

Community structure of meiobenthos from a tropical estuary

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Meiofaunal samples were collected from 3 stations, located in the salinity gradient of Zuari estuary of Goa. Spatially the abundance of meiofauna decreased from lower to upper reaches and followed the trend of salinity distribution in the estuary. The population density showed clear seasonal abundance, the maximum being in premonsoon and the minimum in southwest monsoon season. The fauna showed remarkable recovery after monsoon, due to their resilient nature. Free living nematodes were most dominant, contributing over 50% of the total meiofauna in terms of number and biomass. They were followed by benthic copepods and ostracods/turbellarians in the order of abundance. Vertically, over 60% of the fauna occurred within the top 2 cm of the sediment and the faunal density reduced significantly in the deeper layer. Salinity and availability of food influenced the fauna horizontally while chlorophyll *a* and interstitial water were important in determining the vertical distribution.

Meiofauna has been the subject for intense quantitative study due to the important role it plays in the marine food chain^{1,4}. Earlier short term studies have yielded clear ecological inferences on spatial variability, dominance and vertical distribution. However, the occurrence of temporal pattern, seasonality and the predominance has rarely been demonstrated in the tropical estuaries^{5,6}.

The decrease in number of macrobenthic species from mouth to head of estuaries is well documented^{7,8}. Reduced and fluctuating salinities result in a harsh restrictive environment which directly reduces species diversity. For meiofauna, data on abundance and species richness in relation to salinity are conflicting⁹. In this communication, we report the quantity of meiofauna on a salinity gradient, its seasonal variation and vertical distribution in the Zuari estuary of Goa. The pattern of variability in the meiofauna abundance is discussed in relation to some of the environmental factors. The stations were selected based on the penetration of salt water which is about 20 km during the monsoon season¹⁰.

Materials and Methods

Of the three stations selected in Zuari estuary, st. Z1 was located in the lower and high saline zone while sts Z2 and Z3 were situated further towards head of the estuary, where tidal flow is strong (Fig. 1). All samples were collected with the help of a

hand operated small gravity corer, having a sampling area of 7.06 cm². Five cores were taken on each sampling date at monthly interval, from each station (June 1983 through June 1984) for meiofauna, sedimentary pigment, interstitial water, Eh, organic carbon and grain size. Vertical profiling was made by subsampling at every 2 cm in the upper 10 cm of the core from each station.

Bottom water samples overlying the sediment were collected with a Niskin sampler. Temperature was measured with a reversing thermometer. Salinity and dissolved oxygen were determined by titration¹¹. Interstitial water content was measured by first taking wet weight of the sediment, dried at 110°C and reweighed. Wet weight minus dry

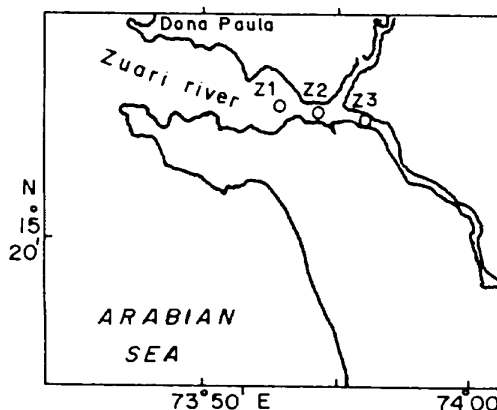


Fig. 1—Map of Zuari river estuary showing station location

weight was interpreted as a rough estimate of the weight of the interstitial water, from which the percent interstitial water was calculated¹². Procedure for the analysis of meiofauna is given elsewhere⁶. Sediment was analysed for particle size by the method of Buchanan¹³.

Results

Zuari estuary is subjected to distinct seasonality in the physico-chemical parameters due to strong southwest monsoon. The tidal influence results in an intrusion of appreciable amount of salt water from the adjacent sea and stratification of the estuary¹⁴. The estuary can be classified as a stratified estuary during the monsoon season. Summary of the environmental parameters is given in Table 1. The annual range and fluctuation in the temperature of the overlying water at bottom was similar at the three stations, due to strong current and mixing of bottom water. Generally the temperature was low during monsoon season and increased gradually during the postmonsoon with maximum in May. The annual variation in the temperature at the three stations was around 7°C.

