

QUANTITATIVE STUDIES ON MACROBENTHIC FAUNA IN THE POLLUTED THANA CREEK & BOMBAY HARBOUR*

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ABSTRACT

Macrobenthic samples were collected from 28 stations covering an area of about 340 square kilometres in the Bombay harbour and Thana creek. Observation on benthic productivity clearly indicated three different zones of production in the surveyed area. The creek head an area of about 4 square kilometre, had a rich macrobenthic biomass of 12,710 kg/km² (dry wt.). A zone of moderate benthic standing crop (1,660 kg/km²) was noticed in the harbour region between stations 9 and 24. Lowest production was confined to stations 4-8 of the creek region and stations 25-30 of the harbour with a benthic biomass of 440 and 220 kg/km² respectively. Polychaetes, bivalves, gastropods, crustaceans and echinoderms, were mostly represented in the macrobenthic fauna. Polychaetes were evenly distributed whereas molluscs and crustaceans were patchy and restricted in their distribution. In terms of biomass (dry wt.) bivalve accounted for 44-66%, crustacean 18-40%, gastropod 8-13%, polychaete 3-4% and echinoderm 0.3%. However, numerically polychaetes were predominant (58-66%). A reduction in the benthic productivity was noticed from 1-15 m depth. Aggregations of *Meritrix ovum* between stations 1 and 3 accounted for the rich benthic productivity at the head of the creek region. The poor benthic productivity in the remaining creek region might be due to the higher pollution load between stations 4 and 8. In general, benthic productivity in the surveyed region was comparatively lower than the reported values from west coast of India.

INTRODUCTION

Some species and communities of benthic fauna are often regarded as being the best indicators of organic pollution because of their constant presence,

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relatively long life span, sedentary or sluggish habits, and differing tolerance of stress. It is well known that environmental or pollutional changes often lead to alterations in the distribution and abundance of benthic animals. Therefore, the pattern of long term changes in water quality will have a definite impact on the sessile benthic communities. Further, it is possible to enumerate the principal species of benthic animal present and also to assess the density which may reflect the presence of pollution in an area. There are several studies on benthic organisms in the estuaries, near and off shore waters of Indian coasts (Panikkar and Aiyar, 1937 ; Jones, 1950 and 1951 ; Seshappa, 1953 ; Kurian, 1954 ; Desai and Krishnan Kutty 1967, a and b ; Desai, 1971 and 1973 ; Parulekar, 1973 ; and Parulekar and Dwivedi, 1973 and 1974). In the present communication an attempt is made for the first time to correlate benthic productivity with the prevailing pollution load in the Thana creek and Bombay harbour.

