Porcupine Newsletter

Volume 5 Number 5

AUGUST 1992 ISSN 0309 - 3085

CONTENTS

Roger Bamber, Hon. Editor
FAWLEY aquatic research laboratories Ltd
Marine & Freshwater Biology Unit,
Fawley, Southampton SO4 1TW, U.K.

PORCUPINE

Hon. Secretary
Ian Killeen
163 High Road West,
Felixstowe IP11 9BD, U.K.
0394 274618

Hon. Treasurer
Jonathan Moore
FSCRC, Fort Popton, Angle,
Pembroke, Dyfed SA71 5AD, U.K.
0646 641404

EDITORIAL

Regarding the reports from the Oban meeting presented in this issue, the nice thing for our Society about deep-sea meetings/papers, etc., is that the word **Porcupine** tends to crop up a fair bit - how many societies have a bank named after them (other than Lloyds!)? I recently visited Chatham Dockyard, wherein the museum does decent coffee and prides itself on its knowledge, both mental and archival, of Royal Navy and other vessels from HMS protodugout onwards. So I asked about HMS *Porcupine* - and they knew nothing!! In a bout of caffeine-induced euphoria I think I undertook to tell them what we know - well it could be useful publicity.

On climate change, Mike McCarthy reports in The Times (24 August) on species of fish normally resident in more southerly waters whose occurrence has increased in recent years in British waters. Useful information to elaborate at the **Porcupine** autumn meeting, being appropriate to its theme (see P.95). I wonder what information may exist on effects of the recent spell of warmer years (global warming or not) on less errant invertebrates - of either zoogeographic inclination. Certainly the northern beach amphipod species *Bathyporeia sarsi* suffered a recruitment failure in the Solent during the warm summer of 1989, while its sympatric and more southerly distributed congener *B. guilliamsoniana* carried on as normal. We would like to hear from readers who may have further information on such trends (see also **PN**, 5; p.91).

I would also like to receive any and all contributions for your Newsletter - the next issue will appear in December, as long as your articles appear in my in-tray in time.

*** FUTURE MEETINGS ***

The 1992 Autumn Meeting will be held on 24-26 October 1992 at the Cornish Biological Records Unit at Pool, Redruth, Cornwall, on the theme of "Southern Species". There is still plenty of time to register for this meeting, particularly if you would like to offer a paper. Please see the first circular which was sent out with the April issue of **Porcupine Newsletter**, and contact Ian Killeen (address above) for any details. All those who have already responded to the first circular will be sent full details with information on accommodation, etc. in late September.

The 1993 Spring Meeting and 16th Annual General Meeting will be held on 13-14 March 1993. In response to requests for a meeting to be held in a more central location, this meeting will take place in Peterborough, hosted by the Joint Nature Conservation Committee (Marine Nature Conservation Review) and will be on the theme of "Coastal and Inshore Marine Communities: Conservation and Coastal Management". Initial enquiries should be addressed to David Connor on 0733 62626.

*** ***

95

WHY IS IT IMPORTANT TO STUDY RATES IN THE BIOLOGICAL PROCESSES IN THE DEEP SEA?

John D. Gage

Dunstaffnage Marine Laboratory, P.O. Box 3, Oban, Argyll PA34 4AD

Statistics on the deep ocean are an exercise in superlatives. Ninety per cent of the two-thirds of the surface of the earth covered by sea lies beyond the edge of the continental shelf, with the deep ocean containing 97% of the water on this planet. It represents a vast resource of hydrocarbons, minerals, renewable energy and chemicals along with its more traditional roles in transport, defence, communication and recreation. We now also have to add the recently perceived influence on the global climate. It also may not be generally appreciated that the vast majority of that area of deep-sea bed beyond the continental shelves which falls within the territorial jurisdiction of the United Kingdom lies to the west of Scotland in the Rockall Trough.

Yet knowledge of the biology associated with the largely sediment-draped floor of this vast area of the solid face of our planet is still rudimentary, with a history of little more than a hundred and fifty years. However, we are now at an exciting period in study of deep-sea biota. Present studies reflect a change in emphasis from the traditional large-scale descriptive studies. On those, one went out on a (usually summertime) research cruise with a track aiming to take samples from widely spaced points in order to cover as much of the deep-sea bed as possible and thence map faunal distributions. In contrast, modern research tends towards detailed studies at one spot addressing the processes going on there. Why is it important to study processes, and particularly their rates, in the deep sea?

Firstly, because of its area, biogeochemists now view the deep-sea bed as a vast sump for carbon sedimented from the ocean's surface. Hence, ignoring the activity of the inhabitants of the sea bed may lead to false assumptions and an incomplete picture of the global carbon cycle and implications of rising atmospheric carbon dioxide.

The second reason why we cannot ignore the biology of the deep sea is because of the increasing importance of understanding the processes underlying the maintenance of the incredibly rich species diversity discovered amongst the smaller-bodied animals inhabiting the deep-sea sediments. It remains little known outside of the scientific community that this biodiversity seems easily to rival the species richness of the tropical rain forest or coral reef. This may seem largely academic, but may even have a commercial significance, as I will explain later.

This all seems a far cry from our past perceptions of the deep sea as a remote and forbidding environment. Until the exploratory voyages of the 'Lightning', 'Porcupine' and 'Challenger' in the 1970s, the prediction was that life would not be found at depths greater than 300 fathoms. The 'Challenger' soon proved this to be wrong in numerous dredgings of deep-sea animals from the greatest depths then attainable. This expedition, although close to the cutting edge of science at the time, did little to project deep-sea organisms as anything more than remote and rather abstract oddities in the catalogue of life. Even the fondly nurtured notion of the deep sea as a repository of archaic or monstrous forms of life long extinct elsewhere (which notion persisted long after the results of the 'Challenger' expedition should have consigned it to a decent burial) has only slowly been extinguished from the minds of biologists and of the public.

It was not until the 1960s and 1970s that modern concepts in deep-sea biology began to unfold. Howard Sanders and Robert Hessler at the Woods Hole Oceanographic Institution in the U.S. revealed, by use of fine-meshed trawls and large box corer samplers, the startling species richness associated

96

with deep-sea sediments which provides such a huge challenge to taxonomists just to describe let alone to explain! Although high species richness remains a surprising fact, it was then thought that the most likely explanation lay in the perceived constancy of the deep-sea environment, where not only does light fail to penetrate to provide any day or night but also temperature varies less than a tenth part of a degree. In this tranquil environment, species were free of the stress of having to adapt to changing conditions and could evolve into numerous, highly specialized, but efficient specialists, each slightly different from the other, in order to make nest use of the limited resources.

Along with this idea there was another largely intuitive view (resulting from the low density of animal life and the sparse amount of available food) that the deep sea is an ecosystem with very low rates of biological activity. The idea received a tremendous boost from the "'Alvin' sandwiches" incident in 1968. The 'Alvin' is the best known of the deep-diving manned research submersibles and is operated by the Woods Hole Oceanographic Institution in the U.S.A.. One day the sub was accidentally dropped from her mother ship into deep water. It took almost a year to get her back again from 1,540 m of water, but when it was raised they found the pilot's salami sandwiches, flask of soup and apple left inside were still almost in edible condition. This led to various *in situ* incubations of various substrates on the sea bed for long periods of time, the results showing rates of microbial decomposition less than 2% of that at the surface. Another very influential piece of research employed the then new technique of radiometric dating (using decay rates of naturally occurring isotopes in the tissues and skeleton of the animal). This concluded from sampling the shell of a minute bivalve mollusc dredged from 3,800 m depth that it was around 100 years old!

The implications of this view of extremely slow rates in life processes in predicting the sensitivity of these highly diverse communities to disturbance by mining or dumping were obvious. Clearly recovery rates would be very slow indeed! What is more, the highly specialized fauna would be much less resilient to the stress of even small perturbations than fauna elsewhere. This was the scene just ten or fifteen years ago. Does it still stand up?

