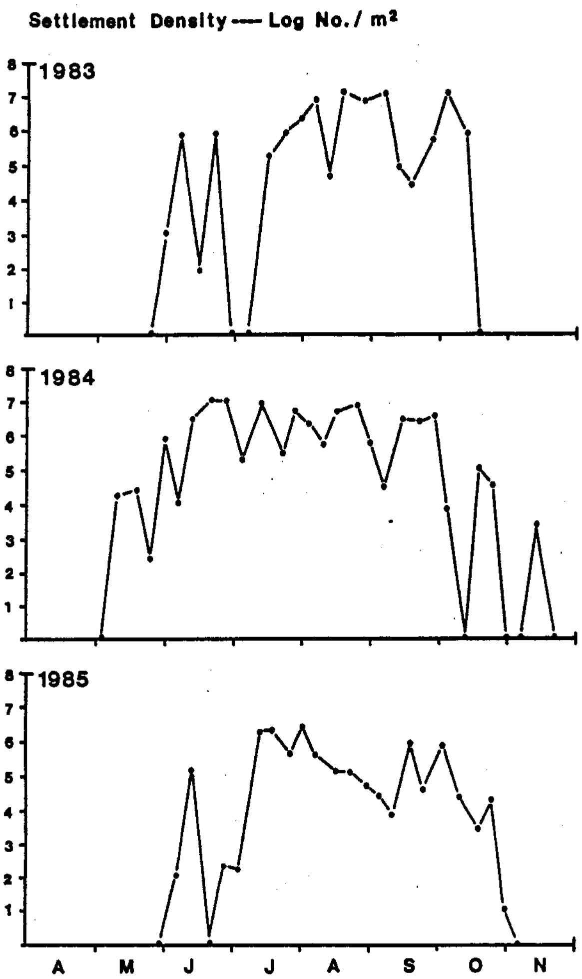

FIGURE 7. Weekly larval settlement densities in the Slipper pond, 1983-1985.

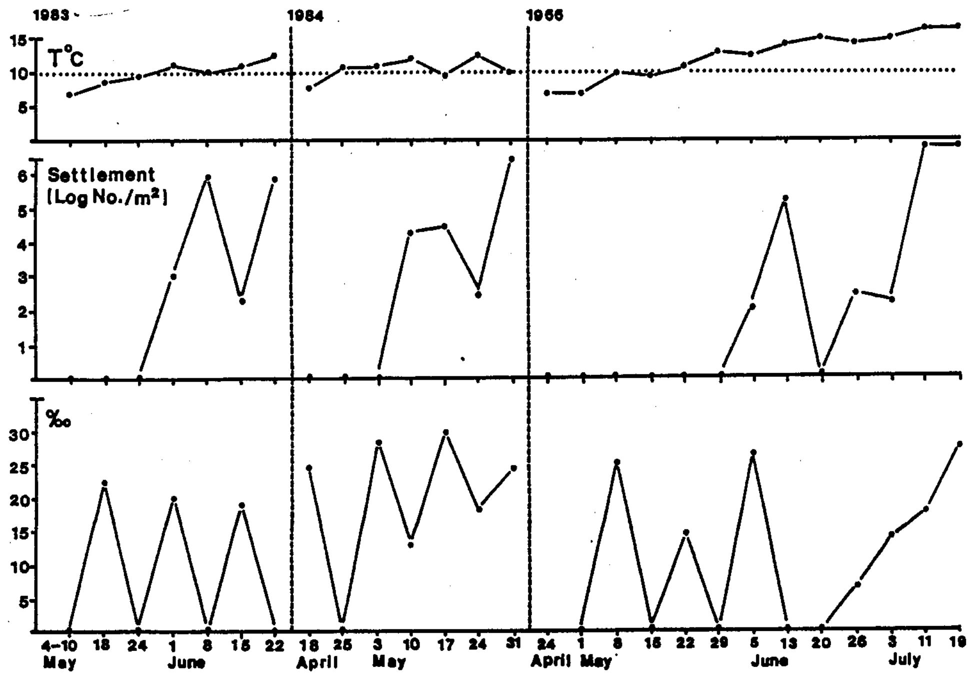

FIGURE 8. The initial larval settlements related to both the minimum temperature and the salinity of the bottom waters.

and to investigate the relationship between spawning/settlement and the level of primary production.