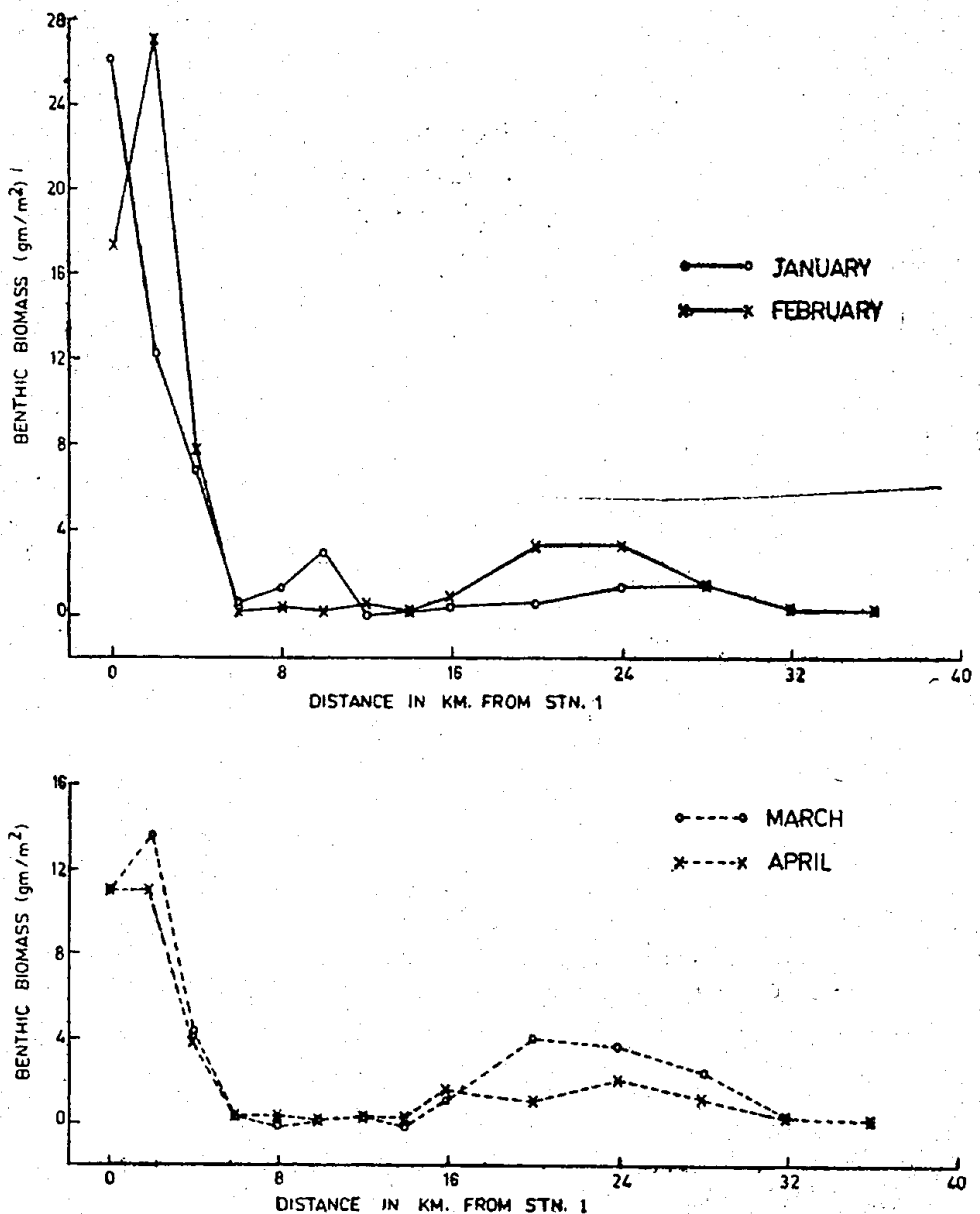


Fig. 5—Lateral distribution of macrobenthic biomass in the Thana creek and Bombay harbour during January - April.

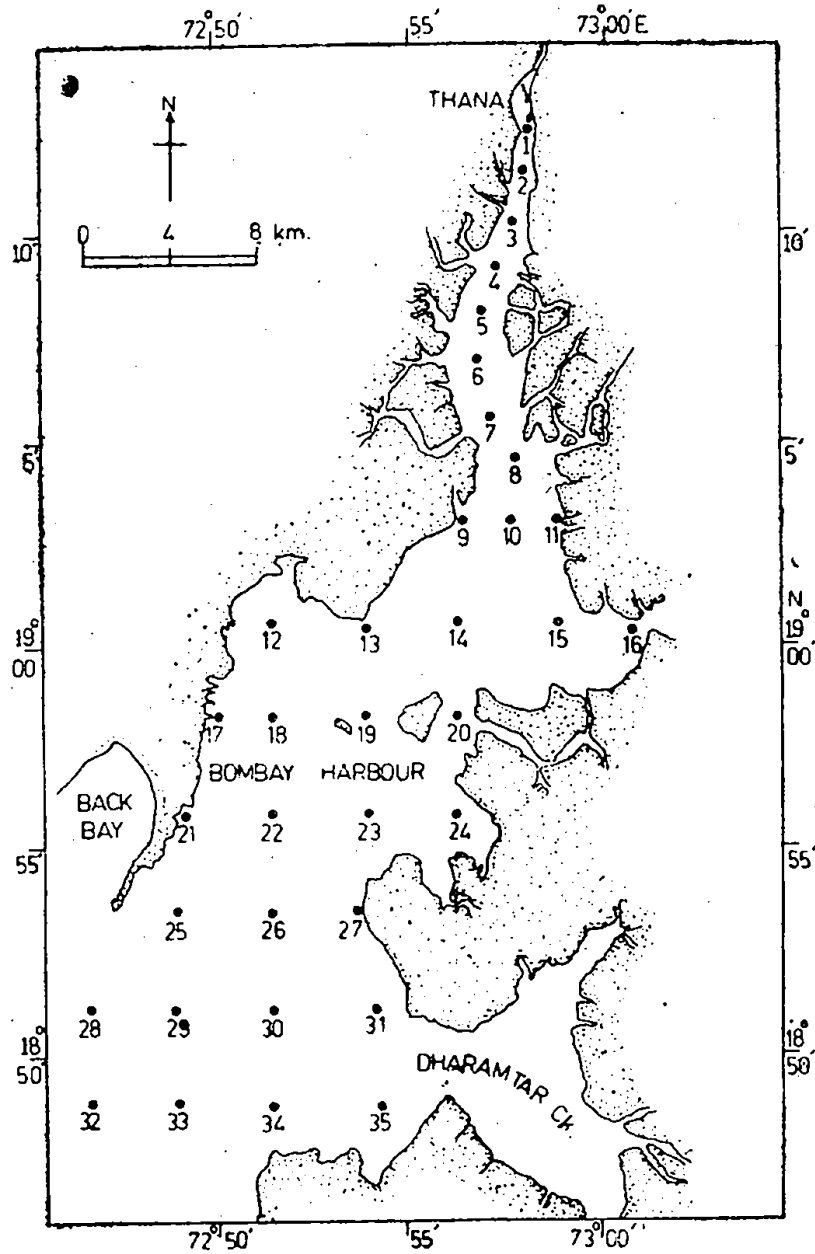


Fig. 1—Map showing the location of sampling stations in the Thana creek and Bombay harbour.

