

Effect of Industrial Effluents on Biota: A Case Study Off Mangalore, West Coast of India

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The inshore waters off Mangalore, receiving industrial effluent discharge were studied for phytoplankton, zooplankton and benthic populations, from Dec. 1984 to May 1985. Total phytoplankton population varied from 7 to 1195×10^3 cells.l⁻¹. Diatoms dominated the phytoplankton population. A striking feature observed was the persistent occurrence of certain species throughout the period of study. Zooplankton biomass ranged between 0.004 and 0.38.ml⁻³. Variations between months and depth contours were observed. Copepods, decapod larvae, chaetognaths and fish eggs and larvae occurred consistently. Copepod was the numerically dominant group but was outnumbered by decapod larvae at certain occasions. Sporadic occurrence of ctenophores, siphonophores, ostracods and cladocerans significantly contributed to the biomass. Macro-benthic fauna were largely composed of Polychaeta (48.8%) followed by Bivalvia (13.6%). Rich faunal composition and biomass were recorded at 5 m depth contour which decreased as the depth increased. Sandy substrata were inhabited by filter feeders whereas muddy substrata were rich in deposit feeders. The results indicated that except for some changes in phytoplankton population, the industrial effluent discharge has not caused any noticeable damage to the inshore areas off Mangalore.

Coastal regions in the vicinity of thickly populated and industrially developed areas receive large quantities of domestic wastes and industrial effluents. Indiscriminate discharge of domestic wastes and industrial effluents may cause irreparable damage to the marine ecosystem. The inshore waters off Mangalore, along the west coast of India, receive effluents from a fertilizer factory and an iron ore company. This region has been investigated with a view to assessing the effect of these effluents on the biota.

Materials and Methods

Three transects were selected for the investigation. Of these, transect 2 was in line with the effluent discharge sites and transects 1 and 3 were respectively to south and north of the effluent discharge area (Fig. 1). Monthly observations (Dec. 1984-May 1985) on phytoplankton, zooplankton and macrobenthos were made from 5, 10 and 15 m depth contours along all the transects. Surface and bottom phytoplankton samples were collected with a Niskin water sampler. Samples were fixed in 1% Lugol's iodine, preserved in 3% formaldehyde and allowed to settle for 3 d. Supernatant solution was decanted and the concentrate was counted in Sedgwick rafter counting chamber. Average density for each depth contour is expressed as cells or filaments.l⁻¹. Surface zooplank-

ton samples were collected by towing a HT net (0.25 m² mouth area, 300 µm mesh width) fitted with a flow meter. Samples were preserved in 5% formaldehyde. Biomass was estimated by displacement method and 20% sub-samples were used for counting. Biomass is expressed as ml.m⁻³ and density as no. m⁻³. Macro-benthic samples were collected using a van Veen grab (0.04

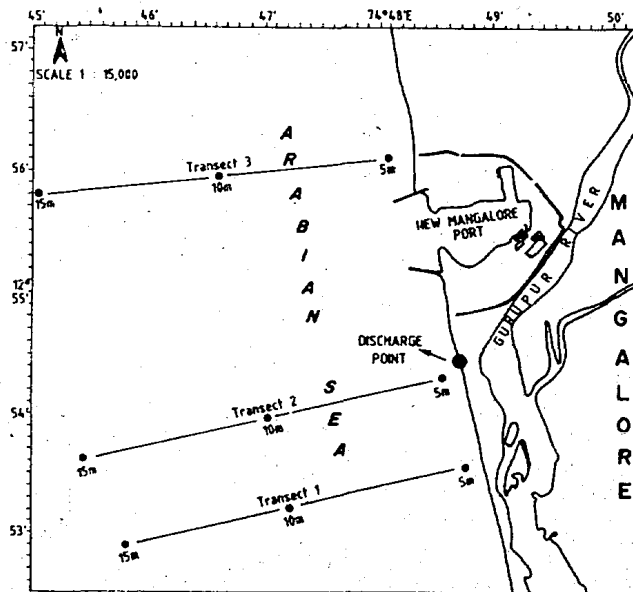


Fig. 1—The study area showing transects

m² area). The samples were washed through a 0.5 mm sieve and the retained samples were preserved in 10% seawater-formalin containing rose bengal stain. They were washed again through 0.5 mm sieve in running freshwater to remove excess sand/mud. All animals were picked and preserved in 5% formaldehyde. Later they were sorted and counted. Wet weight of each group was taken after removing the hard parts. Biomass is expressed as g. m⁻² and density as no. m⁻².

