J. mar. biol. Ass. India, 26 (1 & 2) : 42-46

STUDIES ON PHYTOPLANKTON IN POLLUTED WATERS

K. J. JOSEPH, P. N. K. NAMBISAN, C. S. SHYNAMMA* AND P. T. LAKSHMANAN**

School of Marine Sciences, University of Cochin, Cochin 682 016

ABSTRACT

Seasonal and spatial distribution of phytoplankton in the pollution hit areas of the Periyer River tributary near the industrial belt of Alwaye have been studied. The station near FACT is noted for the total absence or poor concentration of phytoplankton; the high NH_3-N (20 to 500 μ g at l^{-1}) recorded at the station appears to inhibit the rate of photosynthesis. The remaining stations on either side show comparatively less NH_3-N concentrations and support more phytoplankton production.

INTRODUCTION

THE FREQUENT occurrence of fish mortality in the pollution hit areas of Periyar River prompted us to take up this investigation. Though much work has been done on several parameters of apparently less polluted areas of Cochin Backwater (Qasim *et al.*, 1972., Gopinathan, 1972; Nair *et al.*, 1975 a, b; Joseph and Pillai, 1975) very little work has been done in the pollution hit area near the industrial belt of Alwaye. The aim of this study is to analyse the effect of pollution at the primary tropic level. This study forms part of the extensive investigation carried out on pollution in Vembanad Lake and connected waters.

The authors are grateful to the University Grants Commission, New Delhi for financial assistance, to the University of Cochin for facilities and to Prof. Dr. C. V. Kurian for the encourgement to carry out this investigation.

MATERIAL AND METHODS

Samples for hydrography and phytoplankton were collected during pre-monsoon, monsoon and post-monsoon periods from three selected stations; one near FACT (Station No. 2) and the other two Stations, Alupuram (Station No. 1) and Eloor (Station No. 3) on either side of the former. The incorporation of C^{14} was measured though not intended to estimate the quantum of production. Day time variation of O_2, phytoplankton and other hydrographic parameters were also measured, in two selected stations. Quantitative study of phytoplankton was carried out by sedimentation method. Standrad methods were followed for obtaining hydrographic data (Strickland and Parson, 1965).

RESULTS AND DISCUSSION

Though the momentary census of the primary producers need not necessarily indicate the production in polluted waters, their poor concentration to some extent is an index of the adverse environmental conditions prevailing there. During the premonsoon the first station showed comparatively more standing crop (20,000/1) comprising *Pleurosigma* and *Microcystis*, while the second station recorded less phytoplankton (12,500/1), the flora being *Microcystis* and *Thalassiosira* and the last station showed the presence of *Navicula* and *Oscillatoria*, their concentration being 7500/1 (Table 1) The water in the first 2 stations was almost saline free and the third gave a salinity of 3‰

* Present Address : School of Environment Studies, University of Cochin, Cochin 682 016.

* Present Address : Central Institute of Fisheries Technology, Matsyapuri, Cochin 682 029.

The dominant flora in the fresh water station was *Microcystis*. The third station was noted for the total absence of organisms present in other stations. This is a clear indication of the effect of tide and consequent influx of phytoplankters from the nearby estuary where salinity at this period was 29‰. Unless they are tolerant to salinity change they would be physiologically inactive. The last two stations were noted for the high concentration of $PO_4 - P$ during this period (Table 1). It is remarkable to note the almost total absence of Ammonia in the first station and its presence in high concentration in subsequent stations. The highest concentration of 288 μg at NH_3–N/l has been recorded here. The extremely high concentration of both phosphate and ammonia has its origin from the effluents from the nearby factories situated on either bank of the tributary.

During the monsoon period a decrease in the concentration of both phosphate and ammonia was observed. The first station recorded the highest concentration of flora (30,000/1). The phytoplankters were *Oscillatoria, Anabaena* and *Microcystis* of which the latter formed the major flora. The second station close to the source of pollution gave a phytoplankton concentration of 12,500/1 the species being *Thalassiosira* and *Oscillatoria* and the third station showed a concentration of 15,000/1 the phytoplankton being *Thalassiosira, Oscillatoria* and *Synechocystis*. The decrease in the concentration of phosphate and ammonia was due to the fresh water discharge. During the post-monsoon the concentration of phytoplankton at the first, second and third stations was 15,000/1, 8,400/1 and 30,000/1 respectively. While *Scenedesmus, Navicula* and *Nitzschia* were the dominant flora at the first two stations the dominant flora of the third station was *Leptocylindrus*. The nitrate concentrations did not show any marked variation. While the first and last stations were noted for the total absence of phosphate the middle station recorded a concentration of 2.42 μg at/l (Table 1).

Simultaneous day time observations were made during October 1979 in the first two stations at two hours of regular intervals showed marked variations in the qualitative and quantitative abundance of phytoplankton (Table 2). At the first station which was away from the source of effluents from the factories maximum standing crop of 2,74,000/1 was recorded, at 1100 hours. The species included *Nitzschia, Navicula, Thalassiosira, Thalassionema, Synechococcus, Pandorina* and *Cosmarium* species. The phytoplankton concentration showed a gradual increase from 19,000 at 0700 hrs to 2,74,000 at 1100 hrs and then showed a gradual decrease with the decrease of light intensity recording the minimum at 1700 hrs. At 1100 hrs the number of species increased to 7. The incorporation of radioactive carbon was proportional to the density of phytoplankton. Maximum incorporation of C^{14} (1008 cpm) was found between 1100 hrs and 1300 hrs when the standing crops was maximum. The minimum counts observed was 366 cpm between 1700 hrs and 1900 hrs when the concentration of phytoplankton also recorded the minimum. The phosphate and nitrite were present only in traces.