MATERIAL AND METHODS

A close net work of thirty one stations were demarcated for the present study in the Thana creek and Bombay harbour region comprising an area of around 340 km² (Fig. 1). A few shallow stations (16, 27 and 31) could not be covered during the survey due to the presence of mud flats in the region. Monthly collections of benthic samples were made at all stations from January to April, 1975. Samples were collected by using a 0.02 m² van Veen grab. One hundred and twelve benthic samples were collected. The samples were sieved through 0.5 mm stainless steel mesh and the material retained on the sieve was preserved in 5% neutral formalin, for detailed examination. Biomass was calculated on dry weight measurements. The biomass values of molluscs were estimated after removing their shells. The crustaceans were treated with 5% Hcl for dissolving exoskeleton. The weights were determined after drying them in an oven at 100-110°C until constant weights were obtained (6 to 8 hrs). The colour and the nature of sediment samples were determined by visual examinations. Water samples for Physico-chemical parameters were collected from the bottom by means of Nansen bottles. Temperature was measured by using a reversing thermometer and salinity was determined by Mohar method. Dissolved oxygen was estimated by Winkler method. Depth was measured with a lead line or "Echo-sounder". Organic matter in sediment was estimated by following the method of EL Wakeel and Riley (1956).

Description of the area : The Thana creek and Bombay harbour regions (Lat. 18° 55' Long 72° 49') extend over a distance of about 40 km in length and cover an area of about 340 km² (Fig. 1). The harbour region is deeper and wider compared to the creek region of about 16 km which is very narrow and shallow. About 20 mgd of domestic sewage and 7,316 M³/d of industrial waste are discharged into the creek through various inlets, drains and pipelines. The Ulhas river joining the creek is a major source of fresh water during monsoon months.

RESULTS

1. *Physico-Chemical Conditions (Table I) :*

The substratum is mostly of sandy mud in the Thana creek and Bombay harbour. However, close examination revealed three different colour zones of the sediment ; viz (1) the soft greyish sandy mud (mostly from the creek region) (2) the soft light brown sandy mud (mostly from the harbour region) and (3) the soft black sandy mud (between the stations 12 and 15). The third type of substratum indicates a reduced state of the sediment as a result of

TABLE 1—Variation in environmental factors and macrobenthic production in the Thana creek and Boribay harbour during premonsoon period—January to April 1975.

Stn. No.	Depth (m)	Water Temp (°C)	Salinity (‰)	Dissolved Oxygen (ml/l)	Biomass (gm/m ²)	Population Count (no/m ²)	Organic Matter (%)
1	1.5-5.5	23.6-30.5	37.03-37.21	2.51-4.80	10.945-26.262	6342-12266	3.98
2	12.5-5.5	24.0-30.0	37.03-37.15	6.63-4.00	11.049-27.215	6804-18543	2.80
3	2.0-6.5	24.0-30.5	37.15-37.36	3.65-4.05	3.770-7.813	1869-2709	1.32
4	3.0-6.5	24.4-28.0	37.06-37.13	4.16-4.57	0.411-0.672	336-735	3.49
5	3.5-6.5	23.5-27.1	36.10-37.12	5.02-9.14	0.042-1.310	168-336	2.71
6	3.5-7.0	23.3-27.0	36.47-36.95	3.20-5.12	0.102-2.926	147-1008	2.42
7	1.5-7.0	23.5-27.5	35.76-36.90	3.43-5.01	0.091-0.524	126-231	3.14
8	6.5-12.5	24.0-26.6	35.59-38.95	4.57-10.08	0.048-0.153	63-168	2.95
9	1.0-7.5	24.1-27.7	35.70-27.20	2.74-2.77	0.056-0.212	105-273	3.64
10	4.5-9.0	23.4-28.0	35.95-36.70	4.61-5.12	0.058-0.180	84-273	2.93
11	1.0-4.5	24.1-28.5	35.60-36.60	3.58-5.71	0.984-3.446	525-1029	1.00
12	1.5-4.5	23.6-28.0	35.0-36.60	2.74-5.49	1.573-11.787	168-3213	2.71
13	2.0-8.5	24.5-27.5	36.13-37.03	4.11-4.27	0.072-1.874	126-231	3.29
14	5.0-10.5	23.2-27.4	35.95-37.03	4.57-5.49	0.016-0.084	42-231	3.00
15	1.5-6.0	23.5-26.8	37.03-37.94	3.89-5.26	0.117-0.338	315-567	1.85
17	2.4-8.0	24.0-27.1	37.77-36.88	3.66-4.67	1.939-8.639	210-525	3.54
18	5.0-9.5	24.8-28.5	36.13-37.03	4.39-5.71	1.646-4.204	189-231	2.53
19	5.4-13.5	24.0-27.7	36.17-36.70	3.20-7.25	0.144-2.390	189-378	2.72
20	4.5-13.5	24.1-27.9	35.59-37.40	4.48-4.80	0.082-2.783	147-294	2.53
21	8.0-14.5	24.0-27.0	35.05-36.13	3.84-7.62	0.036-0.204	84-231	2.80
22	7.0-13.5	24.0-27.0	35.77-37.00	1.11-6.37	0.492-4.907	105-231	3.49
23	4.0-10.0	23.6-28.0	34.69-37.30	4.81-5.59	1.283-4.004	231-357	2.50
24	1.5-5.0	23.5-27.5	36.60-37.21	4.00-12.00	0.985-2.360	63-336	2.23
25	8.0-14.0	24.0-27.9	35.95-36-38	2.97-5.23	0.086-0.451	147-294	2.45
26	4.5-12.5	24.0-27.3	35.98-37.40	4.80-8.74	0.103-0.352	105-147	2.99
28	10.0-14.5	24.1-38.3	35.95-37.00	4.27-5.71	0.382-0.646	105-359	3.21
29	8.0-15.0	24.0-27.0	35.95-37.30	1.00-5.94	0.028-0.109	21-168	2.40
30	4.5-11.5	23.5-28.0	35.95-37.10	4.69-13.37	0.031-0.072	84-210	2.31