The present incomplete observations, however, contrast with some previous results. Dixon (1980) reported that settlement of *F. enigmaticus* in the Thames Estuary did not occur until October (cf. May at Emsworth), and that a minimum temperature of 18°C was required (cf. 10°C at Emsworth). Straughan (1972) reported that settlement in related *Ficopomatus spp.* occurred over spring tides, in contrast to neap tides at Emsworth.

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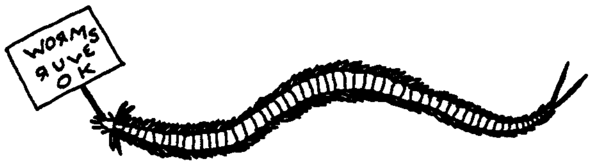

ONCHIDELLA AND THE SUBLITTORAL

by T.C. Tween
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Having recently completed a research project on *Onchidella celtica*, I read with interest Shelagh Smith's contribution to our knowledge of this species in Scotland (PORCUPINE NEWSLETTER, Vol. 3, No. 10). At the risk of turning the Newsletter into an onchid-hunter's house journal, I feel that some of my own observations may also be of interest.

My own search for *O. celtica* in Scotland, which was confined to the shoreline, was unsuccessful. Seven localities in Upper Loch Fyne were visited in August 1985 and careful investigation of the interstitial fauna of the cobbles and boulders failed to reveal a population. This habitat was strikingly different to that of *O. celtica* in Cornwall, where the majority of my work has been carried out (Tween, 1987), and where *O. celtica* is frequently common on exposed rocky shores, a contrast to the sheltered conditions of the sea-lochs. Cornish populations are typically found in midshore crevices, except when individuals emerge to feed on the open rock surface during the ebb. However, reefs with well developed crevices are uncommon around Loch Fyne, and although one example at Furnace was investigated, it failed to yield *O. celtica* amongst an otherwise rich crevice fauna. *O. celtica* is clearly not a widespread or common species on the beaches of Upper Loch Fyne, where it was originally reported by Chumley (1918). However, cereful searching of the literature of *O. celtica* in France reveals that this species is neither restricted to exposed shores nor to crevices in reefs. It is known from the sheltered muddy estuaries of the Rance (Audouin & Milne-Edwards, 1832; Vaillant, 1871) and the Trieux (Bertrand, 1943) in Brittany, and it has also been reported on mudflats on the islets of Bréhat (Beauchamp & Lami, 1921) and Chausey (Fischer-Piette, 1936). At the latter locality, it has been found under stones (Bertrand, 1943), a habitat also reported for the species in the Azores (Bergh, 1890). Thus the intertidal habitat of western Scotland might well be suitable for *O. celtica*.

However, the surprising aspect of the new Scottish records is the possibility of *O. celtica* inhabiting the sublittoral zone. Although the onchidiacean gastropods are known from habitats ranging from the fully marine to the fully terrestrial, the genus *Onchidella* has only been reported from the intertidal zone until now. Indeed, there is only a single record of a species of *Onchidella* - *Peronia irrorata* (Gould, 1852), now synonymized with *O. nigricans* by Stringer (1969) - habitually occurring in tide pools; this instance was reported from New Zealand. *O. celtica* normally avoids standing water on the shore, both in its chosen resting-places and when foraging. This is to be expected of an animal with a functional lung which supplements cutaneous respiration during periods of emersion.

Thus the published record of *O. celtica* at Carrigathorna in southern Ireland (Norton, Hiscock & Kitching, 1977), supposedly from a depth of 15 m, was doubted by the present author, and these misgivings were conveyed to Professor Kitching by letter. In reply, in a letter dated 18 November 1986, he stated "I sent some of the specimens collected by Dr Keith Hiscock at Carrigathorna to Dr N.J. Evans (British Museum, Natural History). He has said that they are not *Onchidella*...", and determined the material as *Onchidoris muricata* (Müller); subsequently a correction was published (Kitching, 1987). Thus the only previous record from the sublittoral has proved to be erroneous, and as far as I am aware this is the only record of this species from Ireland; its status in this area was further considered by Tween (1987).

