

6.3 **ECOLOGICAL STATUS OF THE MAHI ESTUARY,  
SOUTH GUJARAT**

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**ABSTRACT :**

Biological productivity in terms of levels of phytoplankton pigments and standing stock of Zooplankton and macrobenthos of Mahi estuary, south Gujarat was estimated. The upper reaches of the estuary was characterised by high pigment concentration (av. Total chl.  $40.4 \text{ mg/m}^3$ ), and very low standing stock of zooplankton (av.  $0.7 \text{ ml}/100 \text{ m}^3$ ) and macrobenthos (av.  $10/\text{m}^2$ ). However, the middle and lower reaches sustained moderately good values of phytopigments (av. Total chl.  $17.2$  to  $21.3 \text{ mg m}^3$ ) and zooplankton biomass (av.  $7.4$  to  $9.2 \text{ ml}/100 \text{ m}^3$ ) but revealed a moderately low macrobenthic fauna. (av.  $188$  to  $250 \text{ m}^2$ ). The present study when compared with earlier work revealed 80% reduction in zooplankton standing stock associated with a noticeable change in selected water quality parameters. Suitable pollution control measures and alternative mode of waste disposal have become imperative to safeguard the estuarine ecosystem of Mahi river.

**INTRODUCTION :**

The estuaries in south Gujarat play a vital role in draining a large quantum of terigenous input to the Gulf of Cambay Arabian Sea. Among them the Mahi estuary which runs in the east-west direction and joins the gulf of Cambay near Kamboi is of considerable importance. The available information on the quality of environment and ecology of Mahi estuary are limited (1-5). The estuary receives industrial effluents with high BOD, total dissolved from establishments viz; fertilizer, refinery, chemical, pharmaceutical which are present around Baroda. In fact, the estuary serves as an effluent drain for the region. The National Institute of Oceanography carried out hydrographic and ecological surveys of the estuary during 1973-74 and 1981 to recommend suitable site in the estuary for the disposal of industrial wastes. The present report evaluates the ecological quality of the estuary during 1981 with special reference to selected biological parameters and also compares (4,5) the status of the estuarine ecosystem during 1981 with that of the earlier condition during 1973-74. The present paper is the first of this kind on Mahi estuary and hence provides the baseline information for the region for future ecological assessment.

## Environment :

The estuarine stretch extends upto 50 km upstream in the Mahammadpura (Figure 6.4). The sill near Mahammadpura acts as a tidal barrier between the estuarine and fresh water regime. The possibility of sea water crossing the sill is only during the spring high tide. Thus, almost a freshwater regime prevailed at Dabka (upper reach) even during the spring tide. Because of the sill down stream of Mahammadpura experiences a typical estuarine condition associated with marked tidal variations. The estuarine channel gets exposed upto Kavi during the low tide period. The tidal waters remains in the upstream for about 4 to 6 hours whereas the ebb condition extends to a fairly longer time (6-7 hrs). A stretch of tidal flats and shoals are associated with the mouth of estuary which is also wide across. The estuary experiences pronounced freshwater influx especially during monsoon period.

The estuary maintains a fairly good level of DO inspite of large amount of waste disposals. The upper reaches maintain relatively higher pH (av. 8.3 - 8.4 ) as compared to the down stream (av. 7.5 - 8.0 ) whereas the lower and middle reaches record very high levels of suspended load due to siltation associated with strong tidal currents.

## MATERIALS AND METHODS :

Six stations viz; Gangia and Kavi ( lower reaches), Shivmandir and J. Point (middle reaches) and Mahammadpura and Dubka (upper reaches ) were selected along the estuary for the present study (Figure 6.4) . The study carried out between May to November 81. The data on physico-chemical parameters obtained during the present study were compared with earlier work . Phytoplankton pigment concentrations were estimated as per standard methods. Oblique hauls were made to collect zooplankton by using a Heron Tranter Net (mesh size 0.3 mm; mouth area 0.25 m<sup>2</sup> ) with an attached flowmeter. Samples for macrobenthos were collected by using a van veen grab of 0.04 m<sup>2</sup> area. The detailed analyses of zooplankton were carried out as per Nair *et al* (7) while that for benthos method of Govindan (8) was adopted.

