

## MEIOBENTHOS OF POLLUTED AND UNPOLLUTED ENVIRONMENTS OF VERSOVA, BOMBAY

P.K. VARSHNEY\*, K. GOVINDAN AND B.N. DESAI\*\*

*National Institute of Oceanography, Regional Centre, Versova, Bombay - 400 061.*

### ABSTRACT

Quantitative distribution of meiobenthic fauna of Versova (Bombay) waters was studied at four stations during November, 1979 to December, 1980. The nearshore areas represent a typical polluted environment while stations towards offshore represent relatively unpolluted regions because of their effective dilution and mixing processes. A gradual increase in mean biomass values from nearshore towards offshore was evident. The fauna was constituted mostly by nematodes (52.90%), foraminiferans (33.97%), polychaetes (4.05%) and crustaceans (6.15%). Other groups, viz., Radiolaria, Turbellaria, Kinorhyncha, Pycnogonida, Pelecypoda and Gastropoda were occasional inhabitants of the area. During pre-monsoon, higher population density and biomass were obtained from all stations excepting station 2. In monsoon, higher abundance of foraminiferans at station 2 contributed to the maximum biomass and population density. Group diversity of meiobenthos gradually increased from nearshore towards offshore. Substratum was clayey-silt generally, except at station 1, where it was almost sandy. At station 1 and 2, a shift in substratum during monsoon was associated with a change in distribution of foraminiferans. High values of organic matter were associated with clayey silt bottom.

**Key-words:** Polluted environment, meiobenthos, ecology, Versova creek.

### INTRODUCTION

Most of the creeks and inlets around Bombay are being used for the disposal of domestic and industrial wastes. As a result, these creeks and inlets are becoming increasingly polluted day by day. Versova creek (Fig. 1) located on the north-west of Bombay receives about 131 million litre per day (mld) of domestic and 6 mld of industrial wastes and represents a region of increasing organic pollution (NIO Report, 1979). It was, therefore, proposed to take up the benthic study of the creek.

Since benthic animals are considered as the best indicators of water pollution and the meiofauna, being a dynamic element of marine environment, forms a good tool for monitoring the interactions and hypothesis relevant to ecology. The available information on the meiofauna of coastal waters around Bombay is meagre (Parulekar, Nair, Harkantra and Ansari, 1967). The distribution, abundance and seasonal variations of meiobenthos were studied and are presented in this paper.

\* Present Address: Central Institute of Fisheries Education, Versova, Bombay-400 061.

\*\* Present Address: National Institute of Oceanography, Dona Paula, Goa-403 004.

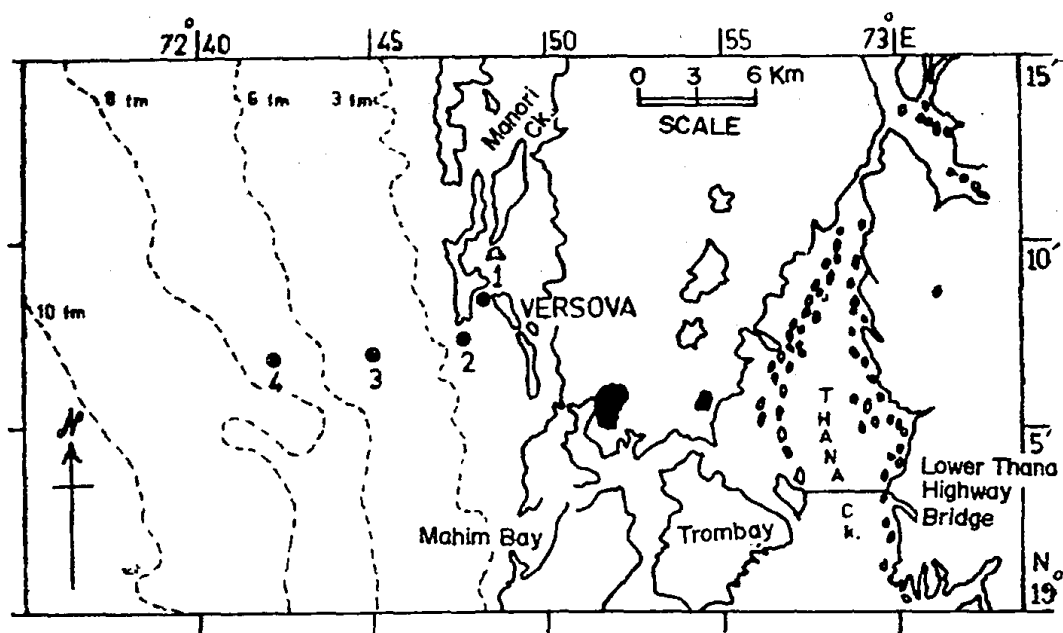


Fig. 1. Map showing the location of stations along the transect of Versova.

