THE BENTHOS OF THE SOLENT

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Introduction

Unlike the Clyde and Plymouth areas, the Solent has until recently lacked established marine laboratories, and little published information is available for the fauna of the region as a whole. However, detailed investigations of particular localities and species have been carried out and much use has been made of the fauna by Portsmouth Polytechnic and the Universities of Southampton and London as a source of laboratory material for undergraduate and postgraduate study.

In his work on the fauna of the Channel, Fischer-Piette (1936) noted that some species were more abundant in the eastern part while others occurred more frequently to the west. Crisp and Southward (1958) also emphasised the division of the Channel into East and West basins on the grounds of temperature, salinity and substrate, while Holme (1961, 1966) complemented their littoral studies with a sublittoral investigation of the Channel in general. The situation of the Solent area, at the junction between East and West Channel basins is, therefore, an important one and it is unfortunate that the lack of continuous studies has precluded the acquisition of data relating to seasonal and long term changes in the fauna. From the majority of the available data which have been published over the last two to three decades, it is apparent that faunistic studies have in general been limited. With respect to littoral investigations, efforts have concentrated on Langstone Harbour (Alexander, 1969; Bone, 1973; Frith, 1976, 1977; Juniper, 1963, Juniper and Steele, 1969; Steele, 1965; Stone, 1969, 1970a, b, c; Switzer, 1958; Thorpe, 1977) and Southampton Water (Ansell, 1963a, b; Barnes, 1971a, b, 1973; Barnett, 1958, 1959, 1968, 1970; Coughlan and Holmes, 1971, 1972; Esser, 1972; George, 1962, 1963a, 1964a, b, c; Hibbert, 1976, 1977a, b; Holmes, 1967, 1968, 1971; Holmes and Coughlan, 1972, 1975; Knap, 1972; Raymont, 1964; Wormald, 1972), while a recent survey of the bottom fauna of the Solent by Barnes *et al.* (1973) and the limited work on *Nucula* spp by Trevallion (1966) stand in isolation as the only sublittoral studies available. The inauguration in 1970 of an annual meeting of the establishments in the region concerned with the marine environment (Central Electricity Research Laboratory, Fawley (CERL); Exposure Trials Station (ETS) of the Admiralty Marine Technology Establishment, Portsmouth; Southern Water Authority Eastleigh; Marine Laboratory and Marine Resources Research Unit, Portsmouth Polytechnic; Department of Oceanography, Southampton University) will hopefully lead to a more rational approach to the collection of data on the local fauna, and provide baseline information which can be used to assess any changes attributable to the continuing development of the Portsmouth/Southampton urban area.

As reported by Juniper (1963), species lists have existed for Hampshire and the Isle of Wight (Anon, 1900) and for the Isle of Wight alone (Morey, 1909) for some considerable time. However these are far from complete for the area as a whole and undoubtedly much out of date. Expanding species lists are being compiled by the Department of Oceanography, University of Southampton and CERL (Barnes, 1971b) for Southampton Water and the west and central Solent, and by the Marine Laboratory, Porstmouth Polytechnic for the eastern Solent including the harbours of Portsmouth, Langstone and Chichester. With the information for such groups as Bryozoa (Crew, 1970), Porifera (Steele, 1965; Juniper and Steele, 1969; Stone, 1969), Polychaeta (George, 1962; Esser, 1972), harpacticoid copepods (Barnett, 1958, 1959; Wormald, 1972) and lamellibranchs (Barnes, 1973), together with the wider studies of Switzer (1958) and Juniper (1963) in the Portsmouth intertidal areas, the sublittoral survey of Barnes *et al.* (1973) and the species recorded from panel studies by CERL and ETS (Stubbings and Houghton 1964), it should be possible to describe the faunal diversity. Recently, by means of near-surface and benthic settlement panels, a more detailed study than attempted by ETS has been made of species settling within Langstone Harbour (Withers and Thorp, 1977). This investigation from 1972-1976, added 30 species to the list for the Solent area incuding one which was new to the south coast. Juniper (pers. comm.), now at Llandaff College of Technology, Cardiff, maintained over a period of 20 years, comprehensive records of the fauna associated with a number of shores in the Portsmouth area, especially near the road and rail bridges onto Hayling Island. As this information was the result of student field courses as well as personal observation (Juniper 1963), however, many of the identifications may not have been confirmed. At present, the records only exist as card index files relating to the presence and location of species, but they could be made available for the compilation of species lists if required.

