Porcupine Newsletter

Volume 4 Number 9

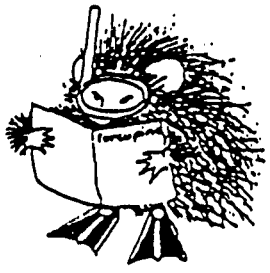
JULY 1990 ISSN 0309 - 3085

- 201 -

CONTENTS

* * * *

Roger Bamber, Hon. Editor
Marine Biology Unit, National Power,
Fawley Power Station, Fawley,
Southampton SO4 1TW, U.K.

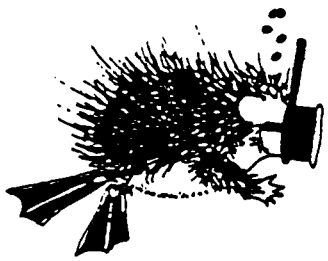


PORCUPINE

Hon Secretary
Dr Martin Sheader

Hon Treasurer
Dr Antony Jensen

Department of Oceanography, The University
Southampton, Hants SO9 5NH, U.K.



Hon Records Coordinator
Jonathan Moore
FSCRC, Fort Popton, Angle,
Pembroke, Dyfed SA71 5AD, U.K.

EDITORIAL

This issue contains reports from most of the presentations given at the Dundee meeting this spring on the theme of Marine Recording. The final session of that meeting comprised a general discussion on Recording, and your Hon. Ed. was asked to note down any salient points; at the risk of sounding smug (would I?), there were very few points raised that had not already been presented in the various talks (though inevitable differences of opinion prevailed - I did note "Refreshing disagreement"). Three serious points were noted; there was a general reinforcement of the recommendation to lodge voucher specimens at a reputable museum, with the caveat that some museums are better than others (here I duck any risk of libel); there was a feeling of insufficient recording from the deep sea - largely attributed to insufficient collecting in the deep sea (with help from HMG); it was unanimously agreed that there should be compiled (and maintained and updated) a directory of available unsorted material - once the money for collecting has been spent, use of the material should be optimized; there were at the time no volunteers. "Discuss".

I have high hopes of feedback from MEMBERS unable to be present in March, particularly on the more controversial bits of the extended contribution on pp.214 *et seq*; and if any attending MEMBERS feel I should have noted and quoted a point which they raised during the aforementioned discussion, I shall be pleased to receive and publish their contributions/letters/protests also.

Members should have received a copy of the latest Membership list with the last Newsletter; would they please address any queries, protests, objections or corrections to the Hon. Sec.

PORCUPINE sweatshirts are available at £11.00 (+ p&p at cost if required). They come in the usual range of sizes up to Extra Large (if unsure err on the larger side), and in white, yellow, pale blue, pink, or framboise with a black design, or black, jade green, red, or purple with a white design (see page 200 of previous issue, or any passing PORCUPINE sweatshirt). Orders should be addressed to the Hon. Ed.. Some items are held in stock (which will get you a faster delivery). Otherwise they are made to order (a potential excuse for delays).

I apologize to MEMBERS who have been waiting some time for their sweatshirts - there was a world shortage of black (!); as of this month, all orders received at time of going to press have been fulfilled, and receipt of any outstanding monies will be gratefully appreciated (Cheques payable to PORCUPINE as usual).

Roger Bamber, Hon. Ed.

COAL-MINING WASTES AS A FACTOR IN THE MARINE ENVIRONMENT

by E. J. Perkins

Solway Marine Investigations, Grove Cottage, Birkby, Maryport, Cumbria, CA15 6RG

INTRODUCTION

It was once presumed that unlike dissolved substances "insoluble" wastes, such as those arising from coal-mining, had little or no effect other than in the immediate area in which the waste was dumped. Such an assumption is a part of a widespread ambiguity of attitude towards a material which can perhaps be regarded as the ultimate pollutant. Thus, in its mining and utilisation coal is responsible for the mutilation and death of thousands of humans per year through accident and the development of bronchitis and cancers, each of which is orders of magnitude greater than the much publicised effects of the nuclear power industry (Fremlin, 1987). Simultaneously, its combustion makes major contributions to the concentration of atmospheric CO_2, to acid rain and to trace element and ^{210}Po contamination of the environment. In the light of such considerations, it is apposite to examine the role of coal mining wastes released to the marine environment.

Solid spoil arising from this activity reaches the shores and coastal waters of Britain in four principal situations, viz., Fife, Durham, Cumbria and South Wales, and in the first three major dumpings are, or have been, made directly into the intertidal. In the Solway Firth these direct dumpings have been carried on for some 250 years as have the less important blast furnace wastes for some 130 years. They reached a peak in the earlier years of this century, but declined sharply after 1945. The last was made in 1988, following a "tidying-up" operation once the Haig Pit, Whitehaven was closed. Apart from the direct dumpings onto the shore, during mining, additional spoil has been added, at various points along the Solway coast, during "clean-up" and "reclamation" operations: indeed, during one of these, in 1971, a whole, large bing at Siddick, Workington was bulldozed onto the shore and thereafter reworked into marine sediments. Although, active dumping has ceased, erosion of material from earlier high shore deposits near Saltom Pit, Whitehaven and of the landscaped bings, at or above the extreme high water mark at Oldside, Workington will continue to make contributions for many years to come.

The blast furnaces slags were poured onto the shore whilst red hot, in many cases down to the mid tide level and in one, at Harrington, to ELWMST. These blast furnace wastes produced a 'rock' known to the industry as slagcrete. This slagcrete, though acceptable as a substratum to the sessile and sedentary benthos, is nevertheless friable, breaks up relatively readily and makes a contribution to the sediments of the Solway Firth (Perkins, 1972). This gradual erosion and breakdown may be expected to persist for many decades, although as will be shown they are, and are likely to remain, minor contributions when compared with coal mining wastes: see also the preliminary report by Perkins and Kendrick (1978).

The following paper is concerned with the fate of the coal-mining wastes once they have been introduced onto the margins and shores of the Solway Firth and their impact upon its inhabitants. To anticipate, the various parts of it would seem to be conflicting and paradoxical, but that is perhaps typical of many problems associated with the effects of waste disposal.

RESULTS

Acid Mine Drainage

Before dealing with the solid wastes, as such, it is appropriate to consider first the effects of mine workings above

EHWMST and of mining spoil dumped above this level. Acid mine drainage (A.M.D.) once considered to be associated specifically with coal mining depends for its production upon the presence of a sufficient quantity of sulphur in the mineral, here coal. It is characterised by a low pH, arising from the presence of H_2SO_4, and increased concentrations of Fe and trace elements including Cd (Down and Stocks, 1978). Such drainage may arise from spoil heaps, existing and old workings, but whilst its impact on fresh waters has long been a matter of concern (Katz,1968) this is not so with respect to the sea.

Cunning Point, near Harrington, is a site of interest in this regard. Here a flow of A.M.D. passes across the shore at three principal points characterised by a relatively thick, highly polished patina of Fe_2O_3 upon the gravel, cobbles and boulders; a similar patina is found particularly upon the winkle *Littorina littorea* associated with this flow. In addition *Actinia equina, Tealia felina, Sabellaria alveolata, Pomatoceros triqueter, Balanus balanoides, B. crenatus, Elminius modestus, Collisella tessulata, Patella vulgata, Gibbula cineraria, Littorina saxatilis, Nucella lapillus, Archidoris pseudoargus, Mytilus edulis, Electra pilosa, Asterias rubens, Taurulus bubalis, Pholis gunnellus, Laminaria saccharina, L. digitata, Ascophyllum nodosum, Fucus spiralis, Cystoclonium purpureum, Gigartina stellata, Chondrus crispus, Lithophyllum sp, Hildenbrandia rubra, Halurus equisetifolius* and *Polysiphonia nigrescens* have been found living, in varying degrees of abundance in association with these flows. The absence of *Fucus serratus* is most marked, but at higher levels the presence of *Ascophyllum* and *F. spiralis*, though variable, seems to be more dependent upon the transport of shingle than on the presence of A.M.D.

The larger macrophytic algae inhabiting the drainage area may be absent or sparse on some ground occupied by large numbers of *Littorina littorea* and *L. saxatilis*. Since such populations require adequate sustenance, it follows that production of the epilithic flora is high, though it may be masked by Fe_2O_3, and includes *Lithophyllum* sp., *Hildenbrandia rubra* and, tentatively, *Verrucaria mucosa*. While such epilithic microorganisms are tolerant of these conditions their prese- does not imply more than the ability to survive. It should be not however, that normal development of receptacles has been noted *Ascophyllum* and *F.spiralis* and normal tetraspore development *Polysiphonia nigrescens*. Copulating pairs of amphipods have been no- in the A.M.D. flow and the breeding cycle of *Littorina littorea*, including the presence of normal, motile sperm, is consistent with that of animals from stations not so affected.

TABLE 1

Some trace element concentrations in winkles, *Littorina littorea*, exposed to acid mine drainage (AMD), at Cunning Point, Cumbria.

Element	Concentration (ppm wet weight) From AMD*	Control
Cd	9.3	0.84
Cr	0.74	0.10
Cu	15.5	25.5
Ni	1.55	0.93
Pb	<0.03	0.18
Zn	38.75	~30

* winkles with 'rusty' shells

In addition to these more obvious phenomena determinations of the trace element content of *L. littorea* from the A.M.D. flow have revealed an elevation of the Cd concentration comparable with that

found in winkles taken some 250m from the Albright and Wilson outfall at Barrowmouth, Whitehaven, an acknowledged source of Cd input to the N.E. Irish Sea (Table 1). Work in conjunction with N.R.P.B. has revealed that when compared with distant uncontaminated sources the concentrations of ^{210}Po are elevated in these winkles, but this will be reported in more detail elsewhere.

Solid Industrial Wastes

Particles of a larger size

The sources of these industial solids, viz., coal mining spoil and slagcrete, lie between Ladysmith, near Whitehaven and Risehow, near Maryport some 20km to the north east. Such of these wastes as are unconsolidated are transported north-eastwards in the dominant longshore drift. This longshore drift is important across the whole shore in Saltom Bay, south west of Whitehaven, but further upstream it effects are most obvious on the beach face slope above the level of neap tides. On the shores of Saltom Bay, this process brought about marked changes in beach level, up to 2m, depending upon fluctuations of input at Ladysmith and the prevailing weather conditions. Since the dumping finally ceased the upper beach level has fallen by ca 3m. During the dumping the biota of the shores of Saltom Bay was reduced to those rocks and boulders which reached above the level of burial and abrasion by the stream of coal mining waste: in all some 2.1km of beach were so affected.