## RESULTS AND DISCUSSION :

### Phytoplankton pigments :

Primary productivity estimates (Figure 6.5) based on concentrations of phyto-pigments viz; chlorophyll (Chl.) a; total chlorophyll (a, b and c) and carotenoides (carot) clearly revealed very high primary productivity of the order of 2 to 4 times more at the upper reaches (av. Total chl. 40.4 mg/m<sup>3</sup> ; carot. 24.2 m. SPU/m<sup>3</sup>) than at middle (av. Total chl. 17.2 mg/m<sup>3</sup>; carot. 9.1 m. SPU/m<sup>3</sup>) and lower reaches (av. Total chl. 21.3 mg/m<sup>3</sup>; carot. 10.3 m. SPU/m<sup>3</sup>) of the estuary. As evident from Figure 6.6, there exists a direct correlation between high concentration of phyto-pigments and very high input of nutrients, in particular, the nitrogenous wastes (Table 6.4) to the upper reaches of the estuary. Thus, the indiscriminate waste disposal in the upstream area positively supported a very high primary productivity at the upper reaches of the estuarine system. However, the phyto-pigment concentrations were

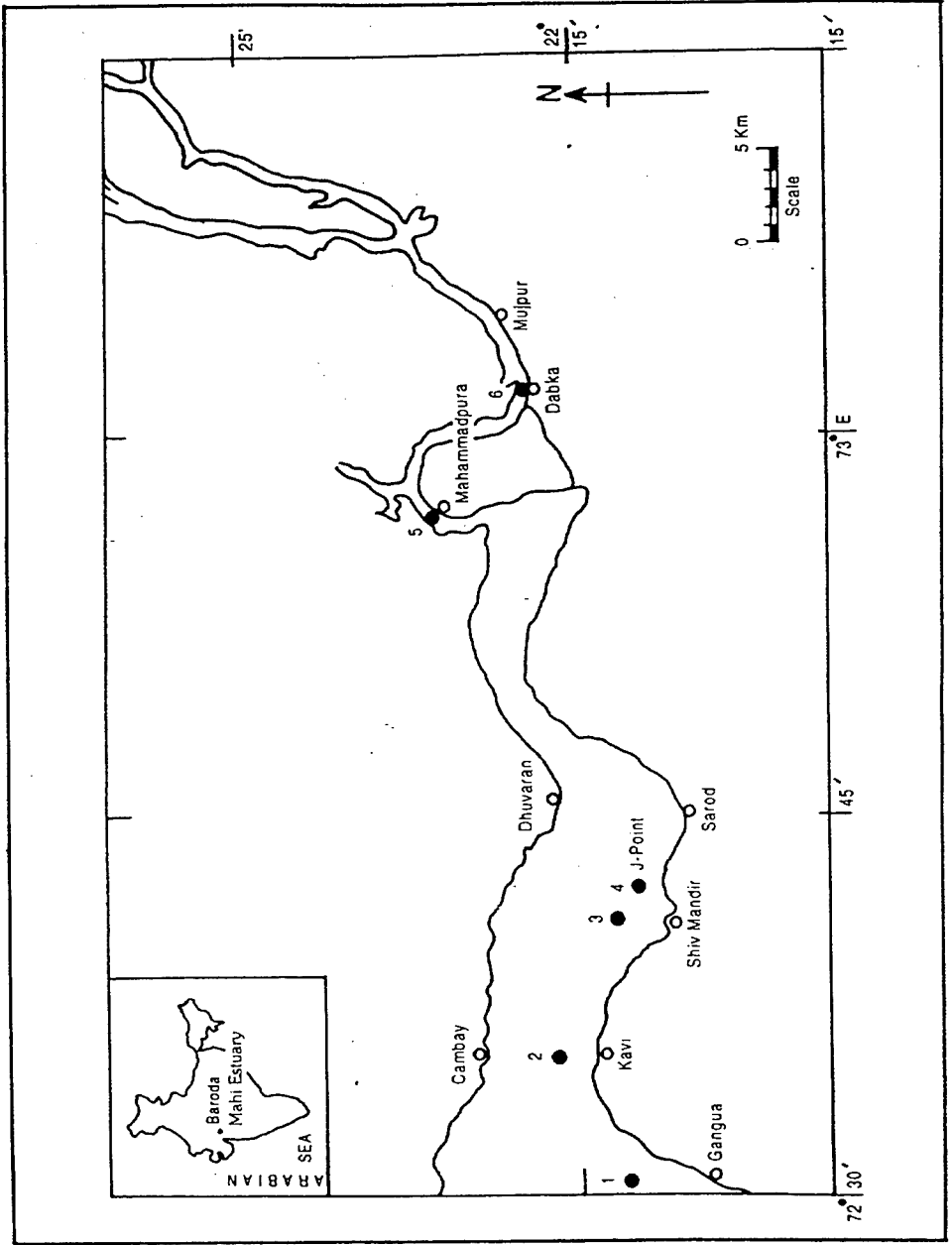


Figure 6.4 Up stream in the Mahammadpura.

