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ABSTRACT

This paper deals with an account of the estuarine diatoms present in the various estuarine systems in India. Their occurrence, seasonal fluctuation and distribution in the various estuaries, particularly from the Cochin Backwaters are dealt with in detail. In addition, the influence of various physico-chemical properties of the environment on the spatial and temporal distribution of diatoms in the estuaries is briefly discussed.

INTRODUCTION

Studies on the biology and ecology of the diatoms in the estuarine waters of India have not received as much attention as those from the seas around the country. Although Biswas (1932) has made casual reference to the distribution of diatoms in his account of the algal flora of the Chilka Lake, the pioneer study on the ecology and seasonal succession of the diatom flora of the estuarine waters of India was that of Iyengar and Venkataraman (1951) for the Cooum estuary in Madras. Since then biological investigations were conducted by various authors on the diatom flora of Chilka Lake (Roy, 1954; Devasundaram and Roy, 1954) and in the Hoogly estuary (Dutta *et al.*, 1954; Roy, 1955; Shetty *et al.*, 1961).

It is an established fact that a combination of different parameters are responsible for the nature and distribution of the flora and fauna in an estuary. Therefore, it is apparent that each estuary or an estuarine system should be taken up as a separate entity for biological investigations. On the Indian coast, there are a number of estuaries of varying dimensions with different hydrograhic properties both physical and chemical and of varying tidal fluctuations. Very little work has been done in these estuaries on the biology and ecology of diatoms. Among the various estuarine systems in India, the Cochin Backwater is important in that it has been fairly well studied for hydrography, primary productivity and other features. This paper embodies a brief summary on the findings of the estuarine diatoms in various estuaries, particularly from the Cochin Backwater, in relation to the influence of various physico-chemical properties of the environment.

Material and Methods

The data on estuarine diatoms of Cochin Backwater is based on observations for a three-year period from 1970 to 1973. During the period 1970–72, weekly collections of phytoplankton net samples were made in the Backwater from two selected stations. During 1972–73, four stations were sampled from Aroor to Fair-way-buoy by collecting water samples from the surface for estimating quantitatively the standing crop of phytoplankton and analysing the various hydrographic parameters.

One ml of the sample from the standard net sample of 250 ml was counted in a Sedwick-Rafter cell which gave the qualitative composition of diatoms for that period. The water samples sedimented in a settling chamber was used for the quantitative estimation of phytoplankton per litre for the year 1972–73.

Hydrographic features such as temperature, salinity, dissolved oxygen and nutrients such as phosphates, nitrites, nitrates and silicates were estimated during the period 1972–73.

Results and Discussion

During the three years of investigations on the diatom flora of Cochin Backwater considerable variation in the standing crop and seasonal fluctuations of the species has been noticed. The qualitative studies on the diatoms of Cochin Backwater reveal altogether 88 species of diatoms, among which 20 species are very common and have pronounced seasonal variation. The seasonal fluctuations of these 20 species of diatoms are represented in the figs. 1 *a* and *b*, and are listed below:

i. Marine	*ii. Marine & Brackish*	*iii. Brackish*	*iv. Brackish & freshwater*
Coscinodiscus centralis	*Thalassiosira subtilis*	*Coscinodiscus radiatus*	*Skeletonema costatum*
Planktoniella sol	*Coscinodiscus excentricus*	*Fragilaria oceanica*	*Cyclotella meneghiniana*
Rhizosolenia robusta	*C. jonesianus*	*Thalassionema nitzschioides*	
Chaetoceros decepiens	*Pleurosigma normanii*		
C. lorenzianus	*P. directum*		
Triceratium favus	*P. elongatum*		
Biddulphia mobiliensis			
B. sinensis			
Ditylum brightwelli			