This tale illustrates the need to distinguish *O. celtica* from the doridacean nudibranchs, which it superficially resembles in external appearance. Closer inspection should reveal the lack of branchial appendages, the pulmonary opening or pneumostome in the ventral mid-line posterior to the foot, and the paired optic tentacles and oral lappets, by which this pulmonate may be identified. It is not intended to imply that there is any doubt as to the identification of the recent Scottish specimens, but the author does have similar reservations about the suggestion of *O. celtica* habitually occurring in the sublittoral.

On Cornish shores, *O. celtica* lives on the middle shore - it does not inhabit regions only uncovered at spring tides; the record of Gardiner (1928), who reported *O. celtica* on rocks at Trevone which, he was informed, were in this zone, appears to be incorrect. Similarly, in France *O. celtica* has only been taken in the littoral zone; dredging in the Rance, adjacent to shores with populations of the pulmonate, failed to produce specimens from deeper water (Fischer, 1929). In addition, *O. celtica* shows a rhythm of activity, during which it feeds and copulates, related to the tidal cycle; these functions only occur when it is emersed. Similar rhythms are known in other species of *Onchidella* (Arey & Crozier, 1921; Pepe & Pepe, 1985) and it is difficult to imagine how a species so well adapted to an intertidal existence could adapt equally to a fully submerged environment (although in the laboratory *O. celtica* will survive under such conditions). A clue to the condition of the Scottish specimens might be found in their behaviour, as both were found to be "floating about". *O. celtica*, with its doridiform body and lack of appendages, cannot swim. In my experience, only moribund individuals, or those otherwise in poor condition, become detached from the substratum, and even then only in the laboratory. Floating specimens have not been found on Cornish shores, and I wonder whether the Scottish specimens might have been other than in the best of health. If so, they may have been swept away from a more usual intertidal habitat.

Whether this interpretation is correct or not, it is likely that somewhere in Scottish waters there is a breeding population of *O. celtica*. As a species with limited locomotory abilities, showing homing behaviour in the adults, internal fertilisation and a capsular development, dispersal opportunities are very limited; it is unlikely that it is just a "visitor" to Scottish shores. In Cornwall, Populations may be of local extent, but where *O. celtica* does occur it is often very numerous, frequently >100 individuals.m^{-2} (Tween, 1987). It is likely that similar populations remain to be discovered in Scotland, as they have in the Bristol Channel where *O. celtica* has recently been found at Croyde Bay (Tween & Storey, in prep.). Such a development is awaited with interest.

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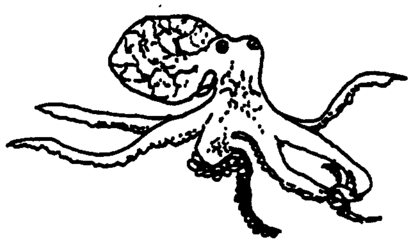

CREATION OF A VOLUNTARY MARINE CONSERVATION AREA ON THE HELFORD RIVER

by N.A. Holme and S.M. Turk

The Helford River, in south-west Cornwall, has long been known as an area of outstanding marine biological importance, being a sheltered arm of the sea, or ria, in which conditions are almost fully marine, and where water pollution was considered to be minimal. Within the inlet there are valuable shores of sand and muddy sand at Helford Passage, Penarvon Cove, Treath and in Gillan Harbour (Holme, 1983). Some of these shores have, or had, considerable areas covered by eel-grass (*Zostera marina*) towards low water mark, and extensive areas are still covered by this species at Helford Passage (Gardiner, 1927; Turk, 1976, 1986). In addition to the many animals (including a number of commensal partnerships) burrowing in the sediment shores, there are surface-living organisms such as ascidians and anemones attached to stones on the more sheltered flats, and at Helford Point the shore is covered by stone 'clitter' which provides a variety of habitats for additional species. Of special interest is a species of goby (*Gobius couchi* Miller & El-Tawil) described for the first time from Helford Point. There are good rocky shores at the mouth of the River, near Rosemullion Head and Nare Point. The River has been particularly productive of mollusc records, nearly 200 species having been listed up to the year 1910 (Holme & Turk, 1986), and many records added subsequently.

