

# MACROBENTHOS OFF MAHIM (BOMBAY) , WEST COAST OF INDIA IN RELATION TO COASTAL POLLUTION AND AQUACULTURE

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## ABSTRACT

Deterioration of water quality clearly indicated a moderate to severe coastal pollution around Mahim whereas a relatively healthy marine environment towards offshore was noticed. Foraminiferans, polychaetes, crustaceans and pelecypods were the dominant macrofaunal groups encountered in the area. The occasional inhabitants like pennatularians, nemertines, sipunculids, ophiuroids and fish larvae were mostly restricted to offshore regions. Biomass and population density of macrofauna were moderate and showed fluctuating trend. Similarity coefficients of foraminiferans (0.89) and polychaetes (0.81) were high for offshore unpolluted stations (3 and 4) as compared to nearshore coastal stations (1 and 2). Faunal diversity was relatively more in unpolluted zone. The diversity Index (H) was more at station 3 for polychaetes (1.39) and at station 4 for foraminiferans (0.54). In general, biomass was high during postmonsoon excepting station 1 which was invariably under severe pollution stress throughout the study period. Foraminiferans were abundant at sandy bottom while polychaetes preferred muddy (clayey-silt) bottom. A noticeable ecological modification associated with faunal abundance and diversity were related to deteriorating marine water quality due to anthropogenic waste disposals. The prevailing water quality around Mahim is unsuitable for any kind of culture practices and also for harvesting economically important marine species.

## INTRODUCTION

Widespread aquatic pollution due to indiscriminate waste disposals causes severe ecosystem modifications and depletion of fishery resources. The demersal fishery potential and stress-induced ecological modifications due to anthropogenic waste disposals of an area can be reasonably evaluated by the estimation of benthic standing crop.

Available information on subtidal macrobenthos (Parulekar *et al.*, 1976, Govindan *et al.*, 1988) of Bombay is inadequate for a definite impact assessment and predictions. The increasing trend in pollution stress of the coastal system of Bombay, however, warrants periodic ecological assessment and pollution monitoring studies. Hence in the present study an attempt was

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made to assess the distribution and abundance of macrobenthos off Mahim, Bombay, in relation to the prevailing coastal pollution and also to evaluate the suitability of the nearshore coastal waters of Mahim for the development of aquaculture.

## MATERIAL AND METHODS

Mahim Creek on the east is connected to the narrow Mahim River and on the west it opens into the Mahim Bay, which in turn meets the Arabian Sea; Mahim Creek and Bay (Lat.  $19^{\circ} 2' N$ ; Long.  $72^{\circ} 49' E$ ) together comprise an area of about  $6 \text{ km}^2$ . The creek receives about 313 mid of domestic and 21 mid of industrial wastes (M&E/EEC Report, 1979). Four stations were identified for the present study (Fig. 1). Monthly collections (Nov '79 to Dec' 80) were made

and analysed for benthos (Varshney *et al.*, 1988) and water quality (Strickland and Parsons, 1968). Sediments were analysed for organic matter and texture (Holme and McIntyre, 1971). Biomass was estimated on dry weight basis.

## RESULTS AND DISCUSSION

Results of environmental and biological parameters are presented in Figs 2-4 and Table 1.

### Water quality :

Spatial, temporal and seasonal fluctuations in selected water quality parameters viz. temperature, salinity, pH, DO and nutrients were noticed in the study area (Figs. 2 and 3). The DO values of the creek (station 1) were almost nil especially during ebb periods than flood conditions, whereas DO levels

