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Distribution of benthic diatoms in brackish water ponds along the Nethravathi estuary, south west coast of India

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Abstract

Temporal and spatial distribution of benthic diatoms in the brackish water ponds along Nethravathi estuary was studied for 12 months from Feb. 1998 to Jan. 1999. The benthic diatom population fluctuated between 168 x 10^4 to 12858 x 10^4 cells/m^2. Maximum abundance of diatoms was noticed during May followed by December and September which coincided the periods of low concentration of nutrients in the sediment during late premonsoon and postmonsoon period. About 41 species of diatoms were recorded representing mainly pennate, of which *Amphora laevisima, A. ovalis, Cocconies littoralis, Diploneis splendida, Mastogloea dolosa, M. exilli, Nitzschia seriata, N. sigma, Navicula hasta, Pleurosigma angulatum, Trachyneis aspera* etc. were dominant. The distribution and variation of benthic diatoms were discussed in relation to temperature, nutrients, pH and texture of the sediment.

Introduction

In shallow aquatic ecosystems with large intertidal regions, benthic microalgae are often important contributors to primary production. The production of benthic microalgae often exceeds that of phytoplankton and macroalgae in shallow aquatic ecosystems. Presence of phytoplankton at few centimeters below the surface of the sediment is probably due to reworking of the sediments by wave action and animals movement (Cadee and Hegeman, 1974). Benthic microalgae present below the photic zone of the sediment have been observed to be photosynthetic when exposed to light (Grontved, 1960; Steele and Baird, 1968 and Cadee and Hegeman, 1974) and hence constitute an important stock of potential primary producers. The benthic microalgal community has been largely ignored in studies of shallow aquatic ecosystems of India. Hence, present study was initiated to understand the qualitative and quantitative distribution and composition of benthic diatoms in space and time in relation to sediment characteristics and hydrographical parameters in brackish water ponds along the Nethravathi estuary, Mangalore.

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Material and methods

The present study was carried out in two brackish water ponds (Fig. 1) at the southern bank of river Nethravathi located in between the railway track and National highway (NH-17) which is about 3 km away from the mouth of Nethravathi and Gurupur estuarine complex which finally drains into the Arabian Sea (12°50'N, 74° 59'E). Among the two ponds one is semienclosed type and the other is enclosed type based on the water flow from estuary proper. These ponds receive water during high tide from Nethravathi estuary and receeds during low tide. The average depth of the ponds during high tide is about 1.5m. During low tide, sides of the ponds are exposed and at the middle of the channel water remains upto a depth of 30 cm. The bottom of the soil is generally sandy-silt. During monsoon season the salinity reduces to less than 1.0 ppt while during late premonsoon salinity may go upto 30 ppt (Mathew, 1994 and Gowda, 1996).

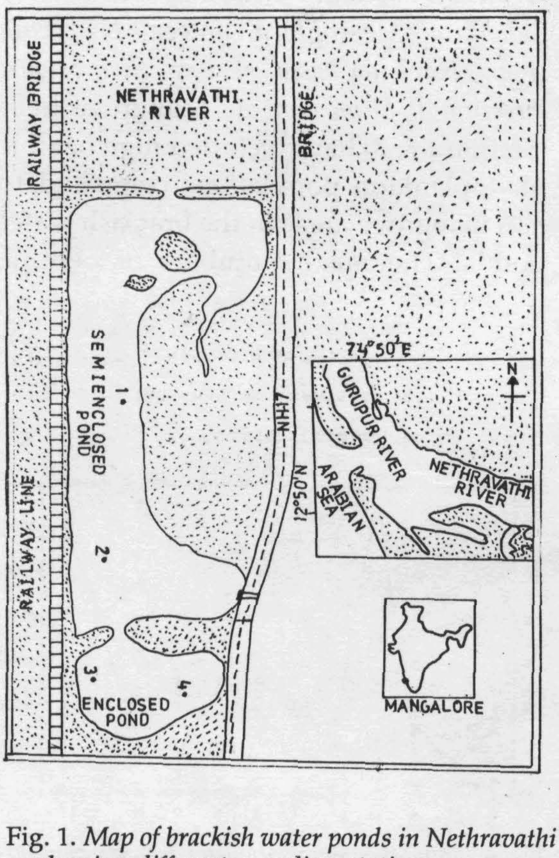

Fig. 1. *Map of brackish water ponds in Nethravathi showing different sampling stations*

Two sampling stations were selected in both the ponds, one near mangrove vegetation and the other in the middle of the pond (Fig. 1). Samples were collected from four stations at monthly intervals during morning hours coinciding with lowest low tide. Samples were collected for the estimation of selected sedimentological parameters such as total nitrogen, total phosphorus, organic carbon and textural analysis.