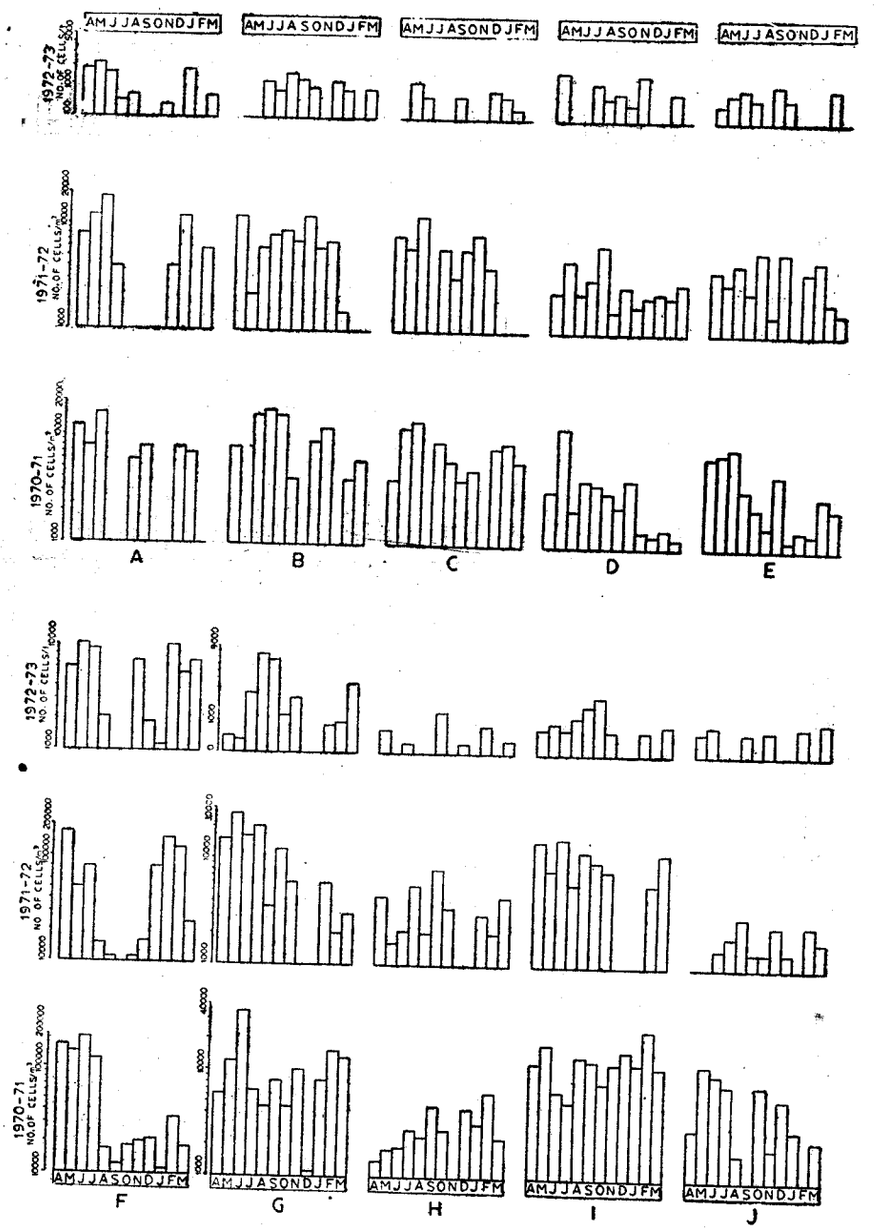

Fig. 1a. A-J. Seasonal abundance and distribution of diatoms dominant in the Cochin Backwater.

A, *Cyclotella meneghiniana*; B, *Coscinodiscus radiatus*; C, *C. jonesianus*; D, *C. centralis*; E, *C. excentricus*; F, *Skeletonema costatum*; G, *Thalassiosira subtilis*; H, *Triceratium favus*; I, *Ditylum brightwelli*; and J, *Rhizosolenia robusta*.