The last decade has seen a marked change in our perception of conditions for life in the deep sea which must have important implications to the view of what was thought to be a particularly vulnerable ecosystem. We now know that the deep sea is not nearly such a constant and tranquil environment as was thought. And with this changed view of the environment has come a different perception of the deep-sea fauna. Deep-sea oceanographers from NERC laboratories at Oban and at the Institute of Oceanographic Sciences' Deacon Laboratory at Wormley, Surrey, have been active and largely instrumental in this changing view of deep-sea biology.

We now know that diurnal variations in bottom current occur, caused by deep-sea tides. Further, there may be major hydrodynamic disturbance, resulting in massive sediment resuspension, caused by benthic storms which result from the kinetic energy in eddy vorticity (analogous to the swirling patterns seen in the isobars of weather charts) transmitted right down to the abyssal seabed. These may be of widespread occurrence, and suggest a hydrodynamic regime far more energetic and subject to much more episodic variation than previously imagined. Of perhaps at least equal significance to the deep-sea biota has come the discovery that seasonal changes occurring at the ocean's surface are rapidly transmitted right down to the bottom.

Sedimentation chambers were set near the bottom to collect the slowly falling detritus, but, instead of relying on just one deployment to measure the amount of material collected, the chambers were set at three-monthly intervals through the year. The results showed that a clear pulse of material, mainly in the form of aggregates of particles, could reach the greatest depths after the spring bloom of phytoplankton. Soon afterwards, scientists at the Institute of Oceanographic Science at Wormley obtained a remarkable visual confirmation of this transmission of seasonality to the floor of the deep

97

ocean from a time-series of photographs taken by a time-lapse camera system mounted on a recoverable "free-vehicle" at 4,000 m depth on the seabed. These records showed the dramatic change in appearance as a result of a thick carpeting of a "fluff"-like layer of phytodetritus lying over the seabed, whose appearance followed the spring bloom in phytoplankton production at the surface by just a couple of weeks or so.

At Oban we had discovered, two or three years previously, another unexpected seasonality in the reproduction of some of the most numerous of the little bivalve molluscs and brittle stars living on the deep sea bed. These findings came from examination of a unique time series of samples that we had started taking in the deep water of the Rockall Trough. But we found few people who would believe that our findings had any general relevance to the deep sea until the data on fluff and the seasonal signal from sediment collectors was published a few years later: this prompted a realization that perhaps the deep sea might show a biological response to this marked seasonal pulse in input of food for the biota living there.

More data on coupling between deep-sea biology and the seasonally pulsed downward flux are now emerging. For example, data from the deep N.E. Atlantic seabed have indicated that populations of benthic foraminiferans expand dramatically in numbers within 1 to 2 months of the phytodetritus arriving at the seabed. German oceanographers have recorded the response in terms of a rapid increase and subsequent downward movement of chlorophyll pigment, which developed in the sediment in just a few days. This downward movement was in fact reflecting the feeding activity of burrowing worms vacuuming up the material from the sediment surface using their trunk-like feeding organs.

How then do we equate these results with the observed low rates of microbial activity? Although particulate organic matter has clearly been shown to display decreasing microbial activity with depth, in line with the 'Alvin' sandwiches, more recent observations showing the phytodetrital floc from the bottom to host vigorous microbial activity after the spring bloom suggest colonization by specialized barophilic heterotrophs *after* the material reaches the bottom. It has also been found that the most active sites of microbial activity lie within the guts of deep-sea animals where they exist in a sort of symbiotic relationship with the host animal to ensure maximum utilization of often low-quality food. So, no wonder that measured rates of microbial degradation were so slow; not only was it not being measured when suitable substrate was available after sedimentation from the surface, but to some extent also in the wrong place, i.e. not in the guts of metazoan animals. As a result, previous estimates of the rate of carbon turnover through bacterial biomass which were slow - up to about 200 days - have been revised upwards, although interestingly rates may remain lower than in shallow water.

As I mentioned earlier, the importance of such data lies in the role of the deep-sea bed in the enormous amounts of carbon passing through the oceans in the global carbon cycle. This component is of supreme importance in our debate of the effects of rising carbon dioxide levels in the atmosphere. Hence the summed activity of the deep-sea benthic community over the vast area of the deep-sea bed may well turn out to be significant with respect to global scale equilibria between the atmosphere and the oceans.

However, the dynamics of the larger organisms remain largely uninvestigated. Research in this area is now increasing in pace, although, like all deep-sea research, it remains an expensive and logistically difficult undertaking to measure rates of anything in the deep sea. In measuring growth rates and recruitment, the discovery of seasonality has had a happy spin-off. This has come about through the not unreasonable discovery, from comparison of the size frequencies of species in our time series of samples from the SMBA permanent stations in the Rockall Trough, that the seasonally reproducing species seem to show a seasonally fluctuating growth. Such behaviour is, of course, the norm amongst shallow water marine animals, which may stop growing completely in the winter. As

98

a result the shells of such animals as the cockle, or the auditory ossicles of fish, show characteristic annuli or growth rings corresponding to these periods of growth stoppage. Although in the past this phenomenon has been linked to the temperature cycle, more recent research has shown such seasonal variation to be controlled mostly by food availability and breeding. In the deep sea too, investigations have turned up growth band patterns apparently very similar to those shown by shallow water relatives.

TABLE 1: Our Changing view of the Deep Ocean

1960s to 1970s view

The deep-sea environment: virtually unchanging temperature; no light; little or no water movement; sparse though constant 'drizzle' of food particles from the surface.

Deep-sea speciation: divergence into numerous narrowly specialised co-existing species, thereby avoiding competitive exclusion.

Biological rates: extremely low rates of recruitment, growth and respiration; low fecundity and long life-spans; low rates of mortality; size and age structure dominated by largest size classes and oldest individuals.

1980s to 1990s view

The deep-sea environment: physical regime relatively constant but subject to intermittently vigorous hydrodynamics, e.g. benthic 'storms'; seasonal periodicity in flux of particles from the surface, i.e. occasional 'downpours' of food.

Deep-sea speciation: divergence into a wide variety of species with rather similar lifestyles; direct competition is minimized by *disturbance* and *patch dynamics*. This occurs through a patchy development of populations which are not allowed to exist long enough to exhaust resources before disturbance creates a new open patch. This is open to random recruitment by water-borne larvae of a wide range of possible species in this 'open' environment.

Biological rates: no single life-history strategy characteristic of the deep sea; rates of growth, recruitment and survivorship show a range as wide as that found in shallow water; short term rates, such as respiration and feeding, can respond rapidly to seasonal periodicities in downward flux of food particles.

On the still untested, but nevertheless likely, assumption that growth bands in the deep sea have a causal basis similar to that in shallow water, it has been possible to investigate the population dynamics of the most abundant species in the community. The methods employed estimate growth either by tracking recruitment modes along the size axis of a seasonal sequence of size-frequency distributions, or by relating growth bands to the size of the animals. In some cases it has been possible to do both and, gratifyingly, the results have not conflicted. The development of optimised models to

99

represent population dynamics has permitted use of the data in estimating for the first time secondary production in the deep-sea benthos. Estimates for the whole of the macrobenthic sediment community, although rather uncertain, indicate that somatic production represents around 3 to 12% of estimated total respiratory carbon uptake of the sediment community.

Let us return to the high species richness associated with the deep-sea bed. Understanding how such biodiversity is maintained in the deep sea will be essential if predictions of environmental sensitivity are going to be anything more than empirical guesses. Certainly, the nooks and crannies of coral reefs and the complex canopy tiering of the tropical rain forest make them intuitively easier to equate with a rich variety in niche specialization supporting a large number of different species. But even in these habitats it has been found that periodic natural disturbance may operate in structuring the community. For example, tree falls, by creating patches of under-utilized habitat followed by a random sequence of recolonization, are thought to provide equally as plausible an explanation for so many co-existing species in the rain forest as do assumptions of narrow niche specialization. Such a complex network of patches, each at its own unique and largely randomly determined stage in development towards utilisation of available resources, may help to explain why the deep sea is so rich in species. The patches may be created initially by grazing disturbance from the passing of a large "vacuum-cleaner" sea-cucumber or by the burrow mound of a large worm. Similar patch creation may take place on other muddy bottoms, for example on estuarine mud-flats. But the latter habitat will not be so rich in species not only because of the physical stresses, such as periodic exposure and varying salinity, but also because of the much more circumscribed area of potential recruitment by water-borne larval stages.