pollution. The creek is comparatively shallow with a depth ranging from 1.5 to 7.1 m. The depth in the harbour region varies from 4 to 15 m. The variation in depth is mostly due to the tidal effect.

The bottom temperature shows a significant seasonal variation. The monthly variation in bottom temperature range between 23.3°C and 30.5°C. The lowest and highest values are recorded during January and April respectively. The bottom salinity values did not differ appreciably during the period of study. The values are quite stable with a range between 34.69‰ and 38.95‰. The values of dissolved oxygen content, are observed to be spread over a wide range in the Thana creek (2.74-5.12 ml/l) and Bombay harbour (3.20 - 5.94 ml/l). In general, the values show an increasing trend from Thana creek to Bombay harbour. The percentage of organic matter varied from 1.0 to 3.9 in the creek and harbour and showed no correlation.

2. Population

The results of the quantitative examination of 112 samples for the macrobenthic fauna collected during January to April 1975, are given in Table 1 and Figures 2 - 5.

Faunal composition and distribution : (Fig. 2 and 3)

Polychaetes, bivalves, gastropods, crustaceans and echinoderms, were the most common groups in the collections. Bivalves were the most dominant component of the macrobenthic fauna especially at the Thana creek during the period of study. They contributed 48 - 68% in terms of biomass and 23 - 27% by numerical abundance. A higher aggregation of *Meritrix ovum* between stations 1 and 3 accounted for the greater numerical abundance and high biomass. They were recorded from most of the stations excepting the stations 13, 14, 18, 29 and 30.

Polychaetes were the second dominant group which showed an even distribution from station 1 to 30. They were the only group represented at stations 29 and 30 during the entire period of study. In number and biomass they accounted for 58 - 66% and 3 - 4% of the total macrobenthic fauna respectively. On the other hand, crustaceans were restricted in their distribution and were mostly recorded between stations 11 and 24 excepting the stations 14, 15 and 21. Occasionally they were recorded at stations 2 and 5. They formed 18-40% of total biomass and 4-8% of total macrobenthic populations. Dominance of annelids and abundance of crustaceans both in biomass and numerical