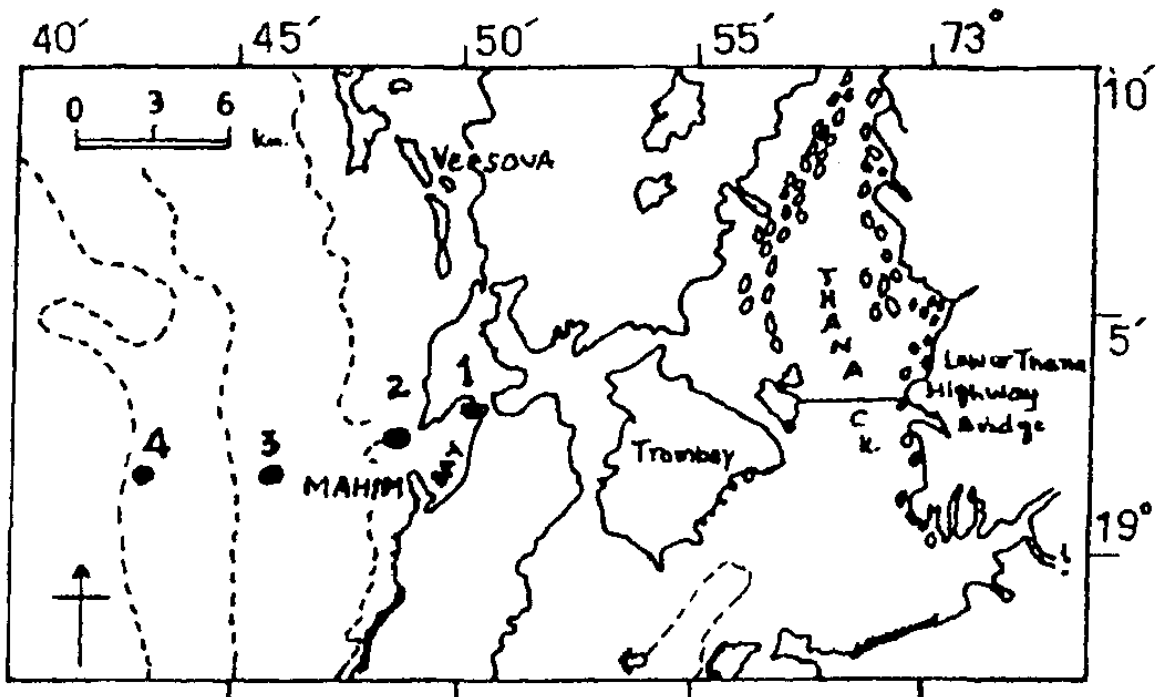


Fig. 1 : Location of stations.