Results and Discussion

Phytoplankton abundance and composition—Considerable variations were seen in the abundance of phytoplankton in the inshore waters off Mangalore at the 3 depth contours (Fig. 2 a and b). The total population varied between 7 and 1195 × 10³ cells. l⁻¹, the lowest in January and the highest in May. Diatoms contributed to the bulk of the population, varying from 1 to 738 × 10³ cells. l⁻¹, which is comparable to other coastal waters and estuaries along the west coast of India¹⁻³. Dinoflagellates dominated at 5 m as compared to 10 and 15 m contours. Bluegreen algae, *Trichodesmium* spp, were abundant in February and March. The highest population and species diversity were recorded in May along transect 3, which incidentally is the farthest transect from the effluent discharge site.

The striking feature observed in this area was the persistent occurrence of certain species during most part of the studies. Certain amount of suc-

cession of species is generally observed in the coastal waters and estuaries along the west coast^{3,4}. Therefore, the persistence of *Rhizosolenia* spp, especially that of *R. stolterfothii* is noteworthy. Further, certain other diatoms such as *Chaetoceros* spp, *Leptocylindrus* spp, *Nitzschia seriata*, *R. delicatula* and *Pleurosigma* spp were also very frequent in the samples, though in relatively smaller numbers as compared to *R. stolterfothii*. A distinct pattern of succession of diatoms from December to February followed by blue green algae was observed in the coastal waters of Goa⁴. On the contrary, in the Mangalore waters, even when the bluegreen algae, *Trichodesmium* spp were dominant during the premonsoon months, the abundance of *Rhizosolenia* spp continued. This is a very unusual feature. It is presumed that the influence of industrial effluents may in some way be responsible for this phenomenon. The reported water pH in this area was slightly higher than the normal values for the coastal waters due to the discharge of chemical effluents⁵. Water and sediment nutrient content were also relatively higher⁶⁻⁸ as compared to other coastal regions. It was also observed that the phytoplankton population was generally high along transect 3 as compared to transects 1 and 2.

Zooplankton biomass and composition—Biomass ranged from 0.004 to 0.38 ml. m⁻³, the lowest was recorded at 5 m along transect 1 in December and the highest at 15 m along transect 3 in January (Fig. 3). Variation between months and depth contours were discernible. Relatively high biomass was sustained in January (0.1-0.38 ml. m⁻³), April (0.09-0.2 ml. m⁻³) and May (0.1-0.24 ml. m⁻³). In general, high biomass values were recorded at 10 and 15 m depth contours as compared to 5 m, with very few exceptions. The range in biomass (ml. m⁻³) was 0.004-0.2, 0.01-0.35 and 0.02-0.38 respectively at 5, 10 and 15 m.

Copepoda, decapod larvae (including adult *Lucifer hanseni*), Chaetognatha and fish eggs and larvae were the major groups of zooplankters which consistently occurred in this region during the period of investigation (Fig. 3). Copepoda was numerically the largest group, varying between 1.2 and 905.8 m⁻³. Rich population of copepods was generally encountered at 10 and 15 m contours and their number was relatively large in April and May. Decapod larvae were the next largest group, ranging from 0.7 to 1141 m⁻³. But, during certain months they outnumbered Copepoda, as for instance at 5 m along all the three transects in

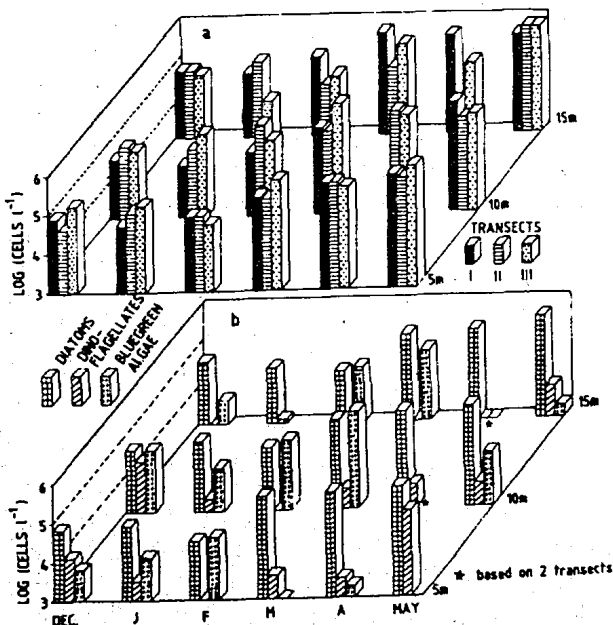


Fig. 2—Average monthly variations in (a) total phytoplankton and (b) major groups along different transects