To the north east of Whitehaven, these effects are generally noted only above H.W.M.N.T on the upper levels of rocky shores and in the beach face slope of sandy shores. Nevertheless as will be seen from Table 2 these materials are found a significant distance upstream of Risehow.

TABLE 2

Solid industrial waste in the shingle of the beach face slope of the Cumbrian coast of the Solway Firth. (Sizes greater than 50mm diameter)

Station	Distance to nearest source (km)	Proportion (%)
Allonby	9	27.9
Mawbray	14	44.0
Beckfoot	16	7.3

It should be noted that the presence of coal and shale, as such, does not necessarily indicate an industrial origin: an unquantified amount will have an origin in the sea bed itself. What is important, however, is the presence of the red-brown coloured burnt shale whose sole origin is a coal bing which has been on fire and the slagcrete particles which have a characteristic colour and form. Such particles may be recognised in the beach face slope and when recovered from soil samples such as those reported in Tables 3 and 4. Other stone dumped with the coal mining waste is often impossible to distinguish from that arising from other sources and no allowance is made for it in the present paper.

Particles of a smaller size

While the preceding section was concerned with those particles obviously present in shingle, the following relates to those which can be recovered from sediments. It will be seen from Tables 3 and 4 that while some industrial waste material was recovered fron the shore at

St Bees, transport in a north easterly direction was sustained with recovery from soils at Westfield, some 40km to the north east of Risehow. The maximum contribution of these wastes to particular soil grades may be considerable, most strikingly at Beckfoot where maxima, in both tables, are higher than those at Allonby 7km nearer to the sources. Such effects are not confined to the shore, for fine soil samples taken from the bed of Allonby Bay, north east of Workington in 1974 contained a mean concentration of 5.5% (range 1.2-19.7%) industrial waste solids, while the coarser fractions, >1mm particle size, comprised a mean proportion of 19% (range tr-70%).

Table 3

Solid industrial waste in coarse solids retained during transect sampling of Solway Firth shores. (Particle size >1mm)

Station	Distance (km)*	Concentration (%) Mean	Maximum	Proportion of Total(%)
Siddick	17	1.1	4.2	16-75
Allonby	30	1.0	3.5	5-75
Beckfoot	37	1.2	10.3	tr-80
Westfield	60	0.02	0.06	tr-70

* Distances measured from the Ladysmith tip: the most seaward source

The distribution of these materials in shore sediments is inhomogeneous and at Beckfoot, in 1971, they were found to reach maxima at about 300m and 1100m from EHWMST. The former was at the transition from the unstable bar associated with the flood channel system to the *Arenicola* flat. The latter on the lower shore was also associated with sediment instability. Clearly, such adventitious additions must influence the grade structure and mechanical properties of the soils affected.

Table 4

Solid industrial waste in surface soil samples from the shores of the Solway Firth. (Particle diameter <1mm)

Station	Distance (km)*	Concentration (%) Mean	Maximum
St Bees	-6	1.8	6.8
Whitehaven Harbour	+2	10	11.2
Parton	5	35	71.8
Moss Bay	11	9	11.5
Siddick	17	11	42.8
Source furthest upstream	21	-	
Allonby	30	7	23.5
Beckfoot	37	7	38.1
Westfield	60	1.1†	2.4

* Measured from the Ladysmith tip: the most seaward source.
† Solid industrial waste included burned shale: nearest source at Flimby, ca 40 km from Westfield.

At Parton, for example,the soil Md_ϕ is ~1.5, whereas on similar, but unaffected shores is ~2.5. At Beckfoot a coarse fraction, i.e. >1mm particle size, range 1-16mm, comprising some 18% of the soil between 0 and 25cm depth changed the Md_ϕ from 2.4 to 2.2, the $Q1_\phi$ from 2.05 to 1.30 when compared with a surface sample which contained 2% of particles at the 2 and 1mm sizes.

It has already been noted that coal mining wastes are the dominant component of industrially derived solids and this may be confirmed by reference to Table 5. The ferruginous waste may be derived from either the coal mining or the steel industry, but the slagcrete, derived only from the iron and steel industry, is about 50 times less abundant that the coal mining wastes.

TABLE 5

Industrial waste solids in Solway Firth sediments.

Station	Mean Composition (%)				
	Coal/ Shale	Burnt shale	Ferruginous	Slagcrete	Total
Particles < 1mm					
Swarthy Hill	4.9	0.7	0.3	0.1	6.0
Allonby	5.7	0.8	0.3	0.1	6.9
Mawbray	8.2	1.1	0.4	0.2	9.9
Beckfoot	5.7	0.5	0.2	0.1	6.5
Westfield	1.0	0.1	0	0	1.1
Powfoot (North shore)	0.5	0.3	0	0	0.8

Since coal has a biological origin, with an obvious potential for bearing bioaccumulated trace elements and radioactive nuclides, it is reasonable to suppose that it can influence the trace element composition of the soils contaminated by it. While there are reasons for believing this to be generally true to some degree, it is most evident at Parton where the contamination is greatest, Table 6. It will be seen from the table that increased concentrations of Fe, Cd, Cr, Cu and Mn, but not of Pb and Zn are recorded and compared with values from uncontaminated soils. It is implicit from what has been said above with respect to acid mine drainage that these trace elements are more or less loosely bound to these particles. In fact experience in the storage and handling of samples from Parton confirms this to some degree, for it is often noted that the walls of the storage vessels, particularly those of polythene, become heavily coated by deposits of Fe_2O_3 (similar to the deposits noted upon the winkles and rocks in the AMD flow at Cunning Point). The work of Fendinger *et al* (1985), for example, indicates the ease with the components of coal may be leached out from it and this work apart there is a large literature which refers to the problem of leachates from coal mining spoil: it is therefore most unlikely that these substances will not be equally available in the chemically active milieu of a marine sediment. All of 10 measurements of the pH of the interstitial water, in January 1979, were 7.9, c.f. waters edge 8.1; the SO_4 content based on 5 analyses was 2.5±0.17%, c.f. waters edge 2.6%. Clearly neither parameter was influenced by the large amounts of solid industrial waste present.

Biological Effects

The gross effects of burial and abrasion by a stream of coal mining waste has been discussed above. The following will be concerned with relationships which have been observed in much less extreme conditions.

The biota of the "sandy" shore at Parton

Contamination of the shore at Parton provided an opportunity to study the populations able to live in its presence. The macrobenthos found was sparse, consisting of *Nephtys cirrosa, N. hombergi, Scolelepis squamata, S. foliosa, Arenicola marina, Echiurus echiurus, Bathyporeia* spp. and *Ammodytes tobianus*. This macrofauna, with the exception of *Echiurus*, is typical both in composition and low abundance with similarly exposed but uncontaminated shores in the Solway Firth area. *Echiurus* has been recorded from no other shore in the Solway.

Table 6

The trace element content of shore soils from Parton and sites uncontaminated by solid industrial wastes.

Trace element concentration	Parton	Control
Fe %	2.7 - 8.4	0.9 - 2.6
Cd ppm	0.9 - 3.0	0.5 - 2.0
Cr ppm	17 - 365	20 - 150
Cu ppm	55 - 410	3 - 19
Mn ppm	550 - 2300	145 - 780
Pb ppm	12 - 185	5 - 125
Zn ppm	20 - 173	14 - 180

The meiobenthos comprised turbellarians, nematodes, gastrotrichs, rotifers, archiannelids, ostracods, harpacticoid copepods, halacarines and tardigrades. No single group asssumed dominance, but the turbellarians, nematodes, archiannelids and harpacticoid copepods each occupied this role at some time. The total numbers of these organisms below 10cm^2 of surface ranged from 830 to 4940. These are large numbers which place the meiobenthos of Parton high in the known world abundance rankings.

The biota of shingle and dune land

At the top of the shore, shingle or dune substrata may be colonised by a flourishing growth of flowering plants. Thus sea kale, *Crambe maritima*, occurs frequently and at Cunning Point grows abundantly upon a shingle which contains >50% industrial waste; it is less abundant, though no less healthy, at Northside where the shingle contains 69% industrial waste, of which 57% was slagcrete. At Siddick a form of dune land, containing large amounts of industrial waste solids, supports species which characteristically occur on such coastal margins and may become covered by a close sward away from areas of disturbance. Such species include *Glaucium flavum, Rhyncosinapsis monensis, Raphanus maritimus, Cakile maritima, Silene maritima, Honkenya peploides, Anthyllis vulneraria, Lotus corniculatus, Potentilla anserina, Polygonum aviculare, Rumex crispus, Plantago maritima* and *Tripleurospermum maritimum*. All grow, flower and produce seed normally.

DISCUSSION

It will be clear from the results given that the Solway Firth is extensively contaminated by industrial solid wastes introduced over the past 250 years. Allen (1987a,b) estimated that the sediments of the Severn Estuary contain some 10^5 to 10^6 tonnes of coal dust and ~10^4 tonnes of coal burning residues. While there is considerable scope for error in such calculations a best estimate for the Solway Firth is that some 10^7 to 10^8 tonnes of solid industrial waste are present in the sediments, coal mining wastes predominating.

Burial and abrasion by these wastes is important near to sites of input, such as Saltom Bay. It would, however, appear from the biotas

inhabiting the sands at Parton and the shingle and "dune-land" of the upper shore at Cunning Point, Northside and Siddick that such wastes have little effect upon their inhabitants. This is in marked contrast to the flow of Acid Mine Drainage at Cunning Point where, although many species can tolerate it, and like *Littorina littorea* may have a normal breeding cycle,the discontinuity of the *Fucus serratus* zone in its path is of obvious significance. Such conflicting results suggest that there is more to learn in this regard.