For the estimation of benthic diatom biomass, sediment samples were collected separately by using a plastic corer (2.9 cm dia). From the core sample, top 1 cm sediment was transferred into the plankton bottle containing pre-filtered sea water. Immediately the sample was fixed by using 4% buffered formaldehyde and few drops of Lugal's iodine solution and then transported to the laboratory for analysis. In the laboratory diatoms were separated and concentrated by floatation technique. Drop method was followed to count the individual cells by using compound microscope. The benthic diatom biomass was expressed as number x $10^4/m^2$.

The nutrients such as total nitrogen and total phosphorus were estimated. Total nitrogen in the sediment was estimated by modified Kjeldhal method using selenium (De, 1962) and the results were expressed as mg/g sediment. Total phosphorus was estimated by following the method of Solar-Zoano and Sharp (1980) and the results were expressed as µg/g sediment.

The organic carbon of the sediment was determined by the wet oxidation method

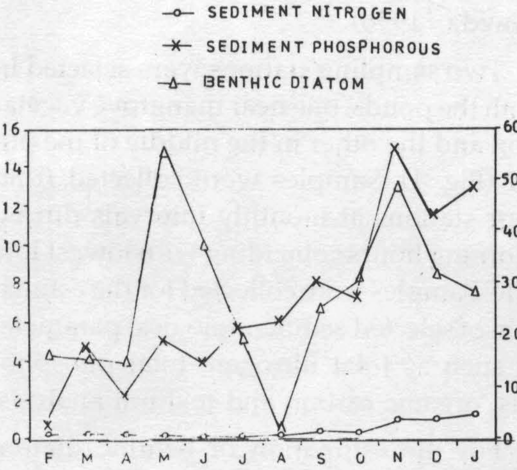

Fig. 2. *Graph showing relationship between benthic diatom and sediment nutrients at station 1.*

(El-wakeel and Riley 1957) and the results were expressed as percentage of total organic matter. Pipette analysis was used for the analysis of sediment texture (Buchanan and Kain, 1971).

Results

During the period of study three groups of benthic phytoplankton were identified *viz.,* diatoms, dinoflagellates and bluegreen algae. Among these, diatoms (83.6%) dominated the phytoplankton population followed by bluegreen algae (10.96%) and dinoflagellates (5.5%). Diatom population was observed to be maximum during late premonsoon season (May) while minimum during monsoon season (Aug) and again gradual increase in diatom population was observed to reach another peak during postmonsoon season (Nov-Dec). The benthic phytoplakton biomass varied from 168 x 10^4 to 12,858 x 10^4 number/m^2. During the period of study about 41 species have been identified, among which 11 species were regular *viz., Amphora ovalis, Achnanthes brevipes, Cocconies littoralis, Licmophora flabellata, Mastogloea, dolosa, Nitzschia sigma, Navicula hasta, N. lyra, Pleurosigma directum, P. formosum* etc. Mangrove areas (Station 1 & 3) have recorded high benthic phytoplankton populations compared to non mangrove areas in the brackish water ponds. The mean numbers of benthic

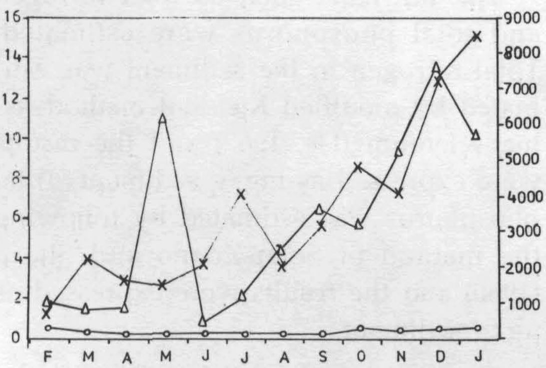

Fig. 3. *Graph showing relationship between benthic diatom and sediment nutrients at station 2.*