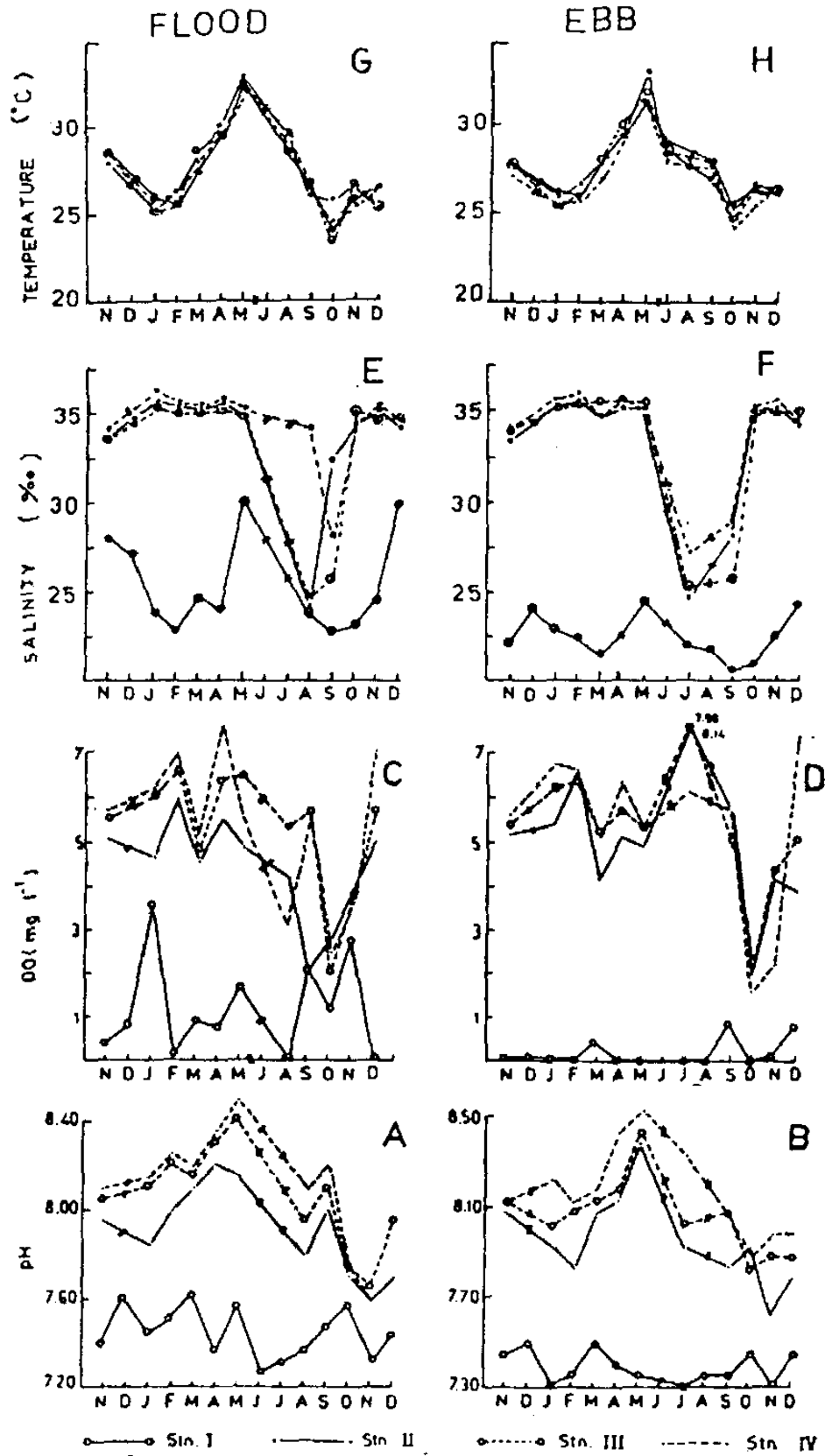


Fig. 2 : Changes in pH (A & B), DO (C & D), salinity (E & F) and temperature (G & H).

