

Distribution of Copepods from the Polluted & Unpolluted Regions Off Bombay

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Distribution and abundance of copepods in the nearshore waters off Bombay were studied at 4 fixed sampling sites during Oct. 1977 to Dec. 1978. The stations Mahim and Thana received domestic and industrial waste while the stations of Versova and Harbour were relatively free from major waste discharge. Maximum population density of copepods (av. 5360/m³) was observed at Mahim, which was about twice than at other stations. Major peaks were noticed in Oct./Nov. and March/April. Of the 21 genera of copepods recorded, *Paracalanus*, *Acrocalanus*, *Acartia*, and *Oithona* were the most common. The polluted regions of Mahim and Thana creek were characterised by the dominance of *Paracalanus*, *Oithona* and *Acartia*. The generic diversity of copepods was greater in unpolluted area.

Most of the creek inlets around the city of Bombay are highly polluted due to indiscriminate disposal of wastes. Mahim creek receives about 313 mld of domestic sewage and Thana creek on the other hand receives about 27 mld of industrial waste water and 6 mld of sewage waste.

Pollution affects the ecosystem. Usually the larval and juvenile stages of aquatic organisms are more sensitive to the environmental changes than the adults. Since the copepods dominate the total zooplankton of Bombay¹⁻⁷ in the present study only copepods are studied with a view to understanding the effect of pollution. In this communication a detailed account on the abundance and diversity of different genera of copepods in polluted and unpolluted regions are presented.

Materials and Methods

Samples were collected from different locations (Fig. 1): (1) Off Versova (depth 10-13 m)—with no pollution; (2) Off Mahim (depth 9-12 m)—large amounts of domestic sewage and some industrial effluents are discharged into the creek⁸; (3) Bombay Harbour (near harbour mouth; depth 10-14 m)—collective effluents from the Thana creek flows down stream with the tidal water with the ebb tide and domestic sewage and large amounts of oil and grease from port area are also discharged⁸; however the strong tidal current maintain sufficient mixing and dispersion; and (4) Thana creek mouth (near new Washi Bridge; depth 8-11 m)—large number of industries around the creek discharge their effluents into the Thana creek near the station.

Samples were collected using a Heron Tranter net (mouth area, 0.25 m²; mesh size, 0.3 mm) with an attached flowmeter. Plankton samples were collected

by oblique surface hauls of 5 min duration. Aliquot of 12.5-25% were taken for the analyses of copepods.

Results

Copepods were the predominant group of zooplankton at all the 4 stations (except at Thana creek during Nov. 1977 to March 1978 when medusae and ctenophores outnumbered them⁷). Twenty one genera were occurred in the collection. Monthly variation of the copepod population during the flood and ebb tide

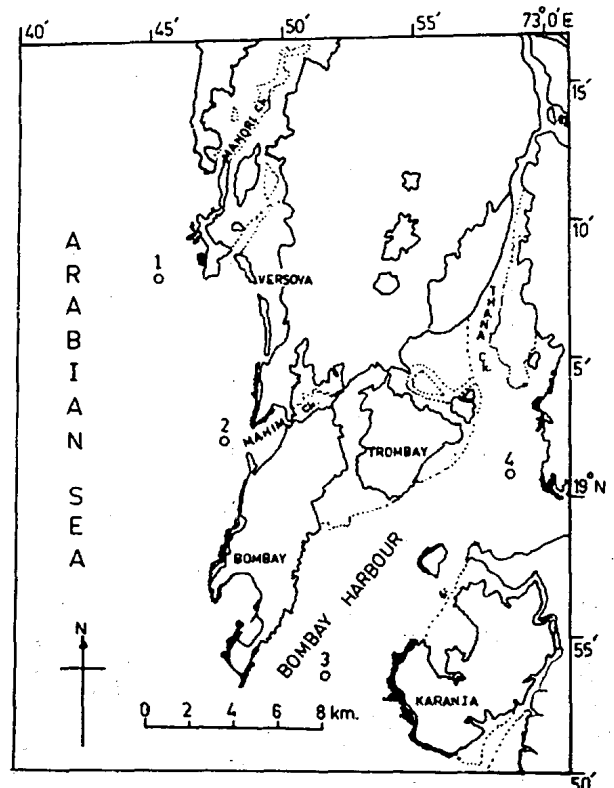


Fig. 1—Location of stations (1, Versova; 2, Mahim; 3, Harbour; and 4, Thana)

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are given in Fig. 2. Percentage variations among the different genera of copepods are presented in Table 1.