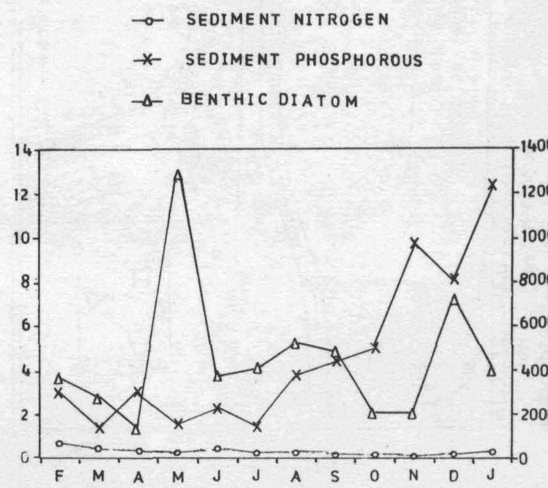

Fig. 4. *Graph showing relationship between benthic diatom and sediment nutrients at station 3.*

diatoms in mangrove area (Station 1 & 3) were to be 3290 x 10^4 number/m^2 and 4511 x 10^4 number/m^2 respectively while in non-mangrove area (Station 2 & 4), it was 2766 x 10^4 and 4803 x 10^4 number/m^2 respectively. Benthic diatom population was recorded to be higher in enclosed pond(1380 x 10^4 to 12,858 x 10^4 number/m^2) than in semienclosed pond (168 x 10^4 to 5608 x 10^4 number/m^2).

Sediment temperature and pH in the study area fluctuated from 25.40 to 35.80° C and 3.57 to 6.61 respectively. The sediment nitrogen and phosphorus were fluctuated from traces to 1.296 mg/g sediment and 0.85 to 19.31µg/g sediment respectively. Organic carbon content varied from 0.062 to 2.23%. Among sand, silt and clay fractions, sand fraction was found to be more dominant at all stations.

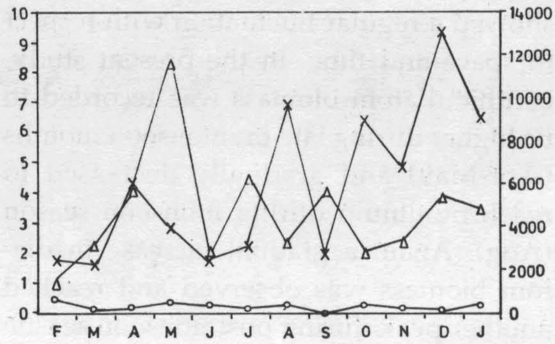

Fig 5. *Graph showing relationship between benthic diatom and sediment nutrients at station 4.*

Water temperature, pH, salinity, nitrate, phosphate and silicate fluctuated in the range of 26.3° C to 37.6° C, 6.65 to 7.70, 0.71 x 10^{-3} to 31.4 x 10^{-3}, 3.91µg-at/l to 14.25 µg-at/l, 0.39 µg-at/l and 46.67 µg-at/l to 128 µg-at/l respectively.

Table 1. *Physico - chemical characteristics (Mean value ± S. E) of sediment.*

Stations	1	2	3	4
Parameters				
Sediment temperature (°C)	30.60±0.98	31.03±0.89	30.97±0.78	30.80±0.83
Sediment pH	5.81±0.25	6.06±0.11	5.45±0.22	5.43±0.25
Benthic Diatom (numbers x 10^4/m^2)	3290±436.93	2766±714.2	4511±893.41	4803±769.03
Sediment chlorophyll *a* (mg/g dry sediment)	0.85±0.14	0.305±0.08	0.75±0.09	0.75±0.14
Sediment nitrogen (mg/g sediment)	0.548±0.10	0.350±0.04	0.231±0.05	0.202±0.03
Sediment total phosphorus (µg/g sediment)	7.01±1.23	6.21±1.26	4.59±1.02	5.04±1.42
Organic carbon (percentage)	0.735±0.06	0.713±0.13	1.127±0.12	1.219±0.13
Sand (percentage)	57.12±2.68	67.81±2.54	54.16±4.30	52.05±3.23
Silt (percentage)	37.09±2.99	26.27±2.38	42.00 ± 4.16	43.55 ± 3.43
Clay (percentage)	5.75±0.94	5.90±0.5	3.829±0.5	4.38±0.7