TABLE 2: Sources and scales of biological disturbance at the sea bed.

Large Scale (least effective in promoting high species diversity)	**Small Scale** (most effective in promoting high species diversity)
Benthic Storms	Foraging by large megabenthos and fish
Strong currents	Bioturbation by large burrowed animals
Slumps and slides	Patchy distribution of phytodetritus

In deciding on future research priorities, clearly the route ahead should include *in situ* experimentation to test various assumptions embodied by these hypotheses. It will be of equal relevance to understand the role of natural disturbance in structuring the extremely diverse deep-sea benthic community, particularly in relation to understanding how resilient the deep-sea communities are going to be to perturbation by man.

However, a final word of caution. A critical shortage in scientists with taxonomic expertise to describe this biodiversity is already making itself evident; until a greater emphasis is placed on this area of science we are going to remain largely ignorant of this remote but rich pool of biodiversity. It is not premature to point out a strategic value in conserving this genetic diversity in order to anticipate discovery of new medicines as have already been found from organisms from the rain forest and coral reef. Certainly, discoveries of thermophilic methanogenic bacteria and mat-forming sulphur-reducers from deep-sea hydrothermal vents are of great interest to biotechnologists. Research to understand better the mechanisms maintaining this pool of species on the deep-sea bed may therefore have more then just academic interest!

HYDROGRAPHY AND VARIABILITY WEST OF SCOTLAND

by D.J. Ellett

Dunstaffnage Marine Laboratory, Oban

In the past twenty years the Dunstaffnage Marine Laboratory (DML) has played a large part in defining the main features of the hydrography of the waters in the western approaches to Scotland. Regular cruises, mostly aboard RRS *Challenger*, have examined the deep water of the Rockall Trough, the slope zone and shelf and sea-loch regimes. Investigations have ranged from Faroe Bank in the north to Porcupine Bank in the south. Emphasis has been not only upon describing the hydrography, but particularly upon determining its variability.

NE Atlantic Waters

DML subsurface data have been collected upon a section from Mull to Rockall since 1975 (Ellett *et al.*, 1986), but a good time series of surface temperature and salinity observations goes back to 1948, when the UK Ocean Weather Ships began crossing the area. The data show the 1950s as a warm decade, the 1960s as cooler with marginally higher salinity, the 1970s as still cool but with much lower salinity, and the 1980s as cool with rather low salinity in spring and summer. Anomalies of the monthly salinity means from 1961-70 values (Figure 1) show the freshening of the 1970s which resulted from the "Great Salinity Anomaly" (Dickson *et al.*, 1988) which circulated around the N. Atlantic subpolar gyre between 1968 and 1982. From late 1989 the figure shows the rise in salinity associated with reports of unusually saline conditions in the northern North Sea (Heath *et al.*, 1991).

Subsurface data show only small trends in temperature during 1975-89, but in 1990 there are indications of cooling at the deeper levels of the Rockall Trough. At upper levels, salinity shows the recovery from the low values of the 1970s, but in contrast lower depths show a fall from 1985 onwards, culminating in notably low salinities at 1600-1800 m in 1990. Water at these depths originates from the Labrador Sea, where two periods of freshening have been noted in recent decades. Wallace

101

& Lazier (1988) observed unusually fresh and cold water there in 1986, but a previous event was the resumption in 1972 of deep water convection after being blocked by the Great Salinity Anomaly. Appearance of these signals in the Rockall Trough would give speeds of advection of about 2.4 km/day and 0.6 km/day respectively. Data in the previous decades from the weather station formerly at the southern entrance to the Rockall Trough (Ellett, 1982) appear to support the slower rate, so that the 1990 deep freshening probably represents the after effects of the Great Salinity Anomaly.

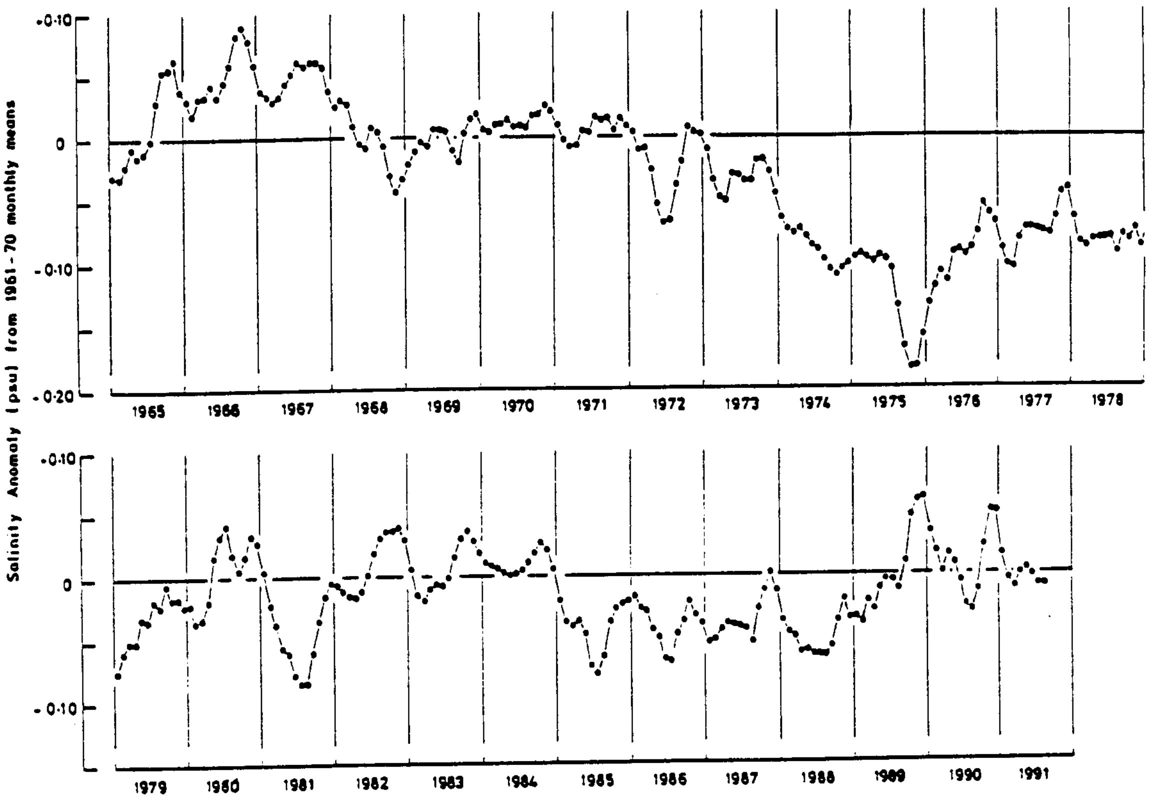


Figure 1. Mean monthly surface salinity anomalies from 1961-70 monthly means for the Rockall Trough (56°-57°N), smoothed by a 3-month running mean.

The Slope Current

An unusually constant feature of the Scottish seas is the current which follows the isobaths of the slope zone west of the Hebrides (Figure 2). DML current meter moorings were first deployed there in 1979 and showed a northward flow, steady in direction, even at depths above the constraining influence of the topography (Booth & Ellett, 1983). Subsequent joint investigations have confirmed that a slope current exists along the whole extent of the UK continental margin, being broader and slower in the south and faster and narrower in the north, although carrying about the same volume of water throughout, estimated at 1.5 million tonnes/sec (Huthnance, 1986). Satellite-tracked drogues have demonstrated that the slope current follows the western flank of the Norwegian Rinne into the northern North Sea (Booth & Meldrum, 1987).

