Indian J. Fish., **50**(4) : 465-471, Oct.-Dec., 2003

Role of meiobenthic assemblages in detritus based food chain from estuarine environment of Goa

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ABSTRACT

The paper describes the variations in ecological parameters and their possible role on vertical distribution of meiobenthic communities in the estuarine marshy environment at Goa. The investigations conducted during post monsoon season suggest that hydrobiological parameters are regulated by local attributes such as land use pattern and coastal processes. Further, the variation in environmental characteristics had direct relationship with meiobenthic population density and its variations. Among biological parameters the sediment Chlorophyll *a* (Chl *a*) was found to be closely related with meiobenthic density ($r= 0.89$: $p<0.001$). The fauna showed higher concentration at 0-2 cms layer. Subsequently, as the depth increased, there was significant decrease in the density of meiobenthic organisms. Another conspicuous observation made in the present study was abundant supply of organic carbon up to a depth of 5 cm.

Introduction

Benthic communities, represented by diversified population of invertebrates within sediments play an important role in enhancing fish production through a detritus based food chain (Coull *et al.*, 1995; Preetha and Pillai, 2000). The estuarine ecosystems due to their dynamic processes and supplemented with microbial colonization (Cho and Azam, 1990) support high fish biomass and are also known to enhance their nutritive value through various benthic processes. Earlier studies (Orth, 1986; Ansari *et al.*, 2001) suggest that among these benthic communities, meiobenthos although smaller in size contribute significantly to total benthic production, mainly due to their high density and high metabolic rate (Gerlach, 1971). The involvement and importance of meiobenthic invertebrates in various benthic processes at sediment - water interface have been reported earlier (Harkantra and Parulekar, 1981; Ansari, 1989).

Available literature (McIntyre and Murison, 1973; Sikora and Sikora, 1985; Galeron *et al.*, 2000) on benthic population density and its distribution in estuarine complex suggest that the benthic production forms an integral part of aquatic ecosystem and play significant role in enhancing secondary production. Further, the dynamic ecological characteristics influence the abundance and occurrence of benthic communities. Hence, an attempt has been made to study the horizontal and vertical distribution of meiobenthic population along

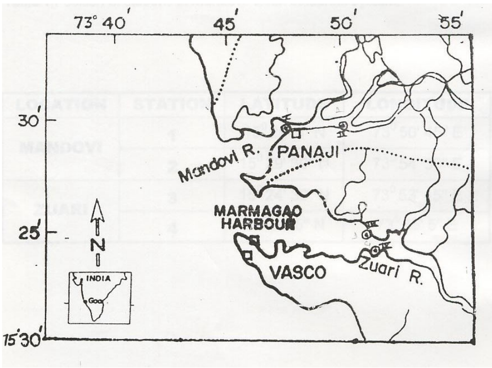

Fig. 1 Map showing the location of study

with physico - chemical parameters in the estuarine waters of Goa and to assess their role in influencing detritus based food chain.

Materials and methods

The intertidal estuarine marshy ecosystem (Fig. 1) is the transformation of gentle sloping of near shore bank of Mandovi and Zuari, which is filled with silt, clay and detritus transported by riverine influx from upper reaches, where mangrove vegetation occurs in high density. The marshy areas extend for a distance of about 4 km, inundated by high tide. The muddy bottom vegetated with mangroves make it highly productive for benthos thus supporting large number of economically important species of avian fauna and fishes which feed on them.

Sediment samples were collected from 4 stations (Fig. 1) situated approximately 2 km apart in the Mandovi estuarine complex, whereas the stations were about 1 km apart in the Zuarine system with the help of hand corer of 4.5 cm inner diameter and 10 cm length. The stations were selected such that they are located closer to the mangroves as these areas support production of large quantity of humus and detritus. Samples were collected during September, 2001 to January, 2002, representing post - monsoon season. Monthly sampling was carried out wherein three replicate cores were collected at low tide by inserting 10 cm length core into the sediment at each station. The core sediments were sub-sectioned at 1 cm interval for the study of vertical distribution of meiofauna, organic carbon and chl *a*. Sediment samples for meiofauna were treated with 5 % formalin mixed with Rose Bengal solution.The interstitial water was collected by digging a hole in the sediment. The percolated water was collected with the help of a plastic syringe and used for the estimation of salinity, dissolved oxygen and chl *a*. In the laboratory, meiofauna was sorted out with the help of two sieves, the upper one of 0.5 mm mesh and the lower one of 0.062 mm mesh size. The animals retained on finer mesh were considered as meiofauna (Coull, 1973; Ansari, 1989).

