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DISTRIBUTION AND ROLE OF BENTHIC MICROALGAE IN COCHIN ESTUARY

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ABSTRACT

Benthic microalgal biomass showed significant seasonal and spatial variation, but unaffected by the changes in the bottom water chemistry. The seasonal variation of biomass may be due to grazing or due to the recruitment of the flora from adjoining marine and freshwater environments. The average contribution of benthic microalgal biomass of 50.8 mg/m^2 is indicative of its substantial contribution to the total microalgal biomass in the estuarine system. The lower biomass value and higher percentage of pheophytin *a* at station 8 projects the impact of industrial pollution at the station. The average value of biomass in terms of active chlorophyll *a* and standing crop are found to exhibit no direct relationship. This may be due to the variation in size and pigment concentration of individual species. Hence quantification of active chlorophyll *a* may be preferred to numerical analysis for a more reliable estimation of primary organic production.

INTRODUCTION

STUDIES on various physical, chemical and biological parameters of Cochin estuary were carried out extensively. These include the study of plant pigments (Qasim and Reddy, 1967), light penetration (Qasim *et al.*, 1968), nutrient cycle (Sankaranarayanan and Qasim, 1969), primary organic production (Nair *et al.*, 1975; Qasim *et al.*, 1969; Pillai *et al.*, 1975; Gopinathan *et al.*, 1984; Joseph, 1988; Bhattathiri, 1992), nanoplankters (Qasim *et al.*, 1974; Sumitra *et al.*, 1974) phytoplankton distribution (Gopinathan, 1972, Joseph and Pillai, 1975) and periphyton (Sreekumar and Joseph, 1995a 1995b).

Benthic microalgae often contribute a large percentage of the total primary production in coastal and shallow waters (Jonsson, 1991). They are the major food resources of benthic invertebrates (Lamberti *et al.*, 1989 and Hansson, 1992) and attain high biomass (Marker, 1976a, 1976b; Yasuno and Fukushima, 1982). The commercially important shrimps, pearl spots, molluscs are bottom feeders which feed on these flora. In shrimp and pisci culture farms, where the oxygen concentration is an important factor that controls the growth and survival of the organisms the benthic microalgae act as renewable resources for oxygen generation. They may retain a part of the newly mineralised nutrients at the sediment surface and thereby having a competitive impact on phytoplankton (Cariton and Wetzel, 1988). Inspite of their significant role in the aquatic food chain practically no work has been done on the benthic microalgae except photosynthetic pigments of benthic microflora (Sivadasan and Joseph, 1995) and community structure of microalgal benthos in the Cochin estuary (Sivadasan and Joseph, 1996). The present work is on the seasonal and spatial distribution and the role of benthic microalgae in the estuary.

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MATERIAL AND METHODS

Cochin estuary extends from Alleppey in south to Azhikode in north with a permanent

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opening to the Arabian sea in Cochin (Fig. 1), Ten stations were selected for the study namely

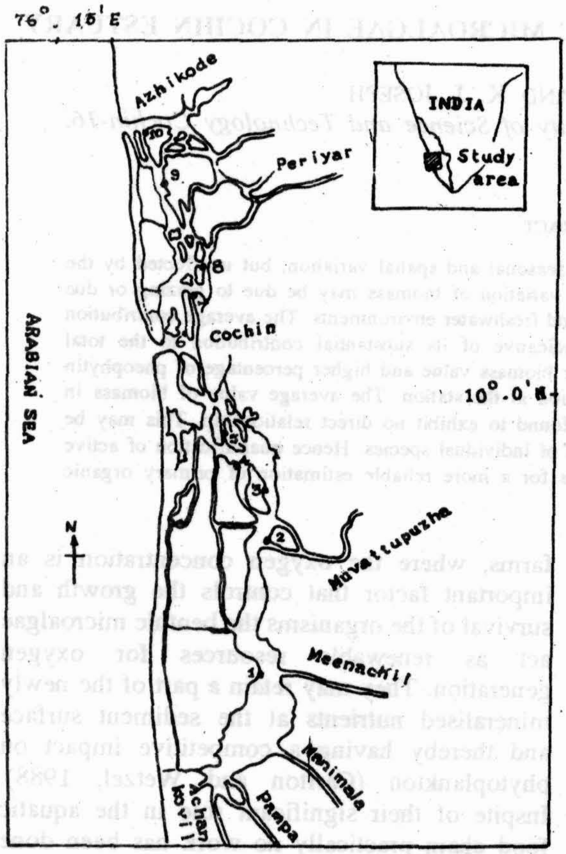

FIG. 1. Station Location.