#### MATERIALS AND METHODS

Stations and their locations on a transect are shown in Fig. 1. Station 1 is located at the creek in the vicinity of discharge of industrial and sewage wastes, while sts. 2, 3 and 4 are located away from the creek towards off-shore.

Monthly collections were made at all the four stations from Nov. '79 to Dec. '80, using a van-Veen grab (0.04 m<sup>2</sup>). A core tube of 2.8 cm in diameter and 10 cm in length was used to collect the samples of meiobenthos from the grab. The core was inserted through the grab window and sediments collected in the core was preserved in 1: 500 Rose Bengal and 5% buffered formaldehyde (Tietjen, 1969). Sediments (50 g) were collected and preserved in ice for the analysis of organic matter and sediment texture. Due to rough weather and other navigational difficulties associated with the formation of sand bar at the mouth of the creek (near st. 2) the sampling was not possible in the month of June. Again the samples could not be collected from sts. 1 and 2 in July, '80.

In laboratory, the sediments were sieved through a set of two sieves, one with a mesh size of 500  $\mu$  and the other one with a mesh size of 45  $\mu$ . The organisms retained on the 45  $\mu$  screen were considered as meiobenthos (Holme and McIntyre, 1971). Biomass was calculated on wet weight basis. Organic matter in sediment was estimated following the method of El Wakeel and Riley (1956). Seive and pipette analyses of sediment were done by the method of Holme and McIntyre, (1971).

Water samples from surface and bottom were collected at all stations and were analysed for salinity, dissolved oxygen, nitrite, nitrate and reactive phosphate following the standard procedure (Strickland and Parsons, 1968).

## RESULTS AND DISCUSSION

### Environmental factors

The seasonal changes in environmental parameters of Versova are given in Table I. Maximum temperature and salinity were observed during premonsoon. Sediment temperature follows the trend of water temperature. Marked vertical gradient in salinity was noticed during monsoon. Dissolved oxygen levels were relatively low during ebb tide in the nearshore waters. Many times dissolved oxygen was not found at st. 1. Wide fluctuations in nutrients were a common feature of the creek (st. 1). Exceptionally, high values of nutrients were noticed at st. 1. Results of the present study clearly reveal low dissolved oxygen, low salinity and higher concentration of nutrients associated with wide fluctuations of these parameters in the nearshore waters especially at st. 1 indicating an unstable environment. In contrast to this, normal levels of oxygen, salinity and nutrients with less variations, indicate, relatively a healthy and stable environment around sts. 3 and 4. Hence based on the amount of waste discharge received by this region and the difference prevailed in the environmental parameters, sts. 1 and 2 were considered polluted areas while sts. 3 and 4 represented relatively unpolluted regions (Varshney, 1982).

### Sediments

The results of sediment analyses are given in Table II. Generally the substrata of the four stations were clayey silt. However, at st. 1 the bottom was sandy during premonsoon but it was sandy-silt in monsoon and postmonsoon periods. A distinct change in texture of sediment from clayey-silt to silty-sand was noticed at st. 2 during monsoon. This change was accomplished by a sediment drift enhanced by strong currents from st. 1 to 2 (Prasad, 1982). The formation of sand bar near st. 2 is recurring feature every monsoon, which completely brings the navigation to stand still. The dominance of nematodes (Fig 3) associated with clayey silt bottom and the abundance of foraminiferans were related to the sandy-silt or silty-sand bottom. Similarly, the abundance of foraminiferans was noticed in substratum of study area (Varshney, Govindan and Desai, 1981).

### Organic matter

Percentage of organic matter was higher in clayey-silt bottom (2.29-3.94) than sandy-silt (1.69-2.86), silty sand (0.11) and sandy bottom (0.24). Usually, lower percentage of organic matter was associated with creek st. 1, excepting monsoon. The low percentage of organic matter at st. 2 (0.11) and higher percentage at st. 1 (2.86) observed during monsoon were chiefly attributed to the shift in the sediment texture. In general, the percentage of organic matter

Table I. Environmental characteristics of Versova.

