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Macrobenthos in Relation to Sediment Characteristics of Nearshore Waters of Chitrapur, West Coast of India Receiving Industrial Effluents

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Abstract

Spatial and temporal variations of macrobenthos in relation to sediment characteristics in the coastal waters of Chitrapur, west coast of India receiving industrial effluents was investigated during pre and post-monsoon seasons of the year 1997-1998. The quality composition of macorbenthos revealed the presence of six families of polychaetes, 16 families of molluscs and three families of echinoderms. Among the above three groups, molluscans formed the bulk of the benthos. Textural analyzes of sediment have shown the dominance of sand in nearshore stations, while at deeper stations, it was dominated by silty fraction. Changes in the textural characteristics of the sediment and the higher level of organic carbon were found to be associated with the reduced frequency of occurrence and abundance of macrobenthos at the stations located near the effluent outfall along 8 m depth contour of Chitrapur section.

Introduction

The coastal waters are not only extensively used for exploitation of marine resources but also utilized for disposal of domestic sewage and industrial effluents causing greater environmental stress. In view of increased urbanization and industrialization along the coastal waters of South Canara district, Karnataka, west coast of India, an intensive coastal water monitoring program was initiated to recognize the impact on coastal water ecosystem due to the above two activities. Among the three major communities of marine environment, the study of benthic communities are found to be better indicators of pollution (Venugopal et al. 1982; Satyanarayana et al. 1994;

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Gopalkrishnan and Nair 1998). The present study was carried out to recognize the impact due to discharge of treated effluents from Mangalore Refineries and Petrochemicals Ltd. (MRPL) and BASF industries on benthic communities in the coastal waters off Chitrapur. The effluents mainly consist of hydrocarbons, increased levels of BOD, COD, suspended solids basically from the sludge and other various compounds including metals such as iron, copper, cobalt and chromium. Studies on benthos along this coast have been carried out by Harkantra et al. (1980), Devasy et al. (1987), Venkatesh Prabhu and Reddy (1987) and Gopalkrishnan and Nair (1998), which have revealed a clearcut seasonal and spatial variation in relation to sediment characteristics.

Materials and Methods

Monthly samplings were carried out from October 1997 to May 1998 in nine stations, four along the Panambur section and four along the Chitrapur section, where MRPL effluent discharge point is located at 5 m depth contour and the effluent from BASF is discharged at 7.5 m depth contour. The distance between these two effluent outfall is 500 m. Samplings were also made from a reference station fixed at 12 m depth contour, (Lat. 12° 58^{1} N, Long 74° 48^{1} E) (Fig.1). Sediment samples were collected using Peterson grab with a mouth area of 0.1 m^2. Part of the sediment sample was kept in polythene bags for texture analysis and remaining sediment was passed through a sieve of 0.5 mm mesh size to collect macrobenthos. Numerical estimation of benthos was carried out and fauna were identified up to generic level and presented as No. m^{-2}. Temporal and spatial variations of total benthos were tested using two-way ANOVA. For textural analyzes of sediments, dried sediment samples were weighed, wet sieved through 0.0625 mm sieve to separate sand, silt and clay fractions, dried again and weighed and expressed as sand percentage. Silt and clay fractions were determined