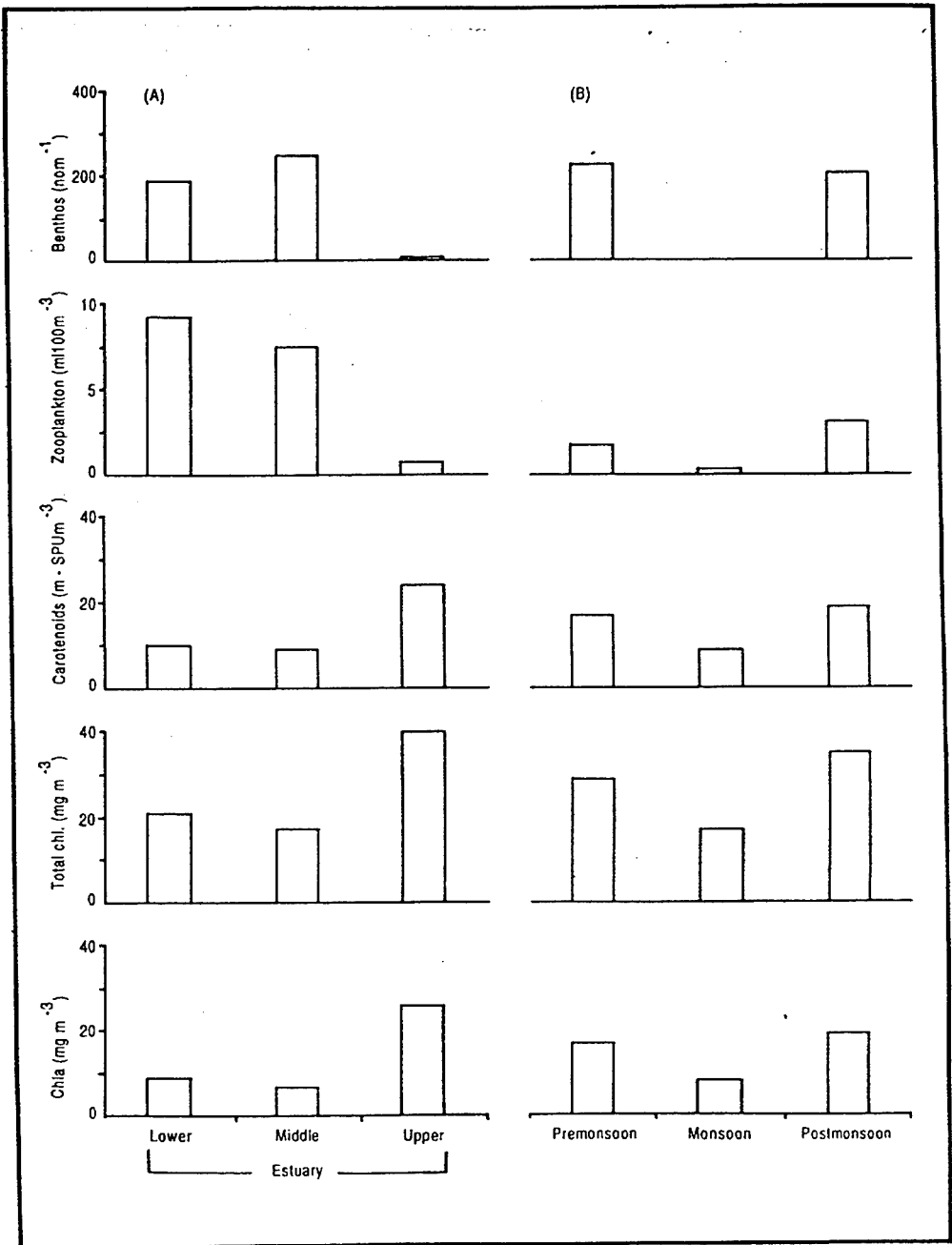


Figure no. 6.5 The values in pre & post monsoon period.

