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Plankton algae as water pollution index of Maipura estuary, east coast of India

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Abstract

Maipura is a tropical mangrove estuary situated in the east coast of India. It is one of the largest sea turtle rookeries of the world and has a great ecological significance. The seasonal variations of different genera of planktonic algae were observed along with the physico-chemical parameters like DO, BOD, salinity and nutrients *viz.* nitrogen (nitrate, nitrite, ammonia), phosphorous and silicate of Maipura estuary during November 1998 and August 1999. The analysis of different community structure of these planktonic taxa revealed that the water of Maipura estuary is organically polluted, which may be due to the impact of organic litter of the adjacent mangrove forests. A total of 15 pollution tolerant genera were encountered during the study period belongs to the Classes *Chlorophyceae, Bacillariophyceae, Cyanophyceae* and *Euglenophyceae.* It has been observed that the estuarine stations were more organically polluted as compared to the coastal stations.

Water pollution indices are commonly used for detection and evaluation of pollution load. Algae are known as reliable biological indicators of water pollution. (Palmer, 1969 and Patrick, 1971). They can be characterized into physico-chemical and biological indices. Biological indices are aimed at providing numerical version of the biological information especially the species composition, the diversity of species, their distribution pattern and by the presence or absence of the indicator species or various groups etc. (Trivedy and Goel, 1984).

Planktonic algae (phytoplankton) are the primary producers in pelagic food chain and they need nutrients like nitrogen, phosphorous and silicate present in ambient water. Growth of different algae and planktonic groups in a water system are the reflection of the water quality of that particular water body. Hence the limnological study is greatly needed for assessment of the water quality especially its pollution stress. A lot of information is available on the study of phytoplankton of Rushikulya and Bahuda estuary of Orissa (Gouda and Panigrahy, 1989, 1996). But there is a complete lack of information on the limnological study of Maipura estuary. The present study is aimed to elucidate the level of organic pollution in Maipura estuary through algal pollution indices together with various physico-chemical properties.

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Material and methods

Maipura is a major distributory of Brahmani river which joins a rivulet Patsala before finds its way to the Bay of Bengal near Wheeler's Island. The river flows in north-east direction (at a latitude of 20°40'N to 20°52'N and longitude 86°77'E to 87°05'E). The coastal areas as well as the beaches adjacent to Maipura estuary represents a unique environment, which attracts lakhs of Olive ridley turtles for their nesting. In fact this area has been identified as worlds major rookery for the sea turtle, Olive ridley. The river on its way to Bay of Bengal forms a dense green stretch of mangrove forest along its side known as Bhitarkanika mangrove. Tide plays an important role for the diurnal variation of hydrological characteristics in Maipura estuary. Its annual cycle is influenced by both the southwest and northeast monsoon. Water and algal samples were collected during low tide from six stations (Fig. 1) through a series of cruises corresponding to the post monsoon (Nov, 1998), pre monsoon (April, 1999) and monsoon (Aug, 1999) seasons. In each season sample collections were made and their average was taken into consideration. Out of six stations three are in upper reaches while one in the

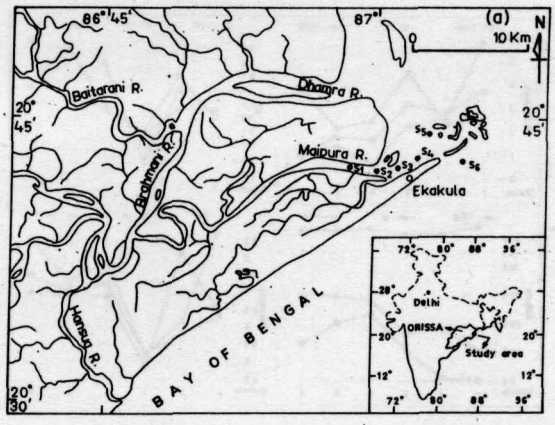

Fig. 1. *Station locations around Maipura estuary*

gradient zone of the estuary and one in the inshore region, and one from the near shore region. Different physico-chemical parameters were analyzed in laboratory using the procedures given in APHA (1985) and by Trivedy and Goel (1986). The phytoplankton samples collected from each of the stations were preserved in 4% formalin followed by Lugol's Iodine solution.