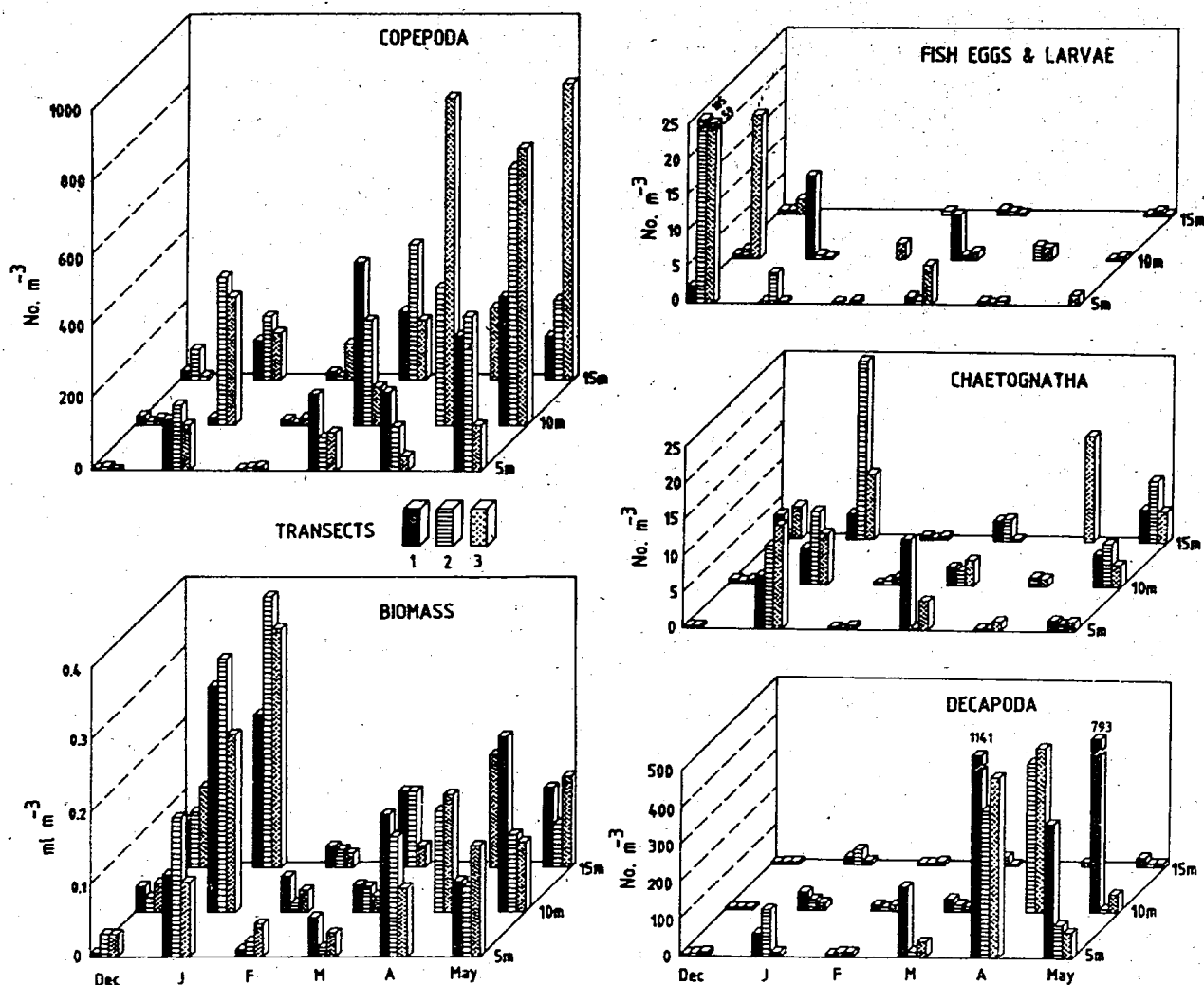


Fig. 3 — Monthly variations in zooplankton biomass and density of major groups along different transects

April, 10 m along transect 2 in the same month and again at 10 m along the same transect in May. The decapod larval concentration was more at 5 and 10 m contours. The large density of decapods at 5 m contour along all transects and at 10 m contour along transects 2 and 3 in April and at 5 and 10 m contours along transect 1 in May was primarily due to the high concentration of adult *L. hanseni*. Chaetognatha was the third abundant group, occurring almost throughout the study period. They varied in number from 0.06 to 24.7 m^{-3} . They sustained relatively higher density along all transects in January. Fish eggs and larvae were poorly represented during most of the months though they sporadically occurred in fairly good numbers at certain areas, as for example, at 5 m along transect 2 and at 5 and 10 m along transect 3 in December.

The other notable groups which were occasion-

ally present in the collections were Cladocera, Ostracoda, Tunicata, Pteropoda, Ctenophora, Hydromedusa and Siphonophora. High concentrations of Ctenophora, Hydromedusa and Ostracoda together were responsible for the increased biomass along all transects in January though the density of none of the 4 major groups was exceptionally high. So also, the sudden appearance of Cladocera in large numbers along transect 3 in February and April and along all transects in May (42.4 - 954.6 m^{-3}), contributed substantially to the total biomass.

