

BENTHOS OF THE NARMADA ESTUARY

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ABSTRACT

Distribution of benthos in relation to environmental characteristics has been studied along a stretch of 55 km in the Narmada estuary. Higher abundance of macro and meio fauna were noticed along the upper and lower reaches of the river respectively. Chaetopods formed the most dominant component of macro fauna, while foraminiferans predominated the meiofauna. The mean ratio between macro and meio fauna in terms of population density and biomass (dry wt.) were 1:90 and 1:3 respectively. Sediments were largely muddy in the upper reaches and sandy in the lower reaches with varying proportions of silt clay. The percentage of organic matter (Av. 0.46%) in sediment was poor. Maximum population density was recorded during the pre-monsoon period. The average benthic biomass was 349 mg/m² for the entire area.

INTRODUCTION

The river Narmada is one of the important perennial river along the central west coast of India and is well known for its fisheries, especially the Hilsa fishery. The hydrography and biological characteristics of the river have not been studied so far. Recently, Regional Centre of NIO at Bombay conducted a detailed investigation of the Narmada river (NIO Report, 1980) and benthic productivity formed part of this investigation. In the present communication benthos both in the fresh water and estuarine zones of the river system were evaluated.

DESCRIPTION OF THE AREA

The river Narmada originates in the Maikala range of Madhya Pradesh and the mouth (about 20 km wide) lies in the Gulf of Cambay (Fig. 1). The study area extends from the mouth to about 55 km upstream. In this region large sand banks get exposed during the low tide. The size and forms of these sand banks change from season to season.

MATERIAL AND METHOD

The period of study was from March to September, 1979 covering pre-monsoon (March to June), monsoon (July-August) and post-monsoon (September) periods prevalent in that area. Eleven stations were selected along the 55 km stretch of the river (Fig. 1). Due to certain navigational difficulties all the stations could not be worked out each month. At different stations samples were collected using a Van Veen grab of 0.04 m² area. For the collection of meiobenthos a core of 2.0 cm diameter was inserted into the sediment through the grab window and samples were collected and preserved in buffered formalin, containing Rose Bengal 1:500. Sediment

samples were collected for the analysis of organic matter and sediment texture from each station. For the analysis of macrobenthos, a fresh grab was operated and samples were sieved through 0.5 mm mesh screen and preserved in 5% buffered formalin.

In the laboratory the sediments collected for meiobenthos were sieved through a 45 μ mesh sieve, the fauna identified and counted under a binocular microscope. Characteristics of the sediment texture were determined by the method of Holme and McIntyre (1971). Organic matter in sediment was determined following the method of Wakeel and Riley (1956). Biomass is expressed in terms of dry weight.

RESULTS

Physico-chemical parameters

The range for different physico-chemical parameters studied are given in Table Ia

Temperature:

Seasonal variation in water temperature in the upper reaches ranged from 25.5 to 30.0°C, whereas at lower reaches the range was 27 to 31.7°C (Table I).

Salinity:

Two distinct zones marked by significant variations in salinity could be recognised within the area of investigation. In the upper reaches (stations 1-6), salinity ranged from 0.03 to 0.10‰ and is considered as the fresh water zone. At the lower reaches (stations 7-11) salinity varied from 0.16 to 31.96‰ and is delineated as the estuarine zone. Minimum salinity was recorded in August in both the zones.

