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SEASONAL AND SPATIAL DISTRIBUTION OF PHYTOPLANKTERS IN COCHIN BACKWATER

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ABSTRACT

The observations made on the phytoplankton of Cochin Backwater for a period of one year at seven selected stations have been discussed. There is considerable seasonal and spatial variation of phytoplankters both in magnitude and composition. During the pre-monsoon period, the phytoplankters were chiefly constituted by species of diatoms of the genera *Chaetoceros, Coscinodiscus, Skeletonema, Pleurosigma* and *Nitzschia* and dinoflagellates of the genera *Peridinium, Gymnodinium* and *Ceratium*. During the monsoon period, the flora is constituted mostly by fresh water species particularly of tLe genera *Pledorina, Volvox, Pediastrum* and *Desmids*. During the post-monsoon period, gradual replacement of fresh water species takes place with the marine forms. The probable factors for the spatial and temporal heterogeneity are discussed.

INTRODUCTION

The aim of this study is to analyse the pattern of distribution of phytoplankters in Cochin Backwater and the probable factors responsible for it. Cochin Backwater was investigated for several other parameters, such as hydrography (Ramamritham and Jayaraman, 1963), plant pigments (Qasim and Reddy, 1967), penetration of the solar radiation (Qasim *et al*, 1968), organic production (Qasim *et al*, 1969) and influence of salinity on the abundance of some phytoplankton (Qasim *et al*, 1972). George (1958) gave a general account on the species composition, while Gopinathan (1972) has discussed seasonal abundance of phytoplankters. All the workers had concentrated their attention in and around the barmouth of Cochin harbour, and no work has been done on the spatial heterogeneity of phytoplankton. The present work gives an account of the seasonal and spatial variation of common phytoplankters in the 90 km. long lake cum backwater system extending from Alleppey in the south to Azhicode in the north.

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Environment

The 90 km. long lake cum backwater system with a total area of about 300 sq. km. offers an ever fluctuating environment to the flora and fauna. This is because of the influence of the sea and several rivers to which the system is connected at various places. On the northern half there are two permanent openings to the Arabian Sea at Cochin and Azhicode. Several tributaries of the Periyar river join the backwaters at the northern half. On the southern half the river Pamba and Muvatupuzha join the system. All these rivers periodically enrich the area by flood waters bringing along with them nutrient rich water.

Material and Methods

The data was collected during 1971–72. Samples for hydrography were collected from 28 stations, of which 7 stations (representative) were selected for the present study. Phytoplankton was collected once a month using a 35 cm. bolting nylon net (0.069 mm mesh size). It was estimated that an average of about 10.5 m^3 of water is filtered through the net in 10 minutes surface hauls (Gopinathan, 1972). Preliminary observations of the samples were made in the live condition and then later counted on a Sedwick Rafter counting system. Carbon production was measured by C^{14} technique and chlorophyll *a* was determined by the method of Parsons and Strickland (1963) using a Unicam Spectrophotometer.

Result

The phytoplankton species given in the present study do not include nannoplankton and ultra plankton as they are not retained in the net. Yet the species of nannoplankton of the genera *Synechococcus* and *Merismopedia* during their blooms occurred in the net samples were also counted. However, the account on the species composition of phytoplankton is not very much affected due to the non-inclusion of nannoplankton as they are represented only by very few species in Cochin Backwater. Qasim *et al*, (1974) found that in Cochin Backwater almost all nannoplankton species except some flagellates are represented by the net collection at least in small numbers. But any quantitative account without nannoplankton is far from even near approximation as about 70% or more of the total phytoplankton production in the estuary is the contribution of nannoplankters.

The total cell counts given here may not reflect the quantity of the standing crop, but may indicate the seasonal and spatial variations. The highest phytoplankton concentration were recorded at stations 2 and 3 during the pre-monsoon, the lowest values were at station 2 in the post-monsoon and at station 4 in the pre-monsoon (Fig. 1). Widest fluctuation is shown by the pre-monsoon and post-monsoon values which show almost the opposite trend. During the monsoon, phytoplankton are quantitatively more or less stable.