During recent years, a decline in the intertidal fauna and flora of the River has been noted, suggesting that conditions were no longer so favourable. It was thought that this deterioration could also affect the local fisheries, oyster farming, food and bait collection, as well as the use of the river for recreation. A number of possible causes of the decline were suggested, but it was not possible to identify the main factor or factors responsible.

Following a proposal to designate the River as a Voluntary Marine Conservation Area, it was decided, at a meeting of individuals and organisations concerned with the River called by Cornwall County Council in July 1985, to form a Steering Group, and to mount a twelve month survey of the whole River in order to assess the influence of such factors as water pollution, visitor pressure, yachting and boating, bait and shellfish collection, and fishing. In addition, studies were to be carried out on the intertidal flora and fauna, with an emphasis on photography, in order to form a baseline from which future changes could be followed.

Two graduate scientists, Roger Covey and Susan Hocking, were employed for the survey, supervised jointly by Stella Turk of the Cornish Biological Records Unit and Norman Holme of the Marine Biological Association, Plymouth. The two graduates were employed during the course of the survey by Cornwall County Council, who sponsored the project, funding being provided by the World Wildlife Fund, in part through the Heinz 'Guardians of the Countryside' Campaign. A contribution was also received from the Duchy of Cornwall.

The survey has now been completed, and a Report and Summary were considered at a meeting of the Steering Group at Helston on 23 July 1987. The Report could not identify any single factor as responsible for the deterioration of the marine life of the River, but isolated a number of activities which in combination, and especially if following or being followed by extremes of weather, were calculated to cause the most harm. These were;

1 - TBT anti-fouling paints;

2 - Silage, slurry, sewage and other effluents;

3 - Education and research (although "fewer groups now visited the Helford River because the fauna has become depleted")

4 - Traditional collection of cockles and other shellfish, known as "trigging", carried out on Good Friday and at other times of the year;

5 - Bait collection.

However, it was considered that many present activities in no way conflicted with the aims of protecting marine life in general, and that some, e.g. oyster cultivation, helped to ensure water quality.

At the meeting on July 23rd it was decided, after discussion of the Report and the issues which it raised, that a Voluntary Marine Conservation Area should be established. The aim of the Conservation Area would be to try to achieve by voluntary means the harmonious use of the River whilst monitoring the quality of its marine environment. Consideration is now being given by the various bodies with an interest in the River, including the Parish Councils, to the way in which the Conservation Area can best be run and to the kind of measures which should be considered.

The "Helford River Survey Report" by Roger Covey and Susan Hocking can be purchased from the County Planning Officer, County Hall, Truro TR1 3BB.

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Letters to the Editor

From Member Dennis Seaward:

CUTTLEFISH BONES

Occasional mass strandings of moribund cuttlefish (*Sepia officinalis* L.) or their "bones" occur, sometimes so spectacularly as to occasion press comment. Sir Alister Hardy ('The Open Sea', Part 1, 1970:320) suggested that "..some exceptionally adverse condition, such as an unusually cold spell in winter, causes a heavy death-roll among them...". But some strandings happen for no obvious reason, for example, all along Chesil Beach in May 1986 (per Donald Moxom).

Does *Sepia* die after spawning, as do some squid species? And if so, is spawning only occasionally synchronous? Answers please, on one side..... to puzzled Member,
Dennis Seaward.

