

Studies on Sublittoral Macrobenthic Fauna of the Inner Swansea Bay

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Sublittoral benthic macrofauna of Inner Swansea Bay, a shallow industrialized embayment on the north side of the Bristol Channel, England, is mainly composed of Polychaeta (43.9%), Mollusca (31.9%), Crustacea (12.7%), Echinodermata (0.7%) and other groups (10.6%). Faunal density and biomass varied from 50 to 3174 specimens m^{-2} ($\bar{x} = 787 m^{-2}$) and 0.5 to 2190.0 gm^{-2} ($\bar{x} = 116.65 gm^{-2}$) respectively. High benthic biomass was dominated by the bivalves *Spisula elliptica* (Brown) and *Nucula turgida* Leckenby and Marshall. The annual benthic production of 233.3 $gm^{-2} yr^{-1}$ or 16.2 $g C m^{-2} yr^{-1}$ can sustain 22.3 tons $km^{-2} yr^{-1}$ of bottom fishes, and carbon requirement by the benthic community is 162.0 $g C m^{-2} yr^{-1}$. There was a definite correlation among the benthic faunal element, their feeding habit, organic carbon and sediment texture.

The Inner Swansea Bay (Fig. 1) is a shallow industrialized embayment on the north side of the Bristol Channel. This bay is bordered by petrochemical and steel complex at present, and the remains of heavy metal industries of the past, all of which have discharged waste directly into the bay or rivers draining into the bay. This industrial impact has given an unique opportunity for studying sublittoral environmental effects, particularly of heavy metals^{1,2}. These are spatial studies of heavy metal distribution in the sediments and water column. It is, however, only recently that the hydrodynamics of the inner bay, as well as the Greater Swansea Bay have been described in detail³.

Ecological studies within the bay have generally been intertidal with the benthos of the sublittoral Greater Swansea Bay being described by Warwick and Davies⁴. Production of the *Abra* community within the bay has been described by Warwick and George⁵. This paper presents a study of the inner part of Swansea Bay between the LWST mark to the north and a line joining Mumbles Head and Port Talbot Harbour to the south.

Materials and Methods

Sublittoral stations (40) were sampled in the Inner Swansea Bay (Fig. 1). At each of these stations three 0.1 m^2 Day grab samples were taken. A sediment sub-sample was removed for grain size analysis and

