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# SEASONAL ABUNDANCE OF PHYTOPLANKTON IN THE COCHIN BACKWATER

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ABSTRACT

Qualitative and quantitative studies on phytoplankton of the Cochin Backwater showed that about 120 species of phytoplankters (excluding nanoplankton) commonly occur in the estuary. Of the 88 species of diatoms, 74 occur regularly and the rest are rare. These 14, have been recorded for the first time from the Indian waters.

Two peaks of abundance were observed—one during the monsoon months (May to July) and the other in the post-monsoon period (October to December). In the Backwater the enrichment of water with nutrients largely occurs during the monsoon months. This seems to be the most important feature governing the quantitative abundance of the species.

## INTRODUCTION

FEW studies on phytoplankton of the Cochin Backwater have been undertaken and only limited information is available on the qualitative and quantitative composition of the organisms and their seasonal variation. Earlier accounts include some general comments on the species composition (George, 1958), estimation of plant pigments (Qasim and Reddy, 1967), problems related to organic production (Qasim *et al.*, 1969) and the influence of salinity on the abundance of some phytoplankton organisms in the estuary (Qasim *et al.*, 1972).

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## MATERIAL AND METHODS

Weekly collections of phytoplankton were made in the backwater, from two fixed stations (Fig. 1), using a net of bolting nylon (No. 21) of 0.069 mm mesh width and of 35 cm diameter. The time of all the collections was between 7 and 8 a.m. The study was extended for a period of two years, from April 1970 to March 1972. The volume of water filtered through the net was determined by a flow-meter (T.S.K. No. 487), attached to the net. It was estimated that on an average about 10.5 $m^3$ of water is filtered through the net in 10 minutes surface hauls. The samples were brought to the laboratory and examined in live condition and the relative abundance of different phytoplankters was noted. The total volume of the organisms collected was determined by the displacement method from an aliquot of 1/5 of the sample.

The samples were thoroughly shaken and from each 1 ml was transferred to a counting chamber (Sedwick-Rafter cell) and all the organisms contained in it were identified and counted upto species. Along with the plankton collections, temperature and salinity of the surface water were also recorded from both the stations. The values related to standing crop, temperature and salinity for all the duplicate months were combined and averaged.

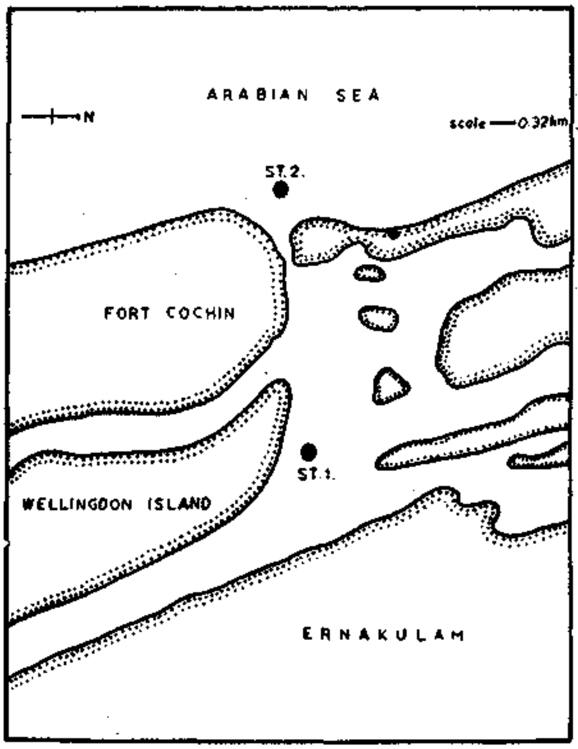


Fig. 1. A portion of the Cochin Backwater with its main connection with the Arabian Sea The closed circles indicate the two stations where observations were made.

## RESULTS

*Standing Crop*

Two peak periods in the standing crop of phytoplankton were noticed in the Cochin Backwater. These were at both the stations (Table 1). The abundance of phytoplankton, as determined from the total volume and total number of organisms, was non-synchronous at the two stations. The peak period of plankton production, however, at both the stations wasfrom May to July. Thereafter, there was a decline in the crop. The second peak lasted from October to November. This was not as pronounced as the first one and was followed by a sharp fall in the standing crop in December. In the early pre-monsoon period (January and February) and end of post-monsoon period (December), the phytoplankton crop was insignificant, as compared to the monsoon months (May to August). In March-April, the phytoplankton was found to be at moderate levels (Table 1).