Sediment distribution

The sediments of the Solent area have been described by Dyer (1971, 1972, Section 4) and Barnes *et al.* (1973). Briefly the sediment distribution follows the overall pattern for the English Channel (Holme, 1966), in that the coarser sediments are found in the western arm of the Solent and fine sediments are characteristic of Southampton Water and the eastern Solent, including the harbours of Portsmouth, Langstone and Chichester. Boundaries between deposits tend to be indistinct with zones of mixed sediments, while the fine sediments gradate from muddy sand, through silts, to mud proper. Sublittorally, the western Solent has deposits of gravel and small stones except for areas close to the mouths of the small river estuaries where they grade through muddy sands and gravels to fine mud. Mud contamination is prevalent in the Solent, except in the region of the Stanswood Bay oyster beds (Barnes *et al.*, 1973), and clean gravels are uncommon. Barnes *et al.* (1973) felt that much of this mud contamination could be attributed to the faeces and pseudofaeces of the American slipper limpet, *Crepidula fornicata* which is abundant sublittorally in the Solent. Southampton Water sediments are predominantly mud, apart from sandy areas between Calshot and Cowes, and limited areas of gravel and gravel with sand to north and south of the Hamble respectively. Similarly, the sediments of the eastern Solent are predominantly mud and sand apart from an offshore gravel area between Ryde and Bembridge.

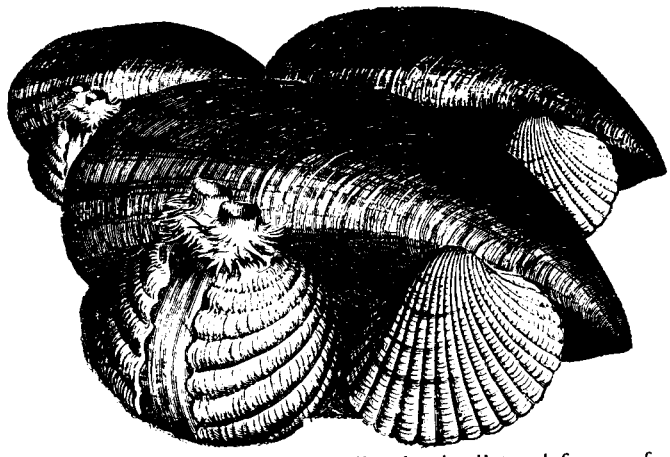
Barnes (1973) summarised the littoral deposits of the Solent as comprising predominantly mud with varying degrees of intermixed sand and coarse surface shingle. A generalised beach would comprise (a) a steep shingle bank at about the high water mark, (b) a more gently inclined slope bearing scattered shingle and (c)

a gently sloping mud or fine sand area extending to or well below low water mark. In sheltered areas salt marsh frequently replaces zones (a) and (b). The sediments of the sheltered harbours of the eastern Solent grade from shingle at the mouth, through sand and muddy gravel, to very fine mud in the northern reaches and sheltered 'lakes'. However, tidal scour may result in areas of muddy shingle. Apart from the area at Bembridge, rocky shores are almost completely absent from the region, and this probably accounts for the restricted diversity of the fauna in the Solent (Crisp and Southward, 1964).

Intertidal fauna

As part of much wider surveys, Crisp and Southward (1958), Crisp (1958, 1964), Evans (1953) and Southward (1967) have touched on the Solent area. The majority of these surveys were rapidly made and concentrated on the southern shores of the Isle of Wight from Bembridge to Freshwater. For example, Crisp (1964) and Southward (1967) were mostly concerned with the effects of the 1962/63 winter on the intertidal fauna of the Channel. Crisp and Southward (1958), on the other hand, looked at the Solent area in more detail (Southsea on the mainland and Bembridge, Ryde, Cowes, Yarmouth, Colwell Bay and Totland Bay on the Island). Juniper (1963) provided a fairly comprehensive faunal list for the Southsea Castle foreshore, Hillhead, Horsea Island causeway (Portsmouth Harbour), Farlington Marshes, the Hayling Island road and rail bridges, the entrance to Langstone Harbour (including the East Winner sandbank) and Bembridge. However, four of these sites no longer exist in the state that Juniper described them. Southsea Castle foreshore has been almost completely cleared of large rocks and associated fauna by Portsmouth Corporation for amenity improvement; Horsea Island causeway was removed during harbour reclamation to provide a route for the M.275 motorway and the pillboxes and concrete blocks that supported a limited rock fauna at the entrance to Langstone Harbour no longer exist. In the case of the shore at Hillhead, the richness described by Juniper has not been retained as considerable damage has been done to the fauna by oil spillage and subsequent clearance operations. More recently, useful information relating to the distribution of Bryozoa in the area has been provided by Crew (1970) and Thorpe (1977), and of Polychaeta by Esser (1972).