Thannirmukkam, Murinjapuzha, Panavally, Vaduthala, Kumbalam, Bolgatty, Chittoor, Eloor, Karthedom and Munambam respectively. Macrophytes free submerged littoral areas at a depth of 75 cm from water level were chosen for sampling during 1992 July to 1994 June. Sediment cores of 0.5 cm thickness were taken using a polythene syringe of area 8 cm^2 (Sivadasan and Joseph, 1995). Replicate samples were taken fortnightly for qualitative and quantitative analysis of microalgae and their biomass. Temperature of the sediment was taken *in situ*. The bottom water samples collected were analysed for other hydrographic parameters such as pH, salinity, dissolved oxygen (Strickland and Parsons, 1972), inorganic phosphate, inorganic nitrate and reactive silicate (Grasshoff *et al.*, 1983). Biomass of benthic microflora was determined in terms of active chlorophyll *a*. Standing crop was estimated by enumeration technique. The percentage composition of pheophytin *a* and the correlation with hydrographic parameters were analysed. (Snedecor and Cochran, 1967). To study the seasonal and spatial variation TWO WAY ANOVA was done for active chlorophyll *a* values.

RESULTS AND DISCUSSION

The hydrographic parameters in the estuary vary to a large extent with the climate and freshwater influx.

pH : Monthly variation of pH reflected to a certain extent the climatic and spatial variation (Fig. 2 a & b). There was a decrease in pH during monsoon followed by gradual increase during post and pre-monsoon. For the entire estuary the pH value varied from 6.77 (monsoon) to 7.61 (pre-monsoon). The statistical analysis showed direct correlation between pH and biological parameters, as well as other hydrographic parameters.

Salinity: The ecosystem being connected to rivers and sea the salinity of the medium was found ever fluctuating (Fig. 2 a & b). Salinity varied from 0.56 ppt (monsoon) to 11.62 ppt (pre-monsoon). The highest salinity values were recorded at station 6 and 10 irrespective of seasons. Though the average values showed no significant correlation, a sudden decrease in salinity with the onset of monsoon resulted in decreased biomass. The correlation with pheopigments can easily be explained by adverse physiological state of microflora to the increase in salinity. The predominant flora at station 1 and 5 were of freshwater which were subjected to wide fluctuation in salinity. In freshwater forms higher salinity would degrade chlorophyll *a* to pheophytin *a*.

Temperature: It ranged from 24°C to 29.5°C at various stations (Fig. 2 c & d). The variations in salinity were found to be similar to that of the earlier studies of surface water layer (Pillai *et al.*, 1975; Kumaran and Rao, 1975; Joseph, 1988). On statistical analysis it was found that very few stations had correlation between temperature and various parameters.

Dissolved Oxygen: Comparatively high values of dissolved oxygen were obtained during pre-monsoon and lower values during monsoon exhibiting little seasonal fluctuations. Qasim *et al.*, 1969; Pillai *et al.*, 1975; Kumaran and Rao, 1975 recorded high values during monsoon and low values during pre-monsoon for the waters. In the present work no correlation between biomass and dissolved oxygen was observed except for a few station. This may be due to the fact that the rate of consumption of oxygen is more than the rate of evolution from photosynthesis in the benthic environment.

Phosphate: Spatially annual average values varied from 1.0 μg at / l at station 3 to 5.43 μg at /l at station 7 (Fig. 3 a & b). Southern stations generally recorded lower concentrations and northern stations gave comparatively higher values. The correlation matrix showed that in the estuary the phosphate concentration was not significantly correlated with biological parameters studied.

Nitrite: The annual average concentration of nitrite varied from 0.25 μg at /l at station 2 to 2.78 μg at /l at station 8, a highly polluted station (Fig. 3 a & b). The correlation matrix showed that there was significant correlation between nitrite and biomass in few stations.

Silicate: The silicate concentration varied with space and time. In the estuary the concentration varied from 3.5 μg at /l in May to 28.4 μg at /l in September and spatialy it ranged from 10.17 μg at /l at station 8 to 14.8