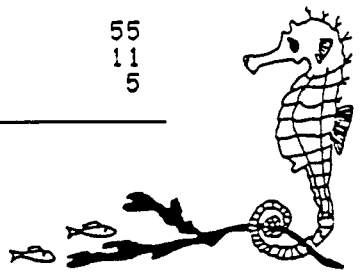
While results relating to the direct effect of coal mining and other industrial waste solids, such as slagcrete, are ambiguous, there is no doubt that the sediments of the Solway Firth are extensively contaminated by these materials which influence the soil grade structure and hence its mechanical properties. Clearly, these effects are likely to be most evident in soils such as those at Beckfoot, for example, where the industrial solids content can reach 38%, even though this shore is some 16km from the nearest source. Such results, it is believed, provide the key to understanding an anomaly of some duration. Thus, Robinson (1956) pointed out that like other similar British estuaries the Solway Firth has been gradually filling with sediment dumped into the Irish Sea during Pleistocene Ice Age and in a general sense this process continues. The anomaly is, however, that despite this strong and persistent trend, the shores and coastline of the Cumbrian Solway have, for some decades, undergone marked erosion.

Ignoring for a moment the influence of the solid industrial wastes the sediments of the Solway Firth are composed primarily of fine sand paricles, i.e., ~0.2 mm, which as Inman (1949) showed are the particles most readily moved by currents. Further, the silt/clay content, i.e., particles <0.0625mm, is in general low, so that these sediments are cohesionless. The introduction of substantial amounts of solid industrial wastes of particles at sizes significantly greater than 0.2mm not only changes the soil structure, but provides loci of turbulence which promote the erosion and transport of the finer particles. These finer particles, once raised into suspension, are transported away to become deposited in situations free of these forces: in practice, this means the uppermost reaches of the Firth and the Scottish shore in situations further downstream. The nett result is that the sediments will, as observed, become thinner, in turn reducing the supply of sand available to maintain the dunelands upstream of Maryport. Consequently, the dunes have been cut back by erosion and in order to maintain some sort of equilibrium the thickness of sand on the shore has decreased still further. Thus a feed-back system of erosion of the coastline and loss of sediment from the shore has developed. In general, the shore sediments are deposited upon a stratum of boulder clay/ bound shingle: when the sand thickness is diminished sufficiently this stratum emerges and it, too, contributes to an increase in turbulence and to a further loss of sand.

TABLE 7

Relative Abundance of Principal Infauna at Beckfoot, 1967 to 1983

	Population Composition %		
Year	Polychaetes	Crustaceans	Molluscs
1967	23	22	55
1976	4	85	11
1983	8	87	5



This process was observed in some detail at Beckfoot where sands having a depth of ~2m in 1962 had by 1983 been reduced to <8cm over large areas, accompanied by the emergence of bound shingle and isolated cobbles. Under the pressure of these changes, the infauna changed from one dominated by *Cerastoderma edule, Macoma balthica* and *Tellina tenuis* to one dominated by the opportunists *Eurydice pulchra* and *Haustorius arenarius* which are typically found in mobile sands. The changes which have occurred are summarised in Table 7. In the wider sense, the effect has been to reduce the amount of food available to fish and birds on the Cumbrian shore of the Solway between Maryport and Silloth at least. In addition, there has been a loss of duneland and its biota and the two combined represent a marked deterioration of the environment available to these species. The deterioration is unarguable even if the hypothesis attributing it to the inputs of solid wastes arising from coal mining and and the operation of blast furnaces is incorrect. It must, however, be pointed out that these changes were already in train before the leisure industry became a serious factor in this area and no other is known that approaches within orders of magnitude the contamination by these solids. As corollary to this argument, it should be noted that if the chemical and paper industries ceased operation today any sign of their activity would soon disappear. The impact of these solid wastes, on the other hand, is one which will persist on a geological time scale.

REFERENCES

Allen J.R.L. (1987a) Microscopic coal-burning residues in the Severn Estuary, southwestern UK. *Marine Pollution Bulletin*, 18(1), 13-18.

Allen J.R.L. (1987b) Coal dust in the Severn Estuary, southwestern UK. *Marine Pollution Bulletin*, 18(4), 169-174.

Down, C.G. and Stock, J. (1978) *Environmental Impact of Mining*. Applied Science Publishers, London, 371pp. ISBN 0 85334 716 6

Fendinger, N.J., Means, J.C., Radway, J.C. and Medley, S.L. (1985) Chemical characterisation of coal leachate. In *The Fate and Effect of Pollutants: A Symposium*. Publ. by University of Maryland, Sea Grant Program, College Park MD (USA), 1985, pp P.57, UM-SG-TS-85-02. TECH. REP. MD. UNIV. SEA GRANT PROGRAM

Fremlin, J.H. (1987) *Power Production: What are the risks*. Oxford University Press, Oxford and New York, 326pp. ISBN 0-19-286078-X.

Inman D.I. (1949) Sorting of sediments in the light of fluid mechanics. *Journal of Sediment Petrology*, 19(2), 51-70.

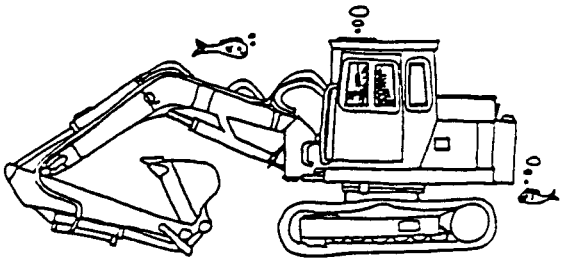
Katz, M. (1968) *The Biological and Ecological Effects of Acid Mine Drainage with particular emphasis to the Applachian Region Streams*. report to the Applachian regional Commission, 1666 Connecticut Avenue, Washington, D.C. 87pp, 15th December 1968.

Perkins, E.J. (1972) Estuaries and Industry. *The Environment This Month*, 1(2), 47-54.

Perkins, E.J. and Kendrick, M. (1978) Contamination of Solway Firth sediments by coal-mining and blast furnace wastes. *Cumbria Sea Fisheries Committee. Scientific Report* no 78/3.

Robinson, A.H.W. (1956) The submarine morphology of certain port approach channels. *Journal of the Institute of Navigation*, 9, 20-46.

* * * * *



Further to Sarah Fowler's article on the Scillies in the last issue (PN 4, pp.182-183), the following additional information was received but unfortunately just after that issue had gone to press. So herewith, but to be read in some conjunction.

SPECIES OF PARTICULAR INTEREST RECORDED IN THE ISLES OF SCILLY BY NCC SURVEYS

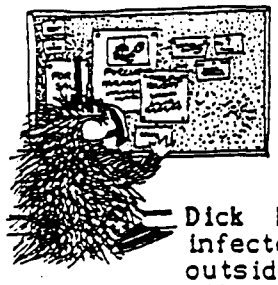
by Sarah Fowler

The Nature Conservation Bureau, 122 Derwent Road, Thatcham
Newbury, Berkshire RG13 4UP

(Many of these are particularly abundant, rarely recorded elsewhere and/or at their geographical limits of distribution.)

Cladophora rectangularis
Schmitzia hiscockiana
Schmitzia neapolitana
Asparagopsis armata
(gametophyte stage)
Gigartina acicularis
(all *Gigartina* spp. present)
Mesophyllum lichenoides
Pikea californica
Dermocorynus montagnei
Cruoriella armorica
Cruoria cruoriaeformis
Peyssonnelia atropurpurea
Bornetia secundiflora
Punctaria crispata
Carpomitra costata
Desmarestia dresnayi
Laminaria ochroleuca
Cystoseira tamariscifolia
Cystoseira myriophylloides
Cystoseira nodicaulis
?Fytheas rosea
(and a wide variety of other erect circalittoral sponge spp.)
Thecocarpus myriophyllum
Anthopleura ballii
Isozoanthus sulcatus
Parazoanthus axinellae
Balanophyllia regia
Leptosammia pruvoti
Alcyonium glomeratum
Eunicella verrucosa
Paraonid sp. nov.
Ehlersia garciai
Natalana gallica
Sabella variabilis
Runcina coronata
Gibbula magus
Turbicellepora magnicostata
Asterina gibbosa
Diazona violacea

* * * * *



NOTICES

Dick Hamond is seeking information on occurrences of *Amphipholis* infected with copepods, either inside (*Parachordeumium amphiurae*) or outside (*Cancerilla tubulata*) or with mesozoans (*Rhopalura ophiocomae*). All information as to whether they are found only at certain seasons, or only in hosts from certain biotopes, would be gratefully received by Dr R. Hamond, Scaldbeck House, Marston, Holt, Norfolk NR25 7BJ.

Further to the wondrous ***Haliphysema tucmanowiczi*** (see Manuel, 1989; PN 4 [4]; 70-71), Dick was quite right! Subsequent to his article not only telling us what to look for but also supplying an excellent figure, the Hon. Ed. has found this punk foraminiferan to be particularly common on holdfasts of *Laminaria* off the north Anglesey coast; and, yes, surprisingly obvious! And wondrous. (But sorry, Dennis, no *Gromia* yet [p.198]; and what about *Astrorhiza*?)

Letters to the Editor

From: Dr R. Hamond, Scaldbeck House,
Morston, Holt, Norfolk NR25 7BJ

CRUSTACEA LEPTOSTRACA, Genus *NEBALIA*

Anyone finding *Nebalia* should determine it with the revision by E. Dahl (1985), "Crustacea, Leptostraca; principles of taxonomy and a revision of European shelf species", Sarsia, 70; 135-165. Without betraying the identity of my re-identified specimens [why not? - Ed.], I must admit that Dahl's figures of the spinulation and segmentation of the antennule were crucial in the identification of a large specimen consisting solely of carapace and mouthparts; and the real *N. bipes* is an Arctic-boreal species so far unknown from British waters. Dahl's distribution maps are remarkable for their lack of records from the North Sea (apart from the coast of Norway), although unspecified *Nebalia* spp. are well known to occur there; records of specified *Nebalia* spp. are much more comprehensive from the other parts of the British Isles and nearby, but nevertheless there may still be surprises in store!

Useful taxonomic characters are fully developed only in adults and progressively less so in younger specimens. It would be helpful if one of our members would act as co-ordinator of all relevant records that come in, so that a much more complete set of distribution maps could be compiled for the various British species; it will not be me, because I am fully occupied with harpacticoids and (in Norfolk waters or nearby) almost all other invertebrates.