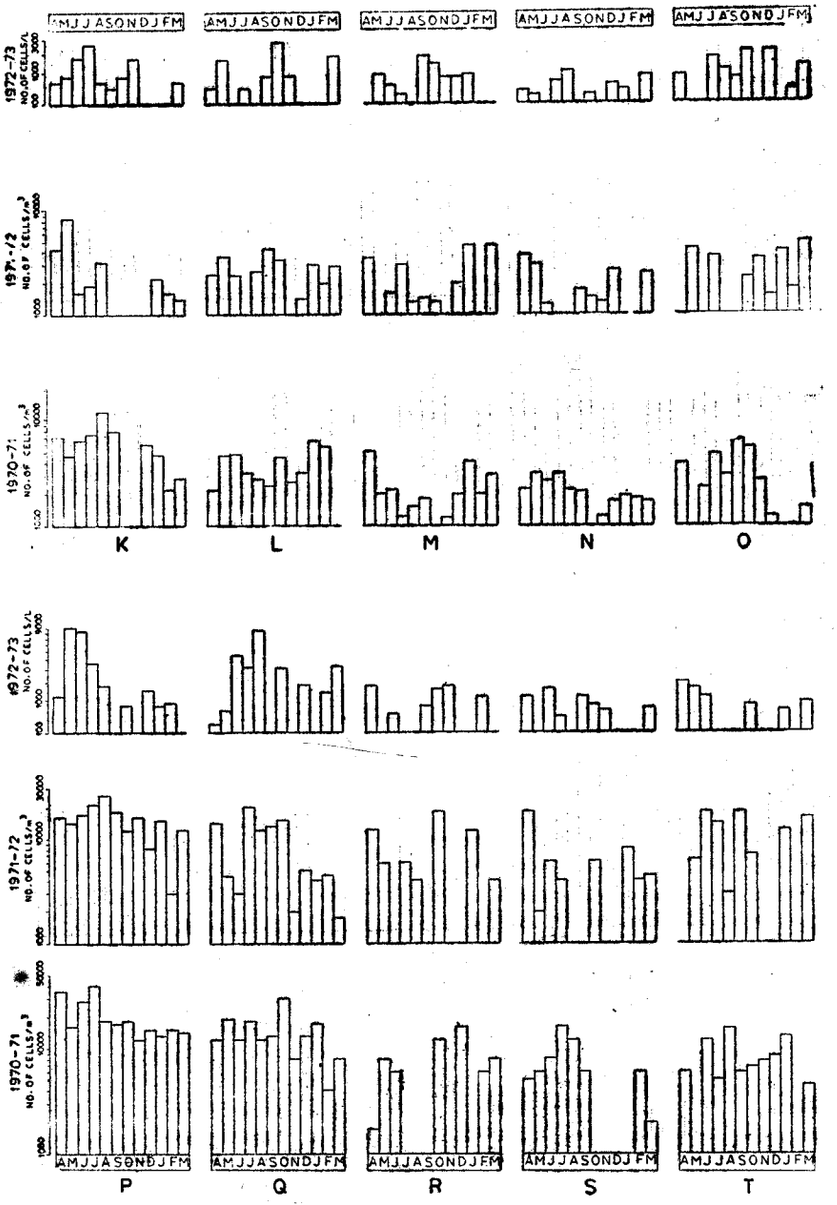

Fig. 1b. K-T. K, *Pleurosigma directum*; L, *P. normanii*; M, *P. elongatum*; N, *Planktoniella sol*; O, *Fragilaria oceanica*; P, *Biddulphia mobiliensis*; Q, *B. sinensis*; R, *Chaetoceros decepeins*; S, *C. lorenzianus*; and T, *Thalassionema nitzschioides*.

Seasonal fluctuation of diatoms in different estuaries :

Majority of the estuarine diatoms of India evince two peak periods, one during the monsoon season of May to August and a secondary peak during the post-monsoon season of October-December (Table 1).

