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MEIOBENTHIC STUDY OFF MAHIM (BOMBAY) IN RELATION TO PREVAILING ORGANIC POLLUTION

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Meiobenthic fauna off Mahim (Bombay) in relation to prevailing organic pollution caused by sewage and industrial wastes was studied during Nov, 79 to Dec. 1980. Hydrographic studies indicate that the nearshore area was under severe pollution stress, especially during ebb tide while conditions were better towards offshore mainly because of dilution. Meiofauna chiefly consisted of Foraminifera, Nematoda, Polychaeta and Crustacea. Biomass and population density were poor in the vicinity of discharge. Gradual increase in mean biomass from nearshore to offshore was evident. Increase in group diversity from inshore to offshore was observed. The sensitive groups like Kinorhyncha, Gastropoda and Acarins were recorded only from offshore or clear zones. Fauna was dominated by Foraminiferans and Nematodes in the sediments dominated by sand and clayey silt respectively. Organic matter was high in clayey silt bottom.

Key-words : Meibenthos. organic pollution. Mahim.

INTRODUCTION

Meiobenthic organisms are considered very sensitive and are indicator of pollution. The available information on the meiofauna of coastal waters of Bombay is meagre (Parulekar, Nair, Harkantra & Ansari, 1976 and Varshney, Govindan & Desai, 1984). The results presented here on the meiofauna of the coastal nearshore regions of Mahim is the first available information.

Mahim is a thickly populated sub-urban locality on the coast of Bombay. The creek near the causeway is known as Mahim creek. On east this creek is connected to the narrow Mahim River, which receives voluminous domestic and industrial wastes on its way. On west it opens into the Mahim Bay which in turn meets the Arabian sea. It receives about 313 mld (million litre per day) domestic and 21 mld industrial wastes (NIO report, 1978). Previous studies on primary and benthic production in relation to prevailing water quality (Varshney, 1982), indicated that the Versova, Mahim and Thana creeks in Bombay are under severe stress of organic pollution. Therefore, it was proposed to study meiobenthos of the creek in relation to prevailing organic pollution.

MATERIALS AND METHODS

Location of stations are shown in Fig. 1. Four stations in Mahim were monitored of which station–1 was located inside the creek under the cause-

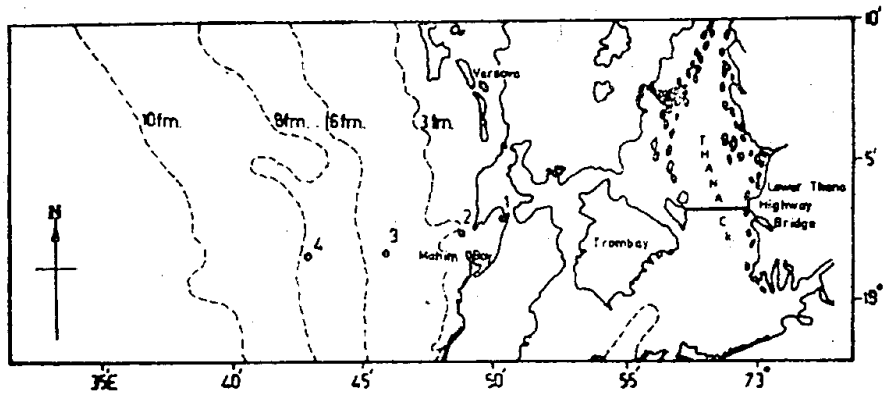

Fig. 1. Map showing the location of stations along the transect off Mahim.

way bridge, and was directly affected by sewage and industrial wastes. Station–2 was near Sea Rock Hotel. While stations 3 & 4 were towards offshore in a transect with station–2.

Monthly collections were made, as described earlier (Varshney, Govindan and Desai, 1984) for meiobenthos and water quality (bottom) at all the four stations from Nov, '79 to Dec, 1980. Due to rough weather and other navigational difficulties sampling could not be done in Dec. '79 and June, '80.

