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Sediment-polychaete relationship in the Vasishta Godavari estuary

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Abstract. A 16 km stretch of the lower Vasishta Godavari estuary (lat. 16° 18′ N long. 81° 42′ E) was surveyed during October 1976–January 1978 to study the polychaete-sediment relationship. Mean high mid- and low water marks at six permanent stations were sampled for studying polychaete distribution as well as sediment characteristics. Sand fraction dominated stations I and II and the silt-clay per cent increased higher up the estuary. Organic matter in the estuary ranged from 0·1 to 4·2% and the amount is generally linked with the silt-clay fraction of the sediment. Depending upon their tolerance to the sediment composition polychaete species colonised different tidal levels. Carnivores were restricted to sandy substrata. For the detritus feeders, the influencing factor appears to be organic matter than the sediment composition.

Keywords. Sediment composition ; organic matter ; relationship ; carnivores ; detritus feeders.

1. Introduction

The importance of the substratum during settlement of polychaete larvae has been documented by Wilson (1953). Sanders (1958) successfully attempted to relate the type of feeding of the organism and the sediment composition in Buzzards Bay, Massachusetts. Thus he found detritus feeders restricted to the mud sediments and filter feeders to the median grain size sediments. In contrast Muus (1967) stated that in any estuary, with irregular or unfavourable fluctuating physical factors, salinity and dissolved oxygen are more important than the sediment composition in influencing the species distribution. Moreover sediment particle size is known to be a function of the mixing and dilution of salt water by freshwater and therefore particle size is dependent on salinity (McNulty *et al* 1962). Muus (1967) therefore concluded that any attempt in that direction is fruitless. However, later works in several other areas revealed the apparent relationship between the substratum and the invertebrate fauna in general and polychaetes in particular.

In the present study an attempt has been made to establish the possible relationship between the abundance of polychaete fauna and the intertidal sediments in the Vasishta Godavari estuary.

2. Area of investigation

The area presently investigated is the intertidal habitat of the Vasishta Godavari estuary, the southernmost branch of the river Godavari, opening into Bay of Bengal at Antervedi (lat. 16° 18′ N ; long. 81° 42′ E). The geographical description of the area and location of the stations have already been given by Srinivasa Rao (1980).

3. Materials and methods

Collections were made from six stations at monthly intervals, from October 1976 to January 1978 excepting in August 1977 due to fast currents associated with high annual floods. At each station sampling was made from three tidal levels *viz.*, mean high water mark (MHWM), mean mid water mark (MMWM) and mean low water mark (MLWM). Sediment was collected using a PVC corer while a metal frame of 20 × 20 × 15 cm dimensions was used for polychaete collection. Techniques employed for the collection and analysis of hydrographic parameters were the same as described earlier (Srinivasa Rao 1980 ; Srinivasa Rao and Rama Sarma 1980). Sand, silt and clay fractions in the sediment were estimated by the pipette method of Krumbein and Pettijohn (1938) whereas the organic matter in the sediment was estimated by the method of Gaudette *et al* (1974).

4. Results

The nomenclature of Folk (1968) is adopted to classify the sediments of Vasishta Godavari estuary and the sediment composition during different seasons is presented in figure 1. The sediments were generally sandy near the river mouth (stations I and II) as the area is influenced by neretic waters and the silt-clay fraction increased with the increasing distance from the river mouth (stations III to VI). Along the transect, the sediment composition varied with increasing silt-clay content down the transect. Generally the upper 3 cm layer of the substratum is an unconsolidated layer while below that is a closely packed silt-clay fraction. This layering is the cumulative result of depositional and erosional factors operating during the tidal cycles and the superimposed annual freshwater floods.