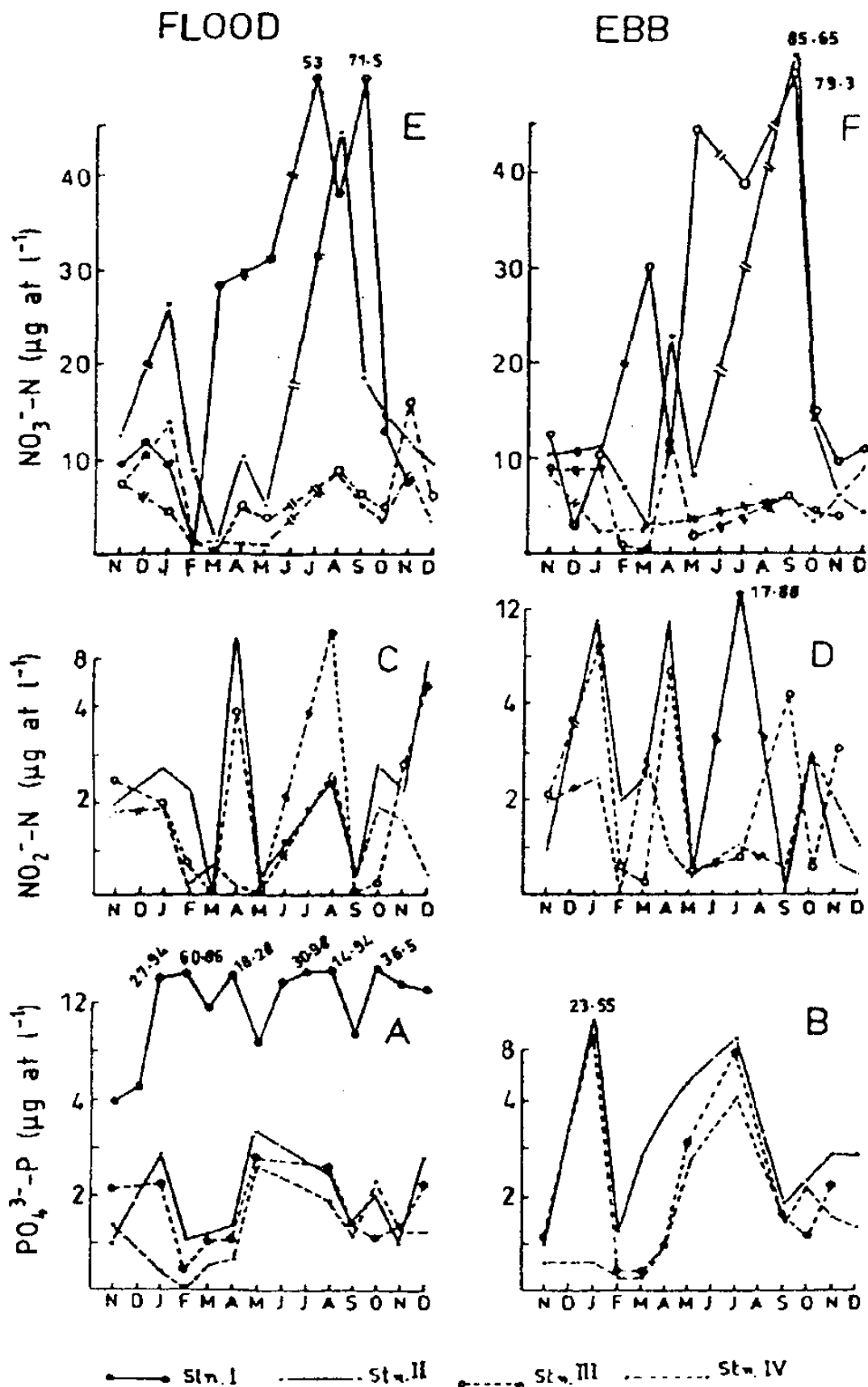


Fig. 3 : Changes in phosphate (A & B), nitrite (C & D) and nitrate (E & F).

of coastal stations were normal and comparable. Seasonally, low DO levels were observed during October. In contrast, the levels of nutrients (Figs 2 and 3) were relatively high at near shore stations (1 and 2) especially during ebb than flood conditions. In general, the creek (station 1) revealed wide fluctuations in selected water quality parameters as compared to the offshore stations indicating an environmental stress due to input of anthropogenic wastes to the nearshore coastal system off Mahim.

**Sediment :**

Station 1, had a sandy bottom while stations 2 to 4 clayey silt bottom (Fig 4). The sediment organic matter was quite low at station 1, due to a sandy substratum, but high and comparable at other stations which had muddy bottoms (Fig 4).

**Macrofauna :**

Population and biomass : Faunal density (Table 1) varied from  $0.6 \times 10^3/m^2$  to  $668.8 \times 10^3/m^2$  and biomass from 0.1 to  $166.2 g/m^2$  in the study area.