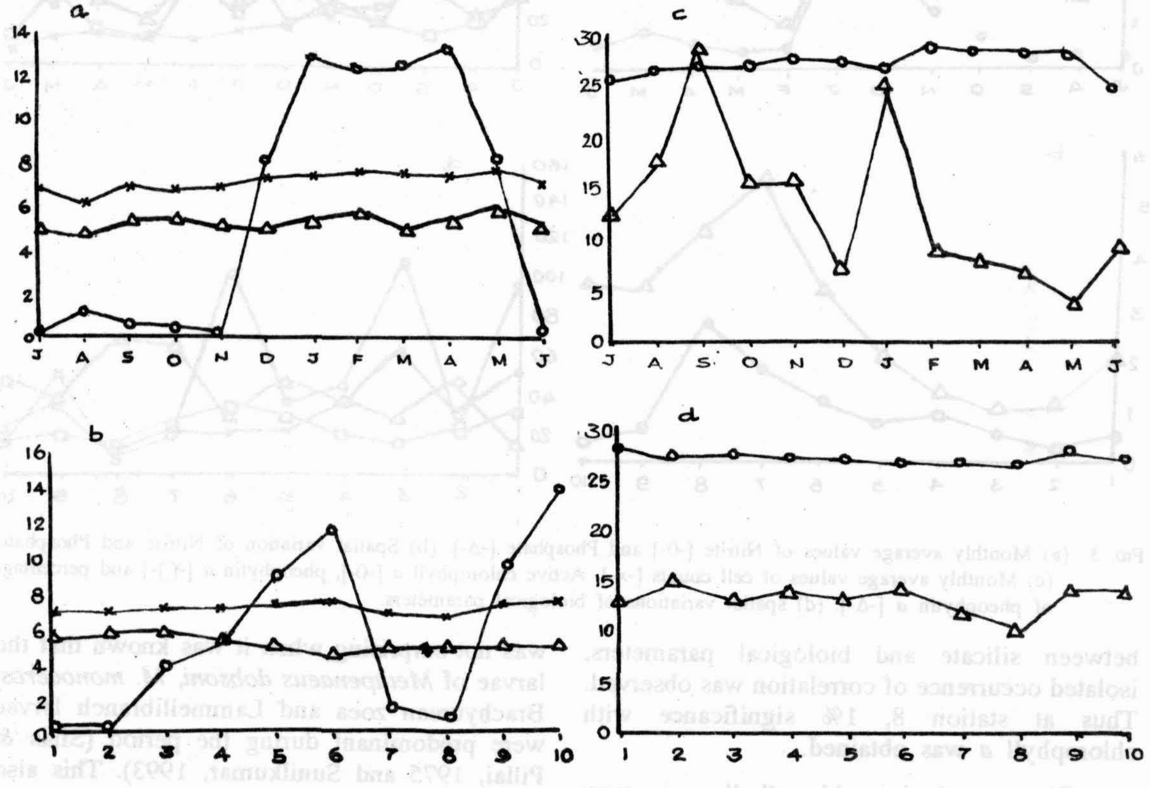

FIG. 2 (a) Monthly average values of salinity [-O-], dissolved oxygen [-Δ-] and pH [-x-]. (b) spatial variations in the estuary. (c) Monthly average values of silicate [-Δ-] and Temperature [-□-] and (d) spatial variations of silicate and temperature in the estuary.

μg at /l at station 2 (Fig. 2 c & d). Though generally there was no significant correlations between silicate and biological parameters, isolated occurrence of correlation was observed. Thus at station 8, 1% significance with chlorophyll *a* was obtained.