Meiobenthos and sediment texture were analysed following the procedure of Holme & Mc Intyre (1971). Analysis of pH, salinity, dissolved oxygen, phosphate, nitrite and nitrate was done (Strickland & Parsons, 1968) for the bottom waters. For analysis of organic matter in sediments the method of El Wakeel & Riley, (1956) was adopted.

RESULTS

Environmental characteristics:

The environmental parameters studied are presented in Tables I & II. Maxima for water and sediment temperature, pH and salinity were observed during premonsoon. Salinity and pH were most affected in inshore stations 1 and 2 during monsoon due to rainfall and externous discharges in the creek. During postmonsoon again, pH and salinity reached to normal level. Water and sediment temperature followed the trend of atmospheric temperature throughout the year.

In the nearshore creek station–1 tidal variations for pH and salinity were prominent, Salinity was comparatively low during ebb tide.

Dissolved oxygen level was very low in the nearshore creek station–1, because of anaerobic conditions due to decay and decomposition of organic matter. During ebb tide dissolved oxygen values at station–1 were almost negligible. Rest of the stations towards offshore showed almost similar conditions and DO ranges from 3.15 to 6.89 mg l^{-1}. No marked seasonal

Table 1. Environmental characteristics off Mahim (Bombay)

Seasons|Stations	FLOOD				EBB			
	1	2	3	4	1	2	3	4
WATER TEMPERATURE (°C):								
Premonsoon	29.58	29.50	28.94	28.88	29.63	29.45	29.01	28.50
Monsoon	27.75	27.75	28.03	27.75	29.25	27.75	28.25	27.90
Postmonsoon	25.75	26.15	25.70	26.00	27.01	26.41	26.21	25.75
SEDIMENT TEMPERATUE (°C):								
Premonsoon	28.44	28.88	28.56	28.38				
Monsoon	27.81	27.33	27.17	27.25				
Postmonsoon	25.50	26.10	26.10	26.25				
pH:								
Premonsoon	7.50	8.16	8.26	8.33	7.40	8.13	8.23	8.34
Monsoon	7.35	7.90	8.03	8.15	7.33	7.90	8.08	8.18
Postmonsoon	7.45	7.75	7.90	7.94	7.41	7.89	7.97	8.06
SALINITY ($‰_c$):-								
Premonsoon	21.86	35.42	35.14	35.38	14.11	35.15	35.52	35.34
Monsoon	16.20	27.45	24.23	30.88	7.39	26.42	25.52	28.15
Postmonsoon	23.63	34.71	34.78	34.86	14.30	34.67	34.82	34.93
DISSOLVED OXYGEN (mg l^{-1}):-								
Premonsoon	0.72	5.24	6.09	6.35	0.01	5.22	5.74	5.90
Monsoon	1.05	3.15	5.56	4.37	0.05	6.89	6.69	6.05
Postmonsoon	1.45	4.32	4.71	5.04	0.04	4.22	4.78	4.81
REACTIVE PHOSPHORUS (mg-at l^{-1}):-								
Premonsoon	24.60	1.77	1.38	0.98	29.45	3.14	1.18	1.08
Monsoon	17.04	2.03	2.05	1.58	31.56	5.09	4.71	2.74
Postmonsoon	16.28	2.10	1.74	1.13	25.77	6.47	2.92	1.24
NITRITE NITROGEN (mg-at l^{-1}):-								
Premonsoon	12.93	3.07	1.17	0.24	15.71	4.03	2.06	1.07
Monsoon	2.52	1.19	5.08	1.51	6.68	8.99	2.93	0.80
Postmonsoon	3.04	3.38	2.60	1.50	6.18	3.28	2.94	2.08
NITRITE NITROGEN (mg-at l^{-1}):-								
Premonsoon	20.43	6.36	2.68	0.80	28.70	10.34	3.60	3.30
Monsoon	34.27	16.46	7.65	7.72	37.09	9.30	6.15	5.90
Postmonsoon	10.34	15.01	9.67	5.57	10.31	9.32	6.64	6.92