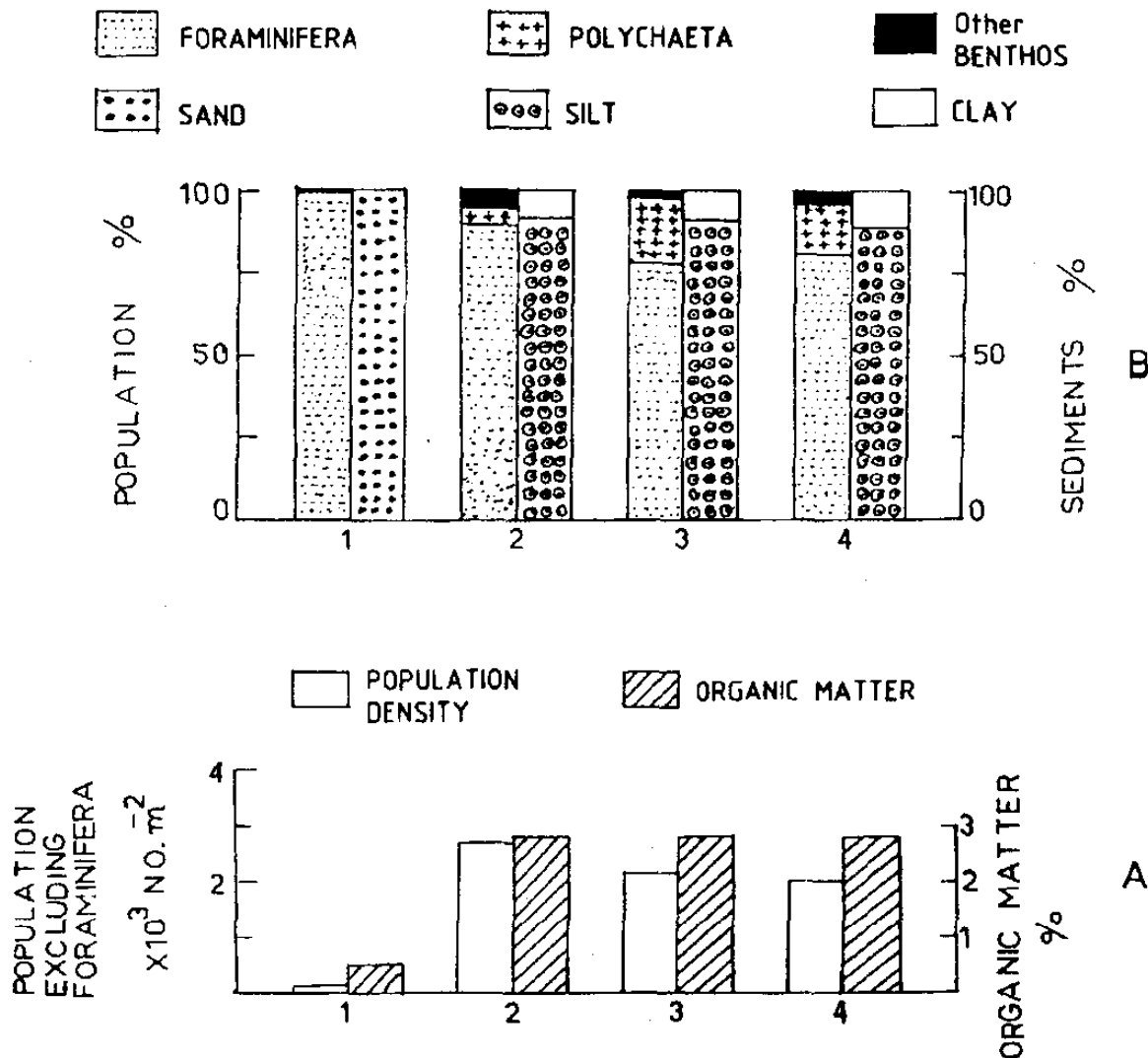


Fig. 4 : Population density in relation to (A) organic matter and (B) sediments.

Table 1 : *Macrobenthic population density (nox10<sup>3</sup> / m<sup>2</sup> and biomass (g/m<sup>2</sup>) off Mahim. Biomass given in parenthesis.*

Months	Stations			
	1	2	3	4
November 1979		8.0 (3.8)	39.4 (19.6)	3.5 (1.2)
December "	2.4 (0.2)	-	-	-
January 1980	12.9 (0.7)	1.6 (0.3)	15.5 (1.0)	10.1 (2.1)
February "	462.0 (18.5)	23.8 (1.6)	3.3 (0.9)	19.6 (1.5)
March	371.0 (14.8)	1.6 (0.2)	17.3 (1.4)	6.0 (3.0)
April	330.4 (13.2)	2.4 (0.2)	3.1 (0.9)	9.2 (0.8)
May	138.8 (5.7)	6.2 (0.4)	5.6 (1.8)	21.4 (1.6)
June	668.8 (20.1)	-	-	-
July	60.4 (2.6)	116.4 (5.8)	5.8 (5.5)	8.5 (0.6)
August "	33.6 (1.3)	107.0 (4.5)	3.9 (0.6)	1.1 (0.3)
September "	43.2 (1.7)	22.6 (1.0)	8.4 (2.1)	10.8 (0.5)
October	287.0 (11.5)	4.8 (1.5)	12.6 (2.8)	1.4 (0.8)
November "	186.2 (7.4)	2.0 (0.1)	1.8 (3.4)	28.3 (39.9)
December "	473.2 (18.9)	40.6 (166.2)	0.6 (0.5)	19.4 (7.3)