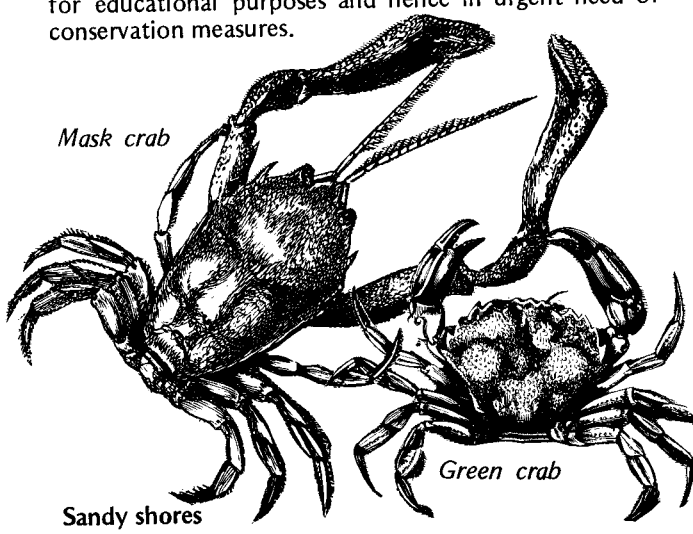
As some of Juniper's (1963) observations span the 1962/63 winter, they record the decimation of littoral sponges, mussels and other bivalves as well as the complete disappearance of the anemone *Anemonia sulcata* and virtually all of the polychaete *Sabella pavonina.* Although the shores of the area have not been deliberately monitored, it is of interest that two of the green form of *A. sulcata* were seen and left *in situ* on the lower shore of the Horse Ledge at Shanklin in May 1971 (Thorpe and Farnham, pers. comm.) and both colour varieties are now very successfully re-established on the ledges at Bembridge. Russell (pers. comm.) reported the reappearance in Langstone Harbour of the clams, *Venerupis decussata* and *V. rhomboides,* absent since 1962/63, while elsewhere Withers and Thorp (1978) noted single small specimens of the razor shell *Solen marginatus* and the crab *Corystes cassivelaunus* from Sinah Sands. Recently, a final year student from Portsmouth Polytechnic has recorded all three limpet species in Freshwater Bay, *Patella aspera* and *P. intermedia* having been absent since the winter of 1962/63 (Crisp and Southward, 1964). It is apparent from the recollections of Wadham



(1940), however, that a decline in the littoral fauna of the Solent region had been taking place for some time before this natural disaster.

Rocky shores

The general lack of rocky shore habitats in the Solent has already been mentioned. With the removal of the rocks and boulders from the Southsea Castle area, the only truly rocky shores within the region are those of St. Helens, Bembridge, Shanklin and Freshwater Bay. To this meagre area can perhaps be added those shores that have a high proportion of large gravel and pebbles mixed into and overlying the mud, such as can be found in the region of the Hayling Bridges and to the south of Farlington Marshes (Milton oyster beds). On the south and south-east extremities of the Sinah sandbank in Langstone Harbour and along much of the Hillhead and Lee-on-Solent shores where mud deposition is not excessive, a varied number of rocky shore animals can also be found. Alexander (1969), Frith (1976, 1977), Juniper and Steele (1969), Rowe (1972), Steele (1965) and Stone (1969, 1970a, b, c) studied the sponges in the Portsmouth area, particularly around the Hayling Bridges. Alexander (1969) and Frith (1976, 1977) concentrated on the animals associated with the sponges *Halichondria panicea* and *Hymeniacidon perleve,* and Edwards (1958) examined the movements of the shore crab, *Carcinus maenas,* in the littoral zone at Chilling. Due to the general paucity of rocky shore fauna in the area, however, the accessible shores are heavily utilised for educational purposes and hence in urgent need of conservation measures.



Sandy shores

In common with the rocky shores, those of sand also have a limited littoral distribution. In the eastern Solent they are represented by Sword and Sinah Sands within, and the East Winner outside the Langstone Harbour

entrance and the Winner and Pilsey Sands inside Chichester Harbour. In addition, the lower shores of South Hayling, Ryde and the St. Helens/Bembridge/Sandown/Shanklin areas on the Isle of Wight are also sandy. In Southampton Water, intertidal muddy sands are confined to the Calshot Spit and Solent Breezes areas, and in the western arm of the Solent, small sand deposits occur at the mouths of the rivers Medina, Newtown and Yar. Since the work of Juniper (1963), who recorded several species of macrofauna from the East Winner (including *Corystes cassivelaunus, Solen marginatus, Ensis siliqua, E. ensis* and *Mya truncata* which are all unrecorded since 1962/63), the sand-dwelling benthos of the area has until recently remained untouched. Withers and Thorpe (1978) have investigated the macrobenthos of Sinah and Sword Sands and the East Winner sandbank, while Withers (1978a) looked at the fauna of sands at Ryde and Bembridge. Apart from most of the usual sand-dwelling amphipods and isopods and the re-introduction of species mentioned above, records of the polychaete *Ophelia rathkei* (Sinah Sands) and the crab *Portunus latipes* (East Winner) are interesting.