Table II. Characteristics of sediment texture off Mahim (Bombay)

Station	Sand (> 63 μ)	Percentage silt (> 4–63 μ)	Composition Clay (< 4 μ)	Organic matter	Texture	Biomass (g m^{-2})
1	100.00	—	—	0.51	Sandy	0.745
2	0.34	94.75	7.91	2.85	Clayey-silt	4.289
3	0.50	91.86	7.64	2.76	Clayey-silt	4.467
4	0.67	89.09	10.21	2.84	Clayey-silt	4.568

changes could be noticed. Nutrients (Phosphate, Nitrite and Nitrate) did not show any uniform trend. They were abnormally high at station–1., due to organic pollutants in the creek, specially during low tide. Perhaps, due to variations in the quantity and quality of sewage and industrial discharges no uniform seasonal variation could be observed.

Sediment texture at station–1, which is inside the creek was 100% sandy throughout the period of study. The organic matter in this sediment was very less (mean 0.51%). Other stations had clayey silty with high retention power of organic matter, values averaging to 2.85, 2.76 and 2.84% for stations 2, 3 & 4 respectively.

Biomass :

A gradual increase in mean biomass from stations 1 to 4 was noticed (Tables II & III). The mean biomass values were 0.745, 4.289, 4.467 and

Table III. Distribution of meiofaunal biomass off Mahim during 1979-80 (g wet weight m^{-2}).

Months/Station	1	2	3	4
November 1979	0.834	4.865	2.850	1.608
December	—	—	—	—
January	0.213	1.234	3.316	4.641
February	1.613	4.343	3.665	10.240
March	2.189	5.858	2.316	8.790
April	0.862	6.150	5.622	2.433
May	0.912	3.956	6.187	7.291
June	1.192	—	—	—
July	0.140	6.033	9.080	2.229
August	0.370	4.146	1.582	1.856
September	0.358	1.932	6.974	5.272
October	0.605	4.978	2.996	3.474
November	0.330	1.615	3.793	1.861
December	0.672	6.353	5.227	5.095

4.568 gm^{-2} at stations 1, 2, 3 & 4 respectively. In general high biomass during premonsoon and low during monsoon periods was observed. Maximum biomass was observed at station 4 (7.188 gm^{-2}) during premonsoon while during monsoon it was at station 3 (5.879 gm^{-2}). Postmonsoon variations in biomass among different stations were not very well marked.

Population Density :

Among the four stations, maximum population density (231.84×10^4 m^{-2}) was observed in March, at station 2 (Table IV) where foraminiferans contributed about 88% of the total population. Minimum population density (3.36×10^4 m^{-2}) was noticed at station 1 in Dec. '80. Mean densities were 2.68×10^4, 101.78×10^4, 80.01×10^4 and 73.41×10^4 m^{-2} respectively.

Table IV. Distribution of Meiobenthic population density off Mahim during 1979-80 ($\times 10^4$ m^{-2})

Month/Station	1	2	3	4
November 1979	13.44	75.04	25.76	23.52
December	—	—	—	—
January 1980	6.16	16.80	60.48	72.80
February	80.64	72.24	50.96	142.00
March	89.50	231.84	87.36	163.52
April	26.88	163.52	140.48	52.64
May	13.44	92.96	134.40	101.92
June	22.40	—	—	—
July	4.48	144.48	150.08	40.32
August	13.44	62.72	22.40	23.52
September	7.84	33.60	113.12	71.68
October	29.12	153.44	51.52	62.72
November	8.96	22.40	66.08	39.20
December	3.36	152.32	69.44	86.24

During pre and postmonsoon periods, gradual increase in population density from stations 1 to 4 excepting at station 2 was observed. Unusually high abundance of foraminiferans at station 2 resulted in high population density of meiofauna throughout the period of observation. Population density at station 4 was comparatively low during monsoon. Population density maxima for monsoon (95.20×10^4 m^{-2}) was obtained at station–3 (140.14×10^4 m^{-2}) and for postmonsoon (84.00×10^4 m^{-2}) at station–2.

