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Biomass and quantitative indices of phytoplankton in Mandovi-Zuari estuary

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ABSTRACT

Biomass in terms of Chlorophyll *a*, cell density and quantitative indices of phytoplankton from two estuarine stations and a coastal station off Goa has been studied during 1997-98. Biomass in terms of Chlorophyll *a* averaged 1.1, 1.3 and 1.4 mg/m³ and cell density 0.72, 0.82 and 0.77 x 10⁴ cells/l respectively at Stns. 1, 2 & 3. Diatoms contributed 85.55, 95.55 and 92.22% respectively at Stns. 1, 2 & 3. Contribution of dinoflagellates was about three times high at Stn 1 as compared to Stns 2 & 3. Significant difference was not observed in the quantitative indices between the stations. Attempts have been made to evaluate the interrelationship between various parameters and the role of salinity and mixing on phytoplankton biomass and diversity.

In an estuarine ecosystem tidal and river currents have a complicated influence on water mixing, sedimentation processes, nutrient levels and productivity. Communities are considered as recurrent organized systems of organisms responding in a related way to changes in the environment (Legendre and Legendre, 1978). The Mandovi-Zuari estuary is a tidal stream estuarine system in which water from surface to bottom remains well mixed for most of the year except during south-west monsoon (Qasim and Sen Gupta, 1981). Changes associated with the onset of southwest monsoon such as greater turbidity, low saline and light conditions have greater influence on phytoplankton dynamics of Mandovi-Zuari estuarine system (Devassy, 1983). Information on phytoplankton ecology of estuaries along west coast of India is limited (Achuthankutty *et al.*, 1981; Devassy,

1983; Ramaiah *et al.*, 1995; Vareethiah and Haniffa, 1997; Devassy and Goes, 1988). Ecological indices are generally used for describing eutrophication, water quality and community structure. The commonly used indices are Diversity (IF), Evenness (J') and Dominance (D'). Diversity indices relate to the nature of species abundance and distribution and are used as an index of environmental changes. Dominance represents the relative abundance of the commonest species. Greater the dominance of a particular species lower the diversity index. The present paper deals with biomass, community structure and species diversity of phytoplankton in selected stations at Mandovi - Zuari estuary and a coastal station along Goa coast.

Monthly observations were made on phytoplankton biomass in terms of Chlorophyll *a* and cell density for a period of

9 months from Stn 1 (Off Cabo); 13 months from Stn 2 (Mandovi) and Stn 3 (Zuari) (Fig. 1). Water samples were collected from surface and bottom using clean plastic bucket and 51 Niskin water

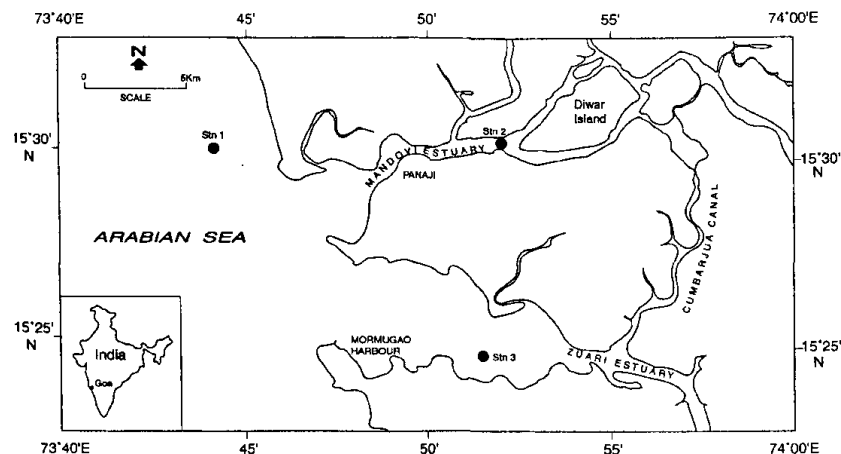


Fig. 1. Map showing station locations

sampler respectively. Depth of water column ranged from 14 - 18 mt at Stn 1 and 2 - 4.5mt at Stn 2 & 3. Chlorophyll *a* was determined by filtering 500 ml of water through GF/F filter paper (0.7 μ pore size) and extraction of pigment in 90% acetone. Fluorescence was measured on a Turner Design Fluorometer (Strickland and Parsons, 1972). For numerical analysis and species composition, 250 ml of water samples from each depth were fixed in Lugol's iodine solution and kept undisturbed for three to four days till complete sedimentation was achieved. The samples were concentrated to a known volume and one ml (in triplicate) of the concentrated sample was taken for counting in a Sedgwick-Rafter under a stereoscopic binocular microscope and the average of three 1 ml counts were used for calculating the number of cells/1. Species diversity (H'), Dominance (D') and Evenness (J') indices were determined as per Shannon and Weaver (1963) and Birch (1981) respectively.

Chl *a* ranged from 0.29 to 2.32; 0.02 to 3.16; and 0.18 to 3.2 mg/m³ respectively

at Stn 1, 2 and 3. Highest value was recorded in October followed by December 2.17, 2.77 and 2.71 mg/m³ respectively at Stn 1, 2 and 3. This was followed by a minor peak in May at Stn 1, March at Stn 2 and 3. Seasonwise Chl *a* was high during postmonsoon at all three stations.