Off Versova—Copepoda formed the dominant components of zooplankton both during high and low tides. Their percentage composition during high and low tides varied from 74.8 to 99.6% and 66.4 to 99.4%

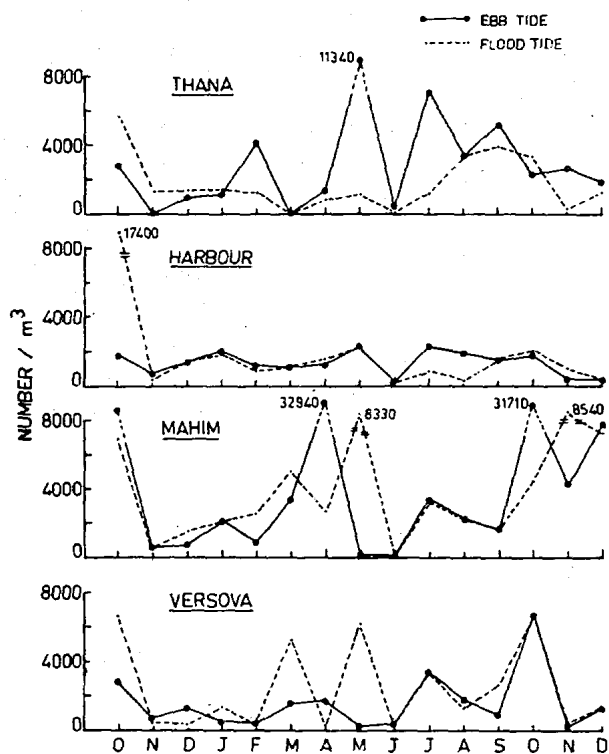


Fig. 2—Monthly variation of copepods during ebb and flood tide

respectively. This order of zooplankton occurred consistently throughout the year. Average density of copepods during the period of study was 2470/m³ during high tide and 2090/m³ during low tide. The highest (6780/m³) and lowest (200/m³) values were recorded during Oct. 1977 and Nov. 1978 respectively.

Eighteen genera of copepods were encountered at this station during the study period (Table 1). Their frequency of occurrence varied greatly; also, in no case all the 18 genera were recorded at a time. Of these 18 genera, 9 were represented irrespective of the tidal condition, the most common being *Paracalanus*, and *Acrocalanus* (Table 1). *Undinula*, *Rhincalanus*, *Pontella* and *Candacia* occurred during low tide while *Corycaeus* and *Microsetella* occurred only during high tide.

The highest number of copepods both during high tide in Oct. 1977 and low tide in Oct. 1978 was predominantly represented by the species belonging to *Paracalanus*, *Acrocalanus*, *Acartia* and *Centropages*. The lowest number of copepods during high tide in April 1978 consisted predominantly of *Corycaeus* spp while the lowest density recorded during low tide in Nov. 1978 consisted of *Paracalanus*, *Acrocalanus* and *Labidocera* spp.

Off Mahim—Percentage composition of copepods varied from 86.5 to 99.9% and 91.2 to 99.7% during high tide and low tides respectively. Their average population density at this station was 6880/m³ during low tide and 3850/m³ during high tide. The highest (32940/m³) and the lowest (70/m³) population density were recorded during low tide in April 1978 and during

Table 1—Average Generic Percentage Composition of Copepods during High and Low Tides

Genera	High tide				Low tide			
	Versova	Mahim	Harbour	Thana	Versova	Mahim	Harbour	Thana
<i>Paracalanus</i>	33.33	47.6	29.37	54.5	36.11	32.6	30.7	49.5
<i>Acrocalanus</i>	18.66	23.7	20.0	3.75	19.44	28.5	26.0	9.7
<i>Acartia</i>	0.83	7.1	5.75	2.87	3.66	16.7	2.7	23.6
<i>Oithona</i>	13.5	10.2	27.37	25.5	9.33	14.5	9.8	3.0
<i>Centropages</i>	4.5	1.0	1.75	—	2.33	1.2	2.0	1.7
<i>Euchaeta</i>	0.33	1.5	3.75	—	11.11	—	8.9	0.4
<i>Pseudodiaptomus</i>	1.66	—	2.5	0.5	0.88	—	—	0.5
<i>Corycaeus</i>	15.83	—	2.0	—	—	—	5.8	—
<i>Macrosetella</i>	2.0	0.2	0.25	0.5	0.77	—	4.2	—
<i>Labidocera</i>	0.5	5.5	5.0	—	7.11	2.2	2.3	0.4
<i>Temora</i>	0.16	0.3	1.0	0.12	0.55	0.3	—	0.3
<i>Undinula</i>	—	0.5	—	—	1.66	—	0.5	—
<i>Rhincalanus</i>	—	—	—	—	1.11	—	—	—
<i>Pontella</i>	—	—	—	—	0.88	1.3	—	—
<i>Candacia</i>	—	—	—	—	0.88	—	—	—
<i>Calanopia</i>	—	0.6	—	—	—	0.4	—	—
<i>Microsetella</i>	0.16	0.1	—	—	—	—	4.3	—
<i>Acartiella</i>	2.5	—	0.25	—	—	—	1.0	3.7
<i>Scolecithrix</i>	—	—	0.87	2.37	—	—	—	—
<i>Eucalanus</i>	—	—	—	10.62	—	—	—	4.8
Miscellaneous	3.11	1.9	1.5	—	4.7	2.3	1.9	2.4

high tide in June 1978 respectively. Highest (8540/m³) density of copepods during high tide occurred in June 1978 (Fig. 2).