Muddy shores

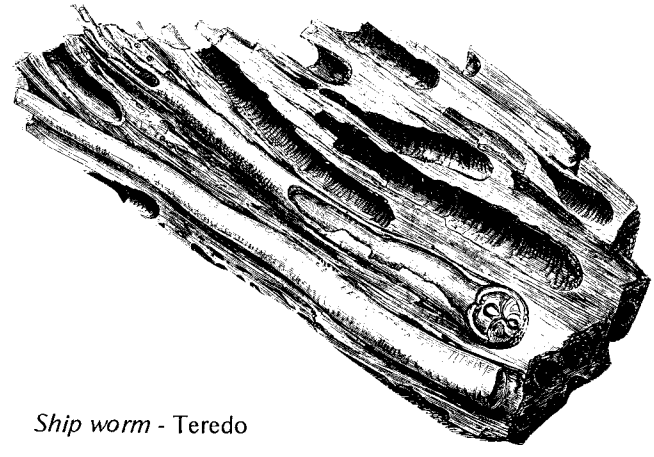
As a result of the inherent problems of moving over and sampling from intertidal muds, much of the data on the infauna are confined to regions within easy reach of the firmer footing afforded by the mud-bound shingle deposits of the drainage channels. More extensive studies have been possible, however, by the use of mud skis for walking and sledges for transporting equipment and samples (Barnett, 1968; George, 1962, 1963b; Martin, 1974). Switzer (1958) examined the animals associated with muddy shores in the Solent, several of Juniper's (1963) sites in Langstone Harbour were of a similar nature and Boyden and Russell (1972) and Russell (1971, 1972) also included the local muddy regions in their studies of the distribution of the cockles *Cardium (Cerastoderma) edule* and *C. (C.) glaucum*. However, in his study of the bird populations of Langstone Harbour, Martin (1974) highlighted the lack of information on mud fauna when trying to ascertain the diet of overwintering Brent geese. Goodhart (1941) produced an excellent study of the amphipods in the predominantly muddy deposits of the Afon Water Estuary at Keyhaven, and this study could provide a useful basis against which to view any recent changes. A list of species from the intertidal mudflats in Southampton Water has been produced by Barnes (1971b) and his papers on lamellibranchs in Southampton Water (Barnes 1973) and on an area of reclaimed land (Barnes and Jones 1974) are useful.

Until recently, other studies of the mud fauna were concerned only with specific animals or groups of animals such as harpacticoid copepods (Barnett, 1958, 1959, 1968; Wormald, 1972) and cirratulid polychaetes (George, 1962, 1963b, 1964a, b, c, 1967, 1968) all on Hamble Spit. Bramble and Goodhart (1941) reported a new enteropneust, *Saccoglossus horsti*, outside the mouth of the Lymington River and it is probably this species that has recently been sampled from Langstone Harbour in the area of Little Island. As a preliminary to laboratory studies on the filtering rate of *Mya arenaria* in relation to temperature, Bone (1973) examined the distribution of the clam in Portsmouth, Langstone and Chichester Harbours. At most sites density was low but at the north end of Langstone Harbour in the Storehouse Lake area, a population of $90m^{-2}$ was located. This population has now disappeared following reclamation of the harbour by tipping. In fact, the only known population of any size was recorded by Withers (1979b) from the upper reaches of the Medina Estuary during a short survey of the mud-inhabiting macroinvertebrates for the Nature Conservancy Council (Tubbs, 1975a). Recently, several discrete, mixed populations of the sipunculids *Golfingia vulgaris* and *G. elongata* and the polychaete *Stylarioides plumosa* were discovered in the southern half of Langstone Harbour (Thorpe and Withers pers. comm.). The largest *G. vulgaris* were considerably smaller than those elsewhere (Gibbs, pers. comm.) suggesting that although the local populations may be slower growing, these long-lived animals may represent a recent introduction or re-introduction since 1962/63. Finally, several investigations have concentrated on the accidental introduction into Southampton Water of the American hard clam or quahog *Mercenaria mercenaria* (Ansell, 1963a, b, 1964; Ansell *et al.*, 1964; Heppell, 1961; Hibbert, 1975, 1976, 1977a, b; Mitchell, 1974a, b, 1976; Rodhouse, 1973).