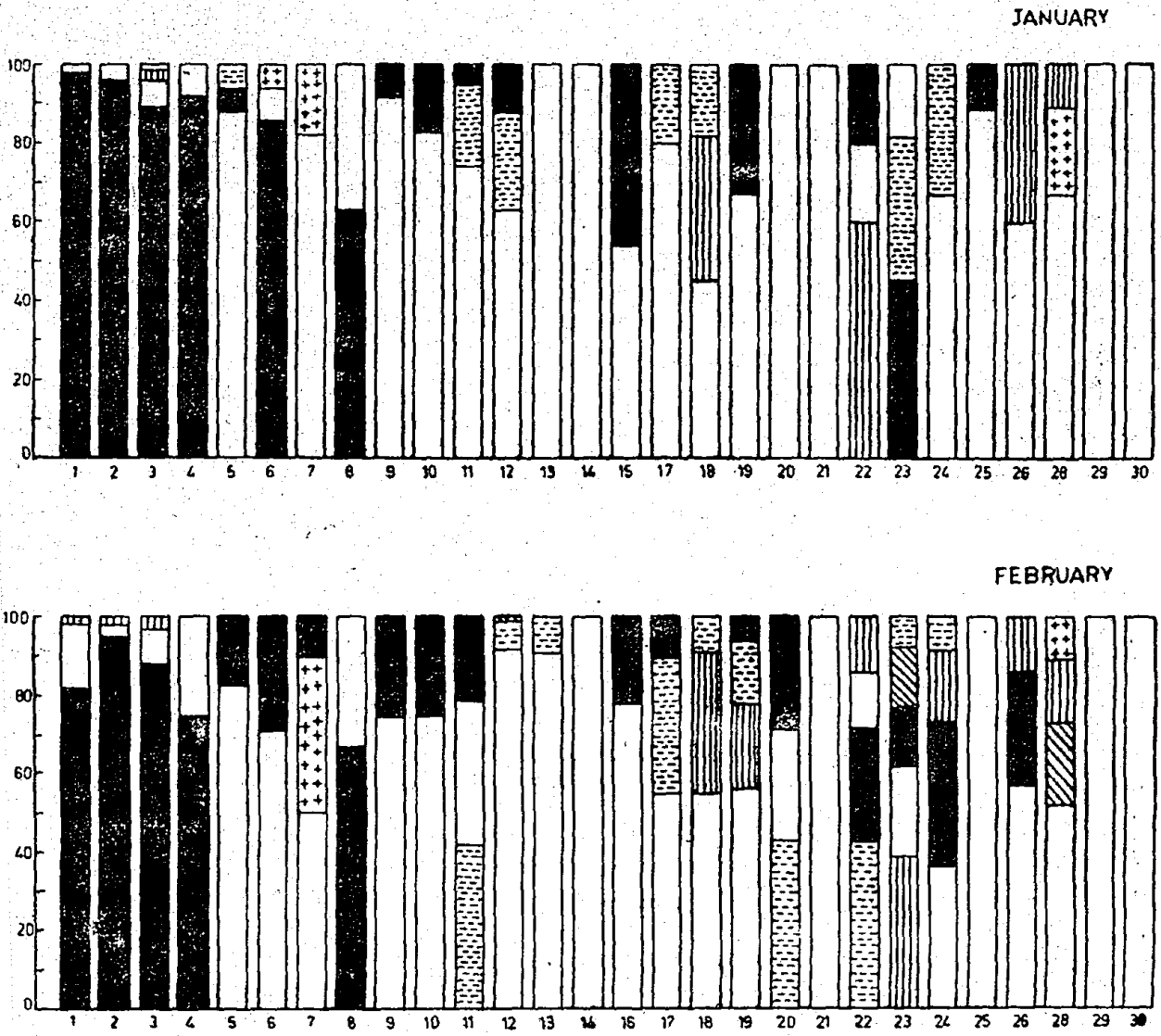


Fig. 2—Percentage composition of macrofauna in the Thana creek and Bombay harbour during January and February.

POLYCHAETE	BIVALVE	GASTROPOD
CRUSTACEA	ECHINODERM	MISC.

