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Meiobenthos of mangrove mudflats from shallow region of Thane creek, central west coast of India

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Studies on the meiobenthos of intertidal zone of mangrove mudflats revealed dominance of nematodes (78.35%) with insignificant seasonal variations. The other constituents were tube polychaetes and oligochaetes, the latter contributing a major share to meiobenthos only at the station in the proximity of sewage outlet. Generally the meiobenthic abundance was higher at low level water mark (44.30% of density and 56.40% of biomass) and low during monsoon (20.90%). The meiobenthic productivity ranged between 4650 to 9835 g/m^2 and was mainly governed by macrobenthic population density.

Information on ecology of multicellular meiofauna and their interaction with macrobenthos in clayey-silt sediment of mangrove mudflats are scarce. The meiobenthos provide information on secondary productivity of the region as they consume bacteria and detritus and in turn act as potential food for macrofauna. They are also responsible for rapid turnover of elements and nutrients. This paper discusses various factors influencing the meiobenthos and its relationship with macrobenthos.

Materials and Methods

Thane creek (long. 72°.55′ to 73°.00′E and lat. 19°.00′ to 19°.15′N) on the west coast of India, lies south of Bombay harbour bay and has its geomorphic head near Thane city where it joins the Ulhas river by a connection. The creek is tide dominated with extensive mangrove mudflats which are in the process of elimination due to anthropogenic activities. The present investigation was conducted from three selected stations from mangrove mudflats of *Avicennia laba* (Fig. 1).

The monthly sediment samples for meiobenthos and macrobenthos were collected from high level water mark (HLWM), midlevel water mark (MLWM) and low level water mark (LLWM) from the intertidal zone of mangrove mudflats from Jan. '92 to Nov. '92. The meiobenthos collection was done in duplicate by a cylindrical metal tube (10 cm length and 3.8 cm dia.). Each core sample was divided into 5 subsamples and preserved in Rose Bengal solution prepared in 5% formalin solution. The macrofaunal abundance was estimated by taking 5 random samples with the help of a shovel (area 0.01 m^2) and the macrobenthos were separated sieving the sediment through 0.5 mm mesh sieve.

All the organisms were sorted taxawise and their densities and biomass computed. The monthly faunal data was condensed into 4 seasons, monsoon (July-Sept.), early postmonsoon (Oct.-Dec.), late postmonsoon (Jan.-March) and premonsoon (April-

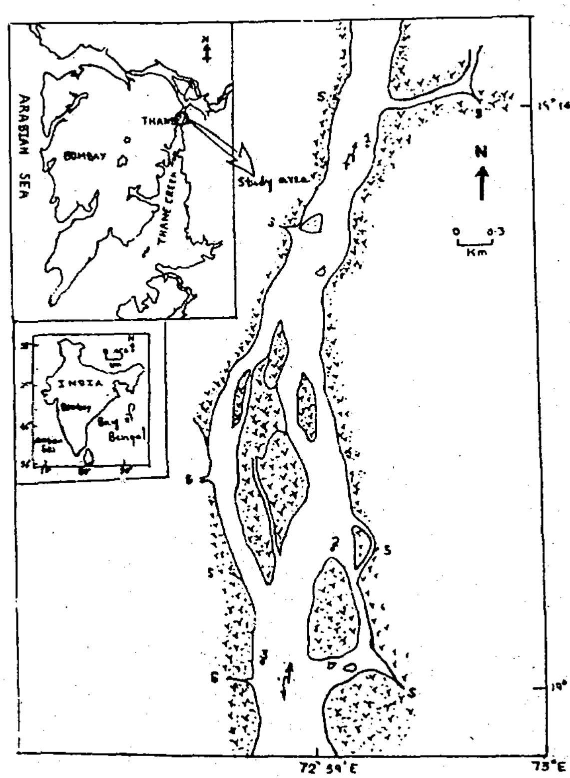

Fig. 1—Map of Thane creek showing sts 1-3 with sewage outlets

June). The southwest monsoon in the year of investigation started in July with light showers in late June, hence the month of June has been treated as premonsoon. The density and biomass of meiobenthos were calculated for 1 m^2. The total biomass of 1 m^2 was then converted to productivity estimates by multiplying factor 8 for meiobenthos[1] and 2.5 for macrobenthos[2]. Major hydrological and sedimentological parameters were determined by using standard methods[3]. The sediment texture was analysed by pipette method[4]. Correlations between different parameters were studied by calculating simple correlation coefficients and were tested at 5% level of significance by using *t* test.

Results and Discussion

The major abiotic factors of mangrove mudflats (Table 1) showed wide variations in salinity, poor DO and predominance of fine grain sediment. The sediment organic enrichment was not high despite sewage outlets, solid waste dumping grounds and mangroves (Fig. 1) when compared with the reported values of mangroves of Goa[5] (av. 4.56% org. C) due to strong tidal currents experienced in this region. But total N of 0.29% in sediment and 17.12 mg/l in ambient waters with high total P (0.082% in sediment and 0.238 mg/l in water) and low DO indicate pollution and eutrophication of the creek.