Applied studies

Apart from the studies of Hockley (1951) and Williams (1969a, b) on the biology of the copepod parasite *Mytilicola intestinalis* in the mussel *Mytilus edulis*, and those of Houghton (1967) on the occurrence of the pea crab, *Pinnotheres pisum*, in *M. edulis*, the remaining faunal investigations of the Solent area are applied in nature and connected with man's use of the sea.

As a result of the fears of the Southampton Docks and Harbour Authorities that the discharge of warmed seawater from the projected power station at Marchwood could lead to the introduction of new marine borer species and an increased incidence of those already present (Holmes, 1972; Pannell *et al.*, 1962), a comprehensive programme was established in 1951 under the auspices of a committee comprising representatives from the Harbour Board, CERL and Southampton University. In 1962, the area monitored was extended to include the possible influence of the Generating Station and the Esso refinery at Fawley. Marine borer attack of wooden test blocks has been closely watched (Eltringham, 1961, 1965; Eltringham and Hockley, 1958, 1961; Hockley and Eltringham, 1958; Hockley, 1963, 1965; Savage, 1972) and Jones (1963) included the Solent in his study of the British *Limnoria*. An early review of the effects of warmed effluents concluded that the breeding period of gribble (*Limnoria* spp.) had been extended and the incidence of the shipworm *(Teredo)* had apparently increased. A more recent study in Southampton Water, however, stated that these earlier



Ship worm - Teredo

conclusions were based upon short-lived phenomena (Coughlan, 1976, 1977a). Coughlan (1977a) reported that the increased incidence of *Teredo* and *Lyrodus* could in each case be attributed to accidental introductions of infected wood (as drift wood and wrecks) adjacent to the test sites, and with the removal of the last infected wood in 1961, the incidence of these species rapidly decreased to zero by 1963. In fact, *Teredo* has been absent from test timbers in 17 of the 25 years covered by the monitoring programme. The rise and fall in the numbers of *Limnoria* in wooden test blocks and battens also seems to bear no relation to the output of warmed seawater from the power stations. Even though discharges have remained relatively constant, the dramatic increase in populations near Marchwood between 1959 and 1962, was followed by a sharp decline from 1963 to 1966 (Coughlan, 1977a). The predicted rise in numbers of the temperate/tropical *L. tripunctata* at the expense of the cooler water species *L. quadripunctata* (temperate) and *L. lignorum* (boreal) has not materialised. Indeed *L. tripunctata* was replaced by *L. quadripunctata* at the warmest site (Marchwood) following the 1962/63 winter, and all species of *Limnoria* suffered a drastic mortality. Numbers were reduced by 75% from their peak in 1962 and recovery to such levels has not since been attained. Despite a recommendation that the monitoring of wood borer attack should cease, a limited programme is continuing (Coughlan, 1977b).

Fouling communities have received much attention in view of their relevance to industrial complexes, sewage discharges into semi-enclosed seawater areas and the performance of protective coatings. Since the opening of the CERL marine station at Fawley in 1969, a programme of fieldwork has been carried out to establish a better understanding of the fauna of Southampton Water, and detailed information is available on lamellibranchs (Barnes, 1971a, b, 1973) and ascidians (Holmes, 1971; Holmes and Coughlan, 1975). Barnes (1971b) provided a detailed account of the species associated with intertidal mudflats and Barnes *et al.* (1973) produced a useful preliminary study of the sublittoral macrofauna of the Solent in which the presence of a single specimen of the whelk *Neptunea antiqua,* thought to be the first from the south coast of England, was noted. While this species has been found off the northern shores of Britain (Beedham, 1972), it was not described by Fretter and Graham (1962) and McMillan (1968) in the south and a record by Prebble (1967) gave no precise location. However, during limited dredging at 1-2 fathoms in the Stanswood Bay area in autumn 1973 (Coughlan, pers. comm.), several empty *Neptunea* shells were recovered from the 'spoil' of the crews 'feast' of whelks. In addition during studies by Portsmouth Polytechnic undergraduates of sublittoral hermit crabs and their shell epibionts, some of the shells examined were undoubtedly *N. antiqua.* These records from the east Solent, along with those from the west, suggest that this species is established over much of the area. Additional species recorded from the Stanswood Bay dredging are given in Table 1.

More directly concerned with the CEGB's operations has been the study of fouling communities in Southampton Water (Coughlan and Holmes, 1971, 1972; Holmes, 1970; Holmes and Coughlan, 1972). Established communities have been compared with those associated with Fawley Power Station and the ETS exposure rafts in Langstone Harbour over the years 1969-1975 in order to provide baseline data against which future environmental changes in Southampton Water and the central Solent can be assessed. Markowski (1959), Ansell (1963b) and Ansell *et al.* (1964) emphasised the potential of heated effluents for commercial culture of animals such as *Mercenaria,* which might benefit from an increased temperature throughout the year, and Barker (1965) studied the breeding, settlement and growth of *Mytilus edulis* at Marchwood in relation to their nuisance value.