*Temperature*

The fluctuations in temperature at the surface for the two year period in the backwater were of the order of 4°C, ranging from 27 to 31.5°C. At both the stations, the temperature variations were not very large. An examination of the temperature values (Table 1) will reveal that during the pre-monsoon months, when the water is highly saline, the temperature records its maximum (January to April). From May onwards, with the onset of monsoon, the temperature values decrease considerably and this decrease continues till about October. The changes in the depth profiles of temperature of the Cochin Backwater have been discussed by Sankaranarayanan and Qasim (1969).

*Salinity*

The salinity variations in the backwater were very wide because of the influence of strong monsoon. Like temperature, during the pre-monsoon months, the backwater shows a clear homogeniety in salinity throughout the water column. With the onset of monsoon during May, the surface water begins to get diluted (Table 1) and in August very nearly freshwater occupies the topmost layer. Thereafter, a gradual increase in salinity occurs and the maximum is attained in March (34-35‰). The salinity variations in the Cochin Backwater have been discussed earlier (Sankaranarayanan and Qasim, 1969; Qasim *et al.*, 1972).

*Seasonal variation in Standing crop*

From Table 1, it is evident that station 2 was richer in plankton as compared to station 1. In July, 6·2 ml of plankton was recorded at station 2, while at station 1, the maximum abundance of plankton was only 3.5 ml in May. However, in the post-monsoon peak, the values at station 1 were higher than at station 2 - 3.8 ml and 2.8 ml respectively. In other months, the values at both the stations were almost similar.

Monthly variations in the cell counts of phytoplankton (excluding nanoplankton) at the two stations have been given in Table 2. It has been reported earlier that the phytoplankton net (No. 21-25 mesh size about 0.069 mm width) samples upto 28% of the total phytoplankton production in the estuary as estimated by $C^{14}$ assimilation (Qasim *et al.*, 1969). The nanoplankton, which form the bulk of the total phytoplankton crop are, therefore, not retained by the net. The phytoplankton counts given in the present study include only those which could be retained by the net and these represent only the larger forms of the estuary. Qasim *et al.* (1972) measured the standing crop of phytoplankton by centrifuging the water and examining the settled organisms. Their counts were many times greater than those reported in the present investigation in which a net was used. They report the absence of dinoflagellates at the surface in the months of July and August at their observation station. Perhaps a regular, on the spot collection gives a better measure of specific abundance of a group at a particular site than towing a net which covers a large area and samples a column of water.

It is clear from Table 2 that during the peak monsoon months, the number of organisms was high. During the period April to December, the diatom *Skeletonema costatum* was quite common. In the other months also this diatom contributed substantially to the phytoplankton crop. Other organisms were also maximum

TABLE 1. *Average monthly variation in temperature and salinity and in the total volume of plankton at 2 stations in Cochin Backwater. (Salinity and temperature are for the surface waters)*

| Month | | Station I | | | Station II | |
|---|---|---|---|---|---|---|
| | Temp. °C | Salinity ‰ | Volume of plankton (in ml) | Temp. °C | Salinity ‰ | Volume of plankton (in ml) |
| January .. | 28.4 | 32.25 | 0.8 | 28.5 | 31.30 | 0.8 |
| February .. | 28.4 | 32.25 | 0.7 | 28.5 | 34.78 | 0.8 |
| March .. | 29.8 | 34.60 | 1.9 | 29.8 | 35.40 | 1.5 |
| April .. | 31.5 | 32.27 | 2.5 | 31.8 | 33.41 | 2.5 |
| May .. | 30.1 | 27.58 | 3.5 | 30.7 | 29.50 | 3.8 |
| June .. | 28.7 | 2.90 | 3.3 | 28.9 | 4.81 | 3.9 |
| July .. | 27.0 | 1.57 | 2.8 | 27.4 | 4.60 | 6.2 |
| August .. | 27.7 | 1.00 | 1.7 | 27.3 | 1.10 | 2.0 |
| September .. | 28.1 | 7.69 | 1.4 | 27.7 | 4.79 | 2.6 |
| October .. | 28.2 | 14.63 | 1.8 | 28.0 | 15.82 | 2.8 |
| November .. | 28.3 | 17.12 | 3.3 | 28.4 | 28.39 | 2.8 |
| December .. | 27.2 | 30.46 | 0.7 | 27.5 | 32.25 | 0.9 |