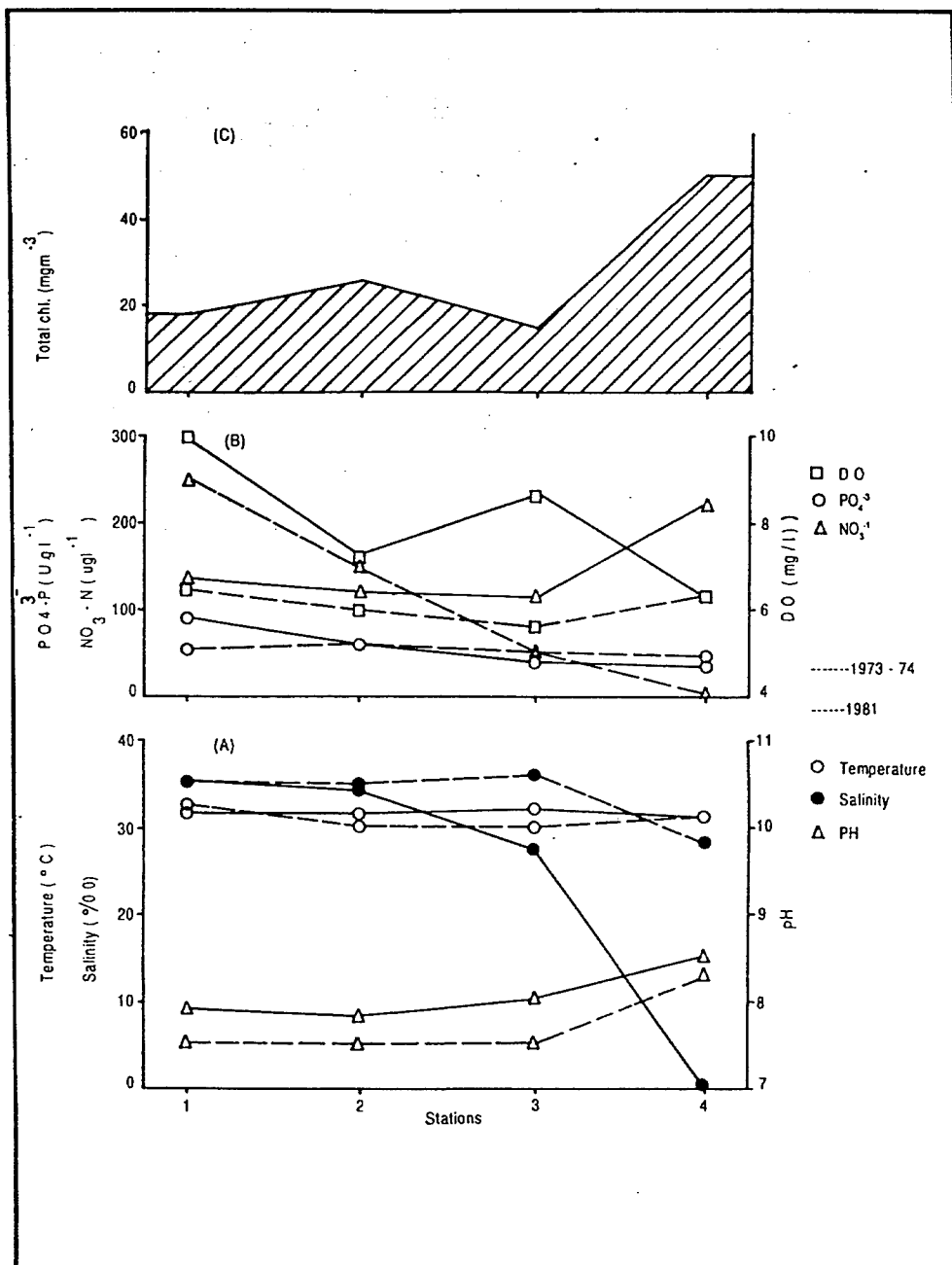


Figure no. 6.6 The phyto-pigment concentrations.