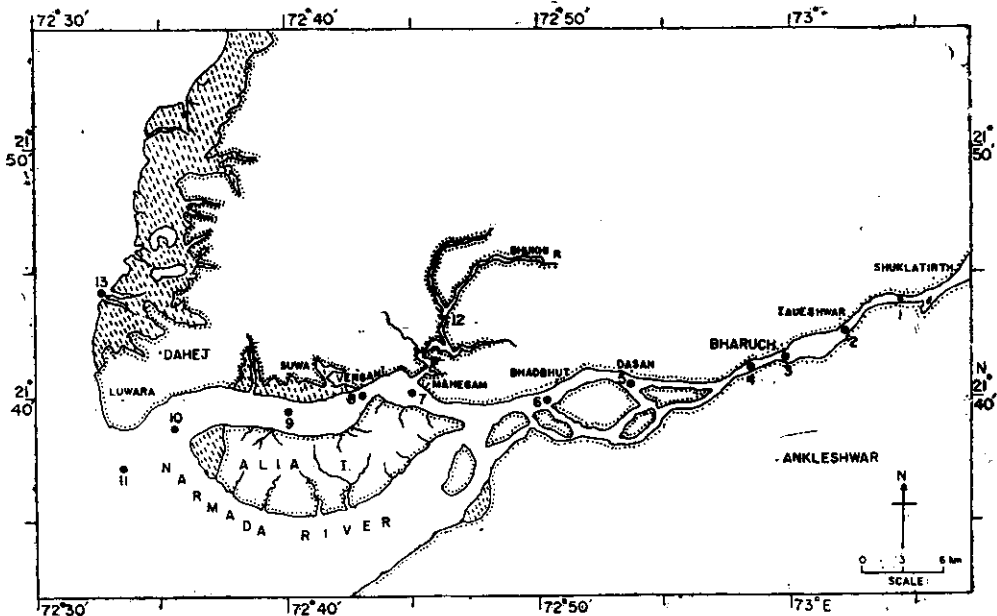


Fig. 1. Map showing the location of stations in the Narmada river.

Dissolved oxygen:

There was not much variation in dissolved oxygen content between the fresh water and estuarine regions. In upper and lower reaches it varied from 6.6 to 9.2 ml/l and 6.5 to 8.3 ml/l respectively, suggesting an excellent water quality.

Nutrients:

Phosphate values varied from 0.32 to 12.16 $\mu\text{g-at/l}$ in the upper reaches, while in the lower reaches it fluctuated between 0.39 and 7.16 $\mu\text{g-at/l}$. Compared to phosphate values, variations in the nitrate values were more in the river. Along the upper reaches the nitrate values varied from 0.07 to 60.0 $\mu\text{g-at/l}$ and in lower reaches it ranged from 1.61 to 81.0 $\mu\text{g-at/l}$.

Highest values for phosphate (12.16 $\mu\text{g-at/l}$) and nitrate (81.0 $\mu\text{g-at/l}$) were recorded in August and this may be due to the influx of large quantities of fresh water during the monsoon.

Organic matter:

The percentage of organic matter varied from 0.03 to 4.66 along the upper reaches, while in the lower reaches it varied from 0.06 to 0.49. In general, high percentage of organic matter was observed in silty clay and clayey silt bottom (muddy), along the upper reaches of the river. The lower reaches having a sandy bottom sustained a lower percentage of organic matter (Table II).

Sediment:

Sediment-texture varied from lower to the upper reaches of the river (Table II). In the lower reaches the sediment largely contained sand with little silt and clay. Stations 8 and 9 had mostly clean sand, whereas in the upper reaches of the river the sediment was mostly of silt and clay (muddy), with varying percentage of sand.

Table I. Range of variation in physico-chemical characteristics* and biomass.

Month	Temperature (°C)	Salinity (‰)	Dissolved oxygen (ml/l)	PO ₄ -P ($\mu\text{g-at/l}$)	NO ₃ -N ($\mu\text{g-at/l}$)	Av. Biomass (mg/m ²)		
						Macro	Meio	Total
Upper Reaches (St. No. 1-6)								
March	25.5-30.0	0.04-0.08	7.7-9.2	0.5-1.68	5.64-13.71	249	273	522
May	28.9-29.5	0.04	7.3-7.6	0.97-1.03	0.21- 0.29	151	63	214
July	28.0-29.6	0.06-0.08	6.6-8.1	0.39-11.84	0.07- 0.57	59	189	248
Aug.	26.5-29.0	0.03-0.10	6.6-8.8	9.35-12.16	3.07-29.00	06	22	28
Sept.	—	—	6.8	0.32- 0.39	54.57-60.00	21	1389	1410
Lower Reaches (St. No. 7-11)								
March	27.0-27.8	12.00-31.63	6.6-7.8	1.22- 5.29	3.57-12.21	36	580	616
May	29.7-31.7	14.94-31.96	6.6-7.8	0.39- 2.16	1.61- 4.21	14	—	14
July	—	—	—	—	—	14	118	132
Aug.	27.00-29.7	0.16- 3.07	6.5-8.3	1.52- 2.32	55.25-81.00	—	—	—
Sept.	—	4.5-14.50	7.5	0.54- 7.16	49.43-57.00	0.5	157	157.5

* Data on physico-chemical parameters were obtained from a report (Jan-1980) of RC, NIO-Bombay.