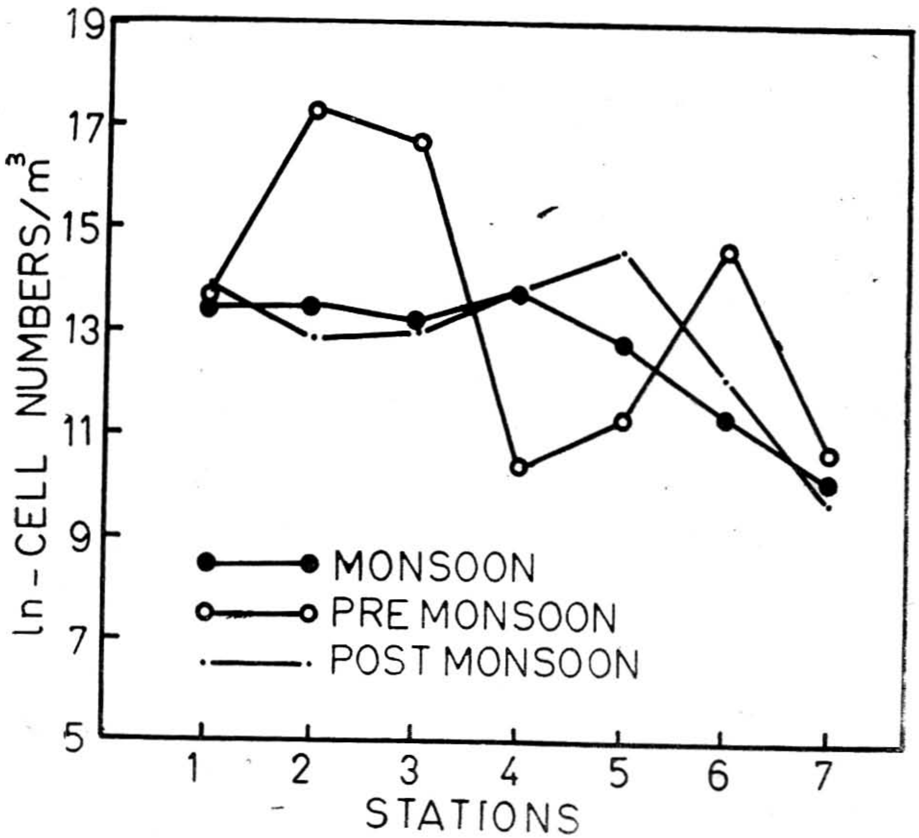

Fig. 1 Quantitative distribution of phytoplankton in Cochin Backwaters.

Chlorophyll *a* values also show seasonal and spatial variation but maintaining the same trend for almost all stations (Fig. 3). During the pre-monsoon it varies from 2.4 mg/m^3 at station 2 and 3 to 21 mg/m^3 at station 6 in the nothern half. The post-monsoon period recorded the highest value of 21.2 mg/m^3 an the lowest value of 2.6 mg/m^3 at the last two stations in the northern half respectively. During the monsoon months the chlorophyll values are more or less uniform and of low magnitude.