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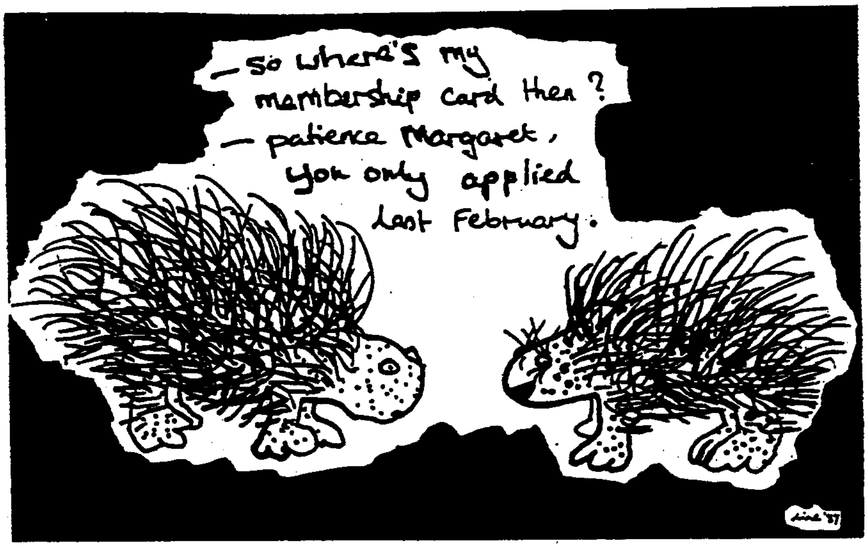
IT SEEMS THAT 1986 was a bad year for *Sepia* - see also Mike Kendall's LETTER in PN Vol.3 (6), p.159, reporting mass strandings along the north-east coast in February of that year. A 3-year study of cephalopod populations in Southampton Water (Bamber, 1981; CEGB Internal Report RD/L/2167 N81) concluded that *S. officinalis* is an annual species, at least in that locality, and indeed they do die after breeding, around mid-summer. While this may just account for the Chesil Beach strandings, the north-east coast strandings seem too early for post-reproductive mortality. So, still, *answers please*! Hon Editor.



I REPRODUCE THE above letter from Margaret Pearse verbatim (etc., drawing by I. Line), and remind Members that PORCUPINE no longer issues membership cards. Receipts can be supplied if specifically requested (requests do not have to be as elaborate as this!)

Porcupine Reviews

BRITISH OCEANOGRAPHIC VESSELS 1800-1950.

by Tony Rice
The Ray Society, British Museum (Natural History)
199 pp. £18.

This comprehensive book will be of general interest to PORCUPINE Members, being quite as browsable as the 'Guinness Book of Records'. Ancient mariners will be stirred by the full descriptions and voyage accounts of such recently retired ships as the *Discovery*, *Discovery II* and *William Scoresby*, whose scientific staff we know or knew. Indeed, the *Discovery* herself is even now lying in Dundee, a link not only with Scott, but with Macintosh and Hardy, while Currie of Dunstaffnage sailed on the *Scoresby* with 'Pop' Hart.