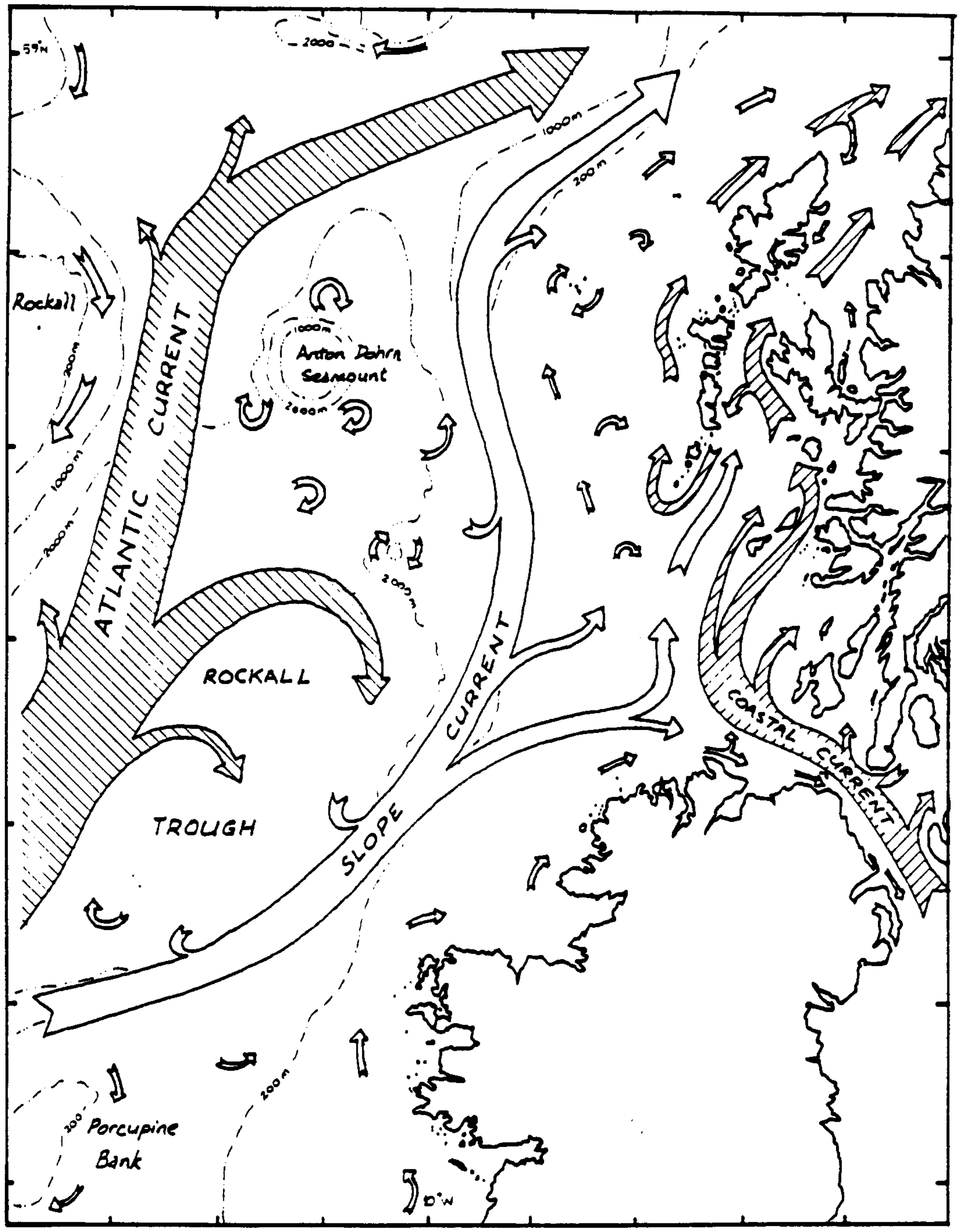


Figure 2. A sketch of the main current paths to the west of Scotland

103

The Shelf Waters

The coastal current through the North Channel retains a relatively high salinity from its Atlantic origins in the Celtic Sea. Between Galloway and Cape Wrath its volume is more than doubled by the input of oceanic water from the outer shelf (McKay *et al.*, 1986), but the freshwater contribution (Barnes & Goodley, 1958) is small, due to the predominantly eastward drainage from the western mountains. Where tidal streams are strong, such as in the North Channel, the Little Minch, west of Islay and around Barra Head, the water column is well-mixed, but in deeper areas with weaker tides stratification develops in summer. Between mixed and strongly stratified areas fronts occur, the most marked being west of Islay (Pingree *et al.*, 1978; Simpson *et al.*, 1979). In the North Channel mixing penetrates to 260 m even in summer, as was shown by the penetration of ^{134}Cs from the Chernobyl accident to this depth a month after the fallout reached Britain (Bradley *et al.*, 1989).

The adjoining outer waters of the Firth of Clyde show an interesting annual cycle (Edwards *et al.*, 1986). In winter, the greater salinity of the North Channel and the enhanced cooling promoted by mixing provide dense water over the sill between Kintyre and Galloway. Some of this water subsides into the deep channel which surrounds all but the southern coasts of Arran, displacing water of lesser density which may have survived from the end of the previous winter. Development of a thermocline in summer and decreasing density in the North Channel again isolate the bottom waters of the Arran Deep and Kilbrannan Sound until the following winter.

After leaving the North Channel, studies of ^{137}Cs show that the coastal current stays close to the coast in its northward progress. Although stratification processes are removed by winter gales, the Islay front persists at this season as a sharp boundary between the coastal water and oceanic water (Economides *et al.*, 1985). The larger proportion of the current passes between Coll and Mull through the Tiree passage and DML have maintained a current meter mooring here during the last decade to monitor the flow. Again a significant seasonal pattern occurs, with winter volumes passing through the passage being 3-4 times those of summer, reflecting the seasonal cycle of wind strength and its prevailing southwesterly direction.

Between the Sound of Mull and the shelf edge, ten stations have been sampled quarterly since 1975, and show surprising differences between adjoining positions. At station C1 within the Sound, salinity variation of monthly mean values for 1975-86 is large (0.70 psu) and broadly corresponds to what would be expected from the local rainfall regime (Figure 3). Only 10 km to the west of this at C2 in the Tiree Passage the annual mean salinity range was reduced to 0.19 psu, but subsequently increased westwards until near-oceanic conditions were reached upon the outer shelf. This confirms that the flow through the Tiree Passage is consistently of coastal current water, whereas to the west between Coll and Barra Head fluctuating proportions of coastal and oceanic water occur.

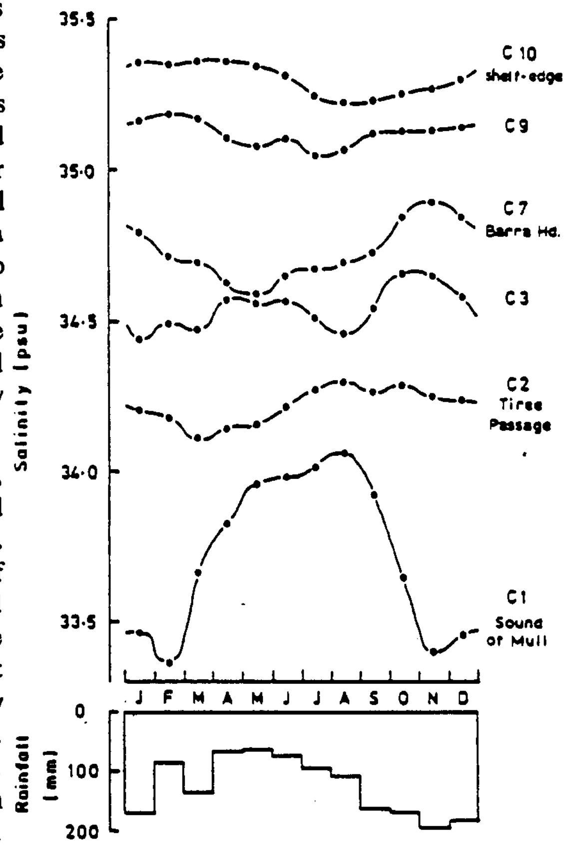


Figure 3. Mean monthly surface salinity, 1975-86, at stations upon a line from the Sound of Mull (C1) to the shelf-edge west of Barra (C10). Lower panel shows Dunstaffnage mean monthly rainfall, 1971-86

A notable event in the UK west coast system was observed upon this section following the flushing in late 1976 of the Irish Sea by a low-salinity pulse which passed C" in early 1977, had reached Barra Head a month later, and the shelf-edge by midsummer.