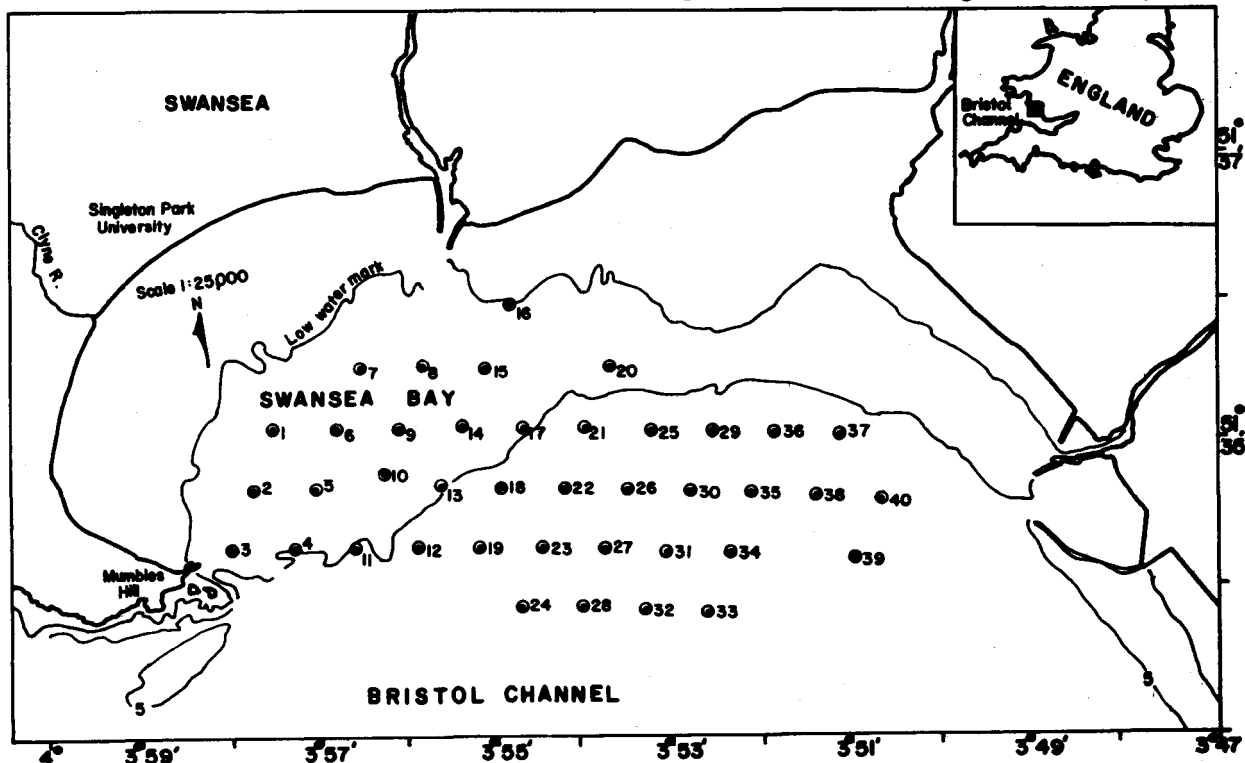


Fig 1—Station location

analysis of organic carbon content⁶. The remaining sediment was sieved through a 1 mm mesh screen. The material retained was fixed in 5% seawater formalin. In the laboratory this material was resorted by hand to collect all fauna for identification. Biomass is expressed as wet weight (excluding hard parts).

For grain size analysis, a sediment sample was dried at 110°C and sieved through 0.5φ unit sieves. From these results the mean φ and sorting coefficient were calculated.

Results

Substratum—Sediment distribution within the bay showed considerable spatial variation. The 2 main sedimentary provinces of the inner bay³ consisted of 12 distinct substrata types (Fig. 2). The western part of the bay, immediately below LWST, was dominated by sandy gravels and stones. This graded into sandy gravels, gravelly sands and sand towards the centre of the bay. The percentage fine material in this western area was very low. By contrast, the eastern part of the inner bay was dominated by fine sediments composed of sandy muds, and muds with some interspersed gravel. The eastern most stations consisted almost entirely of fine muds and clay.

Organic carbon content—The organic carbon content reflected the sediment distribution (Fig. 3). Organic carbon values were low on the western side of the bay and increased eastwards to reach a maximum of 4.21% in the easternmost stations.

Biomass and population density—There was a striking difference in spatial distribution of biomass (Fig. 4) and population density (Fig. 5). The biomass varied from 0.5 gm⁻² at st 40 to 2190.0 gm⁻² at st 29 ($\bar{x}$ = 116.65 gm⁻²). Similarly, the population density increased from 50 to 3174 m⁻² at the same stations.

Faunal composition and distribution—The benthic fauna was composed mainly of Polychaeta (43.9%), Mollusca (31.9%), Crustacea (12.7%), Echinodermata (0.7%), whilst Porifera, Coelenterata, Platyhelminthes, Nemertea, Sipuncula, Bryozoa and compound Ascidian which are classed as other groups formed 10.6%.

The polychaetes were dominated by *Nephtys hombergii* (Audouin and Milne-Edwards) which was abundant over the whole central and eastern bay and is only absent from coarse gravels on the western side of the bay. Other widely distributed polychaetes were *Ampharete acutifrons* (Grube), *Glycera convoluta* Keferstein. Other common polychaetes included *Lanice conchilega* (Pallas), *Owenia fusiformis* Dellechiaie, both occurring in the coarser deposits on the western side of the bay, while *Spiophanes bombyx* (Claparede) was common in the finer deposits on the eastern side of the bay. Other polychaetes found at 3 or

more stations included *Tharyx marioni* (Saint-Joseph), *Eulalia tripunctata*, McIntosh, *Terebellides stroemi* Sars and *Melima cristata* (Sars).

The molluscan fauna was dominated by the bivalve *Nucula turgida* Leckenby and Marshall which was abundant in the finer sediments in the central and eastern parts of the bay. *Spisula elliptica* (Brown) was also common in the east side of the bay while *Abra alba* (W.Wood) was found in sandy mud sediments although it was usually absent from high mud-content sediments. Other bivalves found included *Corbula gibba* (Olivier) and *Venerupis pullastra* (Montagu) both at two stations only.