A comparison of biomass between transects did not indicate any significant variation, notwithstanding the variations observed between months and depths. Although no apparent relationship could be seen between phytoplankton population and zooplankton biomass, it is interesting to note that both the populations were high in April and

May. However, this trend was reversed in January, obviously due to the spurring of ctenophores, siphonophores and ostracods.

Industrial effluents are reported to adversely affect the zooplankton biomass and population density⁹. A marginal decline in biomass and density of major groups, however, is observed as compared to an earlier investigation from the same area⁵. This reduction is not very alarming as the present values are comparable to those reported from other inshore waters along the west coast of India^{10, 11}.

Macrobenthic population and faunal composition—Benthic population in the area of study ranged from 200 m^{-2} ($\equiv 1.5 \text{ g.m}^{-2}$) to 6535 m^{-2} ($\equiv 56.55 \text{ g.m}^{-2}$), the former was recorded at 15 m contour along transect 3 in February and latter at 5 m contour along transect 2 in May (Fig. 4). The population showed a declining trend with increase in depth and hence the faunal composition was generally rich at 5 m contour. The substratum was sandy at 5 m contour of transects 2 and 3 whereas other stations were muddy.

The fauna were chiefly composed of Polychaeta (48.8%), represented by *Diapatra neopolitana*, *Diapatra* spp, *Nerine cirratulus*, *Prionospio* spp, *Scolecopsis* spp, *Spiophanes* spp, *Polydora* spp, *Nereis* spp, *Lumbriconereis* spp, *Glycera* spp, *Nephtys* spp, *Pectinaria* spp, and *Onupis* spp. Bivalvia (13.6%), was constituted by *Paphia textila*, *Donax* sp., *Gafrarium* sp., *Cardium* sp., *Macra* sp., *Pholas* sp., *Macoma* spp and *Tellina* sp. The Gastropoda (3.2%) components were *Conus* sp., *Oliva* sp., *Natica* spp, *Nassa* spp and *Drupa* sp., *Dentalium* sp. was the only representative of Scahopoda (3.2%) inhabiting this region. Brachyuran crab (4%) was constituted by *Matuta* sp., *Portunus* sp., and *Dromidia* sp., Anomura by *Albunea* sp., and *Emerita holthusii*. The other components of benthic community were Amphipoda, Cumacea, Ophiroidea, Asteroidea, Sipuncula and Nemertea.

The benthic population of this region is very much comparable to other areas of the Indian coasts¹²⁻¹⁵. The rich benthic fauna in the near-shore regions, having riverine influence is mainly due to the influx of nutrient rich river water^{12, 14-16}. The same can be attributed to the relatively high biomass at 5 m contour as rivers Netravathi and Gurgur open near the area of study. High concentration of the polychaete, *D. neopolitana* as observed at the 5 m region along transects 1 and 2, have also been reported from the shallow area of Cochin¹⁷ and Goa¹⁸.

It should be stated that although the results of

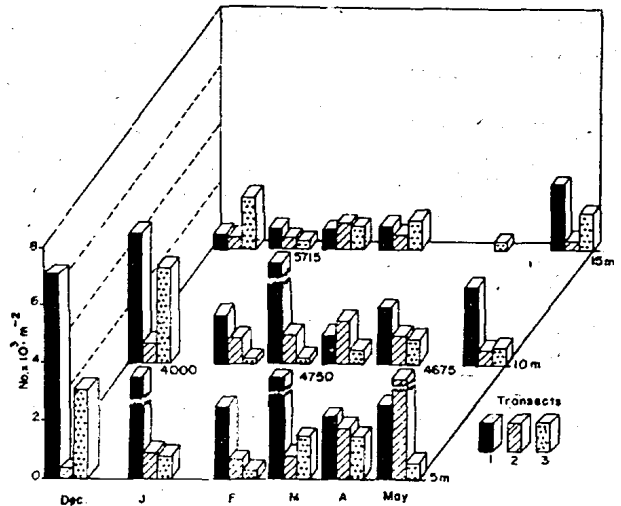


Fig. 4 — Monthly variations in total macrobenthic population along different transects

the present investigation indicate no major alterations to this environment due to the discharge of industrial effluents, they are a cause for concern mainly due to the predominance and persistence of certain species of phytoplankton (*Rhizosolenia* spp) and also to a decline, at a smaller magnitude, of zooplankton biomass and density. At this stage it is difficult to predict the possible long term effects of these effluents on the biota. It is suggested that the region should be monitored periodically so that any change occurring in future can be detected immediately and remedial measures, if required, could be undertaken.

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