Parameters		Flood tide				Ebb tide			
		St. 1	St. 2	St. 3	St. 4	St. 1	St. 2	St. 3	St. 4
<b>Water temperature (°C)</b>									
Premonsoon	S	30.50	31.00	30.75	30.75	30.50	30.75	30.75	30.25
	B	30.25	31.00	30.50	20.50	30.25	30.50	30.50	30.25
Monsoon	S	26.75	26.50	26.50	26.50	28.50	28.50	27.75	28.50
	B	27.00	26.00	26.00	26.00	28.25	28.25	28.00	28.00
Postmonsoon	S	25.10	25.50	25.75	26.25	26.00	26.00	26.75	26.75
	B	25.00	25.25	25.75	26.25	26.00	26.50	26.50	26.50
<b>Salinity (‰)</b>									
Premonsoon	S	35.20	35.65	35.29	34.46	33.23	35.33	35.31	35.47
	B	34.89	35.18	35.42	34.88	33.72	35.18	35.11	34.84
Monsoon	S	25.80	25.21	22.00	24.31	24.49	26.62	27.47	32.65
	B	26.28	28.33	32.38	33.60	25.49	27.34	32.47	33.03
Postmonsoon	S	34.68	34.86	34.78	34.88	27.72	34.12	34.62	34.78
	B	34.64	34.69	34.75	34.97	30.77	33.92	34.57	34.53
<b>Dissolved oxygen (mg/l)</b>									
Premonsoon	S	6.37	6.99	6.99	6.08	3.95	6.69	6.38	6.08
	B	6.08	6.08	7.59	6.37	4.25	6.38	6.08	6.99
Monsoon	S	4.67	5.85	6.26	6.44	0.84	5.26	5.70	6.47
	B	5.54	5.98	5.95	5.58	1.59	2.80	2.55	6.01
Postmonsoon	S	7.13	4.32	7.86	5.80	0.00	3.49	6.35	7.12
	B	6.84	7.86	7.07	7.61	0.00	3.91	6.93	7.73
<b>PO<sub>4</sub>-P (µg at l<sup>-1</sup>)</b>									
Premonsoon	S	3.21	1.11	1.21	0.83	8.24	1.33	1.11	2.88
	B	2.49	1.99	1.49	0.33	4.98	1.66	1.55	0.89
Monsoon	S	3.60	2.10	1.55	1.05	3.82	2.27	1.94	1.38
	B	2.77	2.05	1.32	1.27	2.99	2.21	1.60	1.27
Postmonsoon	S	2.99	3.10	1.38	0.66	12.45	6.25	0.89	1.05
	B	3.60	2.71	1.44	0.00	10.51	6.53	0.17	4.65
<b>NO<sub>2</sub>-N (µg at l<sup>-1</sup>)</b>									
Premonsoon	S	8.99	2.92	6.80	4.84	9.10	4.66	0.56	4.24
	B	19.89	1.04	1.06	0.12	0.06	0.56	0.44	1.38
Monsoon	S	0.12	5.30	17.20	3.10	0.08	6.89	17.09	0.78
	B	38.40	1.90	0.40	0.12	1.60	3.00	0.74	0.38
Postmonsoon	S	7.70	9.30	0.20	0.26	—	8.20	0.16	0.08
	B	6.90	8.00	0.38	—	2.50	6.70	0.00	0.00
<b>NO<sub>3</sub>-N (µg at l<sup>-1</sup>)</b>									
Premonsoon	S	20.80	6.40	8.00	6.60	13.40	7.20	10.40	6.40
	B	24.80	7.00	6.70	0.60	—	9.80	7.20	6.00
Monsoon	S	15.16	11.65	10.53	6.88	16.23	8.56	7.53	7.15
	B	14.18	12.18	11.56	7.65	16.78	9.56	6.98	8.10
Postmonsoon	S	5.60	5.20	4.40	2.60	6.40	9.20	4.60	4.40
	B	6.10	5.30	4.50	3.20	6.90	7.30	4.70	4.60
<b>Sediment temperature (°C)</b>									
Premonsoon	S	29.50	29.75	28.50	28.50				
Monsoon	S	26.75	25.50	26.00	26.00				
Postmonsoon	S	25.50	25.25	25.85	25.50				