In autumn and winter, Atlantic water spreads further eastwards on to the shelf in the area between Malin Head and Barra Head and northwards into the approaches to the Minches (Ellett, 1979). One consequence of this is that cool, saline water sinks into depressions on the shelf and, if tidal mixing is weak, can remain undisturbed when the thermocline reforms above it in spring. An extensive area of water deeper than 200 m some 10 km east of Barra Head offers an example (Figure 4). In mid September 1979 water of temperature less than 9.5°C had survived below 150 m from the preceding winter; six weeks later the temperature was close to 12°C throughout the water column, reflecting the action of autumn gales and, although the salinity section shows that stratification had been temporarily re-established in the upper layers, salinity had risen in the deep (Ellett & Edwards, 1983).

Annual variations on the shelf west of the Outer Hebrides are rather similar. At all levels temperature falls to a minimum in late March or early April, followed by a sharp rise for a few weeks whilst intermittent wind-stirring still penetrates the water column. However, stability increases rapidly at the surface and heat is only slowly transmitted downwards during the summer, lower levels only attaining their annual maxima when autumn winds break down the thermocline and mix downward the accumulated heat of the upper layers. Thus the maximum at 130 m depth occurs typically in November-December (Ellett, 1979).

Conclusion

This hydrographic journey "from the abyss to the shelf" has demonstrated some of the many fascinating physical processes to be found in the near approaches to Scotland's west coast. Their relevance to the fluctuations of living resources and to climate changes provides an impetus to the study of their variability beyond the delights of curiosity.

References

Barnes H. & Goodley E.F.W., 1958. Glasgow Naturalist, **18**; 45-54.

Booth D.A. & Ellett D.J., 1983. Continental Shelf Res., **2**; 127-146.

Booth D.A. & Meldrum D.T., 1987. J. Cons. int. Explor. Mer, **43**; 261-267.

Bradley P.E., Economides B.E., Baxter M.S. & Ellett D.J., 1989. *In:* Radionuclides, a tool for Oceanography (Guary *et al.*, Eds.); pp.281-293.

Dixon R.R., Meincke J., Malmberg S.A. & Lee A.J., 1988. Prog. Oceanogr., **20**; 103-151.

Economides B.E., Baxter M.S. & Ellett D.J., 1985. ICES **CM 1985**/ C:24; 10pp.

Edwards E., Baxter M.S., Ellett D.J., Martin J.H.A., Meldrum D.T. & Griffiths C.R., 1986. Proc. Roy. Soc. Edinb., **90B**; 67-83.

Ellett D.J., 1979. Proc. Roy. Soc. Edinb., **77B**; 61-74.

Ellett D.J., 1982. Wld Climate Progr. Rep., **WCP 21**; 245-254.

Ellett D.J., Edwards A. & Bowers R., 1986. Proc. Roy. Soc. Edinb., **88B**; 61-81.

Ellett D.J. & Edwards A., 1983. Proc. Roy. Soc. Edinb., **83B**; 143-160.

Heath M.R., Henderson E.W. & Slesser G., 1991. Nature **352**; 116.

Huthnance J.M., 1986. Proc. Roy. Soc. Edinb., **88B**; 83-101.

McKay W.A., Baxter M.S., Ellett D.J. & Meldrum D.T., 1986. J. Environ. Radioact., **4**; 205-232.

Pingree R.D., Holligan P.M. & Mardell G.T., 1978. Deep-Sea Res., **25**; 1011-1028.

Simpson J.H., Edelsten D.J., Edwards A., Morris N.C.G. & Tett P.B., 1979. Est. Coast. Shelf Sci., **9**; 713-726.

Wallace D.W.R. & Lazier J.R.N., 1988. Nature, **332**; 61-63.

Porcupine Newsletter, 5 (5), 1992.

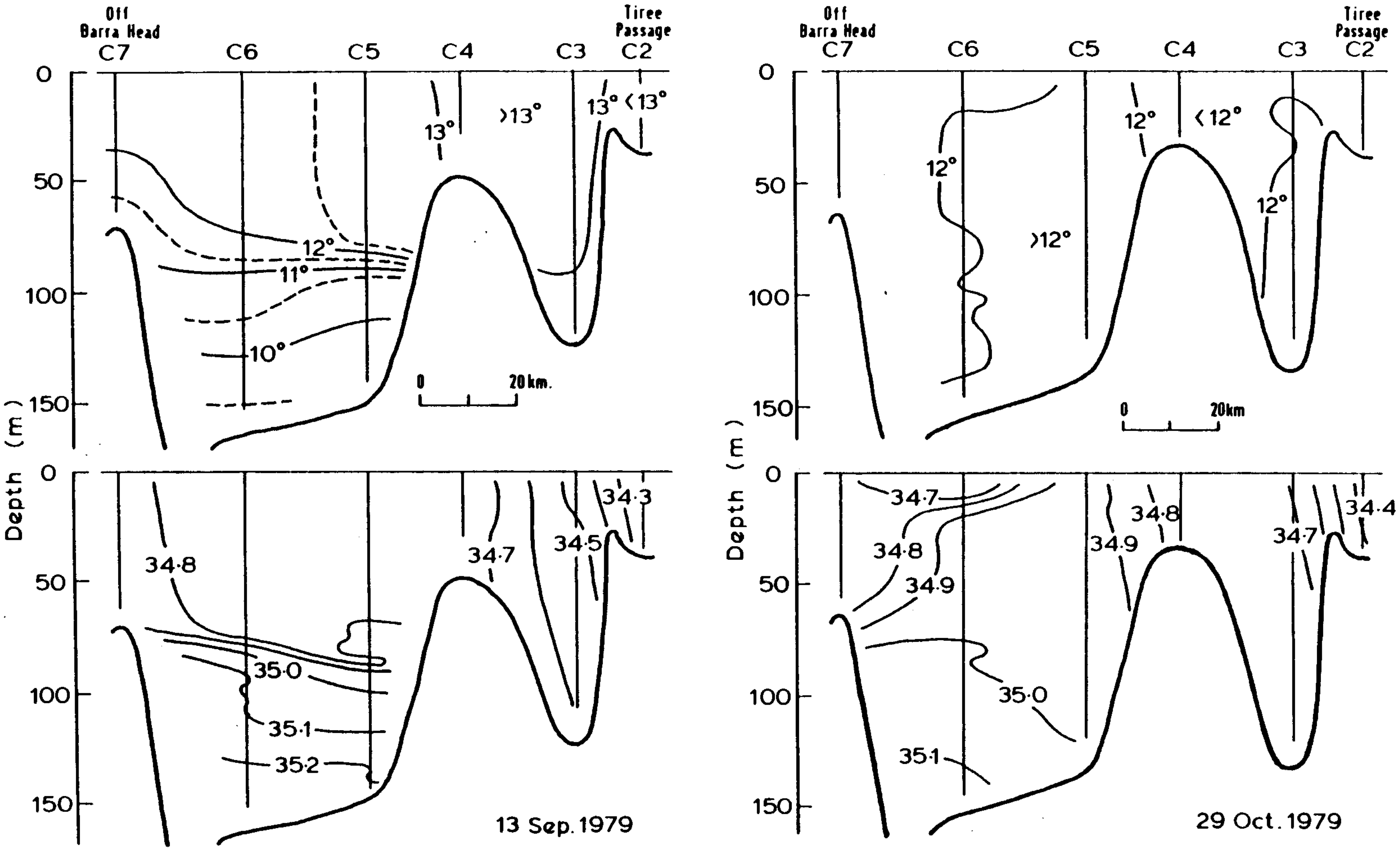


Figure 4. Temperature and salinity sections from Coll to Barra Head, autumn 1979 (Ellett & Edwards, 1983).