Twelve genera of copepods were recorded and in no case all the 12 genera were recorded at a time. Their period of occurrence varied considerably. Of these 12 genera, 8 genera occurred regardless of the tide (Table 1). *Macrosetella*, *Microsetella*, *Euchaeta* and *Undinula* occurred only during high tide and *Pontella* was found only during low tide. Most of the samples collected during both tides mainly belonged to species of *Paracalanus*, *Acrocalanus* and *Acartia*. However, the highest density of copepods recorded at this station during low tide in April 1978 showed the predominance of *Oithona*, *Paracalanus* and *Calanopia*.

Bombay Harbour—Percentage of copepod composition varied from 4.4 to 94.7% and 87.8 to 99.9% during high tide and low tide respectively. They occurred throughout the year and irrespective of the tide. The highest and the lowest population density values were (17400/m³) and (270/m³) during the high tide conditions in Oct. 1977 and June 1978 respectively. The highest and lowest density values for the low tide were 17200/m³ and 370/m³ during Oct. and June 1978 respectively. The average density values of copepods at this station were 2260/m³ for the high tide and 2580/m³ for the low tide. The copepods belonged to 15 genera (Table 1) but in no case they all occurred at a time. Highest density of copepods of both high tide in Oct. 1977 and low tide in Oct. 1978 consisted of species of *Paracalanus*, *Acrocalanus*, *Oithona*, *Acartia* and *Centropages*. The lowest density recorded during high tide in June 1978 was contributed mainly by *Paracalanus*, *Acrocalanus*, *Acartia*, *Scolecithrix*, *Microsetella* and *Calanopia* species. Whereas the lowest value recorded during low tide for the same month, was dominated by *Microsetella*, *Macrosetella*, *Oithona*, *Paracalanus* and *Acartia*.

Thana creek mouth—Percentage composition of copepods varied from 16.4 to 99.7% and 4.3 to 99.6% during high tide and low tide respectively. Highest population density (11340/m³) was recorded during low tide in May 1978 and lowest (1/m³) was also recorded during low tide but in March 1978. The average densities of copepods at this station were 1730/m³ during high tide and 3000/m³ during low tide. Highest (5750/m³) and lowest (3/m³) densities were noticed during high tide condition in October 1977 and March 1978 respectively. High population densities were obtained during high tide from Aug. to Oct. 1978 and during low tide from June to Sept. 1978. Copepods were represented by 13 genera (Table 1) of which 7 genera occurred commonly, irrespective of the tidal conditions. The remaining genera were recorded during high tide.

Maximum densities of copepods recorded during high tide and low tide were contributed mainly by *Paracalanus* and *Acartia* whereas the lowest density recorded in March during high tide consisted mainly by *Acartia*. On the other hand the lowest density in March recorded during low tide was dominated by *Labidocera*, *Paracalanus* and *Acartia*.

Discussion

Major peaks in the distribution of copepods were observed in October/November and March/April with an intermediate peak during monsoon period. The present observation agrees with the previous reports⁴⁻⁵. Mahim has the maximum population density of copepods (av. 5360/m³) which was about twice compared to other stations (av. 2280-2800/m³). Crisafi⁹ found copepods as predominant group in the polluted water of Milazo harbour with dominance of *Acartia* species. In Saronnic Gulf¹⁰ (another polluted area), *Acartia clausi* contributed 90-99.5% of the total zooplankton organisms. In the present study also *Acartia* spp were observed to be quite common in the polluted regions of Thana and Mahim.

All the previous reports¹⁻⁴ on copepods are for the Harbour region only. *Eucalanus* was reported to be a common genera of the Harbour area. However, it was not encountered in the present collection. *Tortanus* and *Idyea* recorded earlier were also absent in the collections. *Undinula*, *Microsetella*, *Acartiella* and *Scolecithrix* are new records for the area.

The genera *Paracalanus*, *Acrocalanus* and *Acartia* were the dominant copepods of Versova, Mahim and Harbour water and *Paracalanus* and *Acartia* of Thana creek. But a deviation from this general trend has been noticed at Mahim and Thana creek specially during the summer months by the predominance of *Oithona* coinciding with high density peak (April) and *Labidocera* during the low density peak respectively.

The predominance of the genus *Oithona* was noticed on many occasions especially at Mahim during the period of maximum abundance of copepods. On the other hand, during the same season (summer) the highest copepod peak (11349/m³ May 1980) at Thana was represented mainly by species of the genera *Paracalanus* and *Acartia*. Thana also represented a highly polluted environment. This clearly shows that the prevailing difference in environmental conditions at Thana and Mahim during the same season may account for abundance and diversity of populations of copepods.

Higher generic diversity was noticed at Versova (18) followed by Harbour (15). Relatively lesser number of genera were recorded at Thana creek (13) and Mahim (12). The percentage incidence of the different genera of copepods at the 4 stations would work out to be 56, 47,

39 and 34 for Versova, Harbour, Thana creek and Mahim respectively. Intensity of pollution is relatively less at Versova and Harbour stations and consequently their environments appeared to sustain the copepods better.

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