The crustacean fauna was dominated by the cumacean *Diastylis* sp. although there was a rich amphipod fauna consisting mainly of *Ampelisca tenuicornis* Lilljeborg and *A. brevicornis* (A. Costa) *Eurystheus maculatus* (Johnston) and *Unicola* sp. The brachyuran *Porcellana longicornis* (L.) was found especially on the west side of the bay. Other decapods included *Eupagurus bernhardus* (L.) and *Inachus* sp.

Discussion

Ecology of Inner Swansea Bay shows considerable variation in both physical and biological parameters. On high resolution sampling, the 2 large sedimentary provinces of the inner bay shown in the study of Greater Swansea Bay by Collins *et al.*³ are now seen to show considerable spatial variation. Within Province [4 (gravelly) sand and sand]³ there is an eastward decrease in grain size with the most gravelly sediments being found below LWST on the west side of the inner bay. This substratum is derived from glacial deposits and is covered by a thin ephemeral veneer of sand. This movement of sediment prevents the accumulation of organic matter, resulting in low organic carbon values on the west side of the bay. The fauna of this area of the bay consists mainly of filter feeding polychaetes and bivalves, together with hydroids, sponges and compound ascidians. Biomass values are low as a result of the continuous movements of sediment.

To the SE of the dredge channel, these coarse sediments grade into coarse sands, to the eastern edge of the border of Province 4 (ref. 3).

To the eastern side of the bay, the variation in sediment texture for Province 1 suggested by Collins *et al.*³, is seen with a variety of fine sedimentary types from muddy sands to the west and more fine material towards the extreme east of the study area. Much of this fine material is believed to have been dumped dredge material and contains very high organic carbon values.

The varying sediment textures are reflected in the fauna present. In the sandy areas of the centre of the bay, the dominant species is *N. hombergii*. Towards the