ED: Sounds like a job for the Hon. R. C. to me. Assuming any records do come in (none from Norfolk yet!). But here's one: the specimen from Saline Bay, Guernsey listed in Bamber (1987: Epifaunal collections from the Channel Islands, September 1986. PORCUPINE NEWSLETTER, 3 [9]; 235-239) has been reexamined and, from Dahl's paper, reidentified as *N. herbstii* Leach.

From: Jan Light, 88 Peperharow Road
Goadalming etc.

Dear Roger,

The answer is a raspberry!

[re. p. 200]

ED: Malheureusement, zut alors! ..... La réponse n'est pas, how you say "a raspberry", pasque celle n'était pas la question. Merci, etc.

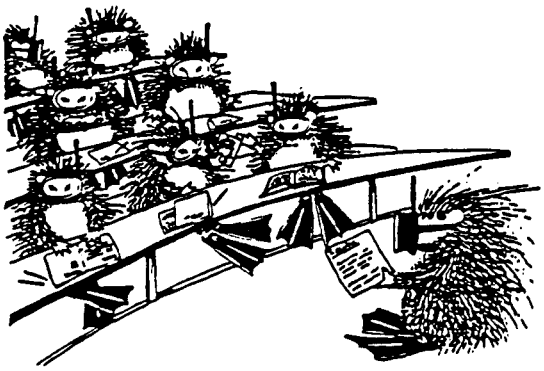
FUTURE MEETINGS

There will be a joint **PORCUPINE** - Conchological Society of Great Britain Field Meeting on the 6th to 8th October 1990 on Anglesey. With *in situ* coordination by Ivor Rees, it is planned to have laboratory facilities available at the Menai Bridge lab. The coastline of Anglesey is diverse, covering a number of shore types including well zoned cliffs, rock platforms with pools, beaches of sand, mud, pebble mud and shingle and a lagoon. As a bonus, there exists a convenient zoogeographic boundary at roughly the north-west corner of the island. What more could you ask?

The Autumn Meeting of **PORCUPINE** will be held at Fawley Power Station, Fawley, Hants, on the weekend of 3rd and 4th November 1990, on the theme of "Plankton". Thos wishing to submit papers, posters or whatever other contributions should contact Dr Frank Evans, Dove Marine Laboratory, Cullercoats, North Shields, Tyne and Wear NE30 4PZ. Local information for the meeting can be obtained from Roger Bamber (Hon.Ed., address as on front cover).

The **PORCUPINE** 14th Annual General Meeting and 1991 Spring Meeting will be a joint meeting with the Coelenterate Group, in Swansea on the 5th to 7th April 1991 on the theme of "Change and Adaptation". Our host will be Professor J.S. Ryland of the School of Biological Sciences, University College, Swansea.

Further information on all meetings can be obtained from the Hon. Secretary Dr Martin Sheader, Dept. of Oceanography, University of Southampton, Highfield, Southampton SO9 5NH (Tel. 0703 593639).



WHY (marine recording)

or SO WHAT?

by Roger Bamber

1. WHAT (am I talking about)

Many* "marine recorders" record as an end in itself, and many don't know why they do it, and mainly don't think why they do it *or* why they might do it. The most obvious evidence of this contention is the lack of communication about marine records or recording. For example, PORCUPINE was set up with various motives, one major one being marine recording: it had a Records Convenor from the outset, and now has a Records Coordinator instead; since PN3[4] the Newsletter has had a specific "New Records" column. And PORCUPINE has had a mildly fluctuating membership around the 200 mark. However, over the years, the Hon Records Co-whatevers have received very few records directly through their Porcupine role, while in 5 years the Newsletter's New Records bit has received only 5 direct submissions.

Yet I don't believe that this lack of communication means that there is a lack of recording or a lack of demand for recording; what is clear is that there is a lack of a relationship between the recording and the demand.

2. WHEREFORE

do people do marine recording? To a large extent, for themselves. It is nice to compile maps, and fill in the blanks, and watch it all develop like Dutch elm disease spreading across the country; and it's a hobby involving travel and fresh air and meeting people; and it can be both social and competitive (primal human instincts). Of which *per se* I have no criticism at all: it is hard to criticise stamp-collecting (though I believe it is more profitable than marine recording). I would suggest to such recorders that there may be more to it. There are customers who actually want records or their synthesis; there are people who record as one stage in a greater whole.

3. WHO

are the customers for marine recording? I won't pretend to think of them all, but will list some that come to mind.

"Stamp collectors" - as already stated there is nothing wrong with recording for its own sake. There are some subtle aspects like looking for the "penny-blacks" of marine biota, and obtaining records at distributional limits - northern- (southern-, western-) most or deepest or shallowest or lowest salinity or whatever.

Exploiters - fishermen (in the broad sense of the word), bait diggers, alginate producers may all be most interested in records of appropriate commercial species. Those recorders who automatically consider such practices to be deleterious should consider the possibility that discovery of a new and sustainably exploitable "stock" may relieve pressure on overexploited situations, as well as putting the overexploited stock into a more realistic 'conservation' perspective. Equally, the identification of such populations allows the development of controlling management guidelines (including total restriction) before indiscriminate exploitation can begin. On the non-commercial side, there are researchers who require material for academic purposes, and to whom a range of localities and habitats, as well as knowledge of localities which can be safely exploited, are important

Statutory Conservancy Bodies (e.g. NCC) - who require records in order to determine what may be rare or "important", as well as (and as a result of which) to define habitats and localities worthy of or absolutely needing protection, be it in the form of nature reserves or whatever. To quote Roger Mitchell, "This information is required in order to determine the nature conservation importance of British marine

*But not all

ecosystems so that a more positive response can be made to potential impacts on this environment. The same information will also be very important in identifying those key marine areas which will be afforded statutory protection by the designation of a series of Marine Nature Reserves ...." (Foreword to Seaward, 1982), and "Records .... are particularly useful for indicating the biogeographic and zoogeographic provinces around Britain and Ireland as part of the framework for this major project [the Marine Nature Conservation Review]. This information will be used in refining and implementing a strategy to ensure that representative habitats and the associated organisms are afforded appropriate protection." (Foreword to Clark, 1985).

"Academics" or scientists - not just the obvious ones such as biogeographers, but also ecologists requiring information on community associations, etc., ecologists and physiologists with an interest in habitat tolerance, autecologists and reproductive biologists wishing to understand the constraints on distribution, colonisation, recruitment and seasonality, taxonomists interested in allopatric and sympatric sibling distributions and information implying phenotypic rather than genotypic differentiation, and both palaeontologists and "neontologists" interested in habitat associations and geographic spread with time, to name but a few. On the non-biological side, marine plants and animals can be indicators of hydrography, climate, stability, and of course physical habitat. Meanwhile, historians find such records valuable in interpreting both the origins of archaeological debris (e.g. shell middens) and the history of exploitation (e.g. artisanal fisheries, commerce). Also in this category is PORCUPINE.

Environmental Impact Assessors - a growing field as both legislation and society's opinion requiring it develop. The presence of records for an area enables more comprehensive and more accurate assessment, both because some work has already been done, and because it assists in planning any field sampling strategy to have some idea of what to look for and where. The presence of records from elsewhere (mapping schemes, whatever) enables the interpretation of the local significance of species or habitats. And if, as is often the case, material is being collected from a previously under- or un-studied site for EIA purposes (or many others), identification of that material is so much easier and probably more accurately undertaken if some recording already exists from the vicinity. The pre-existence of records is more likely to contribute to a better assessment for the same money than to cut costs, unless previous recording surveys are very recent and/or comprehensive.

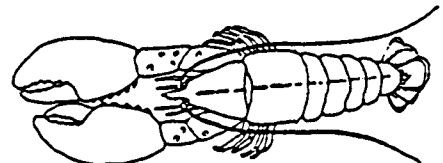
Industry, etc. - including water authorities and coastal industrial developments, who in addition to EIA may wish to know about marine species which may adversely affect their plant or operations (seaweed blockages, mussel or barnacle fouling, water quality). An absence of expected organisms may indicate an adverse environmental characteristic (e.g. periodic high turbidity, local concentration of remote pollution, iceberg scour).

Local councils/government/bureaucracy etc.- who have a use for many aspects of what marine organisms are in (or absent from) their locale, and to what extent their residents are important or unique or a pest (from dolphins to *Physalia* and from maerl to weever fish), with repercussions on hotel siting, tourism, public aquaria, education, sewage effluents, recreation, local interest, sea defences, beach stability and fishing industries.

I apologize for the obvious important potential customers that I have missed, but you get the idea.

4. WHAT do they want

It should be apparent from the foregoing that there is a potential range of customers (a market) wanting not just the biotic but also habitat recording schemes. While their applications may be somewhat diverse, their requirements tend to be similar.



The market initially requires 'Presence' information: what is or is not there (classic basic recording), and not only for those things with big eyes and fur or tasty meat; not only for molluscs or pycnogonids; in fact not only anything.

It is not just what is present that is important: absence not only makes the heart grow fonder, it is meaningful if real - "I looked and it wasn't there"; there is a recurring difficulty with gaps on distribution maps in distinguishing those resulting from a lack of recording from those reflecting genuine absence.

The value of the recording increases immeasurably if it includes not only simple presence or absence, but also does so quantitatively or representatively. Is the recorded species/habitat characteristic of the site, and (not or) is it common and/or dominant; species can be characteristic without being common (particularly those with a large ambit). Absolute mean numbers per square or cubic metre would of course be the most desirable, but the standard rare-occasional-frequent-common-abundant scale answers many requirements.