The mean faunal densities and biomass for stations 1,2,3&4 were 236.1, 28.1, 9.8 and  $11.6 \times 10^3/m^2$  and 8.9, 15.5, 3.4 and  $5.0g/m^2$  respectively. High population densities and biomass were observed during postmonsoon. Benthic population excluding foraminiferans revealed a significant correlation with sediment organic matter (Fig 4). Foraminiferans accounted for higher population counts while pelecypods and polychaetes (*Prionospio pinnata*) contributed the higher biomass structure especially during postmonsoon period.

Faunal composition : Fauna, in general was comparable to that of Versova (Varshney *et al.*, 1988) and consisted of foraminiferans, polychaetes, crustaceans, pelecypods and other less common groups.

Foraminiferans : Foraminiferans were dominant (97.74%) and represented in all collections from the study area. Results indicated (Fig. 4) a decrease in population density of foraminiferans from creek to coastal stations. Foraminiferans obtained from creek and nearshore stations (1 & 2) were somewhat blackish in colour, due to organic pollution as compared to offshore specimens. Five species of foraminiferans namely *Ammonia beccarii* (Linne), *Quinqueloculina seminulum* (Linne), *Discorbis nitida* (Williamson), *Rotalia calcer* and *Elphidium crispum* were recorded from Mahim. The abundance of specific foraminiferans like *Ammonia beccarii* and *Q.seminulum* in the nearshore regions of Mahim could be related to high nutrient input to the

creek system as noticed earlier at Versova (Varshney *et al.*, 1988). An increase in species diversity of foraminiferans was noticed from creek (0.09) to coastal station (0.54).

Polychaetes : Polychaetes (1.75%) were the second dominant group with a mean density varying from  $33/m^2$  to  $1940/m^2$ , with the maximum being observed during postmonsoon.

Twenty four species belonging to 20 genera were encountered. The creek (station 1) was populated by 3 species namely *Paraheteromastus tenuis* Monoro, *Maldinella* sp. and *Protodor illea biarticulata* Day, whereas *Ancistrosyllis constricta* Southern, *Lumbriconereis latreilli* Aud & M.Ed., *Cossura coasta* Kilamori, *Glycera alba* Rothke, *Prionospio pinnata* Ehlers, *P. cirrifera* Wiren, *Cirratulus cirratus*, O.F. Miiler and *Maldinella* sp. were the common species encountered outside the creek region (stations 2,3,&4). *P.pinnata* was the dominant species (79 to 89%) at the coastal stations like at Versova (Varshney *et al.*, 1988) and was encountered in abundance at Mahim during postmonsoon.

The rare species from this region were *Syllis gracilis* Grube, *Nereis* sp, *Neanthes* sp, *Perenereis cultrifera* Grube, *Nephtys inermis* Ehters, *N. polybranchia* Southern, *Eunice antennata* Savigny, *Diopatra neapolitana* Dellechiage, *D.cuprea cuprea* Bose, *Lumbriconereies pseudobi taris* Fauvel, *Glycera rouxi* Aud & M.Ed., *Polydora ciliata* Johnston, and *Sternaspis scutata* (Ranzani). The species diversity (H)

gradually increased from creek (0.86) to coastal stations (1.39).

#### **Crustaceans :**

Crustaceans were occasional inhabitants (0.1%) of the area, represented by Copepods (0.03%), amphipods (0.04%), tanaidaceans (<0.01%), macrurans (0.01%) and crustacean larvae (<0.01%).

#### **Pelecypods :**

The contribution of pelecypods (0.3%) was very low in the study area. Maximum density (11625/m<sup>2</sup>) was noticed at station 1 (December '80) with a predominance of *Pholas bakeri*. Pelecypods in general was increased in abundance from coastal nearshore (8%) to offshore station (41%). Three species namely *Pholas bakeri*, *Mactra* sp. and *Tellina* sp. were common.