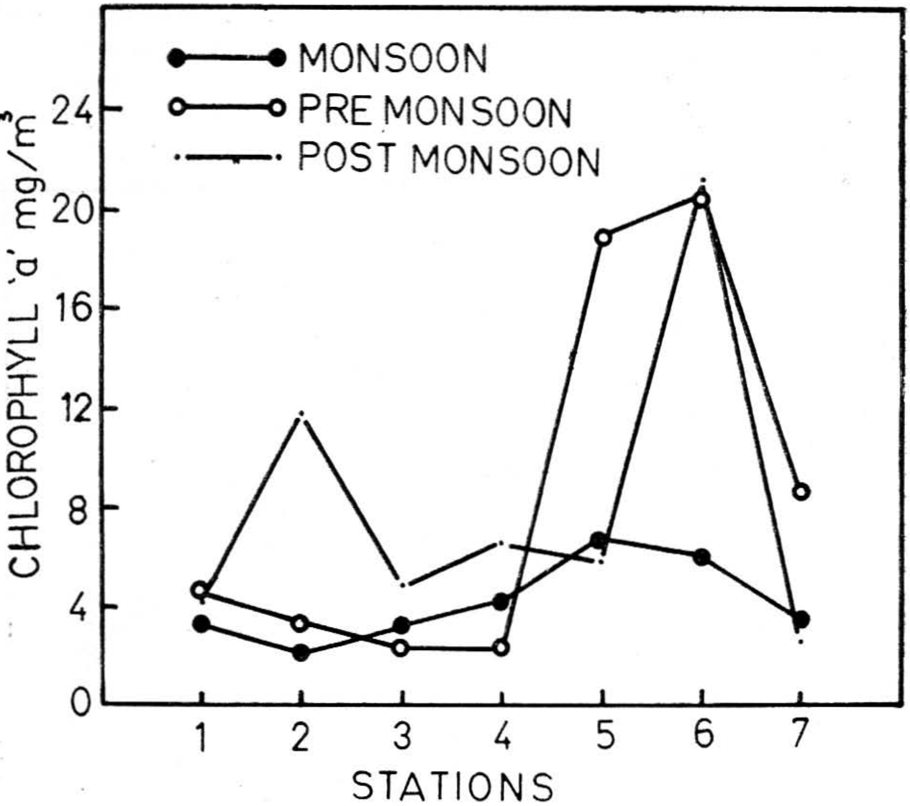

Fig. 3 Seasonal and spatial variation of chlorophyll a in Cochin Backwaters.

Primary production values confirm the phenomenon of seasonal and spatial heterogeneity projected by other parameters such as cell counts and chlorophyll *a* measurements. Though the primary production values are fluctuating from season to season and from station to station, the lowest values are invariably seen during the monsoon. This is in contrast to the inshore environment on the west coast where maximum production occurs during the monsoon months. Stations 4, 5 and 6 are comparatively high productive areas with an average value of 55, 56 and 83 mg/C/m^3/hr and stations 2 and 7 are the lowest productive areas, the average value being 25 and 11 mg C/m^3/hr respectively.

Species composition of phytoplankton varies from season to season and place to place. The percentage composition of phytoplankters having 10% or more of the total number is given against each station (Fig. 2). The