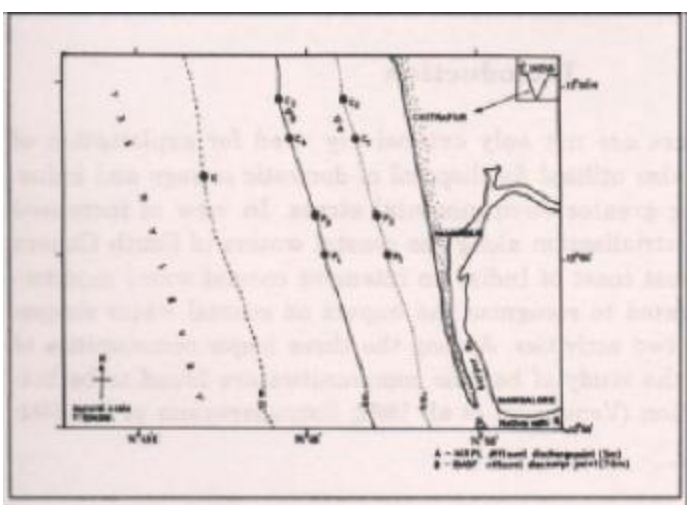

Fig. 1. Location of sampling stations

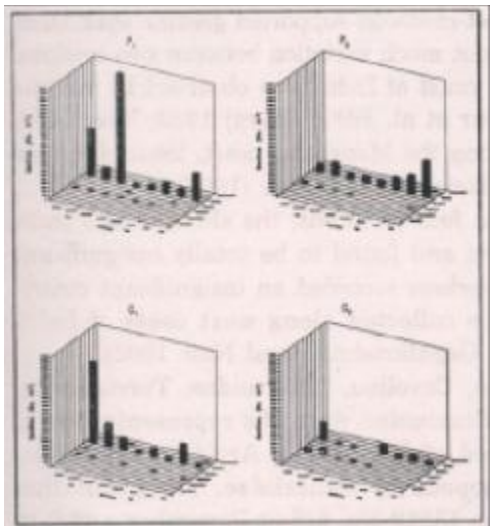

Fig. 2. Monthly variations of macrobenthos (No. m^{-2}) at stations along 4 m depth contour

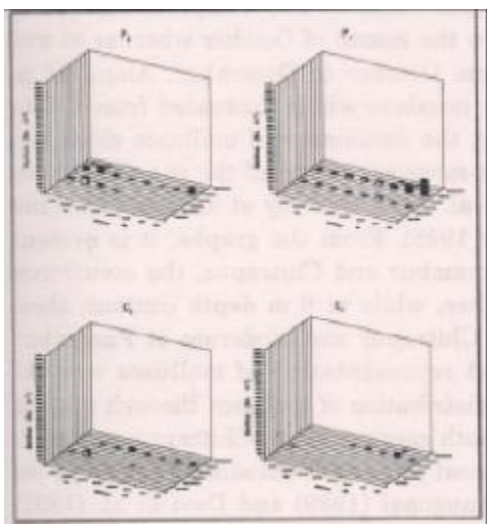

Fig. 3. Monthly variations of macrobenthos (No. m^{-2}) at stations along 8 m depth contour

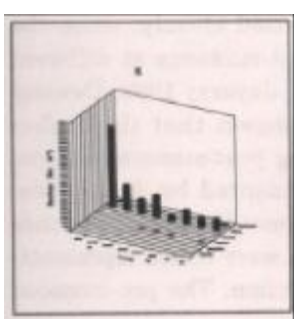

Fig. 4. Monthly variations of macrobenthos (No. m^{-2}) at stations along 12 m depth contour

using Pipette analysis (Buchanan and Kain 1971). Organic carbon of the sediment was also determined (E1-Wakeel and Riley 1957).

Results and Discussion

Macrobenthos

Spatial and temporal distribution of macrobenthos (No.m^{-2}) during the study period is represented graphically in figures 2 to 4. The quality composition of benthos revealed the presence of forms belonging to 6 groups. The class Echiuroidea and Sipunculoidea were almost absent throughout the study except that, 30 No. m^{-2} sipunculids were present at station P_1 in the month of December and 20 No. m^{-2} echiurids recorded at station K in the month of November. Increased population density of echiurids with increased depth was observed in the coastal waters off Mangalore (Jayraj 1982) and higher population of the same were recorded at 20 m and 30 m depth in the nearshore sediments of Gangolli (Venkatesh Prabhu et al. 1993).

Polychaeters were represented by species belonging to 6 families such as Nephthydae, Onuphidae, Lumbriconereidae, Glyceridae, Spionidae and Maldanidae. The density of polychaetes varied from 0 to 250 m^{-2} at Panambur and 0 to 930 m^{-2} at Chitrapur along 4 m depth contour. Whereas at 8 m depth contour, numbers fluctuated from 0 to 860 m^{-2} at Panambur

and 0 to 620 m^{-2} at Chitrapur. At 12 m depth contour, the numbers varied from 0 to 50 m^{-2}. From the graphs, it is evident that, post-monsoon supported greater abundance and higher density of polychaetes without much variation between two sections. Dominance of polychaetes along west coast of India was observed by various workers (Ansari et al. 1977; Parulekar et al. 1982; Jayraj 1982; Venkatesh Prabhu and Reddy 1987). However along the Mangalore coast, lower densities of polychaetes were recorded by Gopalkrishnan and Nair (1998).