Salinity was estimated by the method of Strickland and Parsons (1972) and dissolved oxygen using Winkler's method. Organic content of the sediment was determined by chromic acid oxidation (El Wakeel and Riley, 1956). Sedimentary pigment determination was made to obtain estimates of Chl *a* in the sediment (Strickland and Parsons, 1972).

The data obtained on environmental parameters and meiofaunal density was subjected to computation of simple correlation coefficient (r) to understand the significance of relationship between these parameters and meiofaunal density. The data on meiofaunal density obtained in the present study was also subjected to ANOVA to understand whether there exists any significant difference in the meiofaunal densities with depth.

Results and discussion

The variation in the environmental parameters of the overlying water highlight a gradual decrease in temperature with its lowest value (26.9^{0}C) in November. Such low values during this period are mainly attributed to seasonal influence as evident from low atmospheric temperature values at this time (Qasim and Sen Gupta, 1981; Ansari, 1989). However, the salinity values showed an increasing trend with maximum value (29.75 ‰). It is imperative that the period of heavy rainfall registered a major impact on the variability of environmental characteristics in the area of study. The pattern of variation emphasize the influx of riverine runoff as an important entity to affect salinity and temperature (Qasim and Sen Gupta, 1981). The dissolved oxygen content values were quite stable with marginally low values during September - October. On the other hand, the Chl *a* content as an indication of primary productivity showed an increasing trend towards termination of study period. Qasim *et al.* (1969) while studying organic production in a tropical estuary stated that the chl *a* biomass during this period is of higher magnitude. The environmental factors (temperature, salinity and DO) showed an effect on the physico-chemical characteristics of the interstitial water. It has been documented earlier that the variability in the ecological factors within interstitial waters is a function of the conditions prevailing at overlying water (Ansari and Parulekar, 1998). Benthic autotrophic production at sediment - water interface forms an important source of nourishment for benthic communities (Tietjen, 1968).

TABLE 1: *Temperature, Salinity, DO, Chl a, Organic carbon and meiofaunal density in overlying and interstitial water. (Values± SD)*

	Overlying water			
	Station 1	Station 2	Station 3	Station 4
Temperature (^{0}C)	27.9±2.17	28.53±1.46	28.83±1.33	28.63±1.47
Salinity (ppt)	13.74±7.29	13.52±8.00	15.78±6.72	14.56±7.68
DO (mg.l-1)	3.27±0.72	3.36±0.89	3.43±0.96	3.44±0.83
Chl *a* (mg.l-1)	2.22±1.66	2.85±1.79	3.44±1.70	2.78±0.98
	Interstitial water			
	Station 1	Station 2	Station 3	Station 4
Temperature (^{0}C)	28.13±1.84	28.95±0.79	28.15±1.76	28.18±1.64
Salinity (ppt)	16.50±7.76	15.93±8.67	17.34±6.32	16.45±7.65
DO (mg.l-1)	2.61±0.98	2.81±0.98	2.68±1.03	2.97±0.76
Chl *a* (mg.l-1)	3.60±1.52	3.80±1.56	3.45±0.61	3.58±1.02
Organic carbon (%)	4.69±1.10	4.82±1.11	4.50±1.12	4.37±0.92
Meiofaunal density (no/10cm^2)	258± 203	258±201	381±206	415±228

To assess the biological productivity within sediments, interstitial water was subjected to analysis of plant pigment (Chl *a*) as it forms a key index of quantitative estimation of primary productivity (Ansari and Parulekar, 1998). The distribution of plant pigment (Table I) illustrate that the Chl *a* production in the interstitial waters was high which could be mainly attributed to the cumulative effect of drainage within the interstitial water. Such observations made in the present study highlight the utilization of phytal biomass as a source of energy by meiobenthic communities. Ansari (1989) emphasized the importance of Chl *a*, playing an important role in dominance of meiobenthic population through a detritus based food chain, in a tropical estuarine environment.

Attempts were made to study the availability of organic carbon and the possible relationship with meiobenthic density. The organic carbon content of the sediment in the study area varied between 2.62 and 6.60 % signifying the productive nature of this estuarine complex forming an ideal substrate for the production of benthos (Coull, 1973). Subsquently, the vertical distribution of organic carbon up to a depth of 5 cm (Fig. 2) revealed that with the advancement