TABLE 2. *Average monthly abundance of different phytoplankters (counts/m³) at two stations of Cochin Backwater*

| Months | | Station I | | | | | Station II | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Diatoms | Dinoflagellates | Silicoflagellates | Cyanophyceae | Total | Diatoms | Dinoflagellates | Silicoflagellates | Cyanophyceae | Total |
| January | .. | 21305 | 1500 | 75 | nil | 22880 | 21290 | 1890 | 150 | 1120 | 24450 |
| February | .. | 22070 | 940 | 75 | 525 | 23610 | 20940 | 3630 | 150 | 900 | 25620 |
| March | .. | 22310 | 2170 | 90 | nil | 24570 | 17310 | 2743 | 37 | nil | 20090 |
| April | .. | 47840[a] | 600 | 150 | nil | 48590 | 26600 | 1090 | 120 | nil | 27810 |
| May | .. | 28280 | 5220 | 220 | nil | 33720 | 43930 | 5062[b] | 98 | nil | 49090 |
| June | .. | 34650 | 2882 | 38 | 2250[c] | 39820 | 31730 | 2675 | 225 | 1200[c] | 35830 |
| July | .. | 42700 | 1930 | 120 | nil | 44750 | 40440 | 2100 | 150 | nil | 42690 |
| August | .. | 27670 | 2660 | nil | nil | 30330 | 39566 | 3044 | 150 | nil | 42710 |
| September | .. | 35470 | 1350 | nil | nil | 36820 | 31380 | 3090 | 220 | nil | 34690 |
| October | .. | 16920 | 1080 | nil | nil | 18000 | 16520 | 1420 | nil | nil | 17940 |
| November | .. | 19858 | 752 | nil | nil | 20610 | 15500 | 2130 | nil | nil | 17630 |
| December | .. | 33780 | 1605 | 75 | 900 | 36360 | 20460 | 1630 | 30 | 1950 | 24070 |

a—*Skeletonema costatum* abundant, b—*Prorocentrum micans* abundant, c—*Katagnymene spiralis* and *Oscillatoria* sp. abundant.

during the monsoon and post-monsoon months. The diatoms constituted 97-98.5% dinoflagellates 0.5 to 1.5% and silicoflagellates plus Cyanophyceae 0.5% of the total crop, at the two stations.

The qualitative composition of the organisms has been shown in Table 2. Throughout the year the diatoms formed the major components of the phytoplankters ; dinoflagellates, silicoflagellates and Cyanophyceae were very few. This may be due to the net not retaining the smaller forms which are otherwise quite abundant (Qasim *et al.*, 1972). Qualitatively the phytoplankton showed in all about 120 species ; 88 species of diatoms, 27 species of dinoflagellates, 2 silicoflagellates and 3 species of blue-green algae (Cyanophyceae). The average monthly occurrence of each species is shown in Table 3.

Very few species of phytoplankters occurred throughout the year. The relative abundance of 15 most common forms has been shown in Fig. 2. At both the stations, the diatoms *Skeletonema costatum, Coscinodiscus excentricus, C. radiatus, C. centralis, C. jonesianus, Planktoniella sol, Ditylum brightwelli, Triceratium favus,*