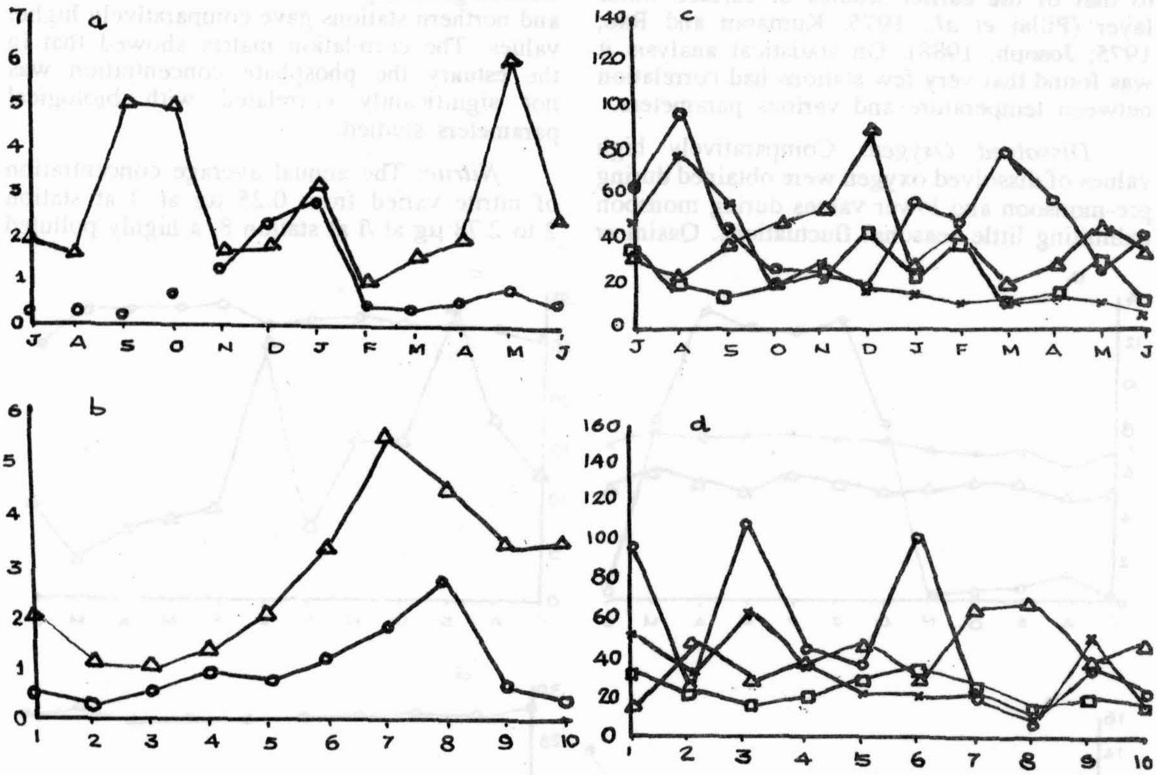

FIG. 3 (a) Monthly average values of Nitrite [-0-] and Phosphate [-Δ-]. (b) Spatial variation of Nitrite and Phosphate. (c) Monthly average values of cell counts [-x-], Active chlorophyll *a* [-0-], pheophytin *a* [-□-] and percentage of pheophytin *a* [-Δ-]. (d) spatial variations of biological parameters.

Biomass: Active chlorophyll *a* is very often used as an index of biomass of benthic microflora (Hansson, 1992). The active chlorophyll *a* concentration during pre-monsoon, monsoon and post-monsoon were estimated to be 55.95 mg/m^2, 63.59 mg/m^2 and 33.3 mg/m^2 respectively. The highest concentration of 243.94 mg/m^2 was observed at station 6 during March, the minimum being 1.51 mg/m^2 at station 8 in June. In the estuary monthly average values ranged from 19.66 mg/m^2 in December to 59.95 mg/m^2 in January, (Fig. 3 c & d). Significant reduction of *chlorophyll a concentration during December* was not surprising when it was known that the larvae of *Metapenaeus dobsoni, M. monoceros*, Brachyurean zoea and Lammellibranch larvae were predominant during the period (Silas & Pillai, 1975 and Sunilkumar, 1993). This also supports that benthic microalgae are important food resources for benthic invertebrates.

Chlorophyll a: Chlorophyll *a* concentration showed wide spatial variation. The annual average ranged from 8.22 mg/m^2 (station 8) to 111.0 mg/m^2 (station 3). Since station 8, Eloor is an apparantly polluted area the lower value of chlorophyll *a* may be due to the impact of industrial pollution. During July and August at station 8 the chlorophyll *a* concentrations were 24.13 and 21.8 mg/m^2

respectively and these comparatively high values may be due to the dilution of pollutants by heavy monsoon showers. The annual average of active chlorophyll *a* in the estuary is 50.8 mg/m^2. This higher concentration of active chlorophyll *a* indicates significant role of benthic microflora in the estuary. TWO WAY ANOVA showed that seasonal and spatial variations were significant at 1% and 5% respectively.

Lag-1 and Lag-1 correlation matrix showed that generally benthic biomass had no correlation with the physical and chemical parameters of bottom water studied. This may be due to the fact that the flora are stationary compared to the plankters in the fluctuating water medium. But a sudden change in hydrographic parameters showed significant reduction of benthic biomass in the estuary during the period at onset of monsoon.

Pheophytin a : Pheophytin, the degraded chlorophyll *a* constitutes 35.49% of the chlorophyll *a* (active chlorophyll+ pheophytin) of the benthic environment in the estuary. During the year the maximum percentage of pheophytin *a* was observed at station 8 (Fig. 3 c & d). Such high percentage would indeed reflect the polluted environment prevailing at the station. Though the maximum concentration of pheophytin *a* recorded was from station 6, its percentage was comparatively low (33.0%). In the estuary values upto 97% were recorded at station 8 during post-monsoon months. Analysis of level of significance with respect to the factors such as salinity, dissolved oxygen, phosphate, nitrite, silicate, temperature and pH with pheophytin *a* showed that values varies with stations. However, for the estuary as a whole there is no significant correlation with pheophytin *a*.

Standing crop : Standing crop of benthic microalgae varied from 15.9 × 106 (pre-monsoon) to 48.75 × 106 (monsoon). Though the standing crop and biomass are found to be directly proportional during monsoon, such a relationship was not found during pre and post-monsoon seasons. This may be due to unaccountability of extremely small size of a few species and the variation in pigment composition. Standing crop was found to be correlated with hydrographic parameters in some stations during particular periods, but the average values showed no such correlation.

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