Discussion

The distribution of benthic diatoms showed a regular fluctuation with respect fo space and time. In the present study, benthic diatom biomass was recorded to be higher during late premonsoon months (Apr-May) and gradually decreased to reach minimum during monsoon season (Aug). Again a gradual increase in diatom biomass was observed and reached another peak during postmonsoon season (Nov-Dec). Benthic diatom population was recorded to be higher in the enclosed pond compared to the semienclosed pond. The diatom biomass was found to be more in mangrove area (Station 1 & 3) when compared to that of non mangrove area (Station 2 & 4). The qualitative distribution of benthic diatom was found to be almost similar in all the stations *viz.*, mangrove and non mangrove area and enclosed and semienclosed ponds. The important species recorded in the present study were mainly represented by *Amphora laevisima, A. ovalis, Cocconeis littoralis, Diploneis splendida, Mastogloea dolosa, M. exilli, Nitzschia seriata, N. sigma, Navicula hasta, Pluerosigma angulatum, Trachyneis aspera* etc. Similar species composition of diatoms were recorded in Cochin backwaters by Gopinathan (1984) and he has prepared the key for the identification of most benthic diatoms for the backwaters of south west coast of India. Sivadasan and Joseph (1995) recorded 47 species of benthic diatoms in Cochin estuary which mainly consisted of *Navicula gracilis, Amphora angusta, Nitzchia clasterium, Gyrosigma spenceri, G. scalproides* and some filamentous algae which belongs to chlorophyceae and cyanophyceae.

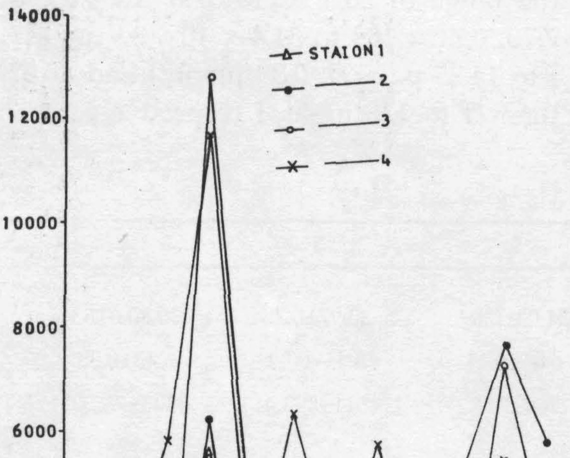

Fig. 6. *Distribution of benthic diatoms at 4 stations in the brackish water ponds*

During the period of high benthic biomass (May), the sediment temperature was recorded to be higher and fluctuated between 35.1 and 36°C. The secondary peak for benthic diatom abundance was noticed during November and December which coincided with higher temperature recorded during postmonsoon period. Eventhough the temperature found to vary from 27 to 31.8° C during monsoon period, the benthic diatom biomass was recorded to be very low. Hence, from the data it is difficult to conclude that the higher temperature supports higher benthic diatom biomass. The sediment pH did not show any marked seasonal variation to influence the diatom biomass in the sediment. From the data it becomes clear that the soil pH was slightly acidic and the pH range was preferred by most of the pennate benthic diatoms to support high benthic phytoplankton production.

The lower values of total nitrogen and total phosphorus in the sediment during premonsoon (May) coincided with high benthic diatom biomass. Similar observations were made by Lukatelich and Mc Comb (1986) in Australian estuarine system. Admiral (1980) concluded that the benthic diatom population in the EMS-Dollard estuary was not nitrogen or phosphorus limited and he found that the nutrient in the water immediately above the sediment surface were not important in controlling the biomass of benthic microalgae. In the present study, the higher benthic diatom biomass coincided with lower nitrogen and phosphorus content in the sediment. Further it indicated that the available nutrients (nitrogen and phosphorus) have been used by phytoplankton for their growth to reach maximum production and thus indicated the lower values of nutrients during higher production of benthic diatom. From the data it is difficult to bring out the influence of organic carbon and sediment fraction (sand, silt and clay) on phytoplankton distribution. However, the high values of organic carbon found during postmonsoon season coincided with the high benthic diatom biomass. The high values for silt and the lower values recorded for sand and clay during late premonsoon contributed to high benthic diatom biomass.

Benthic diatom biomass showed direct relationship with sediment chlorophyll *a* during the period of study. Both diatom biomass and chlorophyll *a* values were recorded to be high during May, December and September. Sivadasan and Joseph (1995) recorded higher chlorophyll *a* values during July-August and they attributed it for the higher standing crop of phytoplankton in the Cochin backwaters. In the present study, a positive significant correlation ($r=0.76$) was observed between benthic diatom biomass and chlorophyll *a* distribution in brackish water ponds of Nethravathi estuary.

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