The maximum, minimum and average organic matter content for all the tidal levels is presented in table 1. The organic matter content is significantly high in the estuary as also observed by Dora and Borreswara Rao (1975). The low organic matter content at the seaward stations (I and II) may be due to the sandy nature of the substratum and sufficient aeration. The increased silt clay fraction and consequent compactness of the sediment and poor aeration resulted in the retention of a high amount of organic matter at stations III to VI. That the clay minerals bind organic matter better than the loose sands is well-known (Sanders 1956). Similar relationship of the organic matter with fine sediments around the Indian subcontinent was observed by Murthy *et al* (1969), Parulekar *et al* (1976) and Ansari *et al* (1977). The high organic matter content in the sediment during summer is the result of high organic production characteristic of the estuaries. Further the contribution from the adjoining mangroves and terrestrial sources is

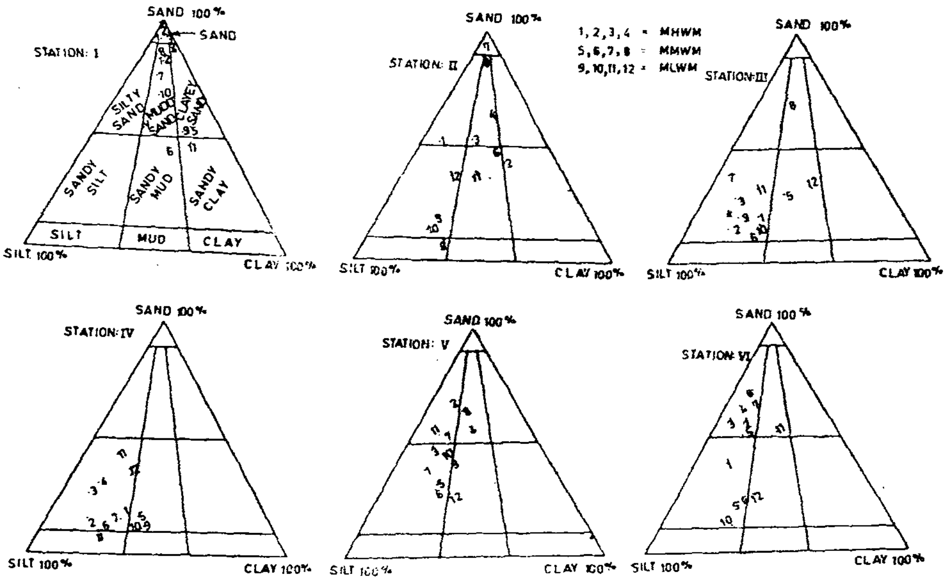

Figure 1. Seasonal variations in the sediment composition during the period of study.

Table 1. Organic matter content in the sediments during the study period.

Station	Tidal level	Minimum (%)	Maximum (%)	Average (%)
I	MHWM	0·11	1·20	0·61
I	MMWM	0·16	2·49	1·53
I	MLWM	1·04	2·64	1·71
II	MHWM	0·17	1·73	0·86
II	MMWM	0·66	3·20	1·85
II	MLWM	0·94	3·52	1·81
III	MHWM	0·39	2·64	1·98
III	MMWM	0·62	3·66	2·25
III	MLWM	0·72	3·20	2·11
IV	MHWM	0·16	3·20	1·99
IV	MMWM	0·97	3·84	2·15
IV	MLWM	0·80	2·62	1·83
V	MHWM	0·27	2·14	1·31
V	MMWM	0·39	2·49	1·73
V	MLWM	0·15	2·57	1·77
VI	MHWM	0·41	4·20	2·34
VI	MMWM	0·38	3·32	2·43
VI	MLWM	0·17	3·74	2·39

remarkably high. The high bacterial activity because of high temperature is yet another factor by which the organic matter reduces in respect of particle size and gets adsorbed onto the sediment.

5. Discussion

In estuaries, the sediment is of paramount importance in influencing the life in general and the benthic fauna in particular. The importance of soil grade as a factor in the distribution of polychaetes has long been recognised (Day and Wilson 1934 ; Southward 1957 ; Bassindale and Clark 1960 ; Clark and Haderlie 1960, 1962 ; Bloom *et al* 1962 ; Williams 1962 ; Estcourt 1967 ; Nichols 1970 ; Boyden and Little 1973 ; Wolff 1973 ; Gray 1974 ; Santos and Simon 1974 ; Grassle and Grassle 1974 ; Buchanan 1963 ; Vietez 1976 ; Whitlatch 1977 and Amaral 1979). Though the food and feeding habits of the polychaetes inhabiting this estuary have not been worked out, the investigations of Sanders (1956) ; McNulty *et al* (1962) and Brett (1963) show that a close relationship prevails between the feeding habits of the infauna, gross organic matter content and the texture of the sediment. Observations made on the morphological features of the polychaetes of this estuary suggested that majority of them are detritus feeders. This is due to the excessive silt-clay fractions in the sediments. The filter feeders are absent up in the estuary as they need well aerated substrata. Such substratum is available at MHWM at station I but prolonged period of exposure and high temperature may be acting as deterrent factors preventing their settlement.