Table II. Population density and biomass in relation to depth, sediment type and organic matter

St. No.	Month	Depth (metre)	Macrofauna		Meiofauna		Sediment Characteristics (%)		Texture	Organic Matter (%)
			No./m ²	mg/m ²	No./m ³	mg/m ²	Sand	Silt & Clay		
1	May	4.0	44	06	—	—	99.5	0.5	Sandy	0.06
2	May	15.5	4049	480	11200	22	1.0	99.0	Clayey silt	0.83
	July	18.5	2618	34	155800	314	1.0	99.0	Silty clay	4.66
3	March	14.0	3058	397	42000	938	1.0	99.0	Clayey silt	0.79
	May	13.0	1210	144	11200	136	1.0	99.0	Clayey silt	0.75
4	March	7.5	1276	571	33600	67	84.5	15.5	Silty sand	0.17
	May	3.0	924	118	56000	112	7.0	93.0	Sandy silty	0.30
5	July	8.25	440	78	33600	140	81.0	19.0	Silty sand	0.83
	March	4.5	132	17	—	—	54.5	45.5	Silty sand	0.60
6	May	4.0	264	9	22400	45	99.0	1.0	Sandy	0.03
	March	4.0	132	11	44800	90	99.7	0.3	Sandy	0.12
7	July	4.5	308	66	56000	112	48.0	52.0	Sandy silty	0.35
	August	7.0	198	6	11200	22	60.0	40.0	Silty sand	0.20
8	September	8.5	88	21	44800	1389	96.0	4.0	Silty sand	0.06
	March	8.0	220	7	56000	112	98.0	2.0	Sandy	0.17
9	July	6.5	22	14	58800	118	96.0	4.0	Silty sand	0.25
	September	10.0	—	—	33600	392	99.6	0.4	Sandy,	0.06
10	March	8.0	176	119	—	—	94.0	6.0	Silty sand	0.44
	August	7.5	—	—	—	—	99.0	1.0	Sandy	0.06
11	September	8.0	44	2	16800	34	99.4	0.6	Sandy	0.16
	March	5.0	44	15	—	—	98.0	2.0	Sandy	0.06
12	May	6.0	22	14	—	—	98.5	1.5	Sandy	0.15
	September	7.0	—	—	—	—	99.3	0.7	Sandy	0.49
13	March	7.5	44	17	282200	1318	86.0	14.0	Silty sand	0.12
14	March	16.0	88	24	316400	1360	87.5	12.5	Silty sand	0.25
15	September	15.0	—	—	100800	202	98.7	1.3	Sandy	0.06

Table III. Percentage composition and percentage prevalence of different faunal groups