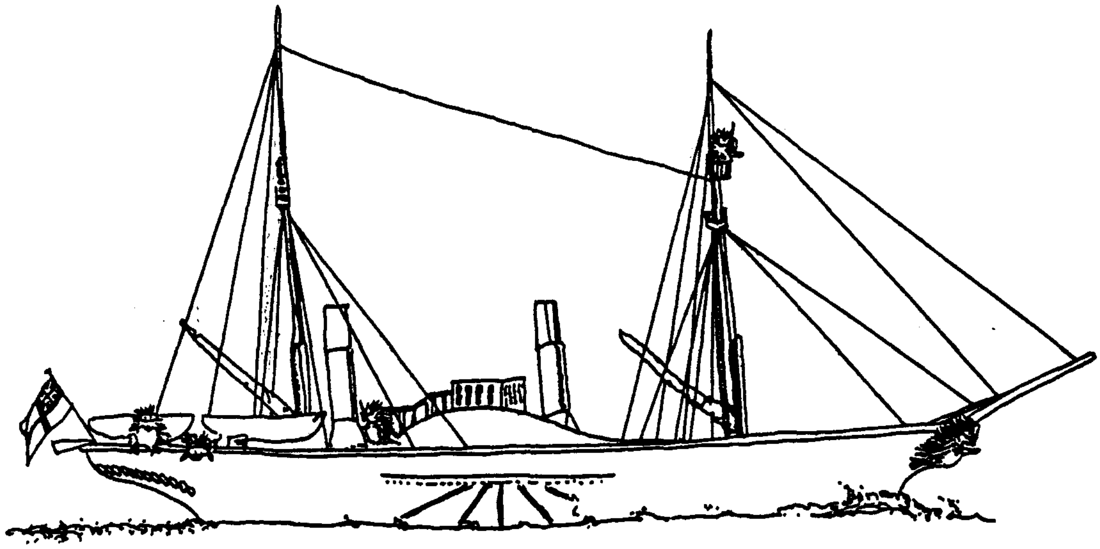
The book is conveniently aranged in alphabetical order of vessels. Among the formal records of dates of building and scrapping, size, sails and engines, are numerous fascinating trivia, so many, indeed, that one is amazed at Tony Rice's range; for instance, who of us knew that the Falklands Islands Dependancy Survey (whose work is now returning to the limelight) was first called operation Tabarin, after a Parisian night-club, the year being 1943. Or that the *Challenger* of the 1950's, unlike her famous predecessor, carried no biologist and that the ship's doctor was given a short course in marine biology at the Plymouth Lab. in order to double in this role.

A great number of the world's most famous research ships are here; the mighty *Challenger* of course, Darwin's (and Fitzroy's) *Beagle*, Huxley's *Rattlesnake*, the *Erebus* and *Terror* which carried J.D. Hooker and Ross to the Antarctic and subsequently Sir John Franklin to his fate in the Arctic, the cranky little *Lightning* dredging off Shetland at 1200 m and measuring sea bottom temperatures down to 0.5°C, effectively blowing away both Forbes' azoic theory and the myth that sea water is densest at 4°C (although that myth was repeated in Parliament by the Civil Lord of the Admiralty as late as 1961 - another Rice snippet!).

But better still, there is a good account of H.M.S. *Porcupine* herself, and best of all a photograph of her. The photograph, of poor quality, is said to be the only illustration of the vessel in existence; well, that is one more photograph than the combined efforts of Members of this Society have managed to discover, and not for lack of trying. Member David Heppel unearthed a line drawing of the ship in Wyville Thomson's "Depths of the Sea", a fairly uninformative outline, less than an inch long in the original. This outline was projected on the screen at an early PORCUPINE meeting, but we now see that, for instance, the true rake of the masts, three or four degrees from the vertical, was very different from the piratical twenty degrees of the sketch in Wyville Thomson. Interestingly, the small outline shows no wheelhouse, although one appears in the photograph; perhaps it was a later addition.

Much of the *Porcupine* material published by Rice has appeared in earlier

Newsletters (PN 1: 8, 9, 159, 187; PN 2: 143). However, the account and photograph together make a most valuable record, one which any Member must be pleased to see.



In such an extensive work there will be errors, but they seem not to be numerous or very important. For instance, I believe the middle name of Captain Edward Calver of H.M.S. *Porcupine* was Killwick, not "Killiwick". A correction slip in the book redescribes the loss of the *Scotia*, and I learn elsewhere that the photographs accompanying the *Shearwater* and the *Egeria* are of other ships. They hardly detract from a very valuable, readable source book.

Tony Rice and the Ray Society have done oceanography a very good service with this volume.

Frank Evans.

NOTICES

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1. IF ANYONE IS INVOLVED in such fishing activity as may make available spare fresh sand smelt (*Atherina*) material, would they please inform Steve Creech at Cardiff University, as he would like some specimens for electrophoretic purposes (and will attend to help catch and collect if location is reasonable).

2. WANTED: RECENT RECORDS (after 1970) of *Zostera* from the Southampton Water area of the Solent. This plant was historically common on the beach at Stanswood Bay (to the point of supporting artisanal prawn fishermen), but cannot currently be found there. When did it go? Anyone who has relevant information is requested to contact the Hon. Editor.