As the production, distribution and composition of the diatom population in an estuary is governed by several hydrographic parameters such as temperature, salinity, dissolved oxygen and nutrients, the various hydrographic properties collected from the Cochin Backwater during the period 1972-73 along with the total number of diatoms is presented in the Fig. 3.

Temperature and diatoms :

In temperate countries, temperature is known to play an important role in determining the fluctuation of diatom population and their distribution. In the tropical estuaries, the temperature never act as a limiting factor for the production of diatoms. In the different estuarine systems of India, though there are marked changes in the temperature, their influence by itself has no direct bearing for the multiplication of new diatom cells.

In the Cochin Backwater, the temperature variation is very low with a range of 4°C (Fig. 2). In the Hooghly estuarine system conditions differ. According to Roy (1955), the low winter temperature in the Hooghly is favourable for the growth of a large number of diatoms resulting in the highest phytoplankton peak in that year. Shetty *et al.*, (1961) have shown that a second diatom peak also occurs during June-August which was observed when the temperature was relatively high (30°C) and this peak was often the highest peak in that year.

Salinity and diatoms :

Unlike temperature, salinity of the estuarine waters of India has a direct influence on the production and fluctuation of diatoms. In the Cochin Backwater, the salinity fluctuations are very wide, because of the influence of monsoon and land run off. During the pre-monsoon period, seawater dominate the estuary and with the commencement of monsoon, freshwater enter the estuary from the nearby rivers and from the rainfall, resulting in very low saline water at the surface and high saline water at the bottom.

Recent studies of Qasim *et al.*, (1972) showed that many organisms 'bloom' in lower salinities in the Backwater indicating that water of low salinities support a greater abundance of diatoms. Such a dependence of the estuarine diatoms on low salinity seems an adaptation to utilize the enrichment of water to a maximum degree.

Table I The peak periods of diatoms in various estuarine systems in India

Estuary	Peak periods of diatoms		No. of species identified	Reference
	Primary	Secondary		
Cochin Backwater	May-July	October-November	88	Gopinathan, 1972
Cooum estuary	January-March	October-December	43	Iyengar and Venkataraman, 1951
Vellar estuary	March-May	—	—	Seshadri, 1957
Zuari-Mandovi system	February-April	December	—	Bhatt, 1972
Hooghly estuary	June-August	November-February	—	Roy, 1949
,,	,,	,,	—	Shetty *et al.*, 1961
,,	—	—	72	Dutta *et. al.*, 1954
,,	—	—	28	Gopalakrishnan, 1971
Chilka Lake	March-June	November	—	Patnaik, 1973
,,	—	—	45	Roy, 1954
,,	—	—	30	Devasundaram and Roy, 1954

During the pre-monsoon period, euhaline species such as ***Planktoniella sol, Coscinodiscus centralis, Chaetoceros decepiens, C. lorenzianus, Triceratium favus, Biddulphia sinensis, B. mobiliensis and Ditylum brightwelli*** dominate the estuary while during the monsoon period, oligohaline forms such as ***Skeletonema costatum, Nitzschia longissima, Coscinodiscus excentricus, C. jonesianus, Pleurosigma normani, P. directum, P. elongatum*** and ***Thalassiothrix frauenfeldii*** are dominant.

Dissolved oxygen and diatoms :

The dissolved oxygen values showed a steady increase from May to September and decrease in October and November (Fig. 2). However, the production of diatoms in an estuary does not seem to have no direct bearing on the dissolved oxygen content, probably because of considerable mixing of alien waters as well as diffusion from and to the atmosphere.