Table - 6.4

Parameters	Gangua	Kavi *	Shivmandir	J.Point *	Mahammaadpura	Dabka
1. Water Temp (°C)	29.8-32.9 (30.9)**	28.4-31.7 (31.4)	26.8-32.8 (30.5)	26.5-32.8 (30.3)	31.5-32.8 (32.1)	27.8-31.9 (30.3)
2. pH	7.9-8.3 (8.1)	7.8-8.5 (7.9)	7.9-8.1 (8.0)	7.9-8.1 (8.0)	7.9-9.0 (8.4)	8.1-8.5 (8.3)
3. Suspended solid (mg/l)	1072-7747 (3073)	1085-3238 (1696)	75-1382 (578)	962-7540 (3407)	333-658 (496)	110-602 (356)
4. Salinity (%)	15.10-35.50 (25.6)	11.07-34.28 (22.8)	17.21-27.8 (22.4)	0.78-30.70 (24.4)	3.80-7.27 (5.5)	0.04-0.56 (0.12)
5. DO (mg/l)	6.6-8.5 (7.6)	6.1-8.6 (7.5)	6.1-9.6 (8.0)	6.8-8.1 (7.6)	7.1-9.2 (8.0)	7.5-12.4 (9.4)
6. Reactive phosphate (ug/l)	76-116 (97)	53-224 (67)	32-146 (76)	62-142 (81)	68-261 (147)	15-112 (55)
7. Nitrite Nitrogen (ug/l)	9-23 (13)	9-60 (31)	12-37 (22)	9.44 (31)	34-479 (158)	5-163 (82)
8. Nitrate Nitrogen (ug/l)	198-415 (324)	54-309 (236)	100-273 (184)	120-279 (200)	42-562 (302)	116-340 (228)
9. Ammoniacal Nitrogen (ug/l)	0-10 (8)	0-20 (18)	4-60 (32)	23-85 (35)	404-595 (500)	160-1276 (690)

\* includes monsoon data

\*\* average values in paranthesis

Source : NIO, 1982.

gradually reduced along the down stream (Figure 6.6) and the values were quite comparable between the lower and middle estuary. Seasonally pre and post-monsoon periods (Figure 6.5) sustained relatively higher concentration (av. Total chl. 29 to 35 mg/m<sup>3</sup>; carot. 16.5 to 18.9 m. SPU/ m<sup>3</sup>) of phyto-pigments as compared to monsoon (av. Total chl. 16.5 mg/m<sup>3</sup>; carot. 8.5 m. SPU/m<sup>3</sup>).

#### **Zooplankton :**

Zooplankton standing stock in terms of biomass indicated temporal, spatial and tidal variations (Figures 6.5 and 6.7) The biomass values fluctuated from 0.4 to 35 ml/100 m<sup>3</sup> with an average of 9 ml/100 m<sup>3</sup> during 1981. Whereas a much wider range in biomass (1.4 to 128 ml/100 m<sup>3</sup>; av. 50 ml/100m<sup>3</sup>) was observed during 1973-74. In general, the flood period (av. 12.2 ml/100 m<sup>3</sup>) sustained 3 times more biomass than ebb condition (av. 4.3 ml/100 m<sup>3</sup>) (Figure 4). Similarly, the lower (av. 9.2 ml/100 m<sup>3</sup>) and middle (av. 7.4 ml/100 m<sup>3</sup>) reaches of the estuary supported a moderately good standing stock as compared to the upper reaches where a very poor standing stock as compared to the upper reaches where a very poor standing stock (av. 0.7 ml/100 m<sup>3</sup>) of zooplankton was encountered (Figure 6.5). Seasonally, post-monsoon (av. 12.3 ml/100 m<sup>3</sup>) period sustained of the order of 2 times more biomass (Figure 6.7) than pre-monsoon (av. 5.7 ml/100 m<sup>3</sup> and also the results supported the earlier findings (1973-74). However, very low standing stock (av. 0.5 ml/100 m<sup>3</sup>) was observed during monsoon Copepods, chaetognaths and decapods were the major constituents both during pre- and post-monsoon periods while the monsoon showed the dominance of fresh water fish eggs and larvae and Macrobrachium sp. in the estuarine system which clearly indicated the influence of freshwater dominance over the marine component especially during the monsoon period.