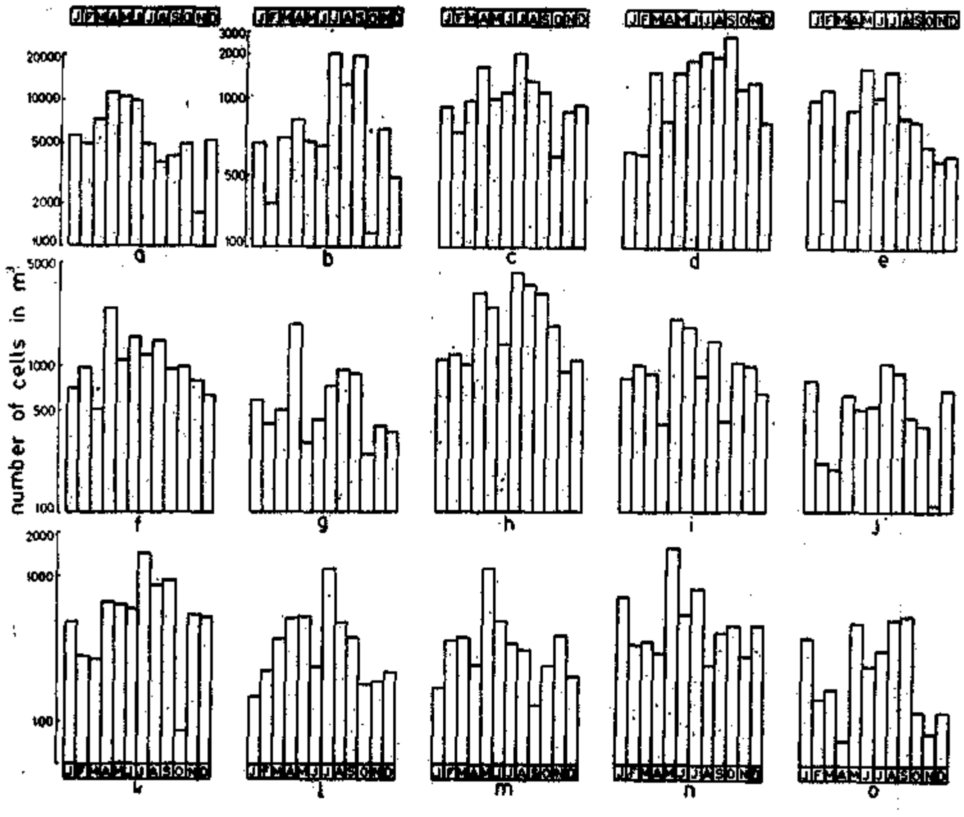


Fig. 2. Seasonal variation in the most common phytoplankters. (average for the two year period April 1970 to March 1972). a. *Skeletonema costatum* ; b. *Triceratium favus* ; c. *Biddulphia mobiliensis* ; d. *Fragilaria oceanica* ; e. *Ditylum brightwelli* ; f. *Coscinodiscus excentricus* ; g. *C. radiatus* ; h. *C. centralis* ; i. *C. jonesianus* ; j. *Planktoniella sol* ; k. *Biddulphia sinensis* ; l. *Pleurosigma normanii* ; m. *Peridinium depressum* ; n. *Ceratium furca* and o. *Diplopsalis lenticula*.

*Fragilaria oceanica, Biddulphia mobiliensis, B. sinensis* and *Pleurosigma normanii* were present throughout the year. The dinoflagellates *Peridinium depressum, Ceratium furca* and *Diplopsalis lenticula* also occurred throughout the year. The two silicoflagellates, *Dictyocha fibula* and *Distephanus speculum* were commonly seen, the latter species was present only in May at station 1. The Cyanophycean forms, *Trichodesmium theibautii, Katagnymene spiralis* and *Oscillatoria* sp. were rarely seen in the collections. Desmids (Conjugales, Chlorophyceae) such as *Euastrum, Micrasterias, Closterium* and *Desmidium* and filamentous green alga, such as *Spirogyra* were observed only at station 1 during July and August.

Among the 88 species of the identified diatoms, 74 were common, while the remaining 14 species seem to be new distributional records in our waters. These are *Amphiprora alata, Tropidoneis elegans, Nitzchia linearis, N. vermicularis, Surirella recedens, S. gemma, S. linearis, S. ovata, S. tenera, S. splendida, Campylodiscus echeneis, C. clypeus, Biddulphia tridens* and *Hydrosera triquetra*, which were observed from May to August at both the stations.