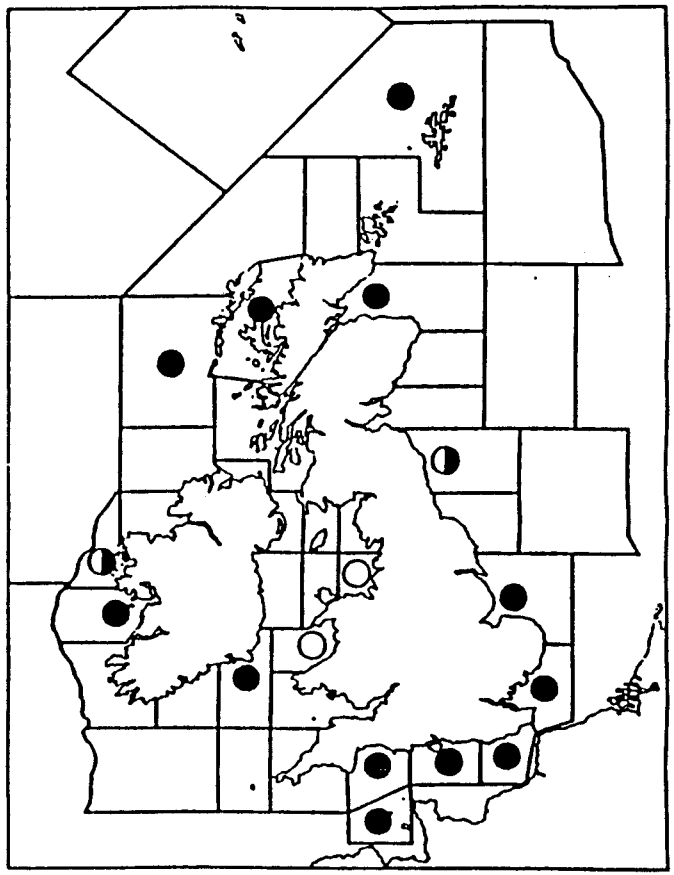
Records are also more useful if they include the stage of the life-history that is being recorded. Herring can be dominant members of a benthic community - but only as eggs. Otherwise, the repeated recording of a single life stage (juvenile or adult) can suggest much about recruitment or development failure and may be an important indicator at a zoogeographic limit. Some stages of a life history are more sensitive to certain environmental stresses than others. Equally the condition of the specimen is valuable information: is the *Sargassum* attached or just floating past; is the mussel capable of breeding; is the *Sepia* post-reproductive and therefore about to die; is the *Spartina* showing signs of "die-back"; is the *Limnoria* in a breeding swarm? All these are characteristics which reflect on the likelihood of the species being recorded again at the site.

Having discovered what is there, it is also worth knowing when. It is not uncommon in recording schemes to invoke some chronological division (e.g. pre- and post-1950 records for molluscs - Seaward, 1982). It is inevitably increasingly difficult to confirm older records (without the material), and their validity deteriorates as taxonomy and the availability of taxonomic expertise changes. Of course, all records eventually get old. While there is clear merit in sampling previously unrecorded sites for new data, it is also of value to repeat sites. The function of repetitive sampling/recording is not merely to confirm old records. To record change or stability is to gain important information, firstly that change or stability does occur. The overwhelming value of long-term surveys to understand natural variability is well accepted and gives a necessary background against which to assess pollution impacts or, to be topical, hypotheses of global warming. In fact we should expect changes in distribution and therefore insist on repeated recording. Is there any value in a map based on all U.K. records of pilchard, for example?

It may seem a truism to quote the worth of "where" the record is from. But "where" is a multidimensional niche. Geographical location can hardly be too accurately recorded, but where includes habitat: tidal height, sublittoral depth, algal frond or holdfast, upper or underside of stones (how big?), in a tidal stream or totally sheltered, lagoonal, estuarine, at the mud surface or burrowed in, anterior or posterior end of a maldanid tube, north or west facing cliff, within 500 m of a discharge, etc. - *ad ALMOST infinitum*. Unlike "what" (the identity of a specimen) the "where" information cannot be retrofitted to a record! But it is not difficult to collect at the time of sampling.

Finally, how does the record relate to other records of the species or habitat or site? Is this animal rare or of conservation interest, in relation to neighbouring records/populations; is this plant typical for the area or novel to the site; is this habitat the only example of its kind in the vicinity; does this record herald a welcome return indicating recovery from impact? And so on.

FIGURE 1. "Distribution map of five species around the U.K. coast" - i.e. marine laboratories (ex. Linn. Soc. Synopsis).



H. ventrosa

FIGURE 2. Distribution of Hydrobia ventrosa from Seaward, 1982.

5. WHAT do they get?

Often the customer gets nothing! Which is to say, much recording is never published, and the data are not only rarely used, their existence is often unknown. Reasons for this vary from the unjustified desire by recording scheme operatives to wait until their results are totally comprehensive, to institutions whose priorities change or whose decision making levels either do not appreciate the value of their data or have a misconceived concept of confidentiality.

Almost as bad, though at least one order of magnitude away, are limited circulation publications of records, so frustrating to 'customers' who know of the data but can't get hold of them, or who only find out about their existence after they have produced their own product (fauna list, map, EIA, thesis, etc.).

Moving on to available end products, maps are perhaps most familiar. We are all familiar with the classical marine laboratories map (Fig.1). It is not a lot of use, but is partly the inevitable product of what I have just described. Most available distribution maps do not give any indication of 'absence' (which could be done by simply mapping the total data set, for example); and a common set of missing data in records is that of common species, which people do not think to record, assuming their distribution to be well known. I know of no maps that give quantitative data; I know of very few which indicate life history stage. The hardest aspect to produce in a map is 'when': the data are dependent on their actual collection times, and national annual updates can hardly be expected for most marine groups; a map distinguishing, for example, post-1960 records may represent only 1961 distribution! Even location ('Where') can be misrepresented on a map, particularly depending on the scale: the map in Fig.2 may be quite adequate for a pelagic fish, with its large ambit, but it was actually produced for a sedentary mollusc - one is forced to suspect a certain amount of lost detail.

Much of this type of information can best be dealt with by accompanying text (don't lose the map!); examples from PN 4 (7) show habitat and quantitative information (Druridge Bay list, pp.161-168) and 'where-else' contextual information (Trink list, pp.143-149).

But briefly, and generally, 'they' don't get enough.

6. WHICH schemes are going on/already exist?

There are published fauna lists for certain areas - Dale Fort, Isle-of-Man, Bristol Channel (littoral), the traditional Plymouth list (now apparently being updated), and the Cullercoats Faunas; these have tended to be "one-offs".

The organized recording schemes underway in this country were listed in PN 3 (4). There were Dinoflagellate, Bryozoan, Crab (now published - Clark, 1985), Isopod, Echinoderm, Polychaete, Sponge, and of course the Conch. Soc. mollusc schemes; there have also been habitat recording schemes, the Phyc. Soc's Seaweed mapping scheme, local mollusc schemes, and even a pycnogonid scheme. The development of these over the last 8 or so years has inevitably ranged from publication of distribution atlases to apparent total demise of the scheme.

There are survey documents published by the Nature Conservancy Council, though of classic limited distribution. There are various publications by the MCS, such as Sponge IV, which tell the reader a few "wheres". The Linnean Society synopses often offer distribution maps together with textual information. The "Atlas of the Seas" by Lee and Ramster of MAFF gives distribution maps of physical and chemical parameters. Even certain industries - the CEGB has published reports from its surveys at relevant sites (some of which get summarized in PN).

And of course there is PORCUPINE and PORCUPINE NEWSLETTER, currently underused but certainly there as a willing repository for marine records, particularly as few other journals will publish such material.

7. So, HOW should it be done?

The glib answer is really - it doesn't matter too much! Except to emphasize: as well and as comprehensively and as often as possible.

Good recording does not necessarily require a lot of money; it does need commitment, awareness (of the market), time, cooperation, feedback (encourage your suppliers of information) and publishing (an end product).

Get identifications right - pester experts if necessary, they are often actually interested! If in doubt, tell the world! People will then leap to boost their own egos by correcting your identification, and you get what you want - the right information - and your own ego is boosted by an accepted authoritative map or whatever publication. Fill in gaps if at all possible, because people tend not to repeat groups once covered. And on that topic, repeat groups once covered (see above). Do not fixate on taxa of your own expertise: if you have already expended time , effort and even money on collecting, send the rest of the material to other people for their own schemes.

Do make the result available, without worrying too much about the quality - an absent end product has no quality at all. Produce text as well as maps, a whole far greater than the sum of the parts. If you wish, computerize, which opens further options such as intercompatibility, a choice of scale (detail) to the customer, a choice of information to the customer, and so on.

8. WHERE should it cover?

Anywhere you like! Probably as big an area as possible, but not at too much cost of detail. Brackish-lagoonal distributions, or headlands versus bays require fairly precise detail; on the other hand, with some beasts detail can be pointless, for example pelagic fish. Mapping should be done on the basis of water bodies rather than land masses, i.e. relate to the habitat subdivisions controlling the distribution of the species concerned. Even the much vaunted 200 m depth contour continually falls down (metaphorically speaking). The map area may need to be very big indeed (Fig.3) - though text may then be a better option.

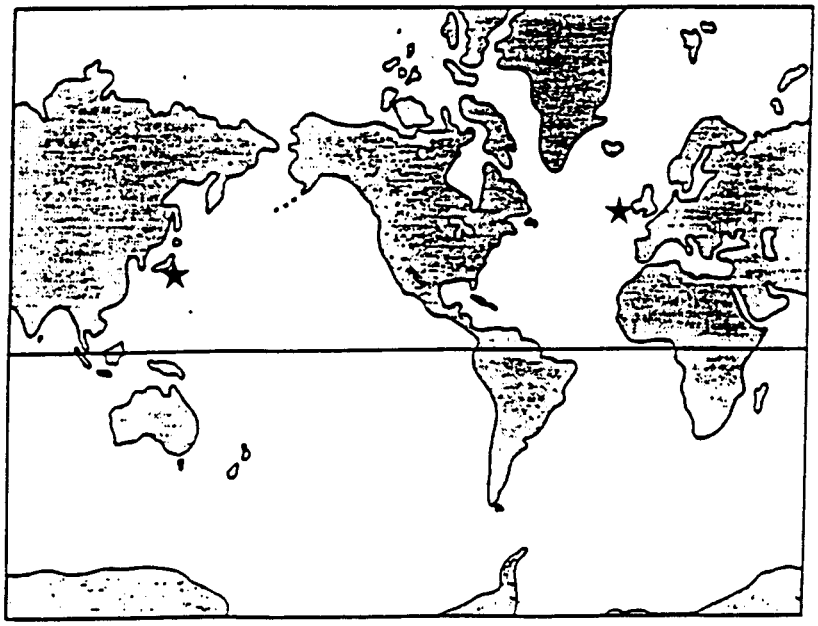


FIGURE 3. Total world distribution of Pallenopsis mollissima records.