#### **Macrobenthos :**

The estuary has a sandy bottom at the upper reaches and a silty-clay bottom along the middle and lower reaches. Very poor macrofauna (av. 10/m<sup>2</sup>) was observed in the upper reaches (Figure 6.5) which could be related to the presence of a coarse sandy bottom associated with severe pollution stress (Table 6.4). Similarly, a moderately low macrofaunal density encountered in the middle (av. 250/m<sup>2</sup>) and lower (av. 188 / m<sup>2</sup>) reaches (Figure 6.5) could possibly be related to various environmental stress in addition to pollution such as the strong tidal currents, very high suspended load and unstable bottom conditions due to siltation. However, the numerical density of macrobenthos did not reveal any marked changes between Pre - and post - monsoon (Figure 6.5). The benthic fauna was chiefly contributed by polychaetes, copepods, macrurans, brachyurans and fish larvae of which the polychaetes (64%) and benthic copepods (69%) were the most dominant groups during pre- and post-monsoon respectively. Thus, apart from adverse effects of pollution the natural stress on the ecosystem also appears to be responsible for very poor benthic standing stock of Mahi estuary.

In general, the estuary is biologically very productive in terms of phytoplankton (3) and moderate for zooplankton standing stocks especially during post and pre-

monsoon periods as compared to monsoon . The monsoon drop in biological productivity in a tropical estuary is a recurring phenomenon and the same has been reported in many Indian estuaries (9) (1981). In fact, the upper estuary of Mahi supports (Figure 3) the pollution induced unusually high primary productivity for the region. However, the productivity trends in zooplankton and benthos clearly suggest that the higher energy input to the estuarine ecosystem especially at the lower tropic level (Primary production) has not been effectively transferred to higher trophic levels (secondary and tertiary productions) through the estuarine food chain. Such modifications in trophic tier results under severe pollution stress and similar cases have already been reported for the polluted locations off Bombay coast (10) Relatively higher standing stock of zooplankton associated with flood is indicative of prevailing unfavourable water quality during ebb. Again, unusual variations in zooplankton biomass can be considered as an index to pollution stress (11) .

The data on comparative study of selected water quality parameters like salinity, pH, DO and nutrients also reveal (Figure 6.6) changes in estuarine condition especially at the upper reaches between 1974 and 1981. The above changes in the estuarine ecosystem were partially brought out by pollution due to industrial wastes and also partly by the changes in estuarine topography (5) For instance, the very high differences in salinity regime reported at Dabka - the upper reaches (Figure 6.6) between 1974 and 1981, could be attributed to considerable changes in the river bed associated with high siltation especially down stream of Mahammadpura (the sill) and the resulting elevation of the bed which could possibly weaken the incoming the tide and therefore, the sea water could not cross the sill in the required quantities to influence the salinity conditions at Dabka during 1981. This view is further supported by the dominance of freshwater regime at Dabka associated with very high input of nitrogenous wastes (Table 6.4) and the effective utilization of nutrients by primary producers (Figure 6.6). Since, the tidal flushing seems to be less effective beyond Mahammadpura, the possibility of near eutropic condition at the riverine segment (3) especially during non-monsoon period could not be completely ruled out. Such high level of production at primary level is being dissipated leading to an overall poor biological potential of the estuarine system. The above view is evidently supported by significant drop to the order of 80% less in zooplankton biomass (Figure 6.7) during 1981 than that of during 1973-74. The above reduction in standing stock was quite evident (Figure 6.7) both during pre and post-monsoon periods of 1981 as compared to that of 1973-74. This clearly indicates a drastic change in the estuarine ecosystem between 1974 and 1981. Therefore, a more effective waste disposal scheme should be not only formulated but also implemented successfully in order to maintain reasonably a better estuarine ecosystem of Mahi river.