TABLE 3. *Species-wise average monthly occurrence*

| | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BACILLARIOPHYCEAE | | | | | | | | | | | | |
| 1. *Melosira sulcata* | — | R | — | R | R | R | — | — | R | — | — | — |
| 2. *Hyalodiscus subtilis* | F | R | — | — | R | R | — | — | — | — | F | R |
| 3. *Stephanopyxis turris* | — | — | — | — | — | R | R | — | — | — | — | — |
| 4. *S. palmariana* | R | R | — | — | — | R | — | — | R | — | — | — |
| 5. *Coscinocira polychorda* | — | R | — | R | — | R | R | — | R | — | R | — |
| 6. *Thalassiosira decipiens* | — | — | — | — | R | F | R | — | R | — | — | R |
| 7. *T. subtilis* | F | C | R | — | C | C | C | F | R | R | R | F |
| 8. *Cyclotella meneghiniana* | R | R | — | R | — | R | R | — | — | — | R | — |
| 9. *Coscinodiscus marginatus* | — | R | — | R | R | F | R | C | — | — | — | — |
| 10. *C. granii* | R | R | R | R | A | R | F | F | F | — | R | — |
| 11. *C. concinnus* | — | — | — | — | R | R | R | — | — | C | — | — |
| 12. *C. perforatus* | F | R | R | — | R | F | R | C | C | C | F | R |
| 13. *C. asteromphalus* | — | R | R | F | F | F | R | F | R | R | F | R |
| 14. *C. oculus-iridis* | — | F | R | — | F | R | C | C | C | — | — | R |
| 15. *C. gigas* var. *praetexta* | — | R | R | F | F | F | F | F | R | R | F | R |
| 16. *Asteromphalus flabellatus* | R | R | — | R | — | — | F | — | — | — | F | — |
| 17. *Schroderella delicatula* | — | C | R | R | — | R | — | — | R | — | F | — |
| 18. *Leptocylindrus danicus* | — | — | — | — | C | R | R | R | — | — | — | — |
| 19. *Guinardia flaccida* | — | — | — | — | — | R | C | R | — | — | — | — |
| 20. *Rhizosolenia stolterfothii* | — | — | — | — | R | R | — | — | — | — | R | R |
| 21. *R. robusta* | R | R | R | — | — | R | R | — | C | — | F | — |
| 22. *R. imbricata* | R | R | R | — | — | — | — | — | — | — | R | R |
| 23. *R. styliformis* | — | — | — | R | R | — | R | — | R | — | R | R |
| 24. *R. calcar-avis* | — | R | — | — | R | R | R | R | R | — | — | R |
| 25. *R. alata* | R | — | — | R | F | F | — | — | — | — | — | F |
| 26. *Bacteriastrum hyalinum* | R | R | — | R | — | R | — | — | — | — | — | — |
| 27. *B. varians* | — | — | — | — | — | — | R | — | R | — | — | R |
| 28. *Chaetoceros coarctatus* | R | R | — | — | R | — | — | — | — | — | R | — |
| 29. *C. denticulatum* | — | R | — | — | R | R | R | — | — | — | — | — |
| 30. *C. decipiens* | — | R | R | C | F | R | — | C | — | — | C | C |
| 31. *C. lorenzianus* | — | R | — | A | R | R | C | F | — | — | — | — |
| 32. *C. affinis* | — | R | R | — | R | R | R | R | R | — | — | — |
| 33. *C. curvisetus* | — | R | F | F | C | R | F | F | — | — | — | — |
| 34. *Eucampia zoodiacus* | — | — | — | — | — | R | — | — | — | R | — | — |
| 35. *Climacodium frauenfeldianum* | — | — | — | R | R | R | R | — | — | — | — | — |
| 36. *Streptotheca indica* | — | — | — | — | — | C | F | — | F | — | — | — |