So look carefully at boundaries (e.g. estuarine v. coastal; N. Anglesey), including those zoogeographic (e.g. Lusitanian, Arctic-boreal), map as appropriate and fill in gaps.

9. WHEN should it cover?

All the time. Do not be put off by someone who has already done it - repetitive recording is most useful, seasonal recording is very necessary, and global warming may be more than a myth. Year to year variation is especially important at the limits of an organism's range, i.e. the local rarities in which we are apparently most interested. More repetition is needed at such limits to confirm their stability, and to follow immigrant colonization.

10. SO WHAT

In conclusion, we now know who wants what, and what it takes, so I would simply recommend:

to recorders: publicise be comprehensive give feedback publish

to customers: encourage give feedback (e.g. thank you) publish fund

to the rest: annoy people with your records or material

to everyone: think why you are (or could be) recording.

Don't be afraid to sell your "wheres"

11. WHOM (acknowledgements)

Apropos the version presented at Dundee, I am grateful to Peter Henderson for the shrimp map, to Jon Moore for letting me in and for info on Porcupine Records, to Sonia Batten for Wherefore and the audience for patience, to none of whom should any blame for the above be attributed.

12. WHENCE (references)

Clark P.F., 1985. North-East Atlantic Crabs. An Atlas of Distribution. Marine Conservation Society, Ross-on-Wye.

Seaward D.R. (Ed.), 1982. Sea Area Atlas of the Marine Molluscs of Britain and Ireland. Conchological Society/N.C.C.

* * * * *

LONG_TERM STUDIES ON AN ESTUARINE MUDFLAT

by Donald McLusky

Dept. of Biological Science, University of Stirling, Stirling FK9 4LA

The Kinneil intertidal mudflat (Forth Estuary, eastern Scotland) receives industrial effluent from several sources, the main ones being petrochemical discharges. The fauna of this eatuarine mudflat has been sampled annually, every August, 1976-1986, using 89 standard stations. The results have been analysed by a variety of computational techniques, using the multivariate technique TWINSPAN to perform community classification of the data. Provided that a merge technique was used, the Twinspan methdo proved a good summary of the data in terms of gradients or groupings within the area. Mean diversity indices gave a good indication of long term changes in the area, and when used in conjunction with community analysis, proved capable of reflecting the man-induced changes which this area has experienced, and provided some evidence of an improvement in the quality of this environment. Variations in the abundance of animals in this area could not, except for one species, be attributed to temperature fluctuations or anomalies.

RECORDING OF ENVIRONMENTAL DATA USING SOLID STATE DATA-LOGGERS IN TOWED VEHICLES

by Bob Williams

Plymouth Marine Laboratory, Prospect Place, West Hoe, Plymouth PL1 3DH

Since 1988 oceanographic vehicles equipped with a variety of optical sensors have been deployed successfully from ships-of-opportunity in the North Sea as part of an environmental monitoring programme. The towed vehicles are deployed and recovered by the ship's crew and the instrument packages are activated automatically during the tow by electronic sea-water switches. The vehicles carry sensors for measuring chlorophyll fluorescence, turbidity, conductivity, temperature, depth and upwelling and downwelling light in three wavebands; the measurements are stored in a solid state logger. The filters used in the irradiance sensors have wavelengths at 412, 450 and 550 nm with sensitivity at 0·1 $\mu W\ cm^{-2}$.

The light measurements are used for the determination of the diffuse attenuation coefficient and the reflectance of blue light (R412, R450) and green light (R550) and, together with measurements of chlorophyll fluorescence, are being used for the development of an algorithm for estimation of primary production in coastal waters and the open sea. Data were shown from a number of fixed-depth and variable-depth vehicle deployments from selected shipping routes in 1988/89, including a Copenhagen, Kattegat, Skegerrak, North Sea, Harwich route. From March 1990 a nutrient sensor measuring combined nitrite-nitrate in a continuous flow analyser will be carried by these towed vehicles.

* * * * *

SPEECH RECOGNITION FOR BIOLOGICAL DATA CAPTURE

by J. Alistair Lindley

Plymouth Marine Laboratory, Prospect Place, West Hoe, Plymouth PL1 3DH

Despite advances in automatic data acquisition by means of particle size spectrum analyses and image analyses, most identification and enumeration of biological material still has to be carried out by appropriately trained biologists. The objective of speech recognition for data capture is to free the biologist from the need to divert attention from manipulating the specimens to recording results in the form of written records or manual operation of a counter.

The systems used at PML employ IBM personal computers and Keytronics voive recognition keyboards. A vocabulary is created and each person using the system "trains" the system to recognize the voice input corresponding to each item in the vocabulary. The user speaks the identification of specimens into a microphone attached to the keyboard and when a spoken input is recognized as an item in the vocabulary the computer bleeps and displays the recognized item on the VDU, enabling the user to validate input. It is hoped to improve the system for users working at a microscope by having an LCD display of the recognized input visible through the microscope.

Once the data have been entered they are available on computer file with no need for ruther transcription with its attendant risk of error and the need for verification.

Experience has shown the system to be reliable and to speed the analysis of samples as well as saving the time normally required to enter the data into computer systems.

* * * * *

USE OF IMAGE ANALYSIS IN BENTHIC MACROFAUNA STUDIES

by J. Alistair Lindley

The use of image analysis techniques in work on benthic macrofauna at PML was briefly described. A MOP-AM03 system was used for size-frequency analysis of molluscs and crustaceans. Animals observed under a binocular microscope fitted with a camera lucida were measured using a light pen on a touch sensitive tablet connected to the system. A program on an attached PC adjusted the measurements for magnification and rounded them to the nearest millimetre. Size-frequency histograms could then be constructed for each species in a sample and the data sorted and stored on files which could be transferred to a mainframe computer.

A more sophisticated system, consisting of a KONTON IPCS Image Analysis system which uses video-camera input to a computer and array processor, was used for measurement of large numbers of *Hydrobia ulvae*. Size-frequency analysis of a sample of 200 specimens could be achieved in 2 minutes. Only minor changes in file format were needed before transferring data to a mainframe computer.

Another application of image analysis was in measuring resin casts of worm burrows using photographs of sections of the casts.

In all cases the time taken in processing the samples was dramatically reduced from that taken using more conventional methods.

* * * * *

A CENTURY OF BIOLOGICAL RECORDING BY MERCHANT SEAMEN: A NEGLECTED ASSET

by Frank Evans

Dove Marine Laboratory (Newcastle University), Cullercoats, North Shields

Shortly after the inauguration in 1854 of the Meteorological Office of Great Britain under the direction of Admiral Fitzroy (formerly Darwin's captain in HMS "Beagle") a programme of structured weather recording was initiated by the Office aboard volunteer merchantmen, known then and now as "selected ships". Aided by a few precision instruments, barometer and thermometers, a comprehensive coded account of the weather was constructed every six hours at sea, largely from visual observations. The purpose of the records was at first climatological, but with the advent of radio the reports became valuable for forecasting. Although modifications in procedure have been made, the methods of recording currently in use would be intelligible to a ship's officer of Fitzroy's time.

Soon after the advent of the scheme, casual notes began to appear in the ships' meteorological logbooks of sightings of biological phenomena at sea. Eventually, an approved place at the back of the logbooks was found for these observations and encouragement for further reporting of marine life was given. Indeed, for a period at the end of the nineteenth century, biological recording became a requirement rather than a request.

Although records of marine life collected in this way now number many thousands, little use has been made of them. A selection appears in the pages of the quarterly "Marine Observer", a journal doubling as a learned journal and house organ, keeping merchant seamen in touch

with the headquarters of the Meteorological Office at Bracknell. At first the neglect of these records may seem justified: how could the accuracy of observations by untrained observers be in any way relied upon? But examination of the reports shows that the animals and plants reported on may often be identified with certainty by an experienced biologist, even when the observer himself is unaware of what he is describing.

For many years, records judiciously chosen to enliven the pages of the "Marine Observer" have been transmitted to experts (so-called by the Met. Office; spare our blushes) for comment. These comments are returned to the originating ship and some of them are appended to the reports that appear in the journal. The experts currently cover the field as follows:

Marine mammals	Dennis McBrearty (Dolphin Survey Project, Cambridge)
Birds	Royal Naval Birdwatching Society
Insects, Reptiles	British Museum (Natural History)
Bioluminescence	Peter Herring (IOS Wormley)
Remainder (Fish, Inverts)	Frank Evans (Dove Marine Laboratory)

Insects, some reptiles and land birds are no more than terrestrial refugees, but the remaining creatures are of direct interest to marine recorders. The total number of species involved is not great, some forms occurring again and again in the reports. One soon gets a feel of what is being reported on so that, for instance, a sketch no more elaborate than:

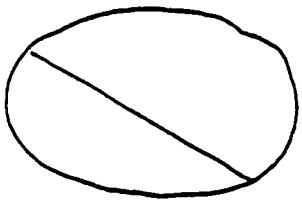


Fig. 1

can at once be recognized as *Velella velella*, the coelenterate "by-the-wind-sailor". Similarly:

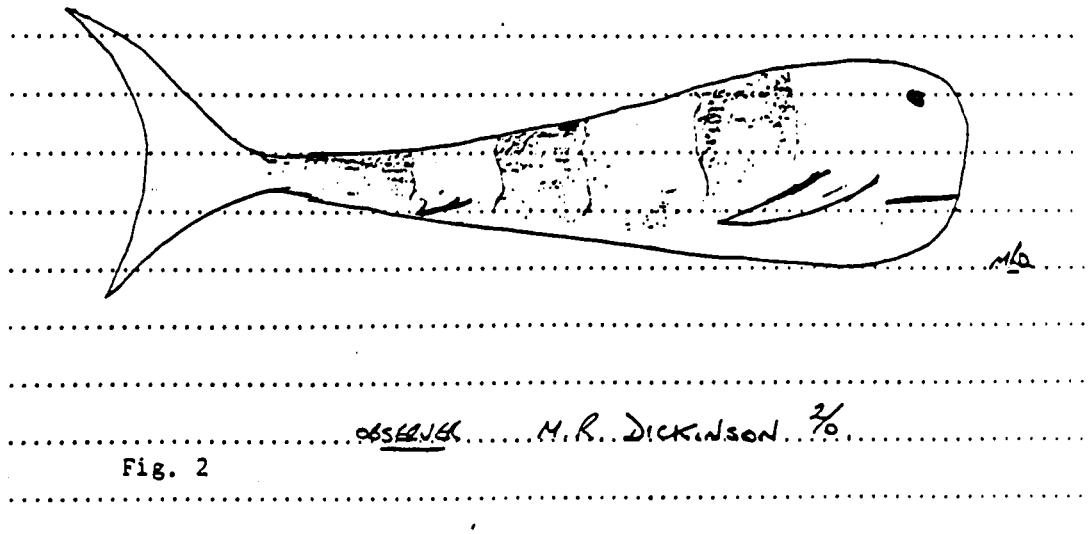


Fig. 2

is *Coryphaena hippurus*, the dorado. Often though, accounts and drawings of great accuracy are sent in (Figures 3 & 4). Nowadays, reports are often accompanied by photographs, which are always helpful.