Results and discussion

Temperature : The surface water temperature recorded during sample collection varied from 23.2°C to 31°C. Minimum temperature was observed during monsoon season, while the maximum was noticed during premonsoon period.

Salinity : Salinity values of the water samples of the study area varied from 6.83-33.37‰. Minimum salinity was observed during monsoon season while maximum salinity was encountered during pre-monsoon period when the river inflow was minimum (Fig. 2).

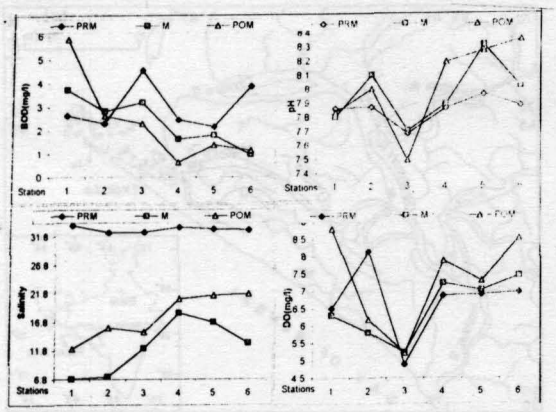

Fig. 2. *Seasonal variations of different physicochemical characteristics*

pH : pH of the study area during sample collection varied from 7.49-8.35. Seasonwise pooled data showed a moderate change *ie.* 7.49-8.35 in post-monsoon, 7.68-7.98 during pre-monsoon and 7.7-8.31 during monsoon period (Fig. 2).

DO : Dissolved oxygen values varied from 4.88 - 8.78 mgl^{-1}. Highest value was noticed during post monsoon period at station -1 while lowest value was noticed during pre monsoon season (Fig. 2).

BOD : Biochemical oxygen demand values varied from 0.62-5.85, 2.14-4.55 and 0.93 - 3.7 mgl^{-1} during post-monsoon, pre-monsoon and monsoon periods respectively (Fig - 2). The magnitude of BOD in the estuarine area were slightly high and indicated the positive symptom of organic pollution, might have contributed from the adjacent mangrove forest and through river run-off.

Nutrients : All the four nutrients *viz.*, nitrate, nitrite, phosphate and silicate showed conspicuous seasonal variations (Fig - 3). Nitrate and nitrite contents varied from 0.07 to 12.96µmol l^{-1} and 0.14 to 6.57 µmol l^{-1} respectively. In general higher values were reported during the post-monsoon and monsoon periods. Silicate concentration varied from 1.21 µmol l^{-1} to 26.28 µmol l^{-1} with a maximum value occurring during post monsoon followed by the monsoon, and pre monsoon periods in order. PO_4^{-3}-P contents were usually low as compared to the nitrate and nitrite. The level of PO_4^{-3} - P ranged from 0.33 to 1.96µmol l^{-1}.

During the present investigation planktonic algae were identified and the pollution tolerant genera (Palmer, 1969) were only listed and the others were ignored. Those genera, which were present 50 and above individuals per ml of water were accounted for. The numbers scored by each genera as proposed by Palmer (1969) are totaled to get the value of algal genus index. A score of 20 or more for a sample is indication of high organic pollutions,