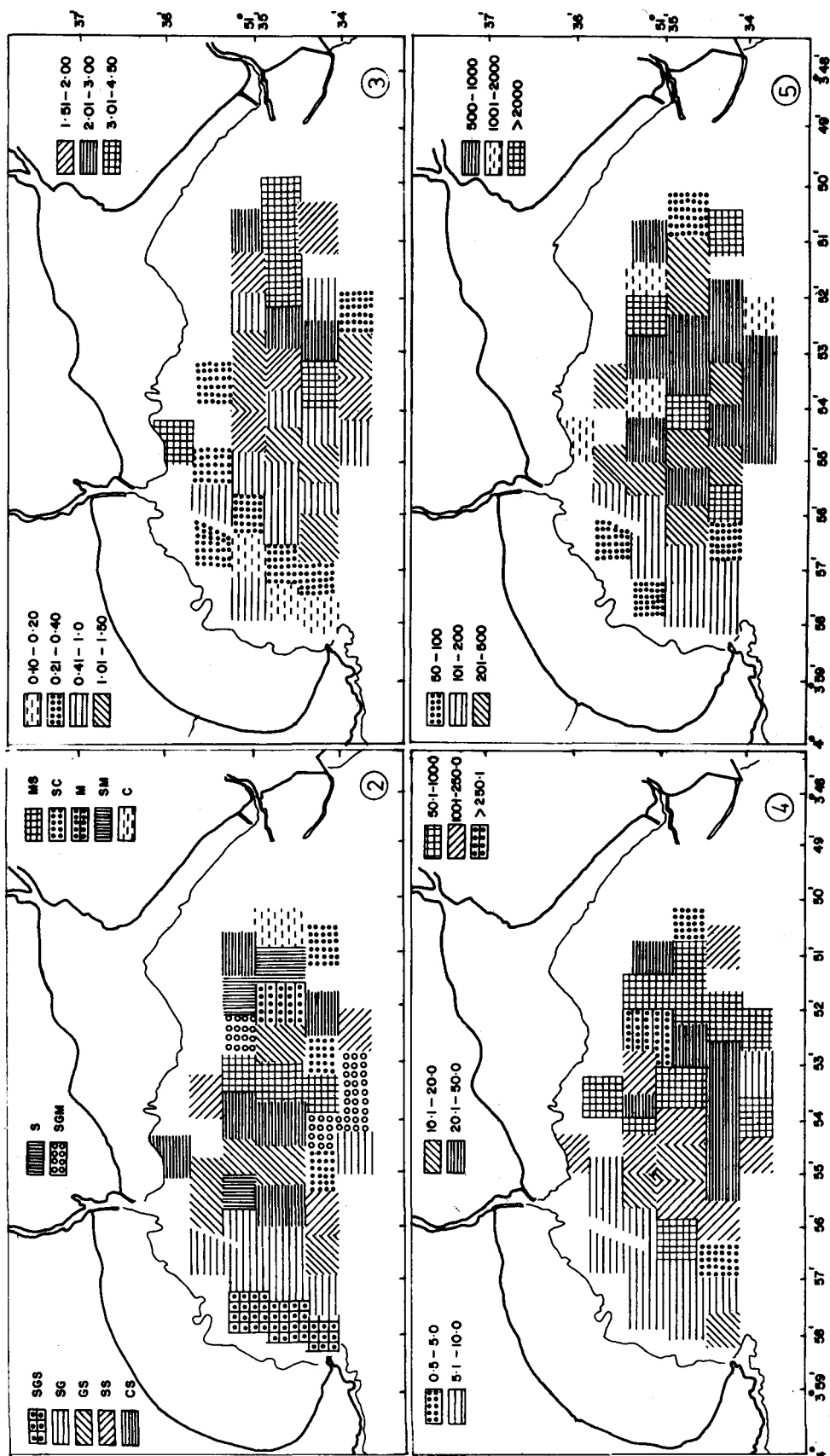


Fig. 2—Sediment distribution [SGS, slightly gravelly sand; SG, sandy gravel; GS, gravelly sand; SS, silty sand; CS, clayey sand; S, sand; SGM, slightly gravelly mud; MS, muddy sand; SC, sandy clay; M, mud; SM, silty mud; and C, clay. Fig. 3—Organic carbon distribution (%). Fig. 4—Biomass distribution (gm⁻²). Fig. 5—Population density distribution (m⁻²).

east of the bay, the area is dominated by deposit feeders. Presumably the high suspended sediment loads result in a clogging of filtering apparatus thus preventing survival of filter feeders in this area.

Sedimentary type is a dominant criterion in the distribution of marine invertebrates in Inner Swansea Bay, which agrees with the earlier observations elsewhere⁷⁻¹⁰. Very coarse sand and the very fine fraction of sediment have a low benthic biomass whereas medium grain size has a rich fauna. Similarly, very low and high values of organic carbon content show poor fauna and medium values show rich fauna. Ganapati and Raman¹¹ indicate that high values of organic carbon lead to anaerobic conditions, thereby effecting the benthic community. Bader¹² observed a decrease of pelycepoidea population related to high values of organic carbon in the mud. The presence or absence of a particular benthic faunal element to particular type of substratum shows its specific substratum preference as indicated by numerous authors^{4,8,13}. Similarly, according to feeding type, suspension feeders are restricted to sandy areas whereas detritus feeders are to muddy areas¹⁴. Though the bay was indentified into 3 main types of benthic communities in the present investigation, quantitatively, there was a distinct heterogenic distribution. Such differences are attributed by the impact of localised biotic and abiotic factors¹⁵⁻¹⁷. The high and low values of the percentage of prevalence of benthic animals show its extent of distribution, adaptation and versatile nature to different biotopes in the bay. Accordingly, polychaeta showed higher values and least by echinodermata.

The mean wet biomass 116.65 gm^{-2} when converted to dry weight¹⁸ amounts to 20.4 gm^{-2} , which closely agrees with the values reported by Warwick, *et al.*¹⁹. Comparing the benthic standing crop and faunal diversity with the tropical waters reported elsewhere²⁰, it seems to be less and more diversified respectively²¹. However, the animal sizes were larger in temperate waters.