Faunal composition:

Meiofauna off Mahim was chiefly constituted (Fig. 2) by foraminiferans, nematodes, polychaetes, and crustaceans (Ostracods, copepods, cirripids, decapods and crustacean larvae) with an occassional incidence of radiolarians, turbellarians, kinorhynchas, acarins, pelecypods, gastropods and miscellaneous groups. The last group included pennatularians, actinozoans and amphipods.

Nematoda was the dominant group at Mahim with a percentage incidence of 47.22. Among the four stations maximum density of 107.52×10^4 m^{-2} was observed at station–3 in July, while the minimum of 1.12×10^4 m^{-2} at station 1 in Jan. Nematodes were abundant at stations 3 (58.85%) and 4 (56.27%). But their percentage was less at stations 1 (13.24) and 2 (39.61).

Foraminiferans contributed about 46.28% to the total meiofauna during the period of study. Maximum population density of 203.84×10^4 m^{-2} was observed at station 2 in Mar. followed by a second peak in April. Minimum density (1.12×10^4 m^{-2}) was observed at station 2 in Jan. Foraminiferans were more abundant at stations 1 (83.10%) and 2 (57.04%) than in the stations 3 (32.38%) and 4 (33.36%).

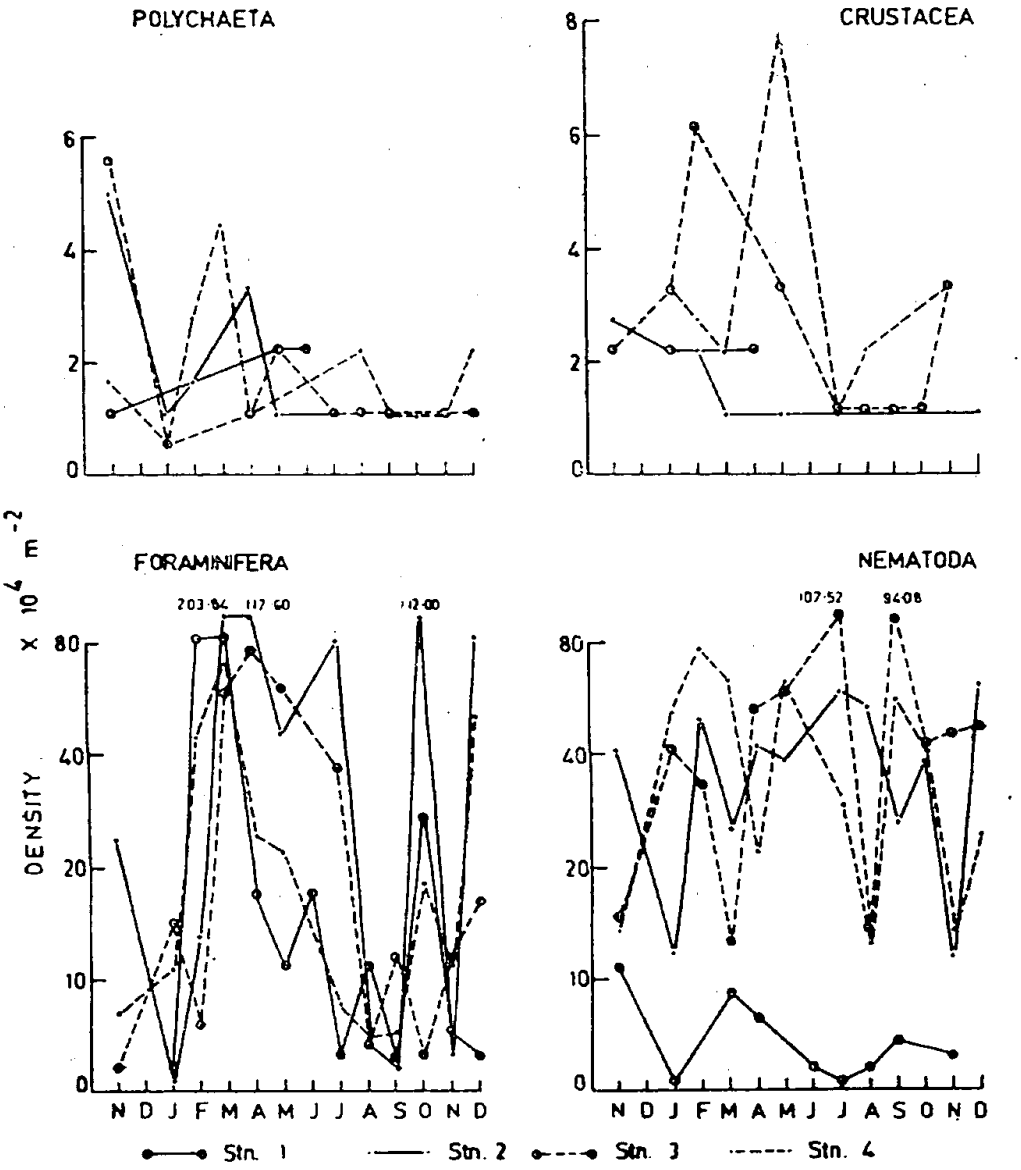

Fig. 2. Distribution of dominent meiobenthic groups off Mahim.

Though percentage incidence of polychaetes was low (1.62), they were present in all the seasons at all the stations. Maximum population density of polychaetes (5.60×10^4 m^{-2}) was obtained at station 3 in Nov, '79 and minimum (0.56×10^4 m^{-2}) at stations 3 and 4 in Dec, '79. Percentage of polychaetes from stations 1 to 4 were 1.74, 1.38, 1.56 and 2.10 respectively.