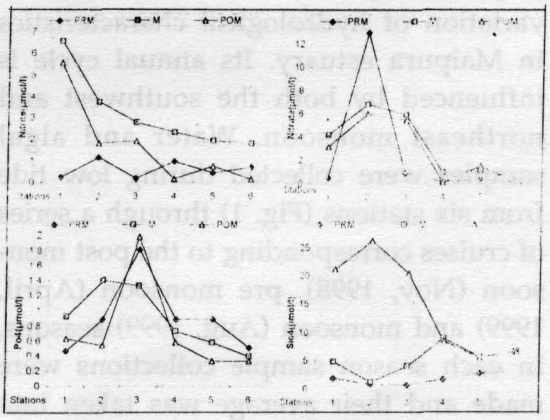

Fig. 3. *Seasonal variations of different nutrients*

Table 1 *Pollution tolerant genera of algae from 6 stations of Maipura estuary in order of decreasing emphasis (Palmer - 1969).*

Genus	Group *	Stations					
		S-1	S-2	S-3	S-4	S-5	S-6
Euglena	F	+	-	+	-	-	-
Oscilatoria	B	-	+	-	+	+	-
Scenedesmus	G	+	+	-	+	-	-
Nitzschia	D	+	+	+	+	+	+
Navicula	D	+	+	+	+	+	
Synedra	D	+	+	+	-	+	-
Melosira	D	+	+	+	+	+	+
Cyclotella	D	+	+	+	-	-	+
Anabaena	B	+	-	+	-	-	-
Fragilaria	D	+	+	+	-	+	-
Stephanodiscus	D	-	-	+	-	-	-
Diatoma	D	+	+	-	-	-	-
Pinnularia	D	+	+	+	+	-	+
Asterionella	D	+	+	+	+	+	-
Dictyosphaerium	G	+	-	+	-	-	-

* Group: B-Blue green algae, D-Diatoms, G-Green algae, F-Flagellates

while a score of 15-19 denotes the presence or moderate rate of organic pollution.

The pollution tolerant genera of algae are listed according to their decreasing emphasis (Table 1). A total of 15 such genera were identified. Out of these, 10 genera belong to the group Bacillariophyceae, 2 each to the group Chlorophyceae and Cyanophyceae and one belongs to the group Euglenophyceae. Genera like *Navicula, Nitzschia, Pinnularia, Asterionella and Melosira* were dominant in all the stations and seasons. Palmer (1969) has shown that genera like *Euglena, Oscillatoria, Scenedesmus, Nitzchia and Navicula* are generally found in organically polluted waters and the same also has been endorsed by Goel *et. al.* (1986). The result of the present study agrees with the contentions of the above authors.

It has been observed from the present study that samples with low nutrient (nitrate and nitrite) concentrations have lower scores of pollution indices (9-12) whereas samples of higher nutrient concentrations showed the high level of organic pollution.

Table 2. *Pollution indices of genera at all the stations of Maipura River (Palmer - 1969)*

	Palmer's Index Numbers Stations					
	S-1	S-2	S-3	S-4	S-5	S-6
Bacillariophyceae						
Navicula	3	3	3	3	-	3
Nitzschia	3	3	3	3	3	3
Synedra	2	2	2	-	2	-
Cyclotella	1	1	1	-	-	1
Melosira	1	1	1	1	1	1
Fragillaria	1	1	1	-	1	-
Stephanodiscus	-	-	1	-	-	-
Pinnularia	1	1	1	1	-	1
Diatoma	1	1	-	-	-	-
Asterionella	1	1	1	1	1	-
Cyanophyceae						
Anabaena	1	-	1	-	-	-
Oscillatoria	-	4	-	4	4	-
Chlorophyceae						
Scenedesmus	4	4	-	4	-	-
Dictyosphaerium	1	-	1	-	-	-
Euglenophyceae						
Euglena	5	-	5	-	-	-
Total Scores	25	22	21	17	12	9

From the results of pollution indices as described by Palmer (1969) (Table - 2) it has been observed that stations 1, 2 and 3 scored above 20 while station-4 scored 17. This indicates that the river (stations -1, 2 and 3) and estuarine (Station - 4) water of Maipura is relatively more polluted than the coastal areas. The coastal (station 5 & 6) stations scored 9-12, indicating thereby that organic pollution load in estuarine and coastal region is not high. This may be due to the mixing of river water in the estuarine and coastal region.

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