The salinity variations were large, ranging from almost freshwater during the monsoon season to marine conditions during the premonsoon season. The maximal extent of seawater intrusion into the estuary is about 67 km, depending upon the freshwater discharge. The dissolved oxygen (DO) of the bottom water was high due to replenishment associated with flushing by strong currents. The values of DO were very similar at three stations, unlike salinity.

Sediment grain size is important for the benthic animals, as it influences the distribution and settlement of different forms of life. The texture of the sediment (median grain size) exhibited the dominance of fine silty mud at Z1 and Z3 while fine to medium sand dominated at Z2. The interstitial water content exhibited variability between the stations which could be attributed to the grain size and pore space in the sediment. However, the mean values varied narrowly among the stations. The values were higher in the finer sediment than sandy deposits.

The organic matter from various sources (allochthonous, autochthonous) in the sediment

Table 1—Summary data of environmental parameters of bottom water

(Values are annual range, and means are in parenthesis)

Parameters	St Z1	St Z2	St Z3
Average depth (m)	9	7	4
Water temperature (°C)	24.0-31.0 (27.8)	24.4-31.0 (28.4)	24.6-32.4 (28.3)
Salinity ($\times 10^{-3}$)	4.8-32.8 (18.4)	2.3-30.8 (11.6)	0.2-25.2 (8.4)
D.O. (ml/l)	3.4-4.9 (3.6)	2.7-4.7 (2.9)	2.8-4.8 (3.2)
Median grain (mm)	0.03-0.08 (0.04)	0.08-0.16 (0.11)	0.03-0.08 (0.05)
Interstitial water (%)	30.8-42.2 (37.7)	20.4-28.6 (24.2)	20.3-28.2 (23.8)
Organic carbon (%)	1.3-3.7 (2.2)	0.9-2.8 (1.8)	0.2-1.6 (0.8)
Sediment Eh (mv)	12-120 (59)	16-216 (99)	17-134 (62)
Chlorophyll <i>a</i> ($\mu\text{g/g}$)	2.7-18.3 (10.4)	2.4-16.1 (8.8)	1.2-13.2 (6.8)

plays important role in the nutrition of the benthic organisms. The mean values varied between 0.8 and 2.2%. High values were associated with fine sediment particles. The redox potential (Eh) is indicative of oxygenation of the sediment. Positive values are generally recorded in oxic condition while negative values indicate highly reducing condition in the sediment. According to Varshnin & Rozanov¹⁵, values below +200 mv indicate reduced condition of the sediment. The mean values ranged from +59 to +99 mv, thus suggesting a reduced condition in the sediment.

Sediment chlorophyll *a* is an important parameter as it indicates the level of primary productivity particularly in the shallow estuarine areas. There was high degree of seasonal variability in the chlorophyll *a* concentration and the annual average values ranged between 6.8 and 10.4 $\mu\text{g/g}$ sediment. The values were high in the premonsoon and low in the monsoon season. Fine grain sand was found to contain high concentration of pigment. Diatoms were the dominant phytoplankton in the sediment.

The meiofaunal abundance and dry weight biomass is given in Fig. 2. The range in number at Z1, Z2 and Z3 were 760-2039, 753-2173, and

615-2168/10 cm², respectively. Total meiofaunal count was lowest during the southwest monsoon period. The number progressively increased with maxima during the premonsoon period at all the stations. The first peak was observed in November, followed by another in April-May. There was progressive decrease in the meiofaunal number along the salinity gradient, from higher to lower salinity. The numerical count in monsoon season was significantly lower than either in post-or premonsoon season ($p < 0.05$). The meiofaunal number was significantly correlated with salinity ($r = 0.82$)

Fluctuation in the monthly biomass followed the trend similar to number wherein low values were recorded in monsoon and high in premonsoon season (Fig. 2). Group-wise, nematodes contributed between 52.2 and 67.4% of the total biomass, followed by ostracods (8.2-28.5%), harpacticoids (0.4-6.2%), polychaetes (1.3-3.4%) and turbellarians (0.5-1.8%). The rest was contributed by other groups. The ostracods although represented in low numbers, contributed more towards biomass due to their larger size.