**Table II.** Characteristics of sediment texture in relation to organic matter and biomass of Versova.

Station	Percentage composition				Texture	Organic matter (%)	Biomass g m <sup>-2</sup>
	Sand (> 63μ)	Coarse silt (63.0—15μ)	Fine silt (15—4μ)	Clay (4μ)			
Premonsoon							
1	100.00	—	—	—	Sandy	0.24	1.594
2	0.59	15.93	73.60	9.88	Clayey-silt	2.29	2.731
3	0.40	15.27	76.08	8.25	Clayey-silt	2.35	3.393
4	0.09	18.45	71.80	9.66	Clayey-silt	3.16	6.201
Monsoon							
1	30.30	0.50	51.82	17.38	Sandy-silt	2.86	0.768
2	78.00	2.00	10.00	—	Silty-sand	0.11	2.996
3	0.07	29.18	65.40	5.35	Clayey-silt	2.32	2.793
4	0.11	15.98	74.17	9.74	Clayey-silt	2.40	1.528
Postmonsoon							
1	8.63	8.62	75.73	7.02	Sandy-silt	1.69	1.374
2	0.77	10.05	80.10	9.08	Clayey-silt	3.94	2.262
3	0.14	9.40	76.48	13.98	Clayey-silt	3.13	2.611
4	0.10	18.00	74.77	7.13	Clayey-silt	3.05	3.060

varied at different stations with seasonal fluctuations. In the present study no definite correlation could be established between the percentage of organic matter and the meiofaunal density and biomass. The formation of a sand bar at the creek mouth during monsoon results in a negative correlation between organic matter and faunal density especially at sts. 1 and 2. The faunal density is closely correlated to the sediment texture.

### Biomass

Distribution of meiobenthic biomass is given in Table III. Mean biomass values obtained for sts. 1 to 4 were 1.304, 2.540, 2.894 and 3.673 g m<sup>-2</sup> respectively. Thus, a gradual increase in the biomass values from creek (st. 1) towards offshore (st. 4) was evident. Highest biomass (8.341 g m<sup>-2</sup>) was recorded at st. 4, while minimum (0.179 g m<sup>-2</sup>) was obtained at st. 1.

Generally high values of biomass with gradual increase from sts. 1 to 4 (1.594, 2.731, 3.393 and 6.201 g m<sup>-2</sup>) were observed during premonsoon. During monsoon, a decrease in the mean biomass values, viz., 0.768, 2.996, 2.793 and 1.528 g m<sup>-2</sup> was noticed respectively for the sts. 1 to 4. Again an increasing trend in the biomass values from sts. 1 to 4 (1.374, 2.262, 2.611, 3.050 g m<sup>-2</sup>) was observed during postmonsoon.

### Population density

Results of meiofaunal population density are shown in Table IV. Maximum population density (165.76  $\times 10^4$  m<sup>-2</sup>) was observed at st. 2 (Sep.