Table 1: Species recorded during dredging operations at Stanswood Bay in autumn 1973

Annelida:	*Ophelia bicornis,* Savigny
	Nereis longissima, Johnston
	N. diversicolor, O.F. Müller
	N. irrorata, (Malmgren)
	Melinna palmata, Grube
	Scalibregma inflatum, Rathke
	Terrebellides stroemi, Sars
	Nephthys caeca, (O.F. Müller)
	N. incisa, Malmgren
Mollusca:	*Ensis siliqua,* (L)
Crustacea:	*Ebalia tumefacta,* (Montagu)
	Macropipus pusillus, (Leach)
	Pirimela denticulata, (Montagu)

Shallow coastal areas often receive considerable quantities of sewage ranging from untreated or "raw" to that conforming to Royal Commission standards for sewage effluents (BOD and suspended solids not to exceed 20 mg l^{-1} and 30 mg l^{-1} respectively). Although the major problem is aesthetic, in certain areas, the local effect can be much more apparent such as in the excessive algal growths within Langstone Harbour. A dry weather flow (DWF) of some 9.0 x 10^6 gallons day^{-1} (mgd) of fully treated effluent (Royal Commission Standard) enters the north of the Harbour from Budds Farm sewage works, while a further 15.0 mgd (DWF) of macerated sewage are discharged from Portsmouth into the Harbour entrance on the ebb tides. Radioactive tracer studies have revealed, however, that some of the latter effluent re-enters the harbour on the succeeding flood tide (Portsmouth Polytechnic, 1976). Concern over the increasing conurbation of the Havant Borough, with the subsequent rise in effluent discharge from Budds Farm (4.0 mgd in 1968 to 8.0 mgd in 1970), led Portsmouth Polytechnic, at the request of Hampshire River Authority, to undertake a general survey of the effects of sewage discharge into Langstone Harbour. Support for these studies was continued by the Southern Water Authority (SWA) when they assumed responsibility for the study following reorganisation of the water industry in 1974. In the course of this extended investigation, much additional information has become available on the benthic fauna of the harbour (Dunn, 1972; Portsmouth Polytechnic, 1976). In anticipation of the completion of the Peel Common sewage works which has a projected DWF of 60.0 mgd into the eastern Solent, a large scale survey of the sub-littoral benthic fauna of the areas likely to be affected by this discharge was initiated in 1975 by the SWA. Over the same period, a regular sampling programme of benthic invertebrates was established and Portsmouth Harbour has been included since 1974 (Soulsby *et al.*, 1978).

As an integral part of the programme to assess and improve the performance of the bottom composition of ships, especially antifouling paints, the ETS have carried out long term surveillance of the more common fouling

organisms settling on non-toxic, raft-borne panels. From 1945-57 the rafts were sited in the southern reaches of Emsworth Channel, Chichester Harbour and subsequently in Langstone Channel, Langstone Harbour. Stubbings and Houghton (1964) discussed the incidence of fouling organisms in Chichester Harbour, including a number of additional species from Langstone Harbour, and since then, almost uninterrupted records have been maintained (Houghton, pers. comm.). At the same time, observations have been made on the introduction of certain immigrant or alien species to the British and European fauna. Bishop (1947) and Houghton and Stubbings (1963) recorded the appearance of the Australasian barnacle *Elminius modestus*, while Houghton and Millar (1960) and Millar (1960) clarified and extended the available information on the introduction of the ascidian *Styela clava* from the Far East.

The remaining studies in the applied field concern the monitoring of trace metal accumulation in molluscs. As bivalves concentrate metals from seawater, the introduction of additional quantities of potentially toxic chemicals into semi-enclosed waters might ultimately be reflected in unacceptable levels in commercial species (Coughlan, *et al.*, 1972). In order to establish baseline data, Romeril (1971 1972a, b, 1973) and Coughlan *et al.* (1972) estimated the levels of zinc, copper and iron in *Mercenaria mercenaria*, and *Cardium (C.) edule*, and *Ostrea edulis*, respectively. Athough metal levels fluctuated erratically with season and age, values were well below those regarded as unsafe for human consumption, despite the heavy and increasing industrialisation of Southampton Water and the addition of ferrous sulphate as an anti-corrosive agent to the cooling water of the Fawley Power Station. Hobden (1967) has looked at iron metabolism in *Mytilus edulis* and Knap (1972) studied zinc levels in *Crepidula fornicata*, while Knap (1972) and Romeril (1973) established a correlation between the level of zinc in the substrate and its uptake by *Crepidula* and *Merceneria* respectively. However, the limited distribution of *Mercenaria* reduces its value as an indicator species. Boyden (1974, 1977) investigated metal content in relation to size in shellfish. Although the use of Portsmouth Harbour as a naval base and dockyard may have led to an input of copper from antifouling compounds, Ellis-Evans (1975) and Spouge (1975) have both shown that, at the present time, levels are well below legislated limits.