| | | J | F | M | A | M | J | J | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 37. | *Bellerochea malleus* | — | — | R | — | R | R | R | — | — | — | — | — |
| 38. | *Lithodesmium undulatum* | — | — | — | R | R | R | — | — | — | — | — | — |
| 39. | *Triceratium reticulatum* | — | — | — | — | R | R | R | F | F | — | — | R |
| 40. | *Biddulphia aurita* | — | — | R | — | F | R | C | R | R | R | R | R |
| 41. | *B. heteroceros* | — | — | — | — | R | R | R | — | — | — | — | — |
| 42. | *Cerataulina bergonii* | A | A | — | F | C | R | F | — | — | — | C | C |
| 43. | *Hemiaulus sinensis* | — | — | — | R | — | — | R | — | — | — | — | R |
| 44. | *Hemidiscus hardmannianus* | — | — | — | R | R | — | — | — | — | — | R | — |
| 45. | *Grammatophora undulata* | — | — | — | — | R | — | — | — | — | — | — | — |
| 46. | *G. marina* | — | — | — | — | — | R | R | — | — | — | — | — |
| 47. | *Fragilaria intermedia* | — | — | — | — | C | C | — | C | F | — | — | — |
| 48. | *Thalassionema nitzschioides* | R | R | — | R | R | F | R | C | R | R | R | F |
| 49. | *Thalassiothrix frauenfeldii* | C | R | — | — | F | — | F | R | F | — | — | C |
| 50. | *T. longissima* | — | — | — | — | R | R | F | R | — | — | — | R |
| 51. | *Asterionella japonica* | C | — | — | F | C | — | — | C | — | — | — | C |
| 52. | *Gyrosigma balticum* | — | — | — | — | — | R | R | — | — | — | — | — |
| 53. | *Pleurosigma elongatum* | R | R | R | — | R | R | — | F | F | — | R | — |
| 54. | *P. directum* | R | R | R | R | F | F | F | R | R | — | R | R |
| 55. | *Navicula hennedyii* | R | — | — | — | — | R | — | R | — | — | — | R |
| 56. | *Amphiprora gigantea* var. *sulcata* | — | — | — | — | — | R | R | R | R | R | — | — |
| 57. | *Cymbella marina* | — | — | R | R | — | R | — | R | — | R | — | — |
| 58. | *Bacillaria paradoxa* | — | — | — | — | — | — | — | — | — | — | R | — |
| 59. | *Nitzschia sigma* var. *indica* | R | R | — | R | R | — | — | — | — | — | R | — |
| 60. | *N. closterium* | R | R | R | — | — | R | R | C | — | — | R | — |
| 61. | *N. longissima* | C | C | C | F | F | F | C | F | R | — | C | C |
| 62. | *N. seriata* | C | F | C | C | C | C | C | R | — | C | C | C |
| | DINOPHYCEAE | | | | | | | | | | | | |
| 1. | *Prorocentrum micans* | F | C | C | — | F | C | C | C | — | C | F | C |
| 2. | *Dinophysis miles* | — | — | R | F | R | R | — | — | — | — | R | — |
| 3. | *D. caudata* | R | — | R | — | R | R | R | C | R | R | — | — |
| 4. | *Amphisolenia bidentata* | — | — | — | — | R | R | R | — | — | — | — | R |
| 5. | *Ornithocercus magnificus* | — | — | — | R | R | R | — | R | R | — | — | R |
| 6. | *Gymnodinium* sp. | — | R | — | R | R | — | — | — | R | — | — | — |
| 7. | *Noctiluca miliaris* | R | — | — | — | R | R | — | — | R | — | — | — |
| 8. | *Peridinium oceanicum* | — | — | — | R | R | — | R | R | — | — | R | — |
| 9. | *P. steinii* | — | — | — | R | R | — | R | — | — | — | — | F |
| 10. | *P. pentagonum* | R | R | R | R | R | R | R | R | — | — | — | — |
| 11. | *P. claudicans* | — | F | R | — | R | R | — | R | R | — | — | R |
| 12. | *P. divergens* | — | R | R | — | — | — | — | — | — | R | — | — |
| 13. | *Ceratium fusus* | R | — | R | — | R | R | R | — | R | R | R | — |
| 14. | *C. tripos* | — | — | — | R | R | R | R | — | — | — | — | — |
| 15. | *C. macroceros* | — | R | R | — | R | — | R | — | R | R | R | R |
| 16. | *C. breve* | R | R | R | R | — | — | — | — | — | — | — | — |
| 17. | *C. vulture* var. *sumatranum* | — | R | — | — | R | R | — | — | — | — | — | — |
| 18. | *Cladopyxis caryophyllum* | — | — | — | R | R | R | — | R | — | — | — | — |
| 19. | *Ceratocorys horrida* | R | — | — | R | R | — | — | R | — | — | — | — |
| 20. | *Podolampas bipes* | R | — | — | R | — | — | — | — | — | — | — | — |
| 21. | *Phalacroma rotundatus* | — | — | — | — | — | R | — | — | R | — | — | — |
| 22. | *Goniaulax* sp. | — | — | — | R | R | R | — | — | — | — | — | — |
| 23. | *Pyrophacus horologium* | — | — | — | — | — | R | R | — | — | — | — | — |
| 24. | *Pyrocystis fusiformis* | — | — | — | — | — | R | — | R | — | — | — | — |
| | MYXOPHYCEAE | | | | | | | | | | | | |
| 1. | *Trichodesmium theibautii* | C | C | F | R | — | — | — | — | — | — | — | — |
| 2. | *Katagnymene spiralis* | R | R | — | — | C | — | — | — | — | — | — | — |
| 3. | *Oscillatoria* sp. | — | — | R | — | C | — | — | — | — | — | — | — |
| | SILICOFLAGELLATAE | | | | | | | | | | | | |
| 1. | *Dictyocha fibula* | R | R | R | R | R | R | R | — | — | — | — | R |
| 2. | *Distephanus speculum* | — | — | — | — | R | — | — | — | — | — | — | — |