106

ABSTRACTS FROM OTHER PRESENTATIONS

BAITED TRAP STUDIES ON GAMMARIDEAN AMPHIPODS FROM BATHYAL DEPTHS OFF NEW PROVIDENCE ISLAND, BAHAMAS.

Lawson, G.S. [1] Young, C.M. [2] & Tyler, P.A. [1]

1. Oceanography Dept. The University. Southampton. SO9 5NH.

2. Harbour Branch Oceanographic Inst. Fort Pierce. USA.

Previous trapping programmes in the deep-sea have used animal carrion as bait. This study attempted to assess the attraction to another food source in the deep-sea, detrital vegetation. In the study area during autumn there is a presumed seasonal increase in the intensity of input of *Sargassum* and *Thalassia* material. Using these macrophyte species as bait, results show two previously unreported observations : i. attraction of amphipods to bait other than animal carrion, ii. the capture of a brooding female in a trap. The absence of amphipods from control traps indicates a chemosensory attraction rather than a shelter response, whereas the variation in species composition between traps with different baits could signify a preference for a particular food type.

ENVIRONMENTAL CHANGES OVER 18,000 YEARS ON THE SHELF NEAR ST KILDA

by J.D. Peacock

18 McLaren Road, Edinburgh EH9 2BN

In studying the recent past, Quaternary workers operating in the shallow seas around the British Isles examine the sediments found in boreholes and use proxy data based on the present day distributions of marine animals and plants (molluscs, ostracods, foraminifers and dinoflagellates) to come to somewhat crude estimates of marine palaeo-temperature, water depth and salinity. Applying this type of evidence to two vibrocores collected south of St Kilda at a depth of about 155 m it can be inferred that the St Kilda basin became free of glacier ice after about 15,000 BP (radiocarbon years ago) and that sedimentation continued in a shallow, low energy, high arctic, muddy environment until after 13,500 BP (Peacock *et al.*, 1992). After a higher energy, somewhat warmer episode that ended about 11,000 BP, there was a return to muddy sedimentation and arctic conditions. Relatively shallow water seems to have persisted into earliest post-glacial times, immediately after 10,000 BP, when water depth was roughly 60 m, still some 90 m below present. This last figure disagrees with the latest geophysical model, which suggests that water depth "should have been" only some 45 m below present in the St Kilda basin at 10,000 BP. Are we interpreting our proxy data too literally? Is the geophysical model, which is based on terrestrial evidence, in error well out on the continental shelf? This is a clear signal for future research.

Reference: Peacock J.D., Austin W.E.N., Selby I., Graham D.K., Harland R. & Wilkinson I.P., 1992. Late Devensian and Flandrian palaeoenvironmental changes on the Scottish continental shelf west of the Outer Hebrides. J. Quaternary Sci., 7; [in press].

107

DEEP-WATER PYCNOGONIDS OF THE NE ATLANTIC: 3-D ZOOGEOGRAPHY

Roger Bamber

FAWLEY arl Ltd, Fawley, Southampton SO4 1TW

All samples which I could find in life or in litt. of deep-water pycnogonids from the north-east Atlantic basin have been analyzed by community statistics. "Recent" material included predominantly samples at the SMBA, Oban and the IOS Deacon Laboratory (part of the Deepseas project), both of whom gave generous access to the material. Zoogeographically, the samples were collected from north of the Equator, south of the Wyville-Thompson Ridge (with a few comparative samples just to the north of the Ridge) and east of the Mid-Atlantic Ridge. 447 samples contained 4171 pycnogonids of 66 species. Despite the fact that only samples containing pycnogonids were analyzed, that often the sampling techniques were unknown and most were not quantitative, the analysis of this data set did show some distinct trends.

Many species showed distributions constrained by latitude and/or depth, but not by longitude. Despite the eurybathic range of a number of species (e.g. *Paranymphon spinosum* from 90 to 3500 m) a distinct change in the pycnogonid species complement with depth was detected at 1500 m (a trend observed in some other taxa in this area). Arctic Basin species (e.g. *Boreonymphon abyssorum*) were present on both sides of the Wyville-Thompson Ridge but extended little further south. Similarly, novel species appeared in the few samples south of the Cape Verde Basin. Within the Northeast Atlantic Basin, deeper species showed a uniform distribution irrespective of latitude, while species occurring in shallower depths showed a division between a "European fauna" (e.g. *P. spinosum*, *Pycnogonum littorale*) and African coast species (e.g. *Nymphon prolatum*, *N. mauritanicum*).

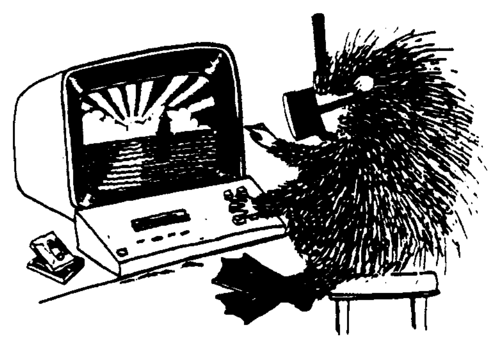
VIDEO PRESENTATIONS

Frank Evans

Frank Evans showed two videos which he had made for teaching purposes. The first was created from a series of 16 mm film shots of captive lobsters taken many years ago at the Dove Marine Laboratory under the direction of H.O. Bull and left there after his death. They were recently transferred to video, edited and a sound track added to make a programme tracing feeding, moulting, copulation, egg-bearing and the production of planktonic larvae.

The second video was intended as a teaching aid on plankton. Over the years Evans videoed the live organisms which he brought into his laboratory as part of his plankton research. Preceded by a sequence demonstrating the sampling of plankton at sea, the various animals and plants were then united on videotape to make a fairly comprehensive portrait of North Sea net plankton.

NB: see also "advertisement" on P. 109.Ed.



108

NOTES & NOTICES

Tributyltin (TBT) is a highly effective biocide that until 1987 was extensively used in antifouling treatments. One of the reasons why TBT is so successful is because it is easily transported across cell membranes. It is one of the organotins and is highly persistent. TBT has been found in the water column, sediments and the surface microlayer. Although there is a partial ban on the use of TBT it is still legally applied to vessels over 25 m in length. This usage of TBT forms a major input into the marine environment. Certain species such as oysters and dogwhelks are very sensitive to TBT. The Marine Conservation Society, with funding from the Department of the Environment, has been using the dogwhelk as an indicator species for TBT pollution for many years. We are carrying on with our survey and so would like volunteers to help. The survey is particularly suitable for small groups to carry out and has been adopted by many school and college groups as a part of their coastal fieldwork. A survey pack is available from Cait Loretto, The Marine Conservation Society, 9 Gloucester Road, Ross-on-Wye, Herefordshire HR9 5BU.

The Wildlife and Countryside Act 2nd Quinquennial review (QQR2), following recommendations by the Joint Nature Conservation Committee, has resulted in the announcement by the Department of the Environment on 15 July 1992 that protection has been extended to a number of potentially endangered species by their addition to Schedule 5 of that Act (1981), including the following marine species:

Thyasira gouldi, Paludinella littorina, Caecum armoricum,
Alkmaria romijni, Eunicella verrucosa, Tenellia adspersa
and *Acipenser sturio.*

Further consideration is also being given to the inclusion of the giant goby (*Gobius cobitis*) and the basking shark (*Cetorhinus maximus*).