During the present study, only on four occasions, the shrimps and crabs were present at four different stations and found to be totally insignificant to the total benthos. Almost all the workers recorded an insignificant contribution of crustaceans in the benthos collected along west coast of India (Venkatesh Prabhu and Reddy 1987; Gopalkrishnan and Nair 1998).

Umbonidae, Cerithidae, Drupidae, Cavolina, Littorinidae, Turritellidae, Trochidae, Olividae, Patellidae and Buccinidae were the representatives of Gastropoda. Bivalves were composed of Donacidae, Arcidae, Mytilidae, Cardiidae and Ostreidae and Scaphopoda by Dentalidae. The population density of Mollusca varied from 240 to 13550 No. m^{-2} at Panambur and 0 to 9960 No. m^{-2} at Chitrapur along 4 m depth contour.

Along 8 m depth contour, the numbers varied from 20 to 2000 m^{-2} at Panambur and 0 to 400m^{-2} at Chitrapur stations. The complete absence of molluscs was observed at station C_3 in the month of October whereas at station C_4, molluscans were absent from October to December. Along 12 m depth contour, station K recorded the numbers which fluctuated from 640 to 10150 m^{-2}. As observed in this study, the dominance of molluscs along the Mangalore coast through post and pre-monsoon season of the year was documented by earlier workers (Ansari et al. 1977; Devassy et al. 1987; Ramana et al. 1990; Gopalkrishnan and Nair 1998). From the graphs, it is evident that, stations at 4 m depth along Panambur and Chitrapur, the occurrence and abundance of molluscs were higher, while at 8 m depth contour, their population density was very poor at Chitrapur and moderate at Panambur section. At 12 m depth station, good representation of molluscs was observed. The spatial imbalance in the distribution of molluscs through out the period of study indicate that, 8 m depth contour along Chitrapur section is under stress possibly due to the disposal of treated effluents from mega industries. Ansari (1977), Devi and Venugopal (1989) and Devi et al. (1991) have observed the changes in the quality of benthos due to the influence of industrial effluents in Cochin backwaters. Similarly, changes in the quality of benthos due to industrial activities were observed along the west coast of India (Devassy et al. 1987; Varshney et al. 1988; Jiyalal Ram et al. 1998). Seasonal variation of molluscs could not be delineated clearly, since the greater abundance was recorded both in pre and post-monsoon at different stations. However, earlier studies (Ansari et al. 1977; Jayaraj 1982; Devassy et al. 1987; Venkatesh Prabhu et al. 1993) have shown that the higher abundance of benthic organisms were recorded during post-monsoon season.

During the study, the echinoderms were represented by Asteroidea, Ophiuroidea and Echinoidea. The occurrence was sporadic and abundance

was very low. Stations located along Panambur section were better representation by these forms than the stations at Chitrapur section. The pre-monsoon season was found to be more congenial than post-monsoon for echinoderms. Similar pre-monsoon abundance of echinoderms was observed along the West coast of India (Venkatesh Prabhu et al. 1993; Gopalkrishnan and Nair 1998).

The results of two-way factorial analysis (ANOVA) on total number of macrobenthos are presented in table 1. It was found that, there was no significant difference in the population density of macrobenthos between months and sections.

Organic carbon and sediment texture

Organic carbon content of sediments (Fig. 5) varied from 0.01 to 1.46%. Stations located along Panambur section registered a narrow range of fluctuation from 0.01 to 0.14%, while at stations in Chitrapur section registered

Table 1. Analysis of variance of population density (No. m^{-2}) of macrobenthos

Source of variation	Source of freedom	SSQ	MSSQ	F-Ratio
Between:				
Months	7	185573264	26510466	2.25
Sections	2	50677808	25338904	2.15
Error	14	164663120	11761651	
Total	23	400914208		