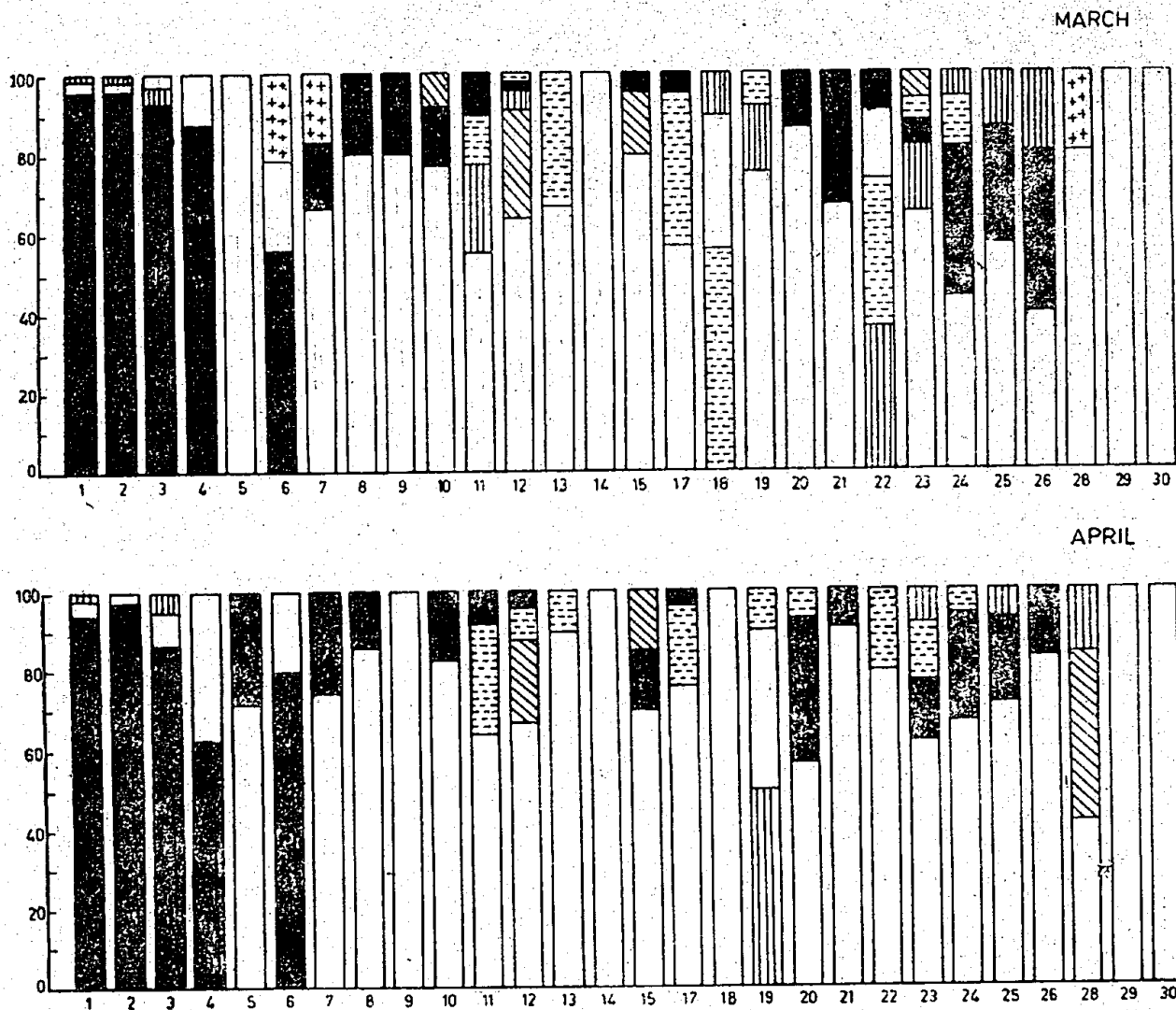


Fig. 3—Percentage composition of macrofauna in the Thana creek and Bombay harbour during March and April.

POLYCHAETE BIVALVE GASTROPOD
 CRUSTACEA ECHINODERM MISC.

number of the macrobenthic fauna were noticed (Parulekar, 1973) from the Central West Coast of India.

Gastropods were unevenly distributed from station 1 to 30. They account for 8-13% of biomass and 3-6% of total macrobenthic fauna. The distribution of echinoderms were restricted to the stations 6, 7 and 28. They were mainly represented by brittle stars. They account for less than 2% by numerical count of the total macrobenthic fauna.

3. Biomass (Fig. 4 and 5) :

The biomass values showed characteristic and uniform steep fall from station 1 to 4 during the entire period of study. Between stations 1 and 3 biomass values varied from 3 to 27 gm/m² (mean : 12.7 gm/m²), which indicated, a high macrobenthic standing crop in the region. The mean values less than 0.5 gm/m² are recorded from station 4 to 10 and 25 to 30, which indicated a poor benthic production in the region. Moderate production amounting to an average of 1.6 gm/m² was observed from station 11 to 24.

During January high biomass was observed at stations 6, 12, 18 and 23 with values 2.9, 1.6, 3.4 and 4.0 gm/m² respectively. In February high values were recorded at station 2 followed by stations 12, 17, 20 and 22. A similar trend was observed during March at stations 2, 11, 17, 22 and 24. In April the peaks appeared at stations 12, 17, 19 and 23.

The seasonal distribution of biomass (Fig. 4) clearly indicated the greater standing crop at stations 1 or 2, 11 or 12, 17 to 20 and 22 to 24 with a gradual reduction in the biomass values from the head of the Thana creek to the mouth of the Bombay harbour. The lateral distribution of benthos (Fig. 5) showed three distinct zonations viz : a rich, moderate and a poor benthic zones in the Thana creek and Bombay harbour.

DISCUSSION

A mean benthic biomass of 2.37 ± 1.53 g/m² (at 5% error) was observed in the Thana creek and Bombay harbour regions during the premonsoon period. The reports from the near shore regions off Calicut (Seshappa, 1953) and Travancore coast (Kurian, 1954), showed the benthic productivity of 10 to 35 g/m² (wet weight) and 18 kg/m² (gross net weight) respectively. A benthic standing crop of an average 6.37 g/m² (dry weight) has been reported along the 10 fathom line off Cochin (Desai and Krishnan Kutty, 1967 b). Further