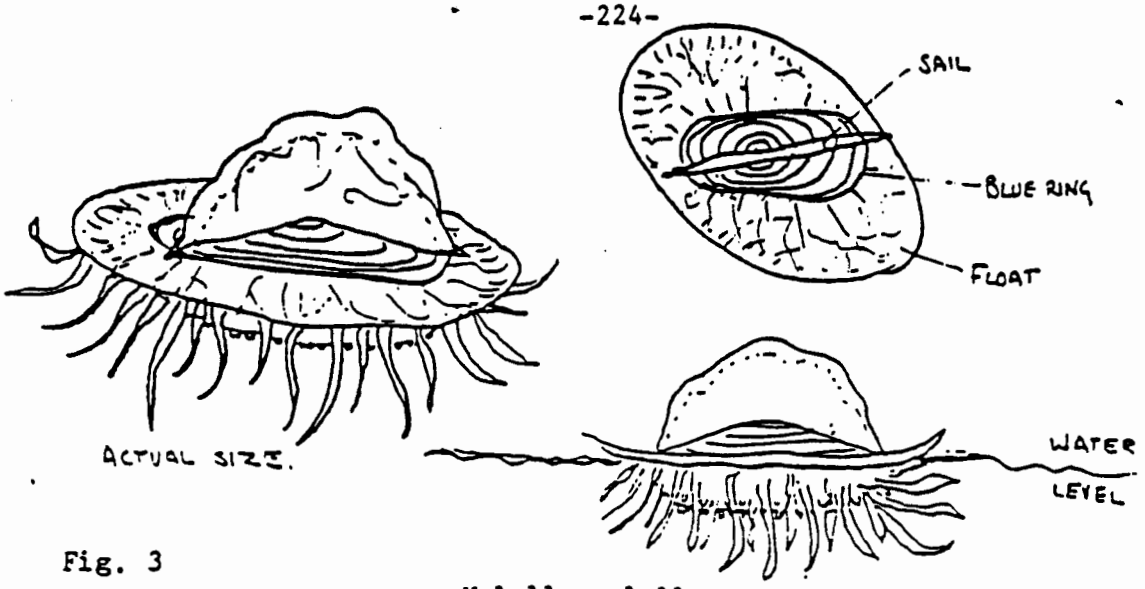


Fig. 3

Velella velella

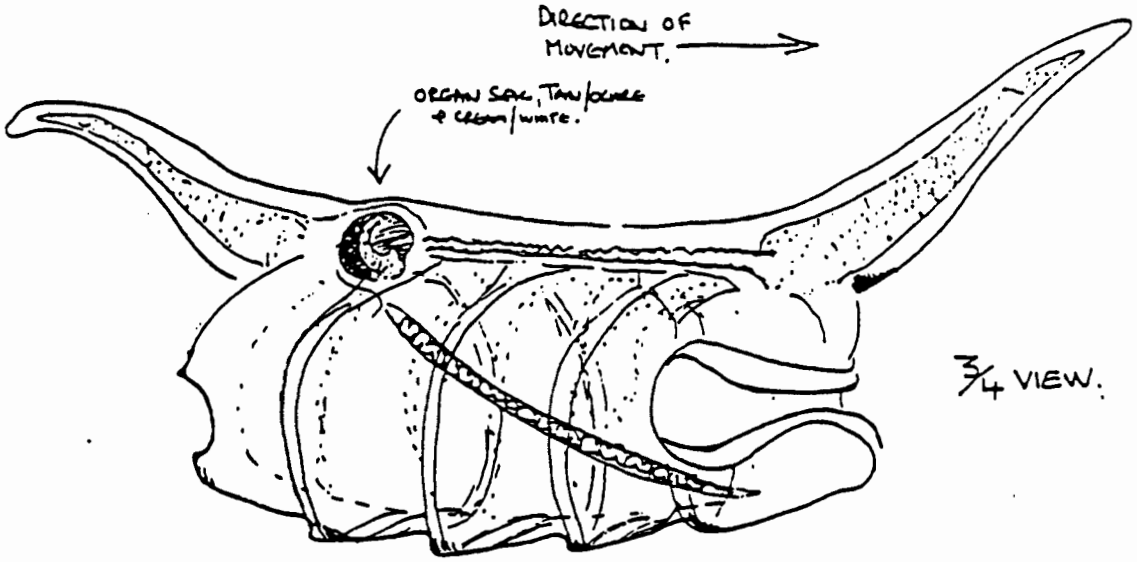
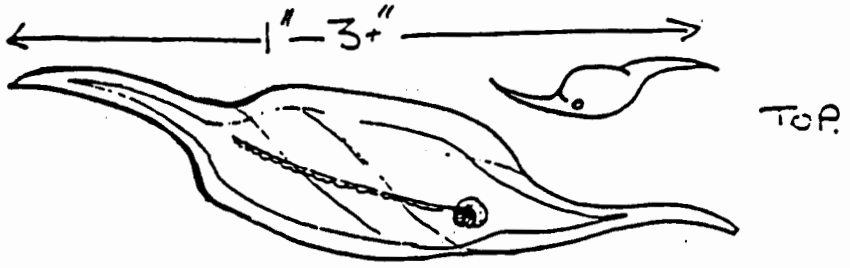


Fig. 4

Salpa fusiformis



Shipping routes, apart from oil routes, are not much altered from a century ago. Although shipping densities have changed, the number of "selected ships" has changed less. Dates and positions of observations are always accurate. So, once identifications are found to be acceptable, the records become cumulatively valuable. However, as noted above, only a selection of records are forwarded to experts for comment. It is desirable that the whole body of information held by the Meteorological Office be assessed and brought from hand-written notes in the numerous logbooks into a usable form.

Some advance has been made in this direction. Dr Tim Wyatt, formerly of MAFF Lowestoft, was able to have copied some twenty years of records from the nineteenth century, while Mr Paul Horsman, when employed by the Marine Society, copied about twenty years of work from the 1950s onwards. Thus there remain perhaps a hundred years of records that require further attention.

Some results have already been extracted from the general data. Descriptions of bioluminescence are common and geographically widespread. From them it has been possible to codify types of display, including the remarkable "phosphorescent wheels" sometimes seen surrounding ships, also the great trains of luminescent waves travelling at high speed and stretching, sometimes, from horizon to horizon, and other puzzling phenomena (Herring & Horsman, 1985).

An enormous outburst of *Velella velella* affected more than two million square miles of the North Pacific in 1985 (Figure 5). In places the animals were so dense that the sea appeared to be totally covered as if by oil sludge. This event was formally recorded only by merchant ships (Evans, 1986). The observations may have a particular significance, since what from satellite photographs may routinely have been taken as coccolithophores were perhaps *Velella* (R. Williams, pers. comm.).

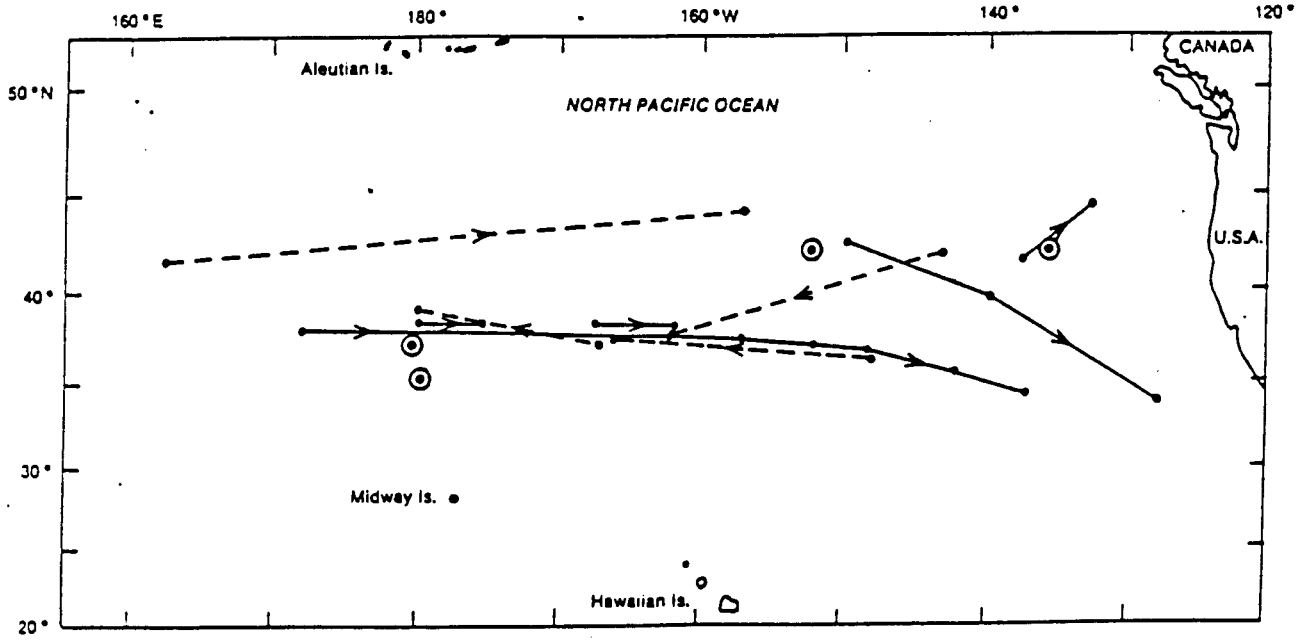


Fig. 5 **Tracks of Selected Ships through shoals of *Velella* in 1985. The plotted routes are in some cases the tracks of more than one ship. Open circles represent single reports.**

The current Marine Conservation Society and Nature Conservancy Council surveys of basking sharks have been enhanced by recent contributions, channelled through the Meteorological Office, from merchant ships.