#### **Others :**

Rest of the macrofauna consisted of less common group like pennatularians (0.03%), nemertines (0.03%), sipunculids (0.01%) ophiuroids (0.01%). fish larvae (<0.03%) and miscellaneous groups (0.01%) which included Ostracods, echiuroids, phoronids, hydrozoans etc. Distribution of most of these groups was irregular and uneven.

Ecological conditions of the creek/bay/nearshore region off Mahim thus varied significantly depending on the anthropogenic fluxes (Zingde and Desai, 1980) and tidal conditions (Sabnis, 1984). The impairment of water quality observed in the creek system could have been highly influenced by the wastes

disposal and a high input of organic load, as also indicated by nil or very low DO level (<1mg/l). Zingde and Desai (1980) and Sabnis (1984) also reported very high BOD (100 mg/l) and nil DO values in this region. However, a gradual improvement in water quality towards offshore as noticed by earlier investigations (Sabnis, 1984) was evident during the present study.

Enhanced levels of trace metals like Cr, Ni, Cu, Zn and Pb both in water and sediment especially in the creek/bay regions, together with a relatively high concentration of these trace metals in zooplankton, benthos and fish/shell fishes of the creek/bay regions was reported by Sabnis (1984). Both water and sediment of the creek/bay regions revealed a very high levels of total viable (TVC) and coliforms (TO counts especially during ebb period as also pathogens such as *Shigella*, *Salmonella* and *Vibrio* in the region (NIO, 1993).

Wide fluctuations in benthic standing stock noticed at the creek system could be mainly attributed to the dominance of pollutant tolerant foraminiferans in the region and a similar trend was earlier reported from Versova (Varshney *et al.*, 1988). Mahim Bay with moderate environmental stress supports very high benthic biomass chiefly contributed by pelecypods. However, a relative stabilization in benthic standing stock (10 to 11 x 10<sup>3</sup>/m<sup>2</sup>., 4 to 5 g/m<sup>2</sup>) associated with stable environmental conditions towards offshore as compared to nearshore coastal system was noticed.

The dominance of foraminiferans like



*A. beccarii* and polychaetes like *Paraheteromastus tenuis*, *Maldinella* sp. and *Protodor illea biarticulata* especially in the creek system indicates their tolerance to organic pollution similar to the situation in Versova creek (Varshney *et al.*, 1988). The most dominant polychaete *P. pinnata* encountered outside the creek system can be considered as a moderate pollution tolerant species. The absence of minor faunal groups may indicate adequate alterations in the food chain which in turn may result in severe imbalance of the coastal marine ecosystem of Mahim.

Low species diversity index (H) associated with rich faunal standing stock especially in the nearshore regions (stations 1 & 2) than offshore areas (stations 3 & 4) also confirms a severe environmental stress in the nearshore regions. Reish (1980) reported a decrease in diversity associated with increase in total benthic productivity in areas of acute pollution at South California.

Macrobenthos, in general, followed a trend very similar to that of polluted coastal system of Versova (Varshney *et al.*, 1988) and Thane (Varshney, 1983). A gradual decline in the commercial fishery potential of the coastal waters of Bombay due to pollution was already indicated (Dwivedi and Desai, 1972). The bay is suitable for intensive clam/oyster culture, but the results indicate a moderate to severe pollution stress in the bay and unsuitability due to high levels of trace metal (Sabnis 1984) and pathogenic bacterial contamination (NIO, 1993). In fact, the observed high benthic

productivity of the creek/bay system is not adequately utilised at the tertiary level for the conversion of demersal fishery standing stock (Varshney *et al.*, 1985). Hence, the poor trophic conversion efficiency (Varshney *et al.*, 1985) and a poor standing stock of fish eggs and larvae (Gajbhiye *et al.*, 1982) indicate unsuitability of the Mahim Creek/Bay system for the coastal aquaculture. However, the proposed marine reserve forest/ecological zone off Mahim may improve the environmental conditions of the bay/creek system in the near future.

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