Conclusions

The South Hampshire area is under an increasing pressure from development (Dunn, 1972; Jackson, 1971; Smart, 1972; Portsmouth Polytechnic, 1976) and various plans have been formulated to cope with an expected massive population increase in the Southampton/Portsmouth area, partly to accommodate London overspill. Considerable development has already taken place, particularly in the urban areas of Portsmouth C.B. and Havant B. which virtually surround Langstone Harbour, and this will continue with additional conurbations such as that proposed at Horton Heath.

Pressures on the environment will increase not only through greater use of marine amenities but also as a result of the development of local industry. The Solent Sailing Conferences of 1972 and 1973 emphasised the national, if not international, importance of the Solent region for both sailing and wildlife. Barnes (1973), Barnes and Jones (1974) and Coughlan *et al.* (1972) for Southampton Water, and Dunn (1972), Tubbs (1975b, 1977) and Portsmouth Polytechnic (1976) for Langstone Harbour focussed attention on the already considerable reclamation of intertidal areas. To this can be added the reclamation scheme for the northern part of Portsmouth Harbour (Tubbs 1975c), and the probability of future schemes due to increasing demand for land for development. Concomitant with increased urbanisation and industrialisation, there will undoubtedly be increased sewage and industrial effluent discharge including chemicals, oil (George, 1970) and waste heat. With some 25% of the world's oil tonnage passing through the English Channel, and a major oil refinery at Fawley, the probability of a serious oil spill must also be high. In this context, Nelson-Smith (1972) has highlighted the effects of oil spillage within estuaries.

Recreational pressures on the environment are likely to come from use of the sea rather than the shore. With reference to Langstone Harbour, Jackson (1971) suggested that sailing would be the major amenity pressure due to the lack of aesthetic appeal of the characteristically muddy shores. Smart (1972) outlined the number of boats that the Solent area presently accommodated and was committed to take at the major moorings in the future (Table 2), and smaller developments are expected

Table 2: Present and possible future distribution of yachts in the Solent area (Smart, 1972)

Location	*Present*	*Proposed*	*% Increase*
Southampton Water	2197	3697	68
Hamble River	2005	2966	47
Portsmouth Harbour	3063	6993	128
Langstone Harbour	2214	3514	58
Emsworth Harbour	2685	3585	33
Chichester Harour	3117	3874	24
Total	15281	24629	61

at Cowes/Medina, Lymington and Newtown. At the same time, he suggested that over the next 20 years there could be a demand for an additional 20,000 moorings which would probably have to be provided in the western Solent and the harbours of Langstone and Chichester because of the extensive shipping movements in the approaches to Southampton and Portsmouth (Rogerson and Andrew, 1972). Since greater boat numbers also entail additional car parking and ancillary facilities as well as more launching and mooring sites, marinas possibly offer a better solution, although their development could seriously conflict with the interests of anglers and naturalists. Tubbs (1972, 1977) emphasised that the harbours and estuaries of the Solent were of national importance for their populations of migrant and overwintering waders and wildfowl and indicated the areas most vulnerable with respect to feeding, breeding and roosting sites. The final report of the Second Solent Sailing Conference stressed that the character of the Solent was dependent upon the maintenance of a balance between interrelated interests which, although at present relatively compatible, could be threatened by an unmanaged extension of water recreation (Anon, 1974). The extent of the increased pressure on the environment is reflected locally in the attention focussed on conservation (Tubbs, 1975a, b, c). The Nature Conservancy Council have supported an evaluation of the biological literature relating to Chichester Harbour (Thomas *et al.*, 1978) and a pilot study on its benthos

(Walker, 1973; Withers *et al.*, 1978). Subsequently they commissioned a two-year study of the biology of the Harbour by the Departments of Geography and Biological Sciences at Portsmouth Polytechnic. Moreover, the creation of the Chichester Harbour Conservancy and the projected Langstone Harbour Operational and Management Plan, together with the Langstone Harbour Conservation Group, should help to provide advice on environmental problems.