Annual benthic production is 223.3 gm^{-2} assuming Sander *et al.*²² conversion factor, when it is converted into dry weight¹⁸ amounting to $32.4 \text{ gm}^{-2} \text{ yr}^{-1}$ or $16.2 \text{ g Cm}^{-2} \text{ yr}^{-1}$ according to Damodarn²³. Considering the 10% ecological efficiency²⁴, the annual carbon requirement is $162 \text{ g Cm}^{-2} \text{ yr}^{-1}$ by the benthic community. There seems to be a considerable amount of organic carbon supply to benthos through the food chain in Swansea Bay. Such a type of benthic work helps in the assessment of pollution, if any²⁵⁻²⁷ and demersal fishery resources as benthos forms the food of bottom fishes²⁸. A close relationship is

established between the demersal fish catch and benthos²⁹. High yield of benthic production $223.2 \text{ gm}^{-2} \text{ yr}^{-1}$ or $2.2 \text{ tons hac}^{-1} \text{ yr}^{-1}$ or $223 \text{ tons km}^{-2} \text{ yr}^{-1}$ can sustain $22.3 \text{ tons km}^{-2} \text{ yr}^{-1}$ amount of bottom fishes in Swansea Bay, taking into consideration Odum's³⁰ hypothetical pyramid from 3rd to 4th trophic level.

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References

- 1 Vivian C M G, *Distribution of certain trace elements in seawater and sediments in relation to local source, Swansea Bay and adjacent parts of Bristol Channel*, Ph. D. thesis University of Wales, 1975, 212.
- 2 Vivian C M G & Massie K S, *Environ Pollut*, **14** (1977) 47.
- 3 Collins M B, Ferentions G & Banner F T, *Estuar Coast Mar Sci*, **8** (1979) 49.
- 4 Warwick R M & Davies J R, *Estuar Coast mar Sci*, **5** (1977) 267.
- 5 Warwick R M & George C L, *A case study of Swansea Bay* edited by M B Collins *et al.* (Pergamon Press) 1980, 517.
- 6 Caudette H E, Flight W R, Joner L & Fogler D W, *J Sedim Petrol*, **44** (1974) 249.
- 7 Sanders H L, *Bull Bingham Oceanogr Coll*, **15** (1956) 345.
- 8 Sanders H L, *Limnol Oceanogr*, **3** (1958) 245.
- 9 McNulty T K, Work R C & Moore H B, *Bull mar Sci Gulf Caribb*, **12** (1962) 322.
- 10 Tyler P, *Biology of benthos organisms*, edited by Keegan B F *et al.* (Pergamon Press) 1977, 559.
- 11 Ganapati P N & Raman A V, *Curr Sci*, **42** (1973) 490.
- 12 Bader R G, *J mar Res*, **13** (1954) 32.
- 13 Christei N D, *Mar Biol*, **30** (1975) 89.
- 14 Johnson R G, *Mar Geol*, **11** (1971) 93.
- 15 Thorson G, *Neth J Sea Research*, **3** (1966) 267.
- 16 Parulekar A H & Dwivedi S N, *Indian J mar Sci*, **3** (1974) 41.
- 17 Wildish D T, *Helgolander Wiss Meeresuntrs*, **30** (1977) 445.
- 18 Thorson G, *Mem Geol Soc Amer*, **67** (1957) 61.
- 19 Warwick R M, George C L & Davies J R, *Estuar Coast mar Sci*, **7** (1978) 215.
- 20 Ansari Z A, Parulekar A H, Harkantra S N & Nair S A, *Mahasagar-Bull natn Inst Oceanogr*, **10** (1977) 123.
- 21 Sterling A, *Bull Dept mar Sci, Univ Cochin*, **4** (1975) 845.
- 22 Sanders H L, Goudsmith E L, Mills E L & Hampson G E, *Limnol Oceanogr*, **7** (1962) 63.
- 23 Damodaran R, *Bull mar Sci, Univ Cochin*, **6** (1973) 109.
- 24 Slobodkin L B, *Growth and regulation of animal population*, (Holt Rinehart & Winston, New York) 1962, 184.
- 25 Pearson T H, *Proc Royal Soc*, **180** (1972) 409.
- 26 Reish D J, *J Environ Planning pollut Control*, **1** (1973) 32.
- 27 McIntyre A D & Eleftheriou A, *J mar Biol Assoc UK*, **48** (1968) 113.
- 28 McIntyre A D, *Ecology of marine benthos*, edited by B C Coul (1978) 301.
- 29 Harkantra S N, Nair A, Ansari Z A & Parulekar A H, *Indian J mar Sci*, **9** (1980) 106.
- 30 Odum E P, *Fundamentals of ecology*, (Saunders & Saunders, Philadelphia) 1973, 228.