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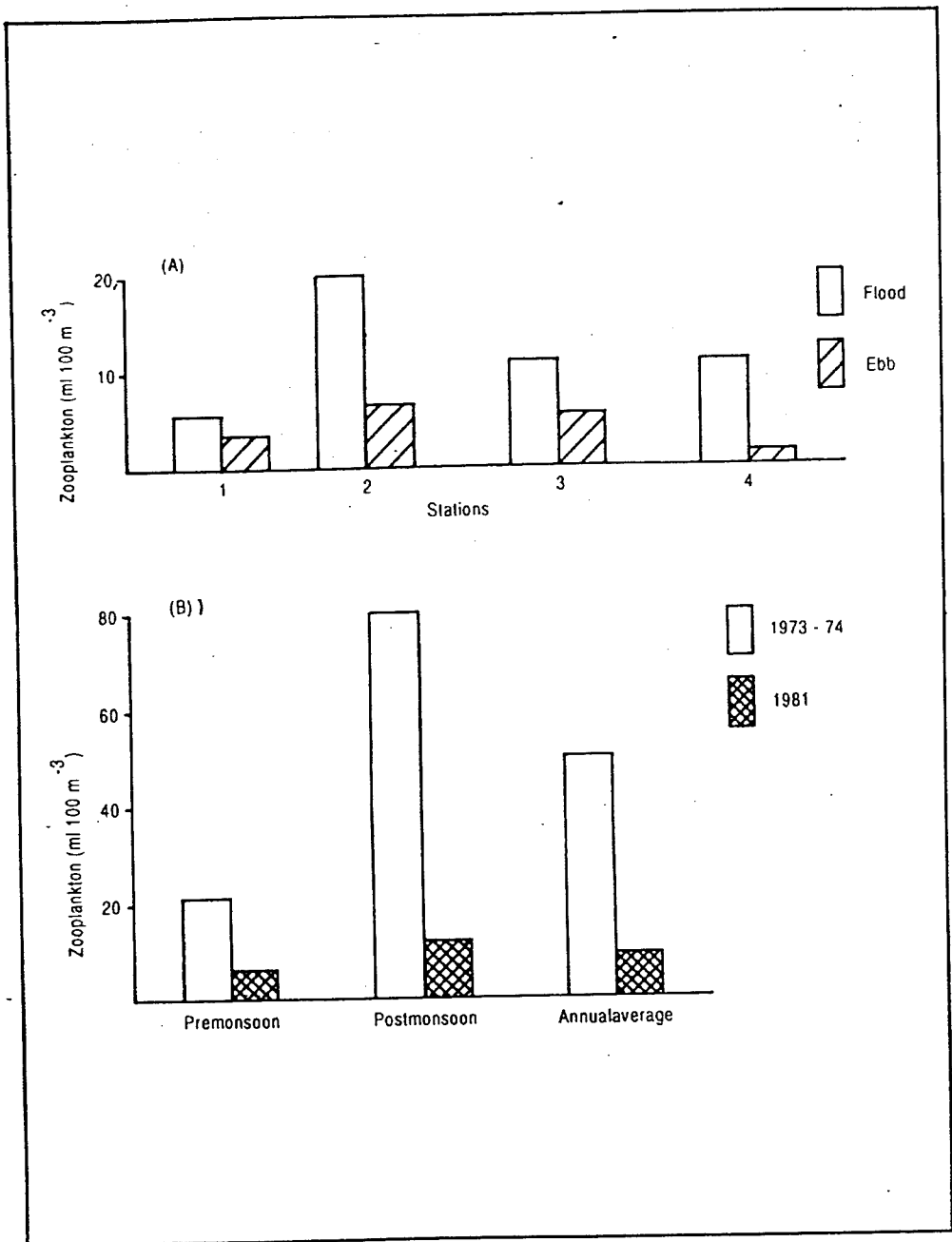


Fig. no. 6.7

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