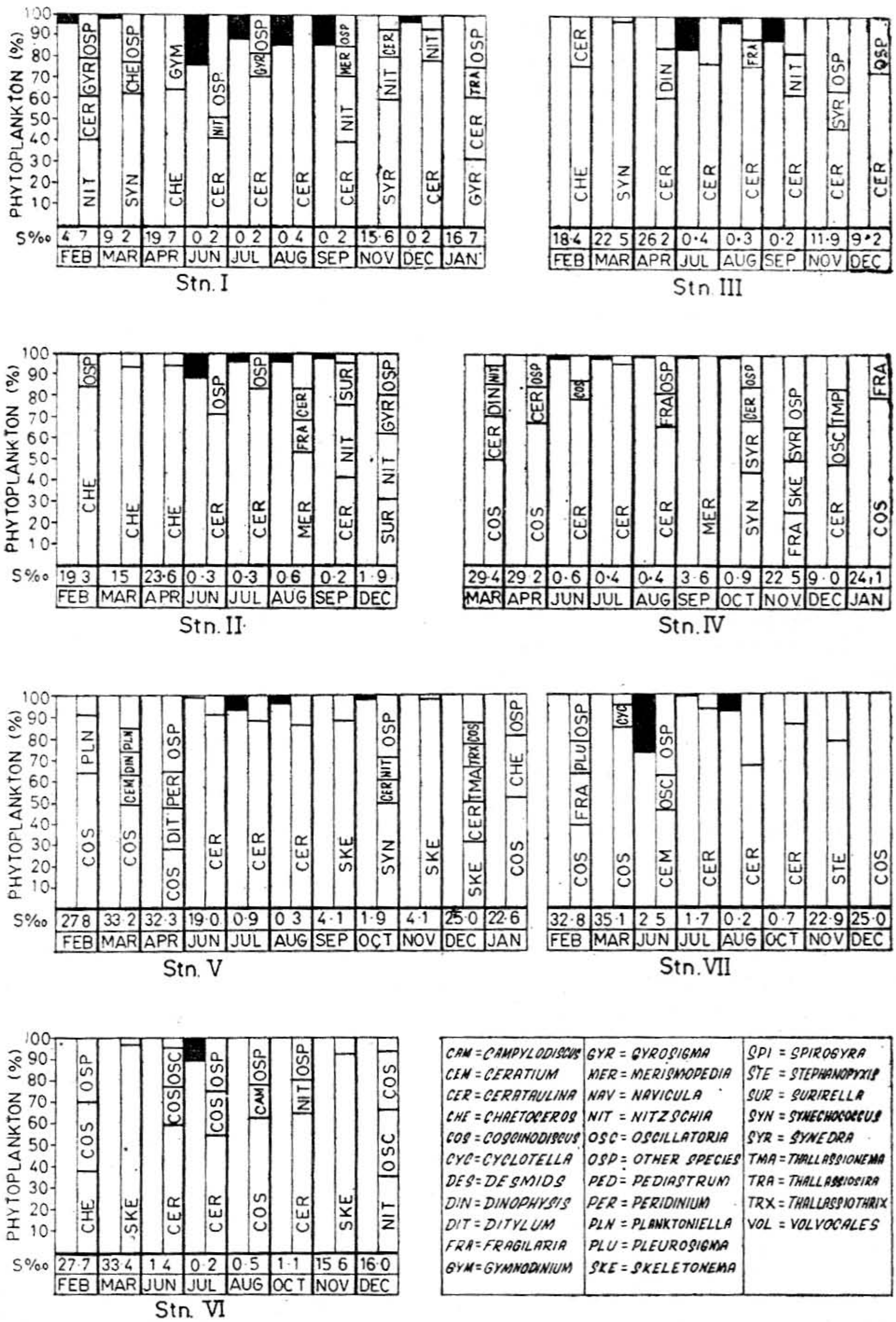

Fig. 2 Species composition of phytoplankters in Cochin Backwaters.

contribution of fresh water species to the total number is also indicated. During the pre-monsoon months at the southern most station the flora consists mainly of *Nitzschia* spp., *Cerataulina bergonii*, *Gyrosigma balticum*, *Chaetoceros* sp and *Synechococcus* sp., at salinity below 10‰ and *Gymnodinium* at salinity 20‰. Monospecific bloom of *Chaetoceros* forms about 90 % of the total plankton at station 2 when the salinity is around 26 ‰ at station 3. Stations 4, 5 and two stations in the northern half which are euhaline during this season support the flora of *Coscinodiscus* sp. and *Chaetoceros* sp.

Though various fresh water species have migrated and got distributed in varying numbers in different areas of this system during the monsoon period, the diatom *Cerataulina bergonii* remained as the single dominant species. The fresh water species include *Pledorina*, *Volvox*, *Pediastrum boryanum*, *P. duplex*, *Scenedesmus quadricauda*, desmids such as *Cosmarium*, *Staurastrum* and *Micrasterias* and filamentous algae such as *Sirogonium*, *Spirogyra* and *Oscillatoria*. The medium which is almost fresh water provided suitable environmental condition for the luxuriant growth of these species.

During the post-monsoon period the first three stations showed the dominance of *Ceratualina bergonii* at a vide range of salinity, other important species at salinity 10 to 17‰ being *Synedra* sp. *Nitzschia seriata*, *N. closterium*, *Bacillaria paradoxa*, and *Gyrosigma balticum*. At the fourth station where the salinity values are as low as 1 ‰ during the month of October, the dominant flora are *Ceratualina bergonii* and *Synechococcus* sp. The remaining euhaline stations during this period show the preponderance of *Fragilaria oceanica*, *Skeletonema costatum* and *Coscinodiscus* sp.

DISCUSSION

The phytoplankton population in a tropical estuary as the one which is discussed here includes estuarine, marine and fresh water species. Estuarine diatoms have the widest adaptability to any change in salinity of the external medium (Williams, 1964). While the growth rates of estuarine clones are not affected in media of wide salinity ranges, clones isolated from sea do not survive in lower salinities (Desikachary, 1972). The above findings give an idea of the pattern of distribution and the probable prominant factor responsible for it. The present study reveals that the phytoplankton in the estuary can broadly be diveded into (1) flora which are well adapted to the flluctuating estuarine conditions and (2) those which are not adapted or a little adapted. While the former comprise of typical estuarine forms which may be permanent residents, the latter represent either fresh water or marine forms migrated to the estuary and seen only for short periods. The different species show different degrees of salinity tolerance. Species such as *Cerataulina bergonii* tolerates a wide range of salinity (0.2 to 17‰) but blooms appear only at low salinity. At station 1, the bloom occurred (80%) of the total population at salinity 0.4‰. When the salinity range was 5-17% the population is reduced to an average of 20%. At salinity 20‰ they almost disappeared. Two peaks of abundance each followed by a fall in salinity are shown by such species. *C. bergonii* is largely distributed in the monsoon months. Iyengar and Venkataraman (1951) observed that *Cyclotella meneghiana* showed 2 peak periods each followed by the southwest and the north-east monsoon showers resulting in a fall in salinity. With the increase in salinity the diatoms disappeared.