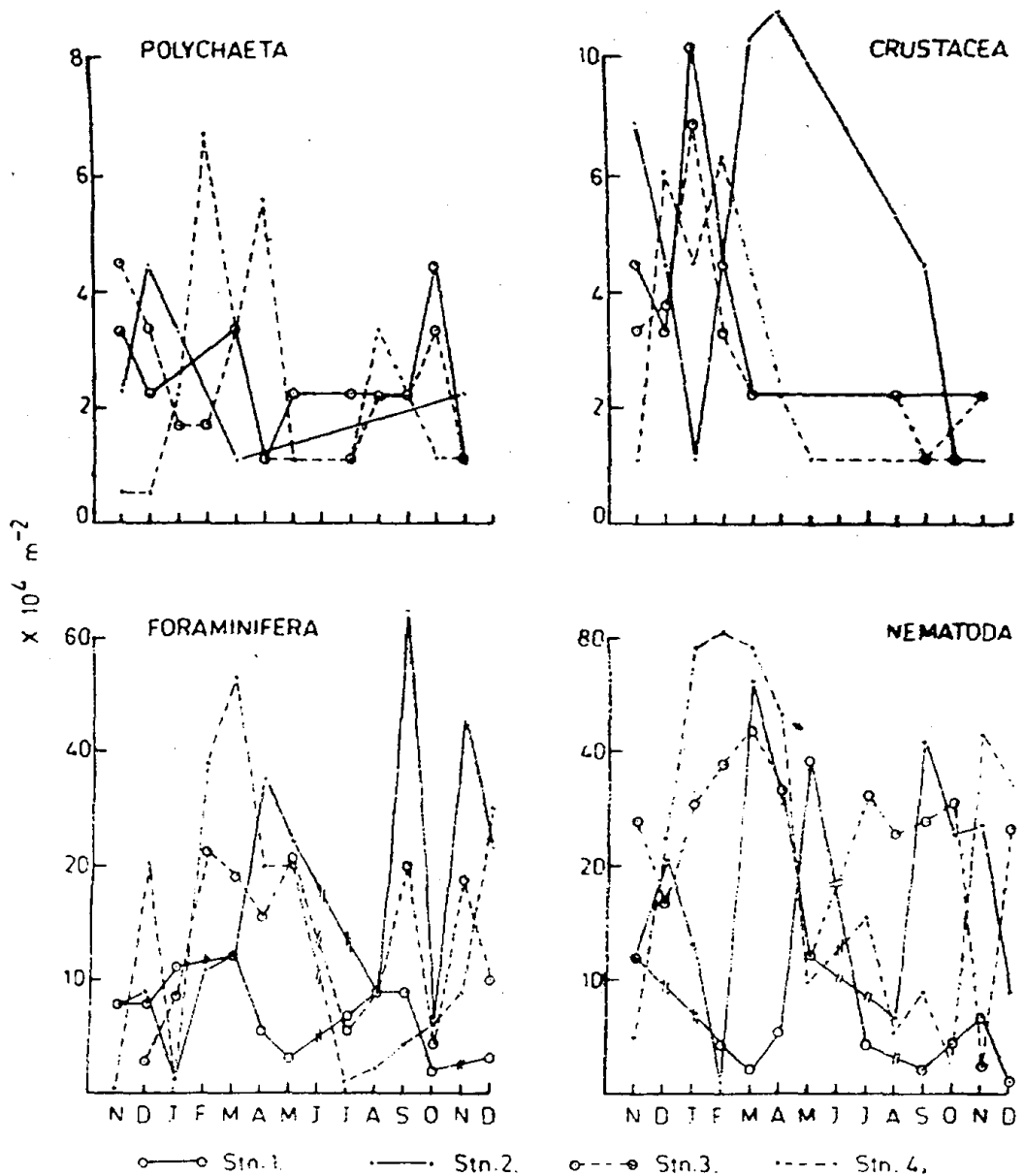


Fig. 2. Distribution of Dominant meiobenthic organisms.

'80), which was chiefly contributed by foraminiferans. Minimum faunal density ( $4.48 \times 10^4 \text{ m}^{-2}$ ) was recorded at st. 1 (Dec. '80). In general, the numerical values were higher at st. 4 and lower at st. 1. Mean population densities for the sts. 1 to 4 were  $17.06 \times 10^4$ ,  $54.09 \times 10^4$ ,  $44.80 \times 10^4$  and  $56.34 \times 10^4 \text{ m}^{-2}$  respectively.

The highest population density during premonsoon ( $97.72 \times 10^4 \text{ m}^{-2}$ ) and postmonsoon ( $48.72 \times 10^4 \text{ m}^{-2}$ ) was obtained at st. 4. St. 1 showed the lowest population density during premonsoon ( $22.12 \times 10^4 \text{ m}^{-2}$ ) and post-

monsoon ( $16.24 \times 10^4 \text{ m}^{-2}$ ). During monsoon the maximum ( $90.72 \times 10^4 \text{ m}^{-2}$ ) and minimum ( $11.95 \times 10^4 \text{ m}^{-2}$ ) meiofaunal densities were obtained at sts. 2 and 1 respectively.

### Composition of meiofauna

The distributions of dominant meiofaunal groups are shown in Fig. 2.

#### Nematodes

Nematoda was the dominant group with a frequency of occurrence of 52.90% along the transect during the period of study. At station 4, two peaks, viz.,  $81.76 \times 10^4$  and  $47.04 \times 10^4 \text{ m}^{-2}$  were observed in Feb. and Nov. '80 respectively. Numerical counts of nematodes ( $1.12 \times 10^4 \text{ m}^{-2}$ ) were much lower at st. 1 (Dec. '80) and st. 2 (Feb. '80). Their percentages were high at sts. 3 (61.16) and 4 (60.79) and low at sts. 1 (37.56) and 2 (41.91). Many times nematodes were absent at st. 1.