Cell density on an average fluctuated from 0.12 to 2.15, 0.04 to 1.97 and 0.06 to 2.74 $\times 10^4$ cells/1 respectively for Stns 1, 2 & 3. Seasonwise cell density on an average was maximum during postmonsoon (0.74 $\times 10^4$ cells/1) at Stn 1, and premonsoon (1.28 and

1.21 $\times 10^4$ cells/1) at Stn 2 & 3. Santhanam *et al.* (1975) reported a cell density 1.5 $\times 10^4$ cells/1 in surface waters of Vellar estuary along east coast. However, Mandovi-Zuari estuarine waters sustained lower cell density in the present observation as compared to the earlier reports of Devassy and Goes (1988).

A total of 48 species were recorded during the period of study. Of these, 37 belonged to diatoms; 7 to dinoflagellates, 2 to blue green algae, 1 to silicoflagellate, and 1 unidentified alga. On an average diatoms contributed 86.55%, dinoflagellates 12.94% and other items 0.51% at Stn 1. Mandovi-Zuari stations (Stns 2 & 3) contributed greater percentage of diatoms as compared to the coastal station (Stn 1). Contribution of dinoflagellates was about three times high at Stn 1 as compared to Stns 2 & 3. Diatom contribution was maximum during premonsoon and monsoon period (av.98.6%) at Stn 2 as compared to Stns 1 & 3. Dinoflagellates contributed 45.9% in January, 31.1% in Oct and 16.7% in

March respectively at Stn 1, 2 and 3.

Diversity indices fluctuated from 0.27 - 3.44 bits/individual at Stn 1, 0.74-3.23 at Stn 2 and 1.13-3.83 at Stn 3. Seasonwise, on an average, diversity index was maximum during premonsoon (2.54) at Stn 1; during monsoon at Stn 2 (2.69) and during post monsoon (2.63) at Stn 3. Observation of maximum diversity during monsoon and postmonsoon agrees well with the earlier reports for Hugh estuary, north east coast of India (De *et al.*, 1994) and Vellar estuary (Hang Ovan, 1987. Vareethiah and Haniffa (1997) recorded phytoplankton diversity ranging from 1.72 - 5.01 bits/individual. Chandran (1985) reported a diversity index ranging from 0.3 to 4.3 bits/individual with higher values during summer and premonsoon in Vellar estuary. Diversity indices ranging from 0.49 to 4.2 bits/individual in surface waters at Mandovi and 1.1 to 4.1 bits/individual in Zuari has been reported (Devassy and Goes, 1989).

Evenness index (J') fluctuated from 0.07-0.98 at Stn 1; 0.19-1.17 at Stn 2 and 0.27-1.04 at Stn 3. Seasonwise it was maximum during premonsoon (0.7) at Stn 1 and during monsoon at Stn 2 (0.96) and Stn 3 (0.83). The evenness index at a bar-built estuary (Thengapattanam estuary) along west coast ranged from 1.4 to 2.96 (Vareethiah and Haniffa, 1997); 0-0.93 & 0-0.98 for Vellar estuary (Ilangoan, 1987; Chandran, 1985); 0.65 to 0.92 at Hugh estuary (De *et al.*, 1994). Close relationship between diversity and evenness has been reported (De Jong, 1975 and Eloranta, 1976). Highest evenness index in the present study coincides with highest diversity.

Dominance index was within the range of 0.02-0.93; -0.01 to 0.81 and 0-0.73 respectively at Stn 1, 2 and 3. Seasonwise, postmonsoon recorded greater dominance index (0.4) than premonsoon (0.24)

at Stn 1. At Stn 2 pre and postmonsoon showed an index of 0.42 and 0.04 during monsoon. At Stn 3 it was maximum during premonsoon (0.38) followed by post monsoon (0.25) and monsoon (0.17). The higher dominance index during pre and post monsoon at Stns 2 and 3 was due to greater contribution of *Coscinodiscus*, *Thalassionemea*, *Pleurosigma* and *Chaetoceros* as compared to the total no of species. Thus the diversity index behaves inversely to the dominance index.

The inter relationship between various parameters has been worked out statistically by combining both surface and bottom values. Highly significant linear relationship was observed between Diversity and Evenness ($p \leq 0.001$ r 0.955 & 0.860); between Cell density and Dominance ($p \leq 0.001$ & $p \leq 0.01$ r 0.69 & 0.059) respectively at Stn 1 & 2. Temperature showed positive correlation with dominance index and cell density as reported earlier (Garcia and Macia, 1980) at 5% level at all the three stations. Correlation between temperature and dominance index was at 5% level (r 0.452) at Stn 1 and 1% level (r 0.57 & 0.51) at Stns 2 & 3. Diversity was inversely correlated with dominance ($p \leq 0.001$). The same has been reported for Vellar estuary (Ilangoan, 1987). Salinity showed a highly significant linear relationship with dominance index ($p < 0.001$ r 0.69) at Stn 2 and an inverse relationship at Stn 1. Observation of inverse relationship between Evenness and cell density agrees well with the observation of Nwankwo (1966). The significant positive correlation of temperature and salinity with cell density and dominance supports the crucial role of salinity distribution and mixing on phytoplankton cell density and diversity at the estuarine stations.

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