Japanese aliens are once again in the news. Specimens (or was it only one?) of the large predatory (molluscivorous) whelk *Rapana venosa* were collected recently by a trawler in the North Sea some 70 miles off Grimsby. A single specimen has been "handed in", but the trawler captain claims "60 others" in his nets. This species originates in Japanese and Chinese waters, although it has been in the Black Sea since 1947 where it is blamed for extensive damage to oyster fisheries. Eminent **Porcupines** have been consulted by the press about this potential threat to North Sea-coast shellfisheries. At present its isolated appearance well out to sea is not a problem. Their arrival is assumed to be by ship-fouling. Interested viewers can see the beast at the Portsmouth Sea Life Centre.

The Polychaete Society is holding a regional meeting at Cardiff from 5 to 8 April, 1993, hosted by the National Museum of Wales and the University of Wales. Despite earlier announcements to the contrary, there is still time to apply, register, submit proposals for oral or poster presentations or whatever takes your fancy. Contact Dr C. Mettam, Polychaete Society Meeting, School of Pure and Applied Biology, University of Wales College of Cardiff, PO Box 915, Cardiff CF1 3TL.

109

Porcupine Ads.

VIDEOS MADE BY FRANK EVANS and available for hire or purchase from Mrs D.A. Croydon, Resources Section, Audio Visual Centre, The Medical School, University of Newcastle on Tyne NE2 4HH, from whom a catalogue of all AVC videos is available.

Cost: Hire (7 days, UK only) - £12; Sale: VHS £37, Umatic £49

1. "**Mechanism of Ocean Tides**", 19 minutes. Presents tidal definitions and tidal theory to an audience assumed to have no previous knowledge of tides. Using figures of the moon, sun and earth, spring and neap tides, semidiurnal and diurnal tides are explained in terms of tractive forces and the equilibrium tide. From there, modern theories of resonance are illustrated, starting with water waves in an oblong bowl and moving on to real tides in the ocean.

2. "**Mechanism of Ocean Waves**", 15 minutes. The confused waves found in a gale at sea are shown experimentally to be made up of a cumulation of simple waves of various wavelengths. Aerial and tank scenes show how energy is distributed in each wave. The effect of fetch in a small lake and at sea is illustrated. Wave action on an eroding coast is seen both from the air and in close detail. Wave action on marine life in sheltered and exposed situations is portrayed. Throughout the film animated diagrams and simple formulae are used.

3. "**Ocean Plankton**", 17 minutes. Net plankton taken in the North Sea is brought living into the laboratory to be examined under the microscope. The process of capture is seen, followed by a full-screen viewing of a comprehensive assemblage of plants and animals. The annual succession of phytoplankton is shown, accompanied by zooplanktonic larvae and subsequent adult forms, both planktonic and benthic. Species are labelled on screen.

4. "**Oceanic Fish of the Tropical Atlantic**", 30 minutes. A portrayal of high-oceanic, near-surface life in the tropical Atlantic. A record of a transatlantic voyage of scientific observation by marine biologists and a meteorologist conducted aboard a drifting yacht.

5. "**The Rocky Shore**", 24 minutes. An exposition of sea-shore zonation as taught to first year marine biology students at the Dove Marine Laboratory, Newcastle University. Photographed on a stretch of rocky coastline exposed to the North Sea, this film explains the conditions of life on the lower and upper shores and examines the characteristic animal and plant life in this physically adverse environment. An easily understood film to prepare students for introductory work on the shore.

6. "**Life History of the Lobster**", 11 minutes. Prolonged and patient photography has produced a series of sequences on feeding, moulting, copulation, egg-bearing and the swimming of the planktonic larvae. Much of the material is unique. The video concludes by indicating the substantial gaps in our knowledge of the life of this commercially important species.

****

110

CANNIBALISM IN JUVÉNILE BASS, *DICENTRARCHUS LABRAX*

Mark H.V. Corps

Calshot Activities Centre, Fawley, Southampton SO4 1BR

In a recent report by Henderson & Holmes (1991) it was observed that strong year classes of bass, *Dicentrarchus labrax*, resulted in lower than expected year class strength the following year. The authors suggested that one possible explanation for this could be cannibalism by the 1- and 2-group fish on the 0-group during the inshore estuarine phase. However, no observational data could be found to support this hypothesis.

Cannibalism in bass has been observed in captive populations (Katavic *et al.*, 1989; Lancaster, 1991; personal observations). It is suggested that cannibalism in captive populations is a density-dependent phenomenon. Wild populations never reach this density threshold, therefore cannibalism does not occur in the wild (Lancaster, 1991).

I report herein some observations which show cannibalism in wild bass during September-October 1991.

I first observed 0-group bass around Calshot Spit on September 12th. Between 12 September and 26 October 1011 bass were studied. Of these, I looked at the stomach contents of only 39 bass of over 14 cm total length; the results are given in Table 1.

Of these fish five contained post-larval bass in their stomachs. Bass of ≥20 cm could be seen chasing shoals of small fish. These shoals contained juvenile sprats, mullet and herring as well as post-larval bass.

Bass are opportunistic feeders (Kelley, 1987). During September/October 1991 the saltmarsh at Calshot contained large shoals of juvenile fish. Bass were exploiting this food source, and it would be somewhat anthropomorphic to suggest that they would select other species but not bass for food.

Of the few studies that have been carried out on the dietary habits of bass around the U.K. coastline (Kennedy & Fitzmaurice, 1972; Aprahamian & Barr, 1985; Kelley, 1987) none have worked in areas where bass are likely to prey on one another. I do not believe that these observations are anomalous and hope to show this by concentrating on the feeding habits of 2+-group bass when the 0-group enter the estuary this summer.

TABLE 1: THE STOMACH CONTENTS OF 39 BASS

CONTENTS	No.
Empty	18
Fish: Bass	5
Goby	2
Decapods: Crab	5
Shrimp	2
Bivalve	1
Polychaete	1
Unrecognizable	5

REFERENCES

Aprahamian M.W. & Barr C.D., 1985. The growth, abundance and diet of 0-group sea bass, *Dicentrarchus labrax*, from the Severn Estuary. J. mar. biol. Ass U.K., **65**; 169-180.

Henderson P.A. & Holmes R.H.A., 1991. Long-term variation in year-class abundance of bass, *Dicentrarchus labrax*, in British waters. National Power Research Report TEC/L/0439/R91; 23pp.

Katavic I., Jug-Dujakovic J. & Glamuzina B., 1989. Cannibalism as a factor affecting the survival of

111

intensively cultured sea bass. Aquaculture, **77**; 135-143.

Kelley D.F., 1987. Food of bass in U.K. waters. J. mar. biol. Ass. U.K., **67**; 275-286.

Kennedy M. & Fitzmaurice P., 1972. The biology of the bass, *Dicentrarchus labrax*, in Irish waters. J. mar. biol. Ass. U.K., **52**; 557-597.

Lancaster J., 1991. The feeding ecology of juvenile bass, *Dicentrarchus labrax*. PhD Thesis, University of Wales; 281pp.

* * * * * * *

Letters to the Editor

From: Frank Evans
15, Thirlmere Ave,
North Shields NE30 3UQ

17 July 1992

Dear Editor: May I through your columns express my sincere gratitude to Porcupine for the most generous financial support the Society gave on the occasion of the two-day scientific meeting and celebratory dinner in Newcastle to mark the retirement of Jack Buchanan and me. It was very much appreciated and my wife, Rosie, joins me in expressing our thanks. The donation was a very well-kept secret which we discovered only as the meeting was ending. The gift to us of a ship's decanter could not have been a more appropriate choice. We shall take pleasure in drinking the health of the Society frequently.