#### Foraminiferans

Foraminifera was the second dominant group with a percentage incidence of 33.97 during the period of study. Maximum population density was observed at st. 2 ( $115.36 \times 10^4 \text{ m}^{-2}$ ) followed by st. 4 ( $52.64 \times 10^4 \text{ m}^{-2}$ ). Minimum population density of  $0.56 \times 10^4 \text{ m}^{-2}$  was also recorded at st. 4 (Nov. '79). In general, higher percentages of foraminiferans were recorded at st. 1 (35.54) and 2 (46.69) than at sts. 3 (26.44) and 4 (28.28).

#### Polychaetes

Polychaetes with a percentage occurrence of 4.05 formed the third largest group. Among the four stations the higher densities of polychaetes in

Table III. Distribution of meiofaunal biomass of Versova during 1979-80 (g wet weight  $\text{m}^{-2}$ ).

Month	St. 1	St. 2	St. 3	St. 4
Nov. '79	2.292	1.880	3.369	0.544
Dec.	0.945	3.145	2.297	2.248
Jan. '80	0.795	1.961	3.629	5.817
Feb.	0.762	0.286	3.551	8.341
Mar.	1.491	5.356	3.282	7.236
Apr.	0.820	3.987	2.820	6.378
May	3.303	1.294	1.921	2.847
June	—	—	—	—
July	1.113	—	2.634	1.576
Aug.	0.179	0.616	2.776	1.608
Sep.	1.012	5.376	2.967	1.400
Oct.	3.055	1.842	3.193	0.727
Nov.	1.016	3.521	1.229	3.984
Dec.	0.140	1.221	1.949	4.990

Table IV. Distribution of meiobenthic population density of Versova during 1979-80 ( $\times 10^4 \text{ m}^{-2}$ ).

Month	St. 1	St. 2	St. 3	St. 4
Nov. '79	29.12	30.24	36.96	7.28
Dec.	13.44	40.32	26.88	53.20
Jan. '80	25.76	19.04	50.40	85.12
Feb.	11.20	11.76	66.08	133.28
Mar.	20.16	95.20	73.92	135.52
Apr.	12.32	87.36	49.28	84.00
May	44.80	36.96	35.84	38.08
June	—	—	—	—
July	13.44	—	42.56	20.16
Aug.	8.96	15.68	40.32	12.32
Sep.	13.44	165.76	52.64	16.80
Oct.	13.44	33.60	42.56	14.56
Nov.	11.20	79.52	28.00	63.84
Dec.	4.48	33.60	36.96	68.32

February ( $6.72 \times 10^4 \text{ m}^{-2}$ ) and April ( $5.60 \times 10^4 \text{ m}^{-2}$ ) and low numerical count ( $0.56 \times 10^4 \text{ m}^{-2}$ ) in Dec. '79 were recorded at st. 4. Their percentages were 10.15, 2.07, 4.42 and 3.67 at sts. 1, 2, 3 and 4 respectively.

### Crustaceans

Crustaceans were mainly represented by Copepoda (3.31%), Ostracoda (1.87%), Decapoda (0.61%) and Cirripedia (0.15%) and other crustacean larvae (0.26%). Maximum numerical abundance ( $17.92 \times 10^4 \text{ m}^{-2}$ ) of crustaceans was recorded at st. 2 (Apr. '80) followed by st. 1 ( $13.44 \times 10^4 \text{ m}^{-2}$ ) in Jan. '80. Minimum density ( $1.12 \times 10^4 \text{ m}^{-2}$ ) was noticed at various stations. Uneven distribution of crustaceans was encountered from sts. 1 to 4. Their percentages were 13.70, 8.29, 4.33 and 3.59 at sts. 1, 2, 3 and 4 respectively.

### Other Groups

Other meiofaunal groups included the Radiolaria, Turbellaria, Kinorhyncha, Pycnogonida, Pelecypoda, Gastropoda and miscellaneous group. The percentages of incidence of the above groups were 0.97, 0.61, 0.05, 0.38, 0.51, 0.05 and 0.65 respectively. Miscellaneous group includes amphipods, sipunculids, hydroids, pennatularians, echinoderm larvae and malacostracans. Total contribution of these minor groups to the meiofauna was insignificant, since the member of these groups were occasional inhabitants with poor numerical abundance. Their distribution was also irregular and uneven. The restricted occurrence of the groups like Kinorhyncha and Pycnogonida only at st. 4 clearly suggests that these groups may be sensitive to the environmental pollution associated with sewage and industrial wastes.