St. No.	Month	Foraminifera %	Nematoda %	Chaetopoda %	Crustacea %	Gastropoda %	Fishes %	Population No./m ²	Percentage Contribution Melo : Macro
1	May	—	—	100	—	—	—	44	00:100
2	May	73.44	—	22.47	1.44	3.89	—	15,249	73.44:26.55
	July	98.35	—	1.64	—	—	—	159,418	98.35:1.65
3	March	62.14	21.74	16.10	—	—	—	45,058	93.21:6.79
	May	67.62	—	19.96	—	12.34	—	12,410	90.24:9.76
4	March	96.34	—	3.53	—	0.06	0.06	34,876	96.34:3.66
	May	98.37	—	1.58	—	0.04	—	56,924	98.37:1.63
	July	82.25	—	0.32	26	17.16	—	34,040	98.70:1.30
5	March	—	—	100	—	—	—	0132	00:100
	May	98.23	—	—	—	1.16	—	22,664	98.83:1.17
6	March	99.70	—	—	0.03	0.27	—	44,932	99.70:0.30
	July	99.45	—	0.27	0.12	0.16	—	56,308	99.45:0.55
	August	98.26	—	—	—	1.74	—	11,398	98.26:1.74
	September	49.90	—	50	0.05	0.05	—	44,888	99.80:0.20
7	March	99.60	—	—	—	0.40	—	56,220	99.60:0.40
	July	99.96	—	—	0.04	—	—	58,822	99.96:0.04
	September	83.00	—	17.00	—	—	—	33,600	100:00
8	March	—	—	25	38	12	25	176	00:100
	August	—	—	—	—	—	—	—	—
	September	99.74	—	—	—	0.26	—	16,844	99.74:0.26
9	March	—	—	—	50	50	—	44	00:100
	May	—	—	—	100	—	—	22	00:100
	September	—	—	—	—	—	—	—	—
10	March	95.24	4.74	0.01	0.01	—	—	282,244	99.98:0.02
11	March	82.27	—	0.01	0.02	17.70	—	316,488	99.97:0.03
	September	100	—	—	—	—	—	100,800	100:00
	Percentage of prevalence	73.07	7.69	57.69	42.30	57.69	7.69	—	—

*Faunal composition and biomass**Macrofauna:*

Macrofauna was represented by chaetopods (82.5%), gastropods (14%), crustaceans (3%) and fishes (0.5%) (Table III). Chaetopods were mostly confined to the upper reaches of the river which also contributed high mean population density (1053/m²) particularly between stations 2 and 4. The mean faunal density was considerably low (55/m²) in the lower reaches of the river. Highest mean population density for the river was recorded in May (1085/m²) and lowest in September (26/m²).

High biomass values for macrofauna (140 mg/m²) were recorded along the upper reaches. The lower reaches of the river contributed very low (av. 18 mg/m²) macrobenthic biomass. The highest average biomass value (270.5 mg/m²) was recorded at st. 3 and the lowest average value (5.2 mg/m²) was recorded at st. 7 (Fig. 2). The maximum mean biomass (249 mg/m²) was recorded in March along the upper reaches, while the minimum value (0.5 mg/m²) was recorded in September along the lower reaches (Table I).

Meiofauna

Foraminifera was the only abundant group and contributed 91% of the total meiofauna. The population was constituted entirely by estuarine species. Other groups observed were gastropods (4.5%), chaetopods (2.5%) and nematodes (2%). foraminiferans were more abundant (62%) in the lower reaches as compared to the upper reaches (38%). In general, the lower reaches contributed a high mean population density (72050/m²) as compared to the upper reaches (37400/m²). Maximum mean

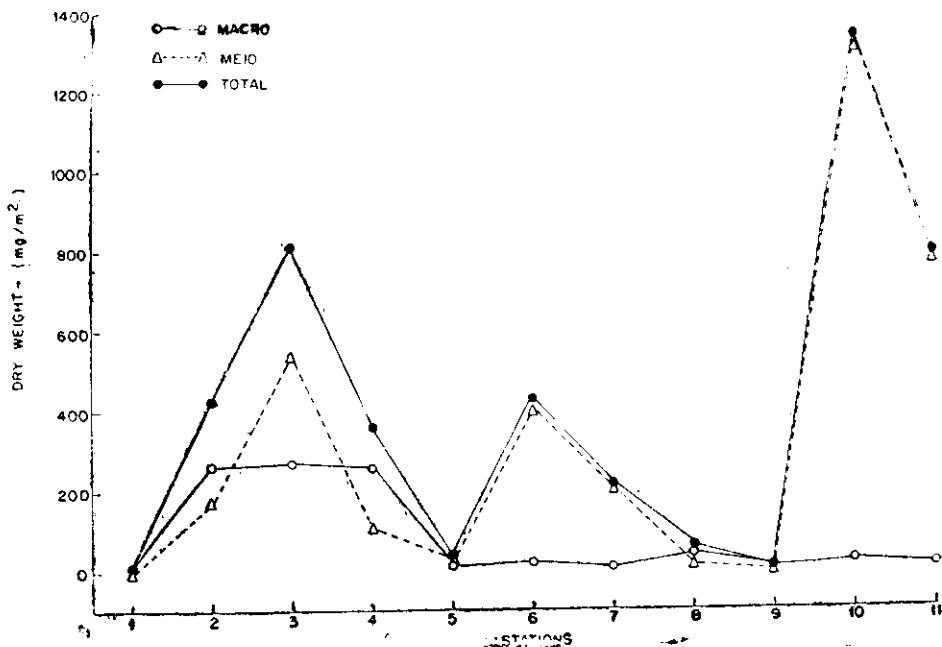


Fig. 2. Variations in the average biomass of benthic fauna.