The study of multicellular meiobenthos in the mangrove mudflats of this region revealed predominance of nematodes (78.35%) at all tidal levels and seasons which was followed by tube dwelling polychaetes (12.48%) and oligochaetes (9.29%). Sporadically a few other polychaetes, bivalves, zoeae and copepods were collected in October and November.

In general the meiobenthic numerical abundance showed alternate peaks with lower densities during monsoon (Fig. 2) perhaps due to scouring of beds. A peak of high meiobenthic abundance was discernible in June at all stations, otherwise it varied stationwise.

High density of meiobenthos at st. 3 (Fig. 2) with marginally higher organic matter (2.52%) when compared with other stations (Table 1), can be attributed to the proximity of large sewage outlet at the former station, even though it cannot be substantiated on the basis of organic matter which was low due to good tidal flushing.

Meiobenthos showed different trends having lowest biomass at st. 2 (av. 52.84 g/month) with twofold higher biomass at st. 3 (av. 111.76 g/month) during the period of investigation. Besides LLWM (44.3% density) was richer and HLWM (21.01% density) was poorer in meiobenthic abundance especially at st. 3. This pattern of high numerical abundance at LLWM (37.7%) deviated at st. 2 with marginal higher richness at MLWM (41.46%).

Nematodes are generally dominant in marine meiofauna[6] but their dominance was evident also during low saline regime (Fig. 2). Besides this group showed insignificant correlation with salinity and tidal amplitude indicating seasonal stability[7] without showing spatial or temporal pattern.

Similar dominance of nematodes (52.90%) in meiofauna from polluted environments of Bombay was reported by Varshney *et al.*[8], with high population density and biomass during premonsoon. But the absence of Foraminifera can be attributed to the estuarine conditions and predominance of fine grain sediment in the mangrove mudflats. High meiofaunal density (2622-6555/10 cm^2) mainly of nematodes (46.7%) and the benthic copepods (23.7%) were

Table 1—Major hydrological and sedimentological characters of three stations

Months	Salinity ($\times 10^{-3}$)			D.O. (mg/l)			Silt (%)			Clay (%)			D.C. (%)		
	St. 1	St. 2	St. 3	St. 1	St. 2	St. 3	St. 1	St. 2	St. 3	St. 1	St. 2	St. 3	St. 1	St. 2	St. 3
Jan '92	26.87	30.70	27.50	1.2	2.0	2.3	42.54	51.91	67.68	48.46	48.07	32.31	2.49	2.58	3.20
Feb '92	33.25	35.17	31.98	2.3	1.3	2.0	64.53	66.79	79.02	43.81	33.18	20.96	2.7	2.72	3.00
March '92	32.62	35.17	34.53	1.6	0.9	1.0	60.78	75.90	64.49	25.31	24.09	35.48	2.21	2.88	2.64
April '92	23.68	37.14	36.45	5.0	1.6	1.2	70.50	60.61	77.02	35.89	38.37	22.97	2.24	2.38	2.74
May '92	35.17	35.81	41.56	1.4	1.7	1.6	79.31	79.63	68.82	19.18	20.35	31.16	2.2	2.31	2.71
June '92	35.17	35.18	34.53	2.4	1.7	1.5	64.49	72.33	73.06	34.62	27.66	26.92	1.91	2.36	2.61
July '92	31.98	26.23	26.22	1.4	3.5	1.4	82.05	77.99	54.90	18.74	21.99	45.08	2.51	1.99	2.56
Aug '92	3.22	10.25	10.25	3.3	2.2	1.5	73.56	76.70	67.64	26.79	23.20	32.34	2.25	2.56	2.59
Sep '92	3.22	1.95	1.95	1.9	3.1	1.3	65.07	81.11	57.74	28.57	18.87	41.22	2.02	2.33	2.69
Oct '92	23.67	27.51	28.14	3.8	1.1	1.5	80.53	62.36	63.81	15.73	37.62	36.18	1.83	1.71	2.89
Nov '92	24.31	27.50	26.23	1.9	2.1	2.2	66.88	66.16	65.20	36.51	33.82	34.44	1.64	1.74	1.80