Moreover, fellow-Porcupines were prime movers in making the arrangements for the programme and it was their energy and thoughtfulness that made everything go so well. Everyone I meet says that as well as being scientifically profitable the meeting was friendly and a lot of fun. I certainly found it so. It was a great pleasure to be with so many old acquaintances, and indeed, so many Porcupines. Thank you!

Now the proceedings are to be published in a single issue of "Experimental Marine Biology and Ecology". This is a rare honour, for which, too, I thank the editor and contributors.

From: Tom Gascoigne
16A York Grove, Peckham
London SE15 2NY

12 May 1992

Now I am 89 and in a parlous state
I've got the rheumatics - sad to relate
My eyes are dim, I cannot clearly see,
A hearing aid the hospital have given me
My left lung is weak - due to my smoking
And my memory is fading - how very
provoking!

At the Oban meeting there was little I heard,
Less I saw, and I spoke not a word,
But I wrote *C. oophaga* in letters bold
On the blackboard. By this means I told
The members that the sea-slug Todd sent me
Was not *C. bellula* and I hope Chris will agree!

Tom Gascoigne

• See Porcupine Newsletter, 4 (10) [1990]; p.235. Hon. Ed.

112

MARINE MOLLUSCS OF THE CHANNEL

Jan Light & Dennis Seaward

Are the mollusc communities of the English and French Channel coasts different?

Do the Cotentin and Portland peninsulas have similar effects upon species diversity?

Are the tidal phenomena of double low in Weymouth Bay, double high in the Solent and huge range in the Bay of St Malo significant in molluscan terms?

Are the eastern limits of western species in the Channel still where Holmes, Crisp and Southward found them in the 1950s?

> For these and many similar questions, the answers are not ends in themselves, but means to an end - that of raising further questions, the WHY?s, which may be answered by further ecological investigations.

But answers to the prime questions require much more detailed and recent knowledge of species distribution than is presently available.

ARE YOU INTERESTED? WILL YOU HELP TO PRODUCE
A CHANNEL ATLAS?

The proposal is at a very early stage, and is regarded as medium- to long-term, i.e. publication in 5 to 10 years.

The area to be covered would be the whole Channel including English and French shores, but eastern and western limits are yet to be decided (see accompanying Figures).

So far as is practicable, we would concentrate on modern - post-1990 - work, certainly for shore records, but it is unlikely that the extensive offshore surveys by Holmes, Cabioch *et al.*, Retière of the 1960s and 1970s will be able to be repeated. Plotting will be on a latitude/longitude grid and we hope to include a quantitative element (see accompanying Figures).

HOW CAN YOU HELP?

CONCENTRATE your recording in under-recorded parts of the coast - we can suggest areas.

DIG OUT any detailed records for the English and French coasts or Channel not already submitted for the scheme.

HOLIDAY along the French or English coast, recording molluscs.

HAVE YOU any contacts among (or are you a ...) French conchologists who may be encouraged to participate.

HAVE YOU a boat suitable for dredging or shallow water sampling?

IF YOU are connected with a marine research establishment, get them interested in the Channel Atlas, or give us an introduction.

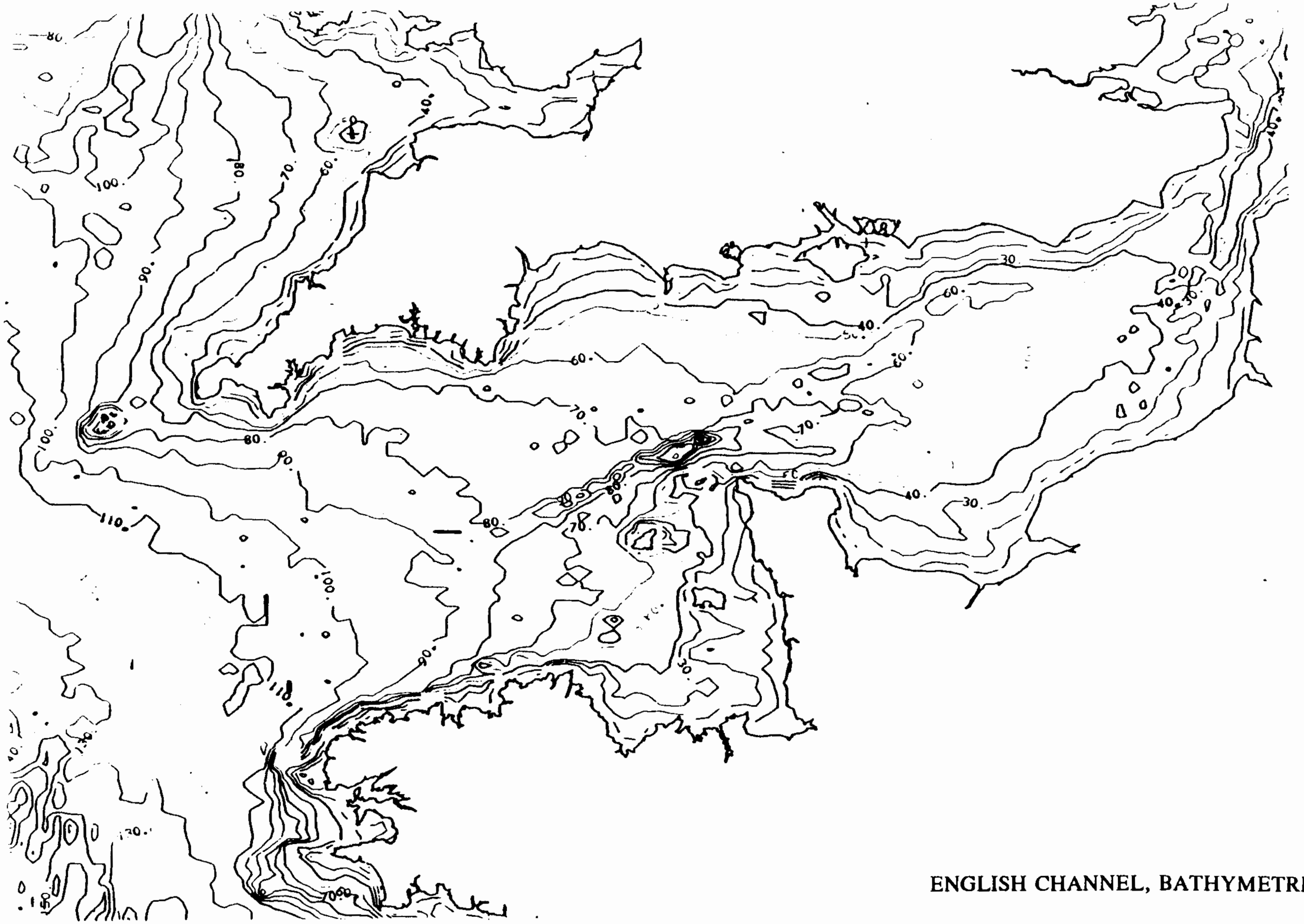
TELL US of your interest, and recruit others.

Marine Recorder/Area Rep S15 Wight
Jan Light
88 Peperharow Road, Godalming
Surrey GU7 2PN, UK

Area Rep S16 Portland
Dennis Seaward
Barn Court, Hamlet, Chetnole
Sherborne, Dorset DT9 6NY, UK

Porcupine Newsletter, 5 (5), 1992.

Porcupine Newsletter, 5 (5), 1992.



ENGLISH CHANNEL, BATHYMETRIC

114

THESE ROUGH DRAFT MAPS SHOW LIVE RECORDS FROM THE 1960's ONWARD...

CAREFUL CONSIDERATION WILL NEED TO BE GIVEN TO THE FIXING OF THE WESTERN LIMIT, IN PARTICULAR...

THE GRID SHOWN HERE IS 6' lat. x 12' long.' i.e. at this latitude, ABOUT 11km x 14km.

IT IS NOT NECESSARILY THE GRID WHICH WILL BE USED IN THE CHANNEL ATLAS