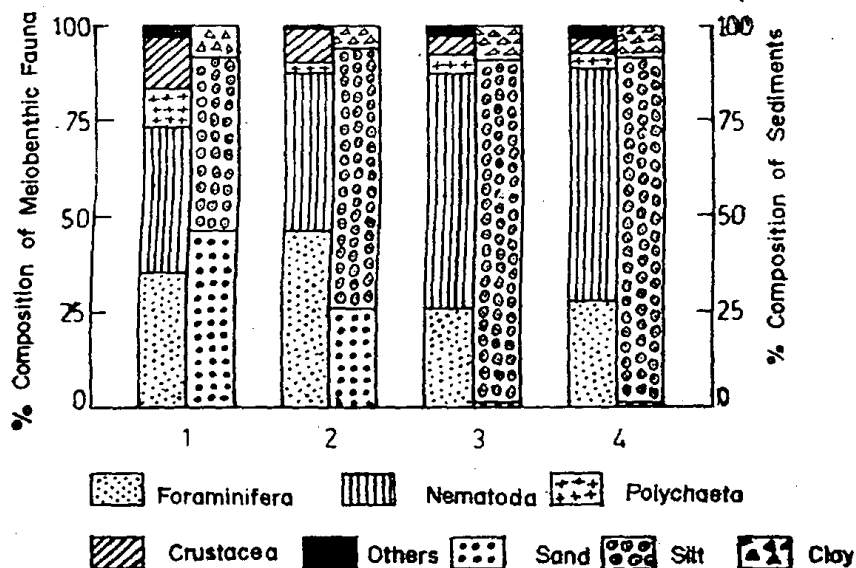


Fig. 3. Relationship of meiobenthic population and sediment texture.



The intensity of pollution gradually decreases from creek towards offshore stations due to higher dilution and assimilation capabilities of the watermass. In fact, the results of the quantitative and qualitative distribution of meiofauna to a greater extent corresponds to the degree of pollution at the creek and the adjacent coastal waters. Hence, the highest mean numerical abundance and biomass (Table III and IV) of meiobenthos are found at st. 4, while the lowest values are mostly confined to the creek st. 1. Sts. 2 and 3 have sustained relatively moderate fauna as compared to creek st. 1, which has a poor meiofauna due to greater pollution stress. However, the meiofaunal counts of the present study are comparatively poor than the meiofaunal counts reported from the unpolluted coastal waters of the Bay of Bengal (Ansari, Harkantra, Nair and Parulekar, 1977).

Seasonal variations in the meiofaunal density and biomass are well evidenced (Table III & IV). A reduction in the mean biomass from premonsoon ( $3.480 \text{ g m}^{-2}$ ) to monsoon ( $2.021 \text{ g m}^{-2}$ ) was clearly indicated. Population density more or less followed the same trend as the biomass. An increasing trend in mean biomass values ( $2.327 \text{ g m}^{-2}$ ) was noticed during post-monsoon period. The reduction in faunal density and biomass noticed during monsoon can mainly be attributed to heavy fresh water influx into the coastal waters and active monsoon currents associated with bed load movements especially at the creek mouth. Overall, 4 major groups, viz., Nematoda, Foraminifera, Polychaeta and Crustacea were common during the period of study. Similar to the present study, the dominance of foraminiferans and nematodes have been reported from the nearshore regions of the Arabian Sea (Desai and Krishnankutty, 1967), Bombay (Parulekar, Nair, Harkantra and Ansari, 1976), the Bay of Bengal (Ansari, Harkantra, Nair and Parulekar, 1977) and Karwar (Ansari, 1978). The number of meiofaunal groups recorded from sts. 1, 2, 3 and 4 were 6, 7, 7 and 9 respectively. Thus an increasing trend in group diversity associated with faunal density and biomass from st. 1 to 4 is evident.

Although the present results revealed a deteriorating condition at the creek, the organic pollution in the nearshore coastal waters of Versova has not yet reached an alarming level. Probably in due course of time the increase in the intensity and accumulation of pollutants may lead to further deterioration of meiofauna resulting in a state of ecological imbalance.

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