SSQ - Sum of squares; MSSQ - Mean sum of squares

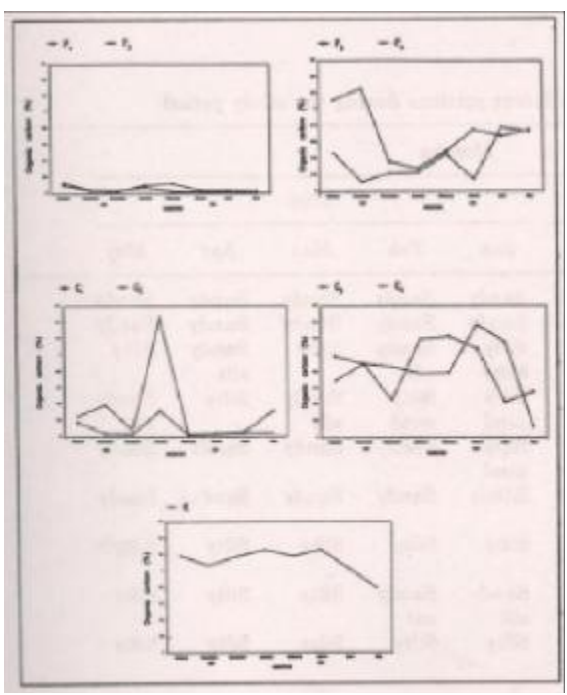

Fig. 5. Monthly variations of sediment organic carbon (%) at different stations

a higher range fluctuated from 0.02 to 1.46%. Along 12 m depth contour, it varied from 0.79% to 1.26%. Paropkari (1979) has characterized the sediments having organic carbon >1% as high and <1% as low in the northwestern coast of India. Along the coastal waters of Mangalore, the values of organic carbon in the above ranges have been observed by Reddy and Hariharan (1986) and Venkatesh Prabhu and Reddy (1987). Further, they have observed high organic carbon in clayey and silty sediments.

The textural characteristics of the sediments (Table 2) showed the dominance of sand fraction in stations at 4 m depth contour along Panambur and Chitrapur sections. While along 8 m depth contour, all the stations had silt dominated sediment except at station P_4 which has sandy during post-monsoon season but changed to silt dominated sediment in pre-monsoon season. Similar silt dominated sediment was observed at station K at 12 m depth contour. The dominance of sand with little or no clay in the Malpe bay and Mangalore coast (Ansari et al. 1977), silt-clay fraction along South-canara coast (Venkatesh Prabhu and Reddy 1987) and clayey nature of sediments off Honnavar (Venkatesh Prabhu et al. 1993) were documented.

During the present investigation, data gathered by sediment texture and distribution of macrobenthos revealed meager to total absence of benthos at stations dominated by silt in the sediment. The spatial distribution of organic carbon by and large showed that the range is higher in the vicinity of effluent outfall. Many authors (Ansari et al. 1977; Venkatesh Prabhu et al. 1993; Venkatesh Prabhu et al. 1997) have observed moderate numbers of benthos in sediment dominated by silt makes it clear that, the silty material, which is present in those stations located near the effluent outfall could be of anthropogenic origin or perhaps might have originated from the industrial discharges.

Table 2. Sediment characteristics at different stations during the study period

Station	Months							
	1997			1998				
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
P_1	Sandy	Sandy	Sandy	Sandy	Sandy	Sandy	Sandy	Sandy
P_2	Sandy	Sandy	Sandy	Sandy	Sandy	Sandy	Sandy	Sandy
P_3	Silty	Silty	Silty sand	Silty sand	Sandy silt	Silty	Sandy silt	Silty
P4	Sandy	Sandy	Silty sand	Silty sand	Silty sand	Sandy silt	Silty	Sandy silt
C1	Sandy	Sandy	Sandy	Silty sand	Sandy	Sandy	Sandy	Sandy
C2	Silty sand	Silty sand	Sandy	Sandy	Sandy	Sandy	Sandy	Sandy
C3	Silty clsy	Sandy	Silty	Silty	Silty	Silty	Silty	Silty
C4	Silty	Silty	Silty	Sandy silt	Sandy silt	Silty	Silty	Silty
K	Silty	Sandy silt	Silty	Silty	Silty	Silty	Silty	Silty

On the basis of the comparison made, changes in the textual characteristics of the sediment and the higher level of organic carbon might be responsible for reducing the frequency of occurrence and abundance of macrobenthos especially at stations located near the effluent outfall to those stations located far away from the discharge points.

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