The Crustaceans included ostracods (0.97%) copepods (0.71%), cirripeds (0.3%), decapods (0.08%) and crustacean larvae (0.07%). Copepods were recorded frequently while ostracods were absent during monsoon period. Maximum density (7.84×10^4 m^{-2}) was recorded in May at station-4. Minimum (1.12×10^4 m^{-2}) was obtained at different stations in different months.

The minor groups include radiolarians (1.68%), turbellarians (0.30%), Kinorhynchas (0.17%), acarina (0.03%). Pelecypods (0.37%), gastropods (0.17%) and miscellaneous groups (0.31%). The incidence of these minor groups was occassional with low densities. Their numerical abundance indicated gradual increase from nearshore to offshore stations.

A gradual increase in group diversity from station 1 to 4 was seen. Group diversity and percentage composition of meiofauna were similar at stations 3 and 4. Some of the sensitive groups like Kinorhyncha and gastropods were recorded only at stations 3 and 4 (offshore). Acarina was recorded only from station 4.

DISCUSSION

Hydrographic conditions showed that the salinity and pH were low and DO was almost nil especially during ebb tide in the nearshore station-1. The concentration of PO_4^{-4}, NO_2^- and NO_3^- were abnormally high in this locality, due to high organic load. It was under severe pollution stress. Concomitant to this, the environmental conditions were comparatively better and healthy towards the offshore (Sts. 2, 3 and 4). Therefore magnitude of pollution gradually decreased because of dilution. Similar results were observed for the water quality off Versova, Bombay (Varshney, Govindan & Desai, 1984).