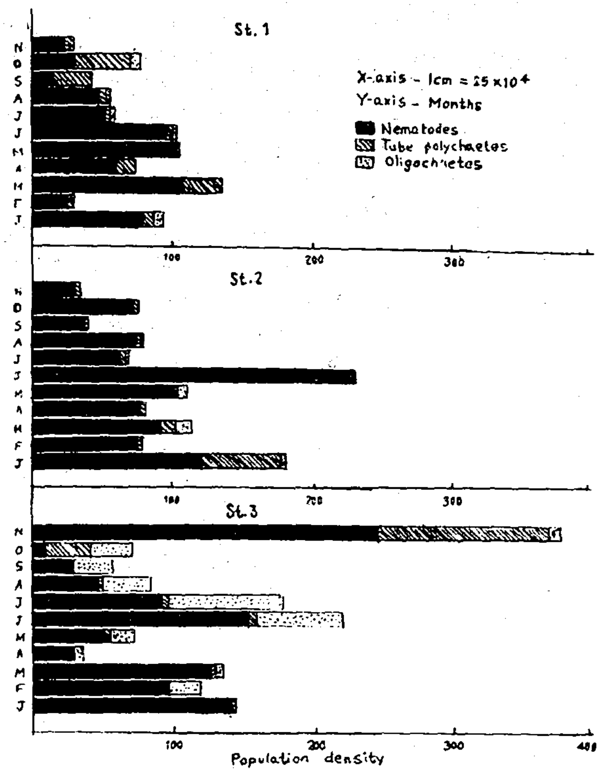

Fig. 2—Monthly meiobenthic density (no/m^2) of three stations

observed from six sandy beaches of Lakshadweep[9] with no correlation with tidal exposure and was generally concentrated at mid and high water mark. According to Raffaeli[10], dominance of nematodes indicates organic pollution due to their tolerance to low DO. The other constituents of meiobenthos also indicated similar pattern except the oligochaetes extended major support (24.27%) to meiobenthic abundance only at st. 3 which resulted in numerical superiority perhaps due to proximity with sewage outlet.

Meiobenthic distribution is largely determined by sediment particles, organic matter and degree of oxygenation[11]. The mangrove mudflats in the present investigation were predominantly clayey-silt with very low percentage of fine sand (0.104 to 4%). The silt constituent often showed significant positive correlations with meiobenthic and nematode abundance and negative correlation with tube polychaetes (Table 2). But the role of organic matter in determining the population density appears to be insignificant perhaps due to higher organic enrichment at all stations in comparison with that observed in Gosthani estuary[12] (0.11 to 1.54% org. C), as a result it fails to show the relationship. Besides, the degree of oxygenation in the predominantly fine sediment must have been limited which apparently did not influence the meiobenthos.

Table 2—Significant correlation coefficients (5% level of significance) with meiobenthos (no/m^2)

	St. 1			St. 2			St. 3		
	HL	ML	LL	HL	ML	LL	HL	ML	LL
Meiobenthos (no/m^2)									
Silt (%)	—	0.9416	0.8156	—	—	−0.4472	0.8420	0.5359	−0.4062
Org. C (%)	—	−0.5514	—	—	—	0.6998	—	—	—
C/N	0.9906	—	—	—	—	−0.6137	−0.4331	—	0.8937
N/P	—	0.5983	—	—	—	—	0.4887	—	0.6086
Macrobenthos (no/m^2)	0.6579	0.5507	—	—	—	0.6987	—	—	0.7039
Nematodes (no/m^2)									
Silt (%)	—	0.4014	0.6876	—	—	—	0.8390	0.5689	—
Org. C (%)	0.4076	—	0.4728	—	—	—	—	—	0.6907
C/N	0.9860	—	0.6887	—	—	—	−0.4057	—	0.6351
N/P	—	—	—	—	—	0.4979	0.4561	—	—
Macrobenthos (no/m^2)	0.6896	0.6051	0.4423	—	—	0.7480	0.4616	—	0.6835
Tube-polychaetes (no/m^2)									
Silt (%)	−0.6472	0.8276	—	−0.6956	−0.6019	−0.7087	—	0.4299	—
Org. C (%)	—	−0.8122	−0.8342	—	—	0.6427	—	−0.4613	—
C/N	−0.4825	0.6378	—	−0.4457	—	−0.7566	—	—	−0.8258
N/P	0.8355	−0.4660	−0.5851	—	—	—	—	—	—
Macrobenthos (no/m^2)	0.9731	—	—	—	0.5747	0.5534	—	—	—

Stationwise average of C/N values in the mangrove sediment varied marginally from 12.97 to 13.91. High C/N values above 10 indicate organic matter of terrestrial origin or derived from benthic macrophytes which is harder to decompose than microphyton detritus and animal remains[13]. This suggests organic matter was not completely utilized by the fauna. Lower N/P values of sediment (4.75-3.42) substantiate terrestrial origin of nutrients mainly through domestic sewage[14]. Both the ratios encountered significant correlation more often with the tube polychaete (Table 2) than the other meiofauna suggesting their role in distribution of the former to some extent.