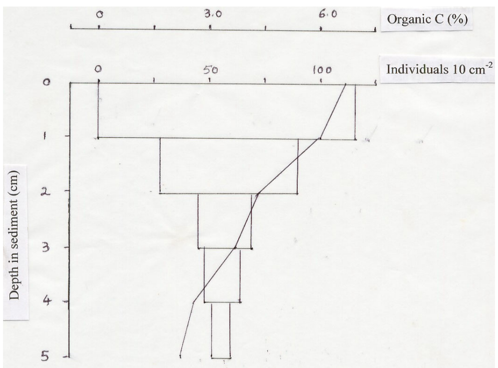

Fig. 2: Vertical variations in meiofaunal density (individuals 10 cm^{-2}) and organic carbon (%).

of depth there were no large differences in organic carbon values up to a depth of 5 cm. However, it was noticed in the present study that, although the organic carbon content was stable, there was marked reduction in the density of meiobenthic population with the depth beyond 2 cm. Such observations made in the present study suggest that the availability of organic carbon as a source of energy for meiobenthic communities beyond 2 cm depth within sediments do not form a decisive factor to sustain their population. The low density of meiobenthic communities could be attributed to the availability of dissolved oxygen within interstitial waters (Gutierrez *et al.*, 2000; Boaden, 1984). The DO content beyond 2 cm depth was meager. The observations made in the present study indicate that the Chl *a* content in the sediment below 2 cms depth is low, however the percentage of organic carbon is stable. The present set of observations indicates that meiobenthic communities in sediments beyond 2 cm depth does not seem to use phytal biomass as a source of energy. Phytal biomass controls the nutritional status in an ecosystem (Pick, 1987; Sreepada *et al.*, 1996).

The results suggest that benthic invertebrates play a major role by acting as shredders enabling the breakdown of larger particles (Relaxans *et al.*, 1996). These processes increase the surface area facilitating bacterial decomposition ultimately elevating the nutritive value through microbial protoplasm. Such processes support the harvestible yield of economically important fish and shellfish population through availability of food material (Orth, 1986; Preetha and Pillai, 2000; Coull *et al.*, 1995).Further, the total group wise density of meiobenthos at different stations (Table 2) indicate that there is no large difference in the meiobenthic population ob-

TABLE 2: *Total average groupwise density (no/10 cm^2 ±SD) of meiofauna at different stations*

	Station 1	Station 2	Station 3	Station 4
Nematodes	205±158	210±165	283±167	315±195
Copepod	31±35	27±28	41±31	41±35
Turbullaria	15±20	23±22	47±66	50±69
Others	7±8	13±4	10±6	9±9

served from two different locations. Earlier reports (Ansari and Parulekar, 1998; Ansari *et al*., 2001) also reveal similar trend.

The vertical distribution of different groups of meiobenthic communities (Table 3) indicated the dominance in top 2 cm layer, whereas the percentage contribution of these groups in depths beyond 2 cm were significantly less ($t = 0.0038$; $p \leq 0.001$). Ansari and Parulekar (1998) indicated that over 60 % of meiobenthic fauna occurred in the top 2 cm layer of sediments and the faunal density reduced significantly in the deeper layers. The various groups represented in the study area emphasised the dominance of nematodes, turbullarians and copepods whereas, other groups namely ostracods and oligochaets were found to occur in low density and were further restricted up to 3 cm layer. Top layers within sediments support high density of meiobenthic communities due to availability of adequate quantity of food and favourable environmental conditions at sediment water interface,largely influenced by mixing processes (Kondala Rao and Murty, 1988; Ingole and Parulekar, 1998). Environmental parameters such as dissolved oxygen ($r = 0.79$; $p < 0.005$) and Chl *a* ($r = 0.89$; $p < 0.001$) play an important role in determining population structure of meiobenthos (Coull and Fleeger, 1977; Gutierrez *et al*., 2000).

The present investigations reveal that the meiobenthic communities tend to dominate top 2 cm sediment layer mainly due to food availability and prevalence of optimum environmental conditions (Ansari and Parulekar, 1998). The role of meiobenthic organisms is well established in scavenging detrital particles, thus supporting detritus based food chain. However, from the observations made in the present study it appears that the microbial loop may play an important role in elevating the nutritional status within top layers of sediment in a tropical estuarine marshy ecosystem.

Acknowledgements

Authors are thankful to the Registrar, Goa University for providing facilities.

TABLE 3.: *Vertical distribution of meiobenthic density (no/10 cm^2±SD) within sediments up to a depth of 5 cm.*

	Depths (cm)				
	0-1	1-2	2-3	3-4	4-5
Nematodes	94±59	62±41	46 ±33	31 ±22	20±17
Copepods	20±17	9±8	4±4	2 ±2	1±1
Turbullaria	13±15	8 ±11	5 ±10	3±8	2±6
Others	5±4	2 ±2	1±1	0	0

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