Depending upon their tolerance to the substratum composition, different species occupied different positions along the transect, however in varying numbers. The capitellid *Heteromastus similis*, nephtyd *Nephtys oligobranchia* and nereid *Dendronereis arborifera* appear to have great resistance for exposure, grain size and salinity. They were represented equally at all the three tidal levels (figure 2) and in almost all substrata except in places where the sand content was less than 10% (Rama Sarma and Srinivasa Rao 1980 ; Srinivasa Rao 1980 and Srinivasa Rao and Rama Sarma 1980). Several other species which cannot tolerate hard substrata at MHWM restricted themselves to the lower tidal levels (figure 2) where the sediment composition was suitable (figure 3). But when forced by wave action they survived there for certain periods.

It is interesting to note that though most species exhibited substratum preference, individuals of each species appeared at times in substrata with different composition (figure 3). It may be because of the influence of the sediment in controlling the abundance of the organisms but not their distribution (Holme 1949 ; Wilson 1953 ; George 1964 ; Sanders *et al* 1965). It also appears that mud dwelling species were able to invade the substrata containing sand while the species inhabiting sandy substrata failed to invade the muddy ones. This may be because of the possible clogging of the feeding apparatus of the sandy inhabitants when they try to invade the muddy sediments. Similar observation was made by Johnson (1971). Thus members of the genus *Glycera*, eunicids *Diopatra neapolitana* and *Lumbrineris heteropoda* which are known carnivores, restricted themselves to the sandy substrata. They feed on the interstitial microfauna available in that habitat. For several sedentarian species like *Magelona cincta*, *Cossura coasta*, *Sternaspis*