population density of meiofauna was obtained from station 11 at the mouth of the river (Table II). Minimum mean population count of meiofauna was recorded at station 8. The highest mean population density of 86111/m² was obtained in March, while lowest value of 5600/m² was recorded in August.

The highest average meiobenthic biomass 1318 mg/m² was recorded at station 10, and the lowest average of 11.3 mg/m² was recorded at station 8 (Fig. 2). The maximum mean biomass value of 1389 mg/m² was observed in September while the minimum value of 22 mg/m² was recorded in August along the upper reaches (Table II).

DISCUSSION

Distribution of benthos in the Narmada estuary appears to be directly correlated to the prevailing physico-chemical conditions and two distinct zones could be identified within the area of investigation. The fresh water zone (upper reaches) and estuarine zone (lower reaches) were characterised by its own faunal assemblage.

The average benthic productivity in terms of biomass for the entire area of investigation was 349 mg/m². Relatively higher abundance of macrofauna was obtained from the upper reaches while the lower reaches sustained higher density of meiofauna. Chaetopods (82.5%) and foraminiferans (91%) were the two dominant groups contributing to the major part of the macro and meiofauna respectively. Parulekar, Nair, Harkantra and Ansari (1976) also reported the dominance of polychaetes and foraminiferans in the macro and meiofauna off Bombay regions respectively.

In general, the meiofauna dominated the macrofauna both in terms of mean population density (90:1) and biomass (3:1). The dominance of meiofauna over macrofauna has been reported in the Cochin backwater (Desai, 1967) and off Bombay (Parulekar, Nair, Harkantra and Ansari, 1976). A rich population counts of foraminiferans in meiofauna seems to be the main factor for such a large difference in the faunal distribution.

The estuarine fauna are chiefly constituted by marine, brackish water, fresh water and migratory components (Day, 1951), while its abundance is determined by several environmental factors (Muss, 1967). The present study indicates the influence of the substratum and the salinity on the distribution of fauna. A similar trend in benthic distribution was reported from nearshore regions of the Arabian Sea (Desai and Krishnan Kutty, 1967) and Mandovi-Zuari estuarine complex of Goa (Parulekar and Dwivedi, 1973 and 74; Parulekar, Rajamanickam and Dwivedi, 1975).

A rich macrofauna was associated with a stable silty sand and clayey silt bottom at the upper reaches. But the lower reaches had a sandy bottom with a poor macrofauna. Many times complete absence of benthic fauna from a clean sandy bottom associated with strong bottom currents (200 cm/sec) at stations 8 and 9 was noticed. Such complete absence of benthic fauna on a substrata of clean sand was also noticed by Eggleton (1931).

The percentage of organic matter and the faunal density showed no direct relationship. However, the organic matter seems to be related to the nature of substratum. Sanders, Hessler and Hampson (1965) also found no consistent relationship between organic matter and faunal density.

The population density and biomass values indicated variations in relation to the prevailing monsoon. A higher numerical abundance (57672/m²) was obtained

during pre-monsoon period. A reduction in the mean population density during the monsoon ($43531/m^2$) and post-monsoon ($39226/m^2$) periods were observed. Similarly the mean biomass value also showed a decrease from premonsoon ($410\text{ mg}/m^2$) to monsoon ($151\text{ mg}/m^2$) period. A considerable rise in the mean biomass value ($403\text{ mg}/m^2$) was noticed in the beginning of the post-monsoon period. The reduction in the numerical abundance of the benthic fauna noticed during monsoon and post-monsoon periods may be attributed to the flooding of the river system.

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