Six dominant groups represented the meiofauna; among which nematodes, harpacticoid copepods, ostracods, turbellarians and polychaetes were the important taxa (Table 2). Nematodes contributed between 80.7-82.4% of the total number. They were followed by harpacticoids (6.5-7.6%), ostracods (2.6-3.6%), turbellarians (2.0-2.8%) and polychaetes (1.9-2.3%). The common genera of different groups were *Neochromadora* sp., *Desmodora* sp., (nematodes), *Halectinosoma curticorne*, *Laophonte* sp. (harpacticoida) and *Prionospio pinnata* (polychaete). Other groups of lesser importance recorded in the samples were kinorhyncha, gastrotricha, tardigrada and crustacean nauplii.

Distribution of nematode feeding type was studied since differences in the nematode fauna may be due to the types of food present¹⁶. The variation in the relative proportion of different feeding types is illustrated in Fig. 3. Several significant trends emerged. The deposit feeders were dominant in fine mud (Z1, Z3) while epigrowth feeders were more in sandy deposits. Predators/omnivores did not show any preference to sediment types. A decrease in epigrowth feeders

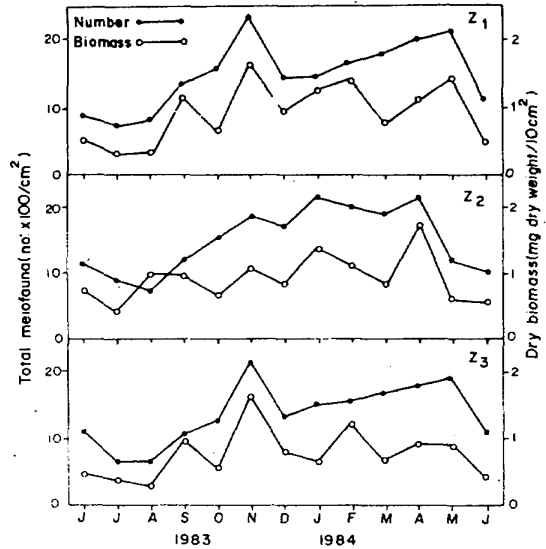


Fig. 2—Monthly variation of total meiofaunal number and dry biomass at sts Z1, Z2 and Z3

Table 2—Average percentage contribution of major meiofaunal taxa.

Taxa	St.Z1	St.Z2	St.Z3
Nematoda	80.7	81.3	82.4
Harpacticoida	6.7	7.6	6.5
Turbellaria	2.8	2.5	2.0
Ostracoda	3.6	2.9	2.6
Polychaeta	1.9	2.3	2.0
Others	4.3	3.4	4.5

coincided with an increase in the deposit feeders. The overall percentage of deposit feeders, epigrowth feeders and predators/omnivores was 45, 36 and 19%, respectively.

Vertical distribution of meiofauna and some of the environmental parameters are given in Fig. 4. On an average, over 60% of the total fauna was present in the top 2 cm layer of the core sample. By contrast the fauna in the 2-4, 4-6, 6-8 and 8-10 cm layer averaged 24, 10, 2 and 1% of the total fauna, respectively. Although nematodes were present in the entire core, their number was high only in the top layer. Benthic copepods being sensitive to oxygen tension, were restricted to upper layer of the sediment. No copepods were observed below 4-6 cm layer. Similar vertical distribution was shown by turbellarians and ostracods. However, the polychaetes were recorded