Until the turn of the century, the Solent was regarded as an important oyster producing area (Reger, 1967). Within the area, Sloan (1972) and Rodhouse (1977) have recently investigated the transport of larvae and the ecological energetics of the oyster respectively. Askew (1972), Barnes *et al.* (1973), Coughlan *et al.* (1972) and Key (1972) suggested that oyster cultivation remained a practical possibility, and since 1974, a rapid resurgence of oyster dredging in both the western Solent and Langstone Harbour has been seen, despite increasing contamination of the area by heavy metals and faecal bacteria. Although heavy metal levels seem to be within acceptable limits, apart from a recent report of mercury pollution in the Portsmouth area (Anon, 1973), closing orders prohibit the removal of shellfish from Langstone Harbour for direct sale as a result of the high level of contamination by *Escherichia coli.* However, Tubbs (1974) has stressed that any further loss of intertidal areas to land reclamation would be at the expense of a potentially highly productive source of food for man.

Although it is recognised that Southampton Water, Cowes Roads and Portsmouth Harbour have to bear increased concentrations of shipping and industry, data must be accumulated to support the maintenance of the sites of special scientific interest and ensure their utilisation for educational and amenity purposes. For example, as industrialisation increases, the discharge of heated effluents into local waters could lead to a rise in temperature over much wider areas, resulting in detrimental biological effects and introductions such as the success of the alga *Sargassum muticum* (Farnham *et al.*, 1973). In 1970, the presence of commercial (Southampton) and naval (Portsmouth) ports resulted in more than 76,000 vessel movements in and out of the Solent (Rogerson and Andrew, 1972). Of the 38,000 entering the Solent, many would have come from other climates and have carried fouling organisms foreign to our shores. In addition to those alien species established in the Solent (Table 3), many more, such as the tropical barnacle, *Balanus amphitrite* var. *denticulata* (Stubbings and Houghton, 1964; Coughlan, 1977c), must have entered local waters as ship fouling or with imported shellfish, and been unable to establish themselves in the existing environmental conditions. If the barrier to the introduction of further species has been temperature, an increase in the present minimum values could be sufficient to enable further invasions to take place and flourish in an environment removed from their normal predators, much as *Crepidula, Elminius* and *Styela* have done. It is interesting to note, however, that *Crepidula,* which was long considered a damaging competitor for food with the oyster, may not be completely undesirable as oyster spat readily settle on *Crepidula* chains in the absence of suitable bottom deposits. At a recent meeting of the Solent Laboratories, it was suggested that it may be necessary to suspend oyster dredging activity for a time to enable *Crepidula* chains so damaged to recover.

Summary

Although it would be possible to prepare an acceptable species list for the Solent from existing sources, quantitative, long-term data for the area are still lacking. Moreover, it is important:

(i) to obtain more quantitative data on the sublittoral fauna of the Solent. If the sea is to be farmed in the future, efforts will concentrate on shallow coastal areas such as the Solent, and lack of available information could seriously impede progress.

Table 3: List of alien species introduced into the Solent area

GROUP	SPECIES	LOCATION & DATE	SOURCE
Annelida:	*Mercierella enigmatica* Fauvel	Chichester Harbour 1974	(Thorp unpublished)
	Pileolaria (Pileolaria) rosepigmentata (Uchida)	Portsmouth Harbour 1975	Knight-Jones, Knight-Jones, Thorp & Gray, 1975
	Janua (Dexiospira) braziliensis (Grube)	Portsmouth Harbour 1975	Knight-Jones *et al.* 1975
Crustacea:	*Acartia tonsa* Dana	Southampton Water 1954	Conover 1957
	A. grani Sars	Southampton Water 1956	Lance & Raymont 1964
	Limnoria tripunctata Menzies	Southampton Water* (date uncertain)	Eltringham & Hockley 1958
	L. quadripunctata Holthuis	Southampton Water (date uncertain)	Eltringham & Hockley, 1958
	Elminius modestus Darwin	Widespread 1945	Bishop 1947
		(? Chichester Harbour 1943)	Stubbings 1950
Mollusca:	*Mercenaria mercenaria* (L.)	Southampton Water 1949	Heppel 1961
		Southampton Water 1925	Mitchell 1974b
	Crepidula fornicata (L.)	Widespread 1880-90	Holme 1961
	Petricola pholadiformis Lamark	Lee-on-Solent (date uncertain)	Duval 1963
Tunicata:	*Styela clava* Herdman	Widespread 1960	Houghton & Millar 1960

* Jones (1963) suggests that the original site of the south coast introduction of *L. tripunctata* was most probably Poole Harbour.

(ii) to monitor the fluctuations of both the fauna and the environment including trace metal levels. In this last respect, attention could be focussed on the further evaluation of *Crepidula* and other species as indicators of heavy metal levels.

(iii) to investigate the communities of the transition zone between the east and west Channel basins, in order that faunal changes resulting from environmental fluctuations can be established.

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