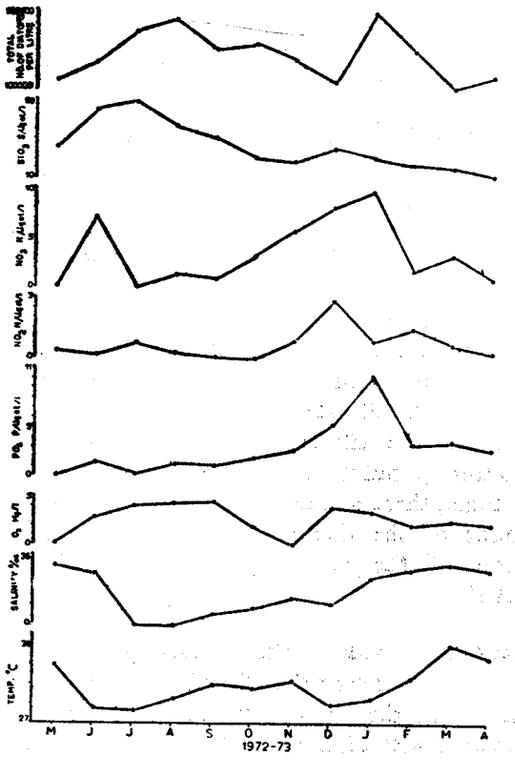

Fig. 2. The different hydrological properties of the Cochin Backwater during the period 1972-73, associated with the total number of diatoms.

Nutrients and diatoms:

Besides salinity, the availability and level of concentrations of nutrients play an important role in the estuarine ecosystem. In the various estuarine systems, nutrient concentrations reach their peak with the onset of monsoon and during the post-monsoon periods, coinciding almost with the higher production of diatoms. However, the nutrient requirements of diatoms are quite variable so much so high concentrations of phosphates or nitrates alone may not give rise to a substantial increase in the production of diatoms.

In the Cochin Backwater high concentration of nutrients seems to lead to an abundance of diatoms and low concentration of other phytoplankters. However, according to Sankaranarayanan and Qasim (1969), the instantaneous concentration of nutrients as inorganic salts does not seem to have a significant source for the diatom bloom.

During the year 1972-73, where data are available for nutrients, the phosphate values show a sudden rise in the month of January, when a 'bloom' of the diatom *Skeletonema costatum* occurred. But in other months, the phosphate content of the water becomes steady (Fig. 2). It is not clear whether the blooming of this particular species of diatom with the increase in the values of phosphate content has any significance. Similarly No_2-N has got a single peak in December. However, No_3-N has shown two peaks in 1972-73, the primary one during the monsoon period and the secondary peak during the post-monsoon period. The peak period of nitrites and nitrates in the pre-monsoon and monsoon periods and subsequent rise in the diatom population suggest that the regeneration of nitrates was faster than the phosphates. The silicate values showed a positive correlation during the monsoon period, when the silicate content of the water was high. But in the post-monsoon period, the silicate content of the water decreases with an increase in the diatom population and conversely with the decrease in the abundance of diatoms, there was an increase in the silicate content (Fig. 2). A detailed account of the definite correlation of the silicate content and diatom population of the Cooum estuary was given by Iyengar and Venkataraman (1951).

From observations made in the inshore waters and various estuarine systems of Indian Seas, it is seen that the 'Biological Spring' falls during the monsoon months, when the diatom peaks coincide with low salinity and temperature associated with high concentrations of nutrients. Qasim *et al.*, (1972) have indicated that the direct relation of diatom population in the Cochin estuarine system with low salinity and temperature could be an adaptation by the diatoms to utilize the available nutrients. Gopinathan

et al., (MS) have further emphasized that the intensity of the seasonal variation of diatom production in the Cochin Backwater was as equal as the spatial variation.

Devasundaram and Roy (1954) have opined in the case of Chilka Lake that it is not clear whether salinity and temperature help the production of diatoms, as much as abundant sunlight which has a definite influence on it. According to Seshadri (1957) in the Vellar estuary, the diatom population is greater at low tide than at high tide due to the presence of an endemic diatom population in the estuary which becomes less concentrated at high tide.

Briefly, the above mentioned facts reveal that the diatoms are found to play the most important role in determining the pattern of seasonal as well as spatial variation of phytoplankton in an estuary.

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