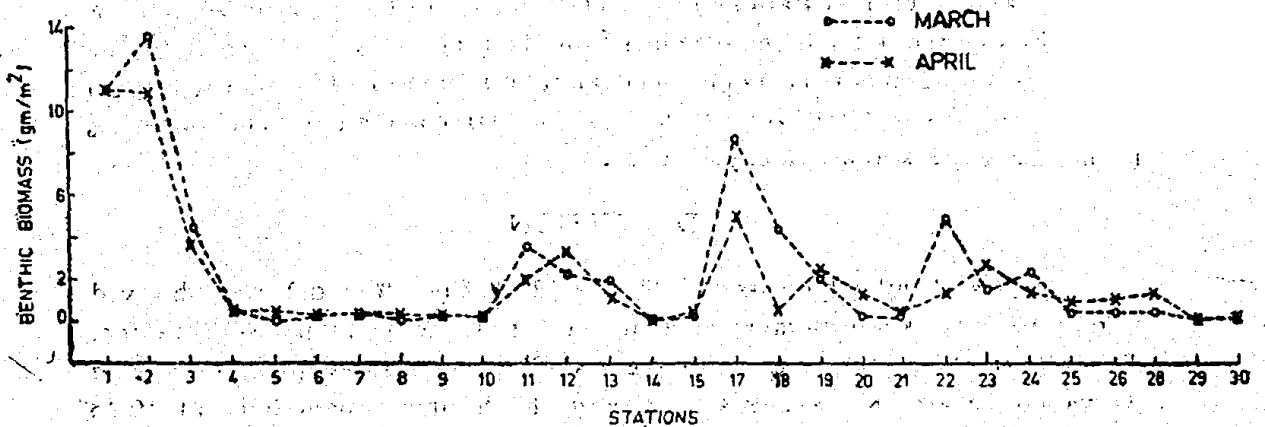
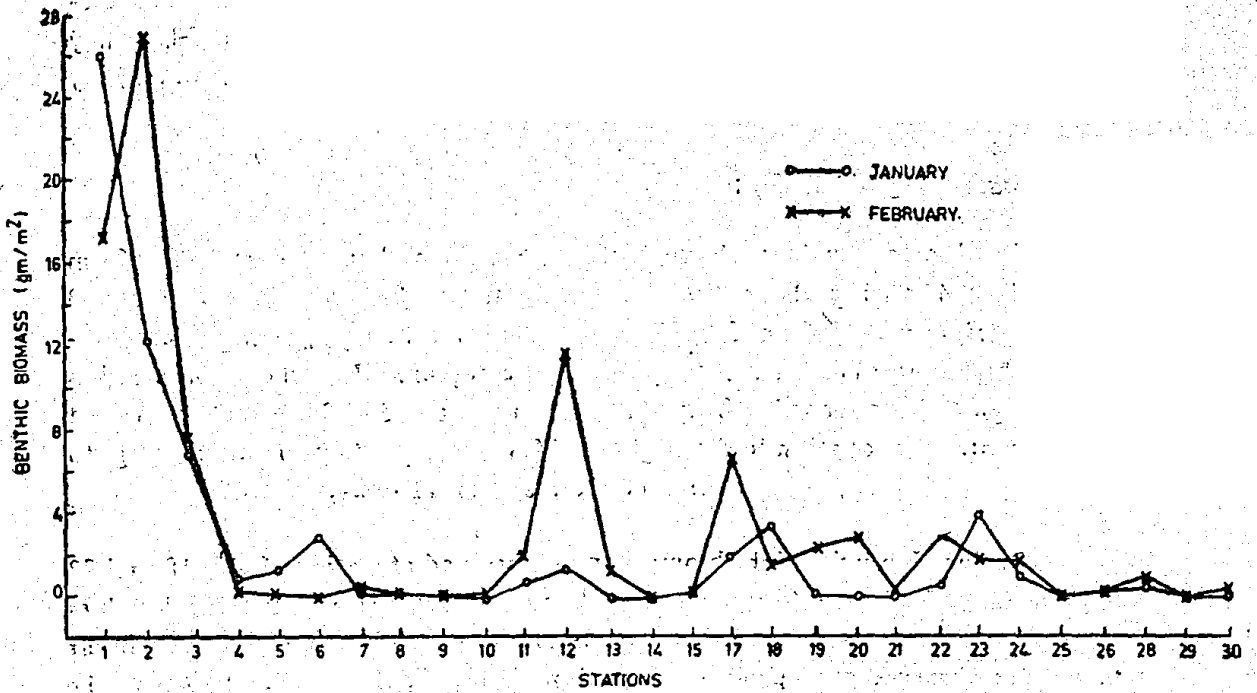


Fig. 4—Variation of macrobenthic biomass in the Thana creek and Bombay harbour during January - April.

studies (Desai, 1971) revealed an average molluscan standing crop of 13.72 g/m^2 in a sandy-muddy bottom (depth : 10-12 m) of the near shore region off Cochin. Recent studies have showed a rich benthic fauna of 13.68 g/m^2 (depth : 5 m) and 10 g/m^2 (average depth : 35 m) of the central west coast of India (Parulekar, 1973) and off Dwarka Coast (Kasinathan *et al* 1977). Considering these previous observations along the west coast of India the average benthic biomass obtained from the Thana creek and Bombay harbour regions is very low. However, the average benthic productivity of $13.71 \pm 5.61 \text{ g/m}^2$ (at 5% error) in a 5 m depth zone in the head of the creek region (Stn. : 1 to 3) is very close to an average benthic productivity of 13.68 g/m^2 from a similar depth zone of the Central West Cost of India (Parulekar; 1973).