Thus the meiobenthic abundance was not determined by any hydrological or sedimentological parameters. Even the moderate load of organic matter did not enhance the meiobenthic abundance as reported by Gee *et al.*[15]

The tide level-wise study of macrobenthos in the same region (Fig. 3) showed highest density and biomass at st. 1 and lowest at st. 3 despite marginal difference in sediment organic matter (Table 1). In general the polychaetes in low density dominated the biotope (66.33%) with poor representation to crustacea and bivalve indicating pollution largely through domestic sewage[14]. They also observed insignificant spatial and temporal distribution with high abundance during monsoon. Furthermore, midlevel water mark (MLWM) was richer in macrobenthic abundance suggesting opposite trends with meiobenthic community due to interaction (Fig. 3). This can be further substantiated by higher numerical abundance of macrobenthos concomitant with lower meiobenthos at LLWM of st. 2 and absence of macrofauana with high meiobenthic density at LLWM of st. 3. The meio/macrobenthic ratio in terms of abundance showed fluctuations in the range of 0 to 5697.91 at st. 3 and comparatively low values at st. 1 (42.12 to 692.98) indicating dominance of meiobenthos at the former station which corroborates the earlier observation. The other reported ratios from Bombay region[16] are 1600 and 994 including the creek[17] showing dominance of meiobenthos. Furthermore, the macrobenthic polychaetes showed frequent significant correlations with the meiobenthic fauna (Table 2). Montagna & Kalke[18] have suggested either macrofaunal competition or predation on meiofauna.

A significant observation was absence of copepods in the meiobenthos indicating high intensity of pollution. Guellec & Bodin[7] have attributed disappearance of copepods to extremly high input in sheltered areas (like mangrove mudflats) which drastically reduces the diversity until disappearance of harpacticoid copepods.

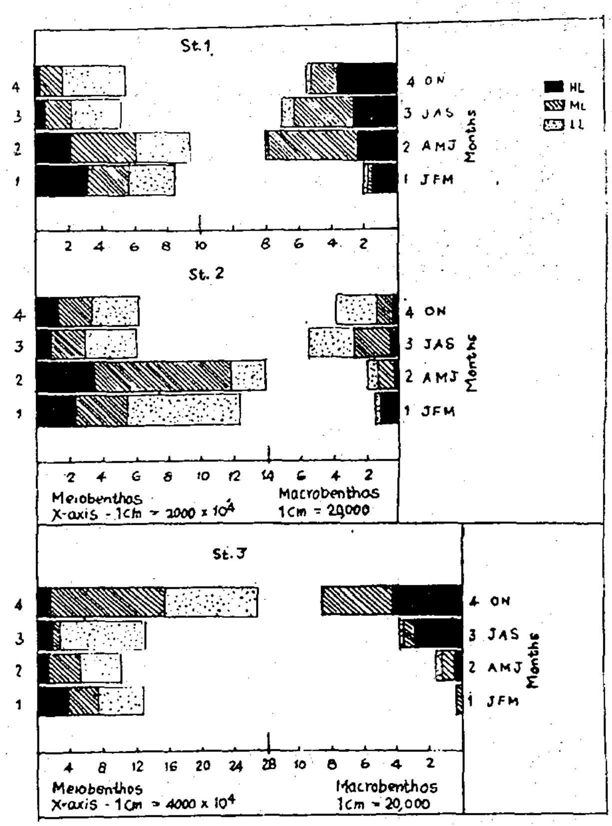

Fig. 3—Seasonwise and tidal levelwise comparison of meiobenthic (no/m^2) and macrobenthic (no/m^2) polychaete densities

Table 3—Total density (no/m^2), biomass wet wt (g/m^2) and production estimates (g/m^2) for meio and macrofauna and percentage contribution of total macro and meiofaunal production (% P) of three stations

St. no.	Meiofauna				Macrofauna			
	Density (no/m^2)	Biomass (g/m^2)	Production (g/m^2)	Production (%)	Density (no/m^2)	Biomass (g/m^2)	Production (g/m^2)	Production (%)
St. 1	78,95,772	631.561	5052.48	40.49	96,300	2970.34	7425.87	59.51
St. 2	10,97,168	581.345	4650.76	36.30	76,800	3264.04	8160.10	63.70
St. 3	1,65,44,340	1229.42	9835.36	85.91	57,790	645.05	1612.62	14.09

The production estimates indicate that the quantitative contribution by meiobenthos to secondary productivity was higher at st. 3 due to lower density of macrobenthos (Table 3). Higher presence of macrobenthos at other stations reduced the meiobenthic contribution by approx. 38% suggesting the meiobenthic abundance is mainly governed by interaction with macrobenthos rather than any other parameters. Similar observation of biotic interaction as a major factor governing the abundance of meiobenthos was also made in eutrophicated tanks even under experimental conditions by Widbom & Elmgreen[19]. Hence the meiobenthic abundance in this region was mainly determined by numerical superiority of macrobenthos and degree of organic enrichment.

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