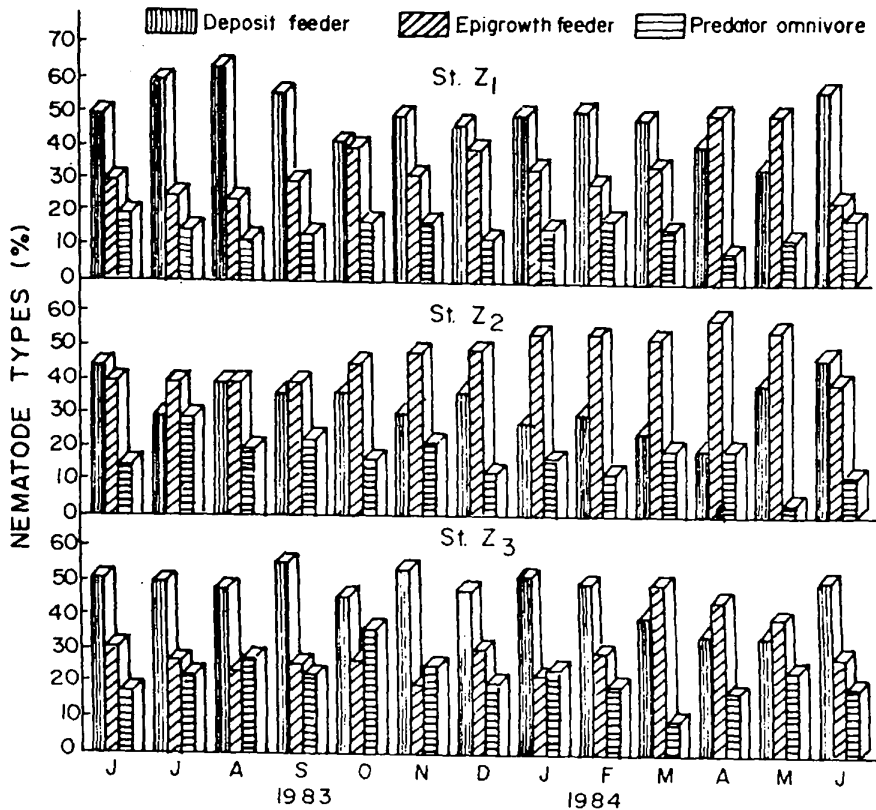


Fig. 3—Abundance of nematode feeding types (percentage) at sts Z1, Z2 and Z3

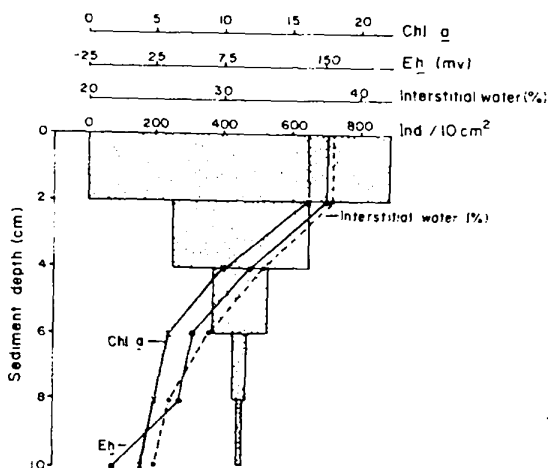


Fig. 4—Vertical average distribution of meiofauna, interstitial water, E_h and chlorophyll a in the sediment

from 0-8 cm depth. Vertical distribution of meiofauna was positively correlated with E_h , interstitial water and chlorophyll a . Dispersion pattern of meiofaunal taxa was calculated according to Morisita's index¹⁷. The index values indicated a contagious or clumped distribution for most of the meiofaunal groups.

Discussion

Meiofauna of Zuari estuary showed considerable seasonal variation, both in occurrence and abundance. High variability in the abundance has been reported from the Indian coast^{5,6,18}. The reduction in salinity and resuspension of sediments during the monsoon cause mortality of metazoan meiofauna and are responsible for the seasonality in distribution. The increase in population after the termination of monsoon in September indicated the resilient nature and ability of meiofauna to quickly repopulate the disturbed sediment¹⁹.

The rise in temperature, salinity and food supply during summer are responsible for increase in meiofauna^{6,20}. Marked changes in nematode population were associated with seasonal changes in the feeding type. Variation in the abundance from lower mouth to upper reaches could be related to the gradient of salinity and sediment grain size. Ostracods prefer the fine silty sediment. The seaward increase in meiofauna number is due to the predominance of marine and euryhaline taxa in the estuarine benthic fauna for most part of the year except the monsoon season²¹.

The reported decline in the number of organisms with increasing depth in the sediment has been confirmed in this study. Zones of high productivity such as the 0-2 cm layer could support high density in the upper layer of the sediment. The reduction in interstitial water and Eh led to reducing condition in the sediment which acted as barrier for many meiobenthic organisms. Most meiofauna can not tolerate the reducing conditions and are thus restricted to the oxidised sediment zone above it²². The presence of nematode in the deeper layer probably reflects their capability to tolerate the reducing condition. Therefore the peak abundances of different feeding types in nematode species may, as a result of their sensitivity, be restricted to different layers.

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