Salinity is invariably stable in the regions presently surveyed. The nature of substratum (soft sandy mud) also did not vary much except a change in colour of the sediment. It is evident from the results that the salinity and substratum seems to have no significant effect on the abundance of benthic animals in the Thana creek and Bombay harbour, although the influence of these physical factors on benthos have been reported earlier (Sanders; 1958, Beljaev and Vinogradova; 1961, Sokolova and Pasternak; 1962, Desai; 1971 and 73, and Parulekar and Dwivedi; 1973 and 74). The range of variation in depth (1-15 m) is limited in these regions, a reduction in the benthic productivity is noticed from shallow (average depth : 5 m) to comparatively deep regions (average depth : 10). Although, the entire creek region is shallow (5 m), the benthic productivity at the head of the creek (Stn. : 1 to 3) is much greater ($12.71 \pm 5.61 \text{ g/m}^2$) than the remaining creek region ($0.44 \pm 0.20 \text{ g/m}^2$). However, the benthic productivity in shallow regions (average depth : 4 m) of the harbour area (Stn. : 9, 11, 12, 13, 17 and 24), is comparatively much better ($2.48 \pm 1.53 \text{ g/m}^2$) than the stations between 4 and 8 of the creek region. But a definite reduction in the benthic standing crop ($0.80 \pm 0.51 \text{ g/m}^2$) was observed in the remaining part of the harbour area (average depth : 10 m). The reported benthic biomass (0.68 g/m^2) from the central West Coast of India along the 10 m depth zone was also low (Parulekar, 1973). About 50% of the the total benthic productivity of the harbour region is contributed by an area of about 100 Km^2 between stations 17 and 24 whereas the rest of the stations between 9 and 15 (70 Km^2) and 25 and 30 (120 Km^2) account for the remaining 50% productivity of the harbour area. A low benthic standing crop (1.18 g/m^2) between stations 9 and 15 is chiefly attributed to the effect of industrial waste and domestic sewage from the creek (Stn. : 9 to 11) and polluted bottom as revealed by black sandy mud (Stn. : 12 to 15). The very low benthic productivity (0.22 g/m^2) between stations 25 and 30 in the harbour

region, is perhaps due to high concentration of suspended matter (200 mg/l recorded in this region during the entire period of survey. The high turbid condition of the water might have an adverse effect on the settlement of larvae and thus resulting in a poor benthic standing crop in this region.

The total macrobenthic standing crop at the head of the creek (Sta. : 1-3; area 4 Km²), the rest of the creek region (Sta. : 4 to 8 ; area 46 Km²) and the harbour region (Sta. : 9 to 30 ; area 200 Km²), is calculated 50,849 Kg., 20,240 Kg., 3,77,000 Kg. (dry weight) respectively. The expected macrobenthic standing crop in the entire creek region (50 Km²) is about 6,35,500 Kg. whereas the observed value shows only 71,080 Kg. A great reduction in the benthic standing crop value in the creek region is mainly because of a zone of very low benthic productivity of 20,250 Kg. between stations 4 and 8. Further, the head of the creek region accounts for about 70% of the total benthic standing crop of the entire creek region. The benthic productivity in the head of the creek region is about 12,710 Kg./Km² whereas the rest of the creek area contributes only 440 Kg./Km². It is about 1,300 Kg./Km² in the harbour region. The reason for the very low benthic productivity of 440 Kg./Km² in an area of about 46 Km² (Sta. : 4 to 8) of the Thana creek region, is mainly due to the discharge of industrial waste and domestic sewage in the creek region between stations 4 and 8. However, the benthic productivity in the Thana creek and Bombay harbour regions, by itself, is comparatively much lower, considering the previous observations on different near shore regions of the West Coast of India.

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LEGENDS FOR FIGURES

- Fig. 1—Map showing the location of sampling stations in the Thana creek and Bombay harbour.
- Fig. 2—Percentage composition of macrofauna in the Thana creek and Bombay harbour during January and February.
- Fig. 3—Percentage composition of macrofauna in the Thana creek and Bombay harbour during March and April.
- Fig. 4—Variation of macrobenthic biomass in the Thana creek and Bombay harbour during January - April.
- Fig. 5—Lateral distribution of macrobenthic biomass in the Thana creek and Bombay harbour during January - April.

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