Chaetoceros sp. adapted to comparatively high salinity is the dominant flora during the pre-monsoon period. As station 2 reveals, the bloom of *Chaetoceros* sp. occurred during the pre-monsoon when the salinity was 15 to 24 ‰ where it consisted of 90% of the total flora. Cultures of *Cheatoceros lorenzianus* isolated from inshore regions of Cochin gave high rate of photosynthesis (Qasim, 1972). This shows that among euryhaline diatoms there are forms which exhibit optimum growth in lower middle and higher salinity ranges. Similarly while Qasim *et al*, (1972) observed a succession of *Coscinodiscus* bloom at a salinity range 0 to 25 ‰, the present study shows that optimum salinity for *Coscinodiscus* sp. comprising mostly of *Coscinodiscus perforatus* is around 30 ‰ and they do not thrive at low salinity. This is illustrated by their distribution at station 5. During the post-monsoon months when the salinity is 23 to 25 ‰ *Coscinodiscus* sp. constitutes 10 to 50 % of the total number. During the pre-monsoon when the salinity increases from 28 to 33 ‰ it is about an average of 50 % and the maximum of 65 % at salinity 28 ‰. Further decrease in cell counts at still higher salinities supports the assumption that the optimum salinity for the species is around 30 ‰. At station 5 the bloom of *Skeletonema costatum* appears at low salinity (4 ‰). The increase in salinity is usually not favoured by the species. Similarly *Nitzschia* sp. consisting mainly of *N. seriata* and *N. closterium* are abundant in the monsoon and post-monsoon months and not during the pre-monsoon period when the salinity is high. Desikachary (1972) found that *N. amphibia* isolated from estuary did not survive in higher salinity (20 - 25 ‰).

Salinity changes affect the distribution of dinoflagellates also. Species of *Peridinium, Ceratium, Gymnodinium* and *Dinophysis* are seen in the pre-monsoon when the salinity is high. In addition temperature also may have a critical role in the distribution of dinoflagellates. They can survive at lower nutrient concentrations than diatoms. These factors make their appearance in the pre-monsoon months.

It has been reported that marine flora are unable to tolerate a lowering of salinity (Kain and Fogg, 1958; Jorgenson, 1960). Desikachary and Rao (1972) observed that fresh water clone of *Cyclotella meneghenian*a shows slight decline of growth at higher salinities. Guillard and Ryther (1962) found that while estuarine clones of *Cyclotella nana* evinced a wide adaptability and grew in all salinities ranging from 0.5 to 32.0 ‰, marine clones did not tolerate lowering of salinity. As the figure shows (Fig. 1) the fresh water species which appear in large numbers during monsoons disappears in summer. They make their appearance in varying numbers at different stations. The maximum of 25 % has been seen at station 1 and 7 during the month of June. But station 1 with its very low salinity (0.2 ‰) provides more appropriate medium than the last station with salinity 2.5 ‰. The fresh water species show some degree of salinity tolerance as evidenced by their continued presence inspite of the slight increase in the salinity. Their negative correlation with salinity shows that at higher salinity their rate of proliferation is either low or they do not proliferate at all.

Though salinity has apparently no influence on primary production in the estuary it is one of the important factors which controls the species composition and succession of phytoplankton. It is true that the quantum of production is not affected even by the drastic change in salinity. This is not because the physiological activity of the phytoplankters is unaffected but due to the replacement of suitable organisms along with the displacing medium and the salinity tolerance of certain existing species. The balance of the total quantity of the organic material is not upset as the process of photosynthesis in toto is not retarded.

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