A—abundant ≻ 5000 cells; C—common ≻ 1000 cells; F—few ≻ 500 cells; R—rare ≺ 250 cells; — absent (counts/m³).

## Discussion

While studying the seasonal variation in the abundance of phytoplankton, the total number of cells per unit volume and the displacement volume of plankton generally showed a similar trend excepting on few instances (Table 2) when the occurrence of monospecific bloom of *Skeletonema costatum* did not fit in with the general pattern. The temperature as such seems to have no direct influence on the phytoplankton production. Except for the decrease in temperature associated with the rainfall, large variations in temperature do not exist in the estuary (Qasim *et al.*, 1969). Thus it would appear that the increase in number as well as in volume is really brought about because of the enrichment of water with nutrients which occurs during the monsoon months and is associated with a fall in temperature and salinity.

In coastal waters also the reduction in salinity and temperature is linked with the enrichment of water with nutrients which leads to an increase in phytoplankton production. The effect of salinity on the phytoplankton abundance has been discussed in detail by Qasim *et al.*, (1972). In the Cochin Backwater the seasonal variability of the nutrients, especially nitrates and phosphates, control the production of phytoplankton. The role of nutrients and their seasonal variation in the Cochin Backwater have been discussed by Sankaranarayanan and Qasim (1969). The first peak of phytoplankton abundance observed during the monsoon months (May to July), appears to coincide with the maximum concentrations of phosphates and nitrates in the estuary (Sankaranarayanan and Qasim, 1969). The phosphorus and nitrogen values after attaining their first peak during the period of May to July, decline sharply. This seems to be associated with a sudden fall in the standing crop of phytoplankton also. Another peak of nutrient enrichment in the backwater occurs during the post-monsoon period (Sankaranarayanan and Qasim, 1969). The second peak in the phytoplankton production noticed also coincides with this period.

These features clearly indicate that the changes in salinity and temperature associated with high nutrient concentration in the backwater are mainly responsible for the abundance of phytoplankton during the monsoon and post-monsoon periods. Subrahmanyan (1958, 1960) and Subrahmanyan *et al.* (1971) have shown that along the west coast of India, whenever there was a fall in temperature and salinity associated with the enrichment of water, a rise in the abundance of phytoplankton occurred. Studies on the phytoplankton of the Calicut coast (George, 1953 ; Subrahmanyan, 1959) and on the Trivandrum coast (Menon, 1945), showed that almost all peaks of phytoplankton production coincide with low salinity, low temperature and high nutrient concentrations. A direct relation of phytoplankton production with low salinity and temperature seems an adaptation by the phytoplankton to utilize the enrichment to the maximum degree (Qasim *et al.*, 1972). These studies confirm that in the inshore areas where much dilution occurs, salinity, temperature and nutrients are the main factors controlling the abundance of phytoplankton.

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