Station 1 showed a low mean biomass (0.745 gm^{-2}) because of relatively healthy environment towards offshore, stations 2, 3 & 4 sustained high biomass and population density. Biomass was almost constant in these stations. Population density of meiofauna was exceptionally high at station 2 (101.78×10^4 m^{-2}) and it gradually decreased at station 3 (81.01×10^4 m^{-2}) and st-4 (73.41×10^4 m^{-2}). Off Versova (Bombay) also the same pattern of distribution of biomass and population density were noticed (Varshney, Govindan & Desai, 1984).

Foraminifera, Nematoda, Polychaeta and Crustacea were the major groups reported. Foraminiferans dominated the near shore stations 1 (83.10%) and 2 (57.04%). Percentage of foraminiferans decreased towards the offshore stations 3 (32.38%) and 4 (33.36%). Offshore stations 3 and 4 were dominated by nematodes 59.85% and 56.27%, respectively.

Meiobenthic production (biomass) was usually high during premonsoon. Population density was high during premonsoon and moderate during postmonsoon because of rehabilitation after monsoon. A severe decline in the shallow water benthos during south west monsoon and the subsequent recolonisation during postmonsoon period which was rather slow and unsteady has been reported off Calicut (Seshappa, 1953).

The meiobenthic fauna was dominated by nematodes wherever the sediment was predominated by silt and clay (clayey silt). Hence, nematodes were abundant at stations 3 and 4. Damodaran, (1973), Weiser (1960), Muss

(1967) and Varshney, Govindan & Desai, (1984), have reported that namatodes prefer fine and soft substratum, because of their pump like apparatus.

Abundance of foraminiferans was associated with the substratum with varying percentage of silt and clay in the stations 1 and 2, where the sandy bottom prevailed (Fig. 3). Abundance of foraminiferans in the sandy substratum has been observed in the Narmada estuary and off Versova (Varshney, Govindan and Desai 1981 & 1984) and of the mud bank of Kerala coast (Damodaran, 1973).

Increase in the group diversity of meiobenthos from nearshore to offshore stations was evident during the present investigation. Variations in

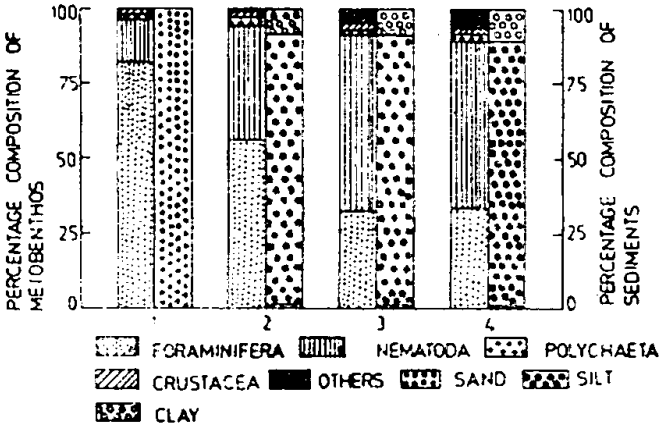

Fig. 3. Meiobenthic population in relation to sediment texture.

percentage composition were similar at stations 3 and 4. The sensitive groups like Kinorphyncha, and gastropods were recorded only from offshore cleaner waters (stations 3 and 4). Acarina was reported only from station–4. Similar results had been reported for the meiobenthos off versova (Varshney, Govindan & Desai, 1984).

In the present investigation the unstable sandy bottom, low percentage of organic matter in sediments, organic pollution load through discharges, considerable fluctuations in water quality, salinity and DO levels during ebb tide were some of the important factors responsible for poor meiobenthic fauna encountered specially at station 1 in the vicinity of discharge. Desai and Krishnan Kutty (1967) for the benthic fauna of Cochin backwater also observed the effect of some of these environmental parameters on the distribution (abundance) of benthic fauna. The environmental conditions were comparatively much better and stable at stations 3 and 4. Hence, relatively higher numerical abundance and group diversity were encountered towards offshore.

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