For the future, a computer database needs to be set up and the records already assessed put onto it. The forty years of copied material already available require examination and entry. Ideally the remaining material should then be systematically examined so that a complete record is compiled, together with an estimate of the quality of each identification. From the data recorded it would then be possible to offer records to specialists on request, to map the major species and perhaps to gain some insight into the long term stability or otherwise of species boundaries at the surface of the great oceans.

It is tantalising that, in addition to this great wealth of uncollated data, further voluminous records are almost certainly to be found in the naval archives of the great sea powers, including our own, as well as in merchant ship logbooks of one sort or another in many lands.

REFERENCES

Evans, F., 1986. *Velella velella* (L.), the by-the-wind-sailor, in the North Pacific Ocean in 1985. Mar. Obs., 56; 194-200.

Herring, P.J. & P. Horsman, 1985. Phosphorescent wheels: fact or fiction? Mar. Obs., 55, 194-200.

* * * * *

AMALOSOMA EDDYSTONENSE STEPHEN 1956, AN ECHIURAN NEW TO SCOTLAND, WITH NOTES ON ITS PROBOSCIS AND HABITAT

by David W. Connor

Nature Conservancy Council, Northminster House, Peterborough PE1 1UA

Populations of an echiuran worm have been recorded from a number of Scottish sealochs during recent surveys for the Nature Conservancy Council. Diving biologists have frequently seen the worm's long forked proboscis retracting rapidly across the seabed into its burrow. The echiuran had been ascribed, until now, to *Bonellia viridis* Rolando, 1821, the only species on the British list known to have such a bifid proboscis (Stephen, 1960; Stephen & Edmonds, 1972). However, *B. viridis* typically lives in rock crevices in the Mediterranean, a habitat very different from that of the Scottish populations. Consequently, the species identity required confirmation, and specimens collected in 1988 by the author from Loch Nevis and Loch Alsh revealed it to be *Amalosoma eddystonense* Stephen, 1956.

A. eddystonense is only previously known from the Plymouth area, from where it was originally described, and from Galway Bay, Ireland, where the species was collected from fish guts (O'Connor & Mulligan, 1977). The species is still occasionally collected in trawls off Plymouth (P.E. Gibbs, pers. comm.). All specimens collected by Stephen (1956) and O'Connor & Mulligan (1977) lacked a proboscis, and indeed the proboscis of *A. paradolum* (Fisher, 1946), the only other species in the genus, is also unknown (Stephen & Edmonds, 1972).

The worm has an elongate, flattened and slightly channelled fleshy proboscis with a markedly bifid tip. The proboscis of a preserved worm of 65 mm body length measures 70 mm with each fork up

to a further 130 mm long. In life the proboscis is extremely protractile, extending 60 cm or more across the surface of the sediment. The rest of the anatomy is as described by Stephen (1956). The genital groove of the female, however, lies posterior and not anterior to the nephridial openings as is stated by Stephen & Edmonds (1972). The body and proboscis are green in life, the colour fading to a dull grey-brown in formalin.

The echiurans are fairly common in sheltered sealochs, occurring in densities of up to 1 per m^2, most often in stony sediment of fine sand and mud between 10 and 30 m depth. Collection of a specimen in Loch Alsh using an air lift showed the animal to occupy a burrow with a smooth vertical shaft about 20 to 25 cm deep, which turned sharply through 90° to run horizontally for a further 30 cm or so. A combination of the burrow's depth and the stony nature of the sediment much reduces the chance of its collection by remote sampling gear, and the worm is extremely difficult for divers to collect without the aid of an air lift to remove the surrounding sediment.

The long bifid proboscis, quickly retracted when approached, is a characteristic feature from which to identify this echiuran *in situ* and it seems most probable that previous records of *Bonellia viridis* from Scottish sealochs should now be attributed to *A. eddystonense*. A full list of records, from north to south, is therefore considered to be:

Location	Source	Comments
Loch a'Chairn Bhain	Davies, 1989a	
Loch Glendhu	Davies, 1989a	
Loch Dunvegan, Skye	Holt, 1988	As *Bonellia viridis*
Loch Sligachan, Skye	Hiscock & Covey, 1990	
Caolos Pabbay, Skye	Hiscock & Covey, 1990	
Loch Alsh	Connor, 1989	Collected by diver-operated air lift.
Loch Duich	Connor, 1989	
Loch Hourn	Breen *et al.*, 1986	As "echiuran sp."
Loch Nevis	Breen *et al.*, 1986	As "echiuran sp."
Loch Nevis	MNCR unpubl. data	Diver-collected specimen
Loch Ailort	Howson, 1990	
Loch Sunart	Mackinnon & Lumb, 1988	As *Bonellia viridis*
Loch Sunart	Davies J., 1990	
Loch Fyne	Davies M., 1989b, 1990	
Galway Bay	O'Connor & Mulligan, 1977	Specimens from fish guts. Species not recorded during extensive benthic surveys. Specimen in National Museum of Ireland (NMI 41.1977) examined.
Plymouth	Stephen, 1956	Type locality. Specimens collected by dredge. Type specimen not located at British Museum (N.H.)

The two specimens from Loch Nevis and Loch Alsh are deposited in the Ulster Museum (Accession numbers BELUM Mp1 and Mp2)

References

Breen J.P., Connor D.W. & McKenzie J.D., 1986. A marine survey of Loch Nevis and Loch Hourn, western Scotland. Glasg. Nat., 21; 153-172.

Connor D.W., 1989. Survey of Loch Duich, Loch Long and Loch Alsh. Nature Conservancy Council, CSD Report No. 977 (Marine Nature Conservation Review report MNCR/SR/010/89)

Davies M., 1989a. Marine Nature Conservation Review surveys of Scottish sea lochs: Lochs a'Chairn Bhain, Glendhu and Glencoul. (Contractor: University Marine Biology Station, Millport). Nature Conservancy Council CSD Report No. 983.

Davies M., 1989b. Marine Nature Conservation Review surveys of Scottish sea lochs: Loch Fyne. (Contractor: University Marine Biology Station, Millport). Nature Conservancy Council CSD Report No. 984.

Davies M., 1990. Marine Nature Conservation Review surveys of Scottish sea lochs: Towed video survey of Loch Fyne. (Contractor: University Marine Biology Station, Millport). Nature Conservancy Council [Field Report].

Davies J., 1990. Sublittoral survey of Loch Sunart and Loch Teacuis. Nature Conservancy Council CSD Report No. 1075. (Marine Nature Conservation Review report MNCR/SR/03/90)

Hiscock S. & Covey R., 1990. Marine biological surveys around Skye. Nature Conservancy Council CSD Report No. 1076. (Marine Nature Conservation Review report MNCR/SR/004/90)

Holt R.H.F., 1988. Seasearch survey of the sealochs of north Skye. (Contractor: Marine Biological Consultants Ltd). Nature Conservancy Council CSD Report No. 897. (Seasearch Report SS/1/1988).

Howson C., 1990. Marine Nature Conservation Review surveys of Scottish sea lochs: sea lochs of the Sound of Arisaig and Ceann Traigh. (Contractor: University Marine Biology Station, Millport). Nature Conservancy Council [in press].

Mackinnon M.C. & Lumb C.M., 1988. Loch Sunart sublittoral survey. (Contractor: M.C. Mackinnon). Nature Conservancy Council CSD Report No. 794.

O'Connor B. & Mulligan M., 1977. *Amalosoma eddystonense* (Echiurida: Bonellidae), an echiuroid new to Ireland. Ir. Nat. J., 19; 97.

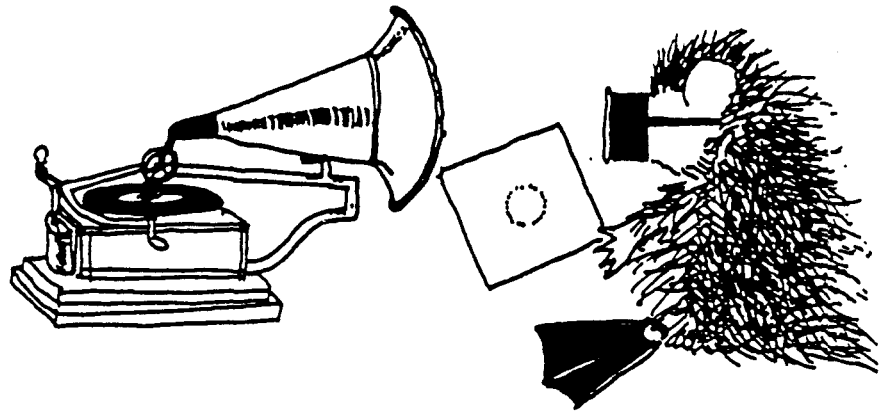
Stephen A.C., 1956. *Amalosoma eddystonense* sp. n., a new species of Bonelliidae. J. mar. biol. Ass. U.K., 35; 605-608.

Stephen A.C., 1960.British echiuroids, sipunculoids and priapulids with keys and notes for the identification of species. Linnean Society of London Synopses of the British Fauna, 12; 27pp.

Stephen A.C. and Edmonds S.J., 1972. The Phyla Sipuncula and Echiura. London, British Museum (Natural History), 528pp.

* * * *

new records



A less than welcome new record, the Chinese Mitten Crab, *Eriocheir sinensis*, was recorded for the first time from the Medway Estuary, Kent, England, this Spring. Four adult specimens were collected by John Fleming from the cooling water intake filter screens of Kingsnorth Power Station, including a berried female. The latter was kept alive for some weeks at Fawley Marine Biology Lab, and survives (when last examined) minus the eggs (which failed to develop) at Southampton University Oceanography Dept., ready to entertain visitors.