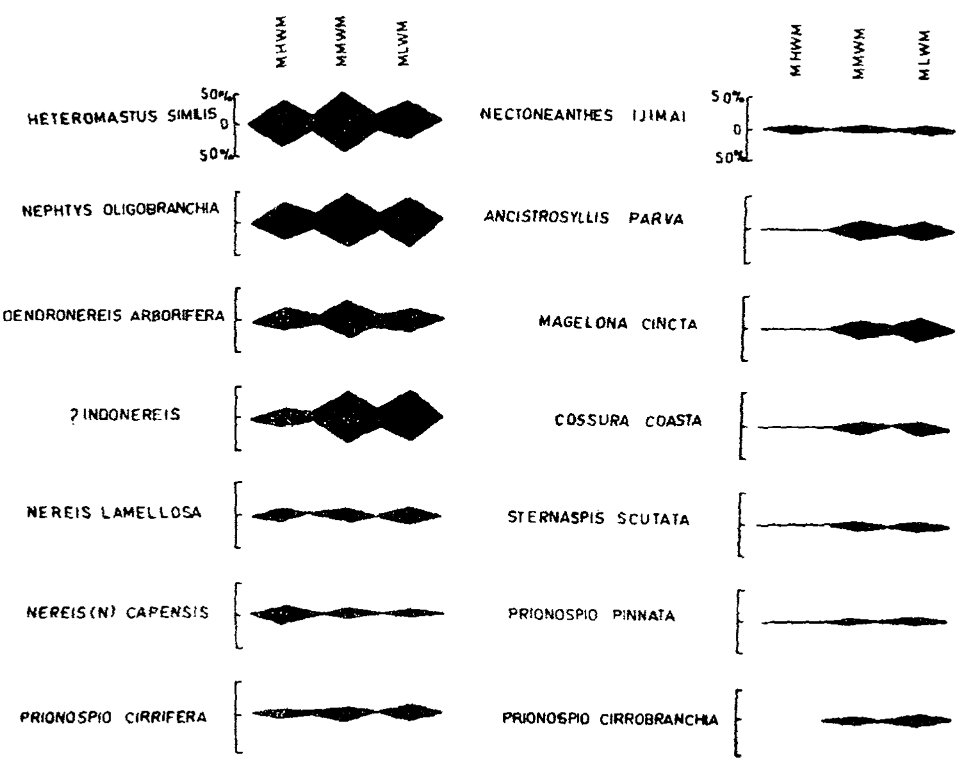

Figure 2. Transectwise distribution of polychaete species in the Vasishta Godavari estuary.

scutata and members of the family Spionidae which are detritus feeders, there appears to be no substratum preference, except the avoidance of sandy substrata.

Nereis lamellosa occurred in good numbers at station I where grass was present which not only provides stability to the substratum but also keeps the temperature low, in addition to providing food material in the form of detritus. The importance of grass in the distribution and food patterns of intertidal organisms was shown by MacGinitie as early as in 1939.

Organic matter in the sediment plays an important role in the abundance and distribution of benthic polychaetes especially in estuaries where the organic matter content available in the shallow water sediments is usually very high. Buchanan (1963) observed that the distribution of the organisms is generally related to the temperature, salinity and grade of the soil and more closely with the organic matter. However the organic matter in the utilisable form in the sediment is reported to be important for the polychaete survival.

Organic matter in the Vasishta Godavari estuary is chiefly of plant origin which is brought down by a multitude of small creeks, finally getting embedded in intertidal sediments. This material is played up and down the estuary and also between MHWM and MLWM in the intertidal region. In addition the intertidal organisms themselves contribute to the organic matter content apart from the minute fraction swept in from the sea through tidal action.

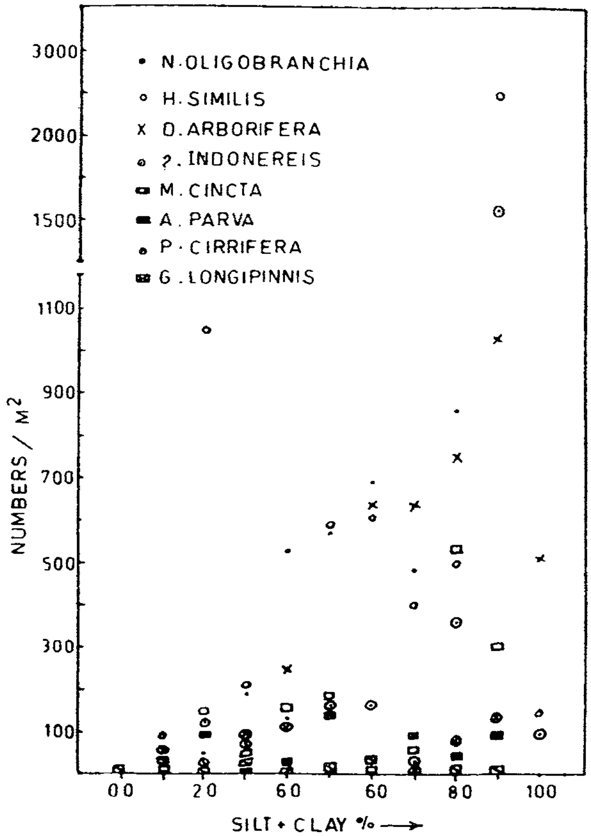

Figure 3. Sediment composition and the density of polychaete species.

The capitellid *Heteromastus similis* was found to be cosmopolitan in distribution (in respect of the nature of substratum) but the major factor which outweighed all other factors is decidedly the organic matter content (Srinivasa Rao 1980). The detritus feeders *Dendronereis arborifera*, *Magelona cincta*, *Sternaspis scutata* and *Cossura coasta* were found in greater abundance in muddy areas where the organic matter content was high. On the other hand the carnivores of the family Glyceridae and Enuicidae have shown no special relationship with the organic matter. Similar is the case with *Nephtys oligobranchia*, a proven carnivore (Srinivasa Rao and Rama Sarma 1978).

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