The second station showed high concentration of phosphate, the maximum value recorded being 955 μg at/l. The maximum phytoplankton concentration recorded was 94,800/1 at 0700 hrs which was only one third of the maximum standing crop recorded at the other station. The number of species was also restricted to 4 while the other stations supported more number of species. The environmental parameters appeared to be unfavourable for the survival of certain species. The comparatively poor concentration of phytoplankton may be due to long generation time which was influenced by environmental conditions. The dominant phytoplankters distributed were *Navicula, Nitzschia* and *Scenedesmus*.

The phytoplankters *Thalassionema, Synechococcus, Cosmarium* and *Pandorina* which

TABLE 1. *Seasonal variation of Phytoplankton*

Station No.	Pre-monsoon S ‰	O_2 ml/l	NO_3-N µg at/l	NH_3-N µg at/l	PO_4-P µgat/l	Phyto-plankton	Monsoon S ‰	O_2 ml/l	NO_3-N µg at/l	NH_3-N µg at/l	PO_4-P µg at/l	Phyto-plankton	Post-monsoon S ‰	O_2 ml/l	NO_3-N µg at/l	NH_3-N µg at/l	PO_4-P µg at/l	Phyto-plankton
1.	0.0	4.53	1.85	4.50	Trace	20,000	0.0	2.93	5.48	Trace	1.4	30,000	0.0	5.55	3.33	3.40	Trace	15,000
2.	0.0	2.28	4.89	288.00	110.14	12,500	0.0	3.11	6.10	88.60	27.53	12,500	0.0	5.44	4.66	78.00	2.42	8,400
3.	3.1	3.79	6.25	215.00	148.14	7,500	0.0	3.07	7.07	68.86	31.06	15,000	0.0	5.65	4.66	72.00	Trace	30,000

were present at Station No. 1 were totally absent in Station No. 2. The absence of these flora at Station 2 was significant in spite of the close proximity of the stations. Unlike the other station where the maximum concentration was at 1100 hrs, the maximum concentration observed at station No. 2 was at 0700 hrs. Here too, there was close relation between C^{14} incorporation and phytoplankton concentration. The incorporation of radioactive carbon varied from 49 cpm between 1300 hrs and 1500 hrs to 1086 cpm between 0700 hrs and 0900 hrs. The corresponding phytoplankton concentrations were 6,000/l and 94,800/l.

The phytoplankton population of the area under investigation includes mainly of estuarine and fresh water species. Estuarine diatoms have the widest adaptability to any change in salinity of external medium (William, 1964). These estuarine species were recruited to this area due to tides. Their photosynthetic rate did not appear to be affected by the change of salinity as indicated by the direct relation of the incorporation of C^{14} and phytoplankton parameters prevailing at station 2 which was near the source of pollution acted as a barrier in the distribution of certain species as was evidenced by their total absence. The effluent was not found to inhibit the rate of production, but controlled the generation time and qualitative distribution of phytoplankton. However, in lesser concentration, the effluents enhanced the rate of production. Aqueous extract of several hydrocarbons in lesser concentration has been found to enhance the rate of photosynthesis in selected species of phytoplankton cultures.

The pre-monsoon period recorded the highest concentration of 20,000/l at station 1 whereas the two stations recorded comparatively low standing crop. The low concentration of phytoplankton was probably due to the high concentration of phosphate (Table 1). The monsoon period also showed almost the

same trend. The post-monsoon value indicated that the lower concentration of PO_4–P in this region did not act as a controlling factor. From this study it is evident that atleast certain species did not tolerate phosphate concentration above a particular level. This is evident from the exculsion of certain species and comparatively poor concentration of phytoplankton in the area of high phosphate concentration.

TABLE 2. *Day time variation of hydrographic parameters*

Time hrs.	Temp. °C	PO_4–P µg at/l	NO_2–N µg at/l	NH_3–H µg at/l	(O_2 ml/l	pH	C^{14} cpm	Phytoplankton/l
				Station 1				
700	29.6	tr	9.34	9.29	5.1	7.3	428	19,000
900	30.4	tr	tr	3.57	5.2	7.30	504	84,000
1100	30.6	tr	tr	17.86	5.1	7.25	1008	2,74,000
1300	31.0	tr	tr	5.00	5.15	7.20	792	1,72,000
1500	31.1	41.50	tr	28.57	5.2	7.35	438	50,000
1700	30.0	41.50	tr	14.29	5.2	7.35	366	14,400
				Station 2				
700	30.8	892.70	56.00	1152.00	5.0	6.3	1086	94.800
900	30.8	954.96	28.00	659.30	5.0	8.6	90	8,000
1100	30.6	705.56	35.42	84.50	5.0	8.2	108	24,000
1300	30.8	394.29	56.00	205.00	5.0	6.8	48	6,000
1500	30.1	41.50	14.00	82.86	5.2	6.85	564	33,000
1700	30.1	278.4	12.68	40.00	5.2	—	102	7,000

The comparatively low concentrations of phytoplankton are not due to the lack of phosphate (and other nutrients), but due to the extremely high concentration of phosphate which inhibit the growth.

In many waste affected waters, nitrogen is the algal growth controlling nutrient especially when the degree of pollution is very high. In less polluted waters, phosphate play the corresponding role (Curt Forsbert, 1976).

This polluted environment does not support the survival of organisms at higher trophic level. Though the effluents appeared to be apparently not harmful at the primary trophic level the conversion of primary food to higher trophic level is made impossible at this area by effecting mortality of fish and other organisms.

References

CURT FORSBERG 1976. Nitrogen and phosphorus as Algal growth limiting nutrients in waste receiving water. In: O. Devik (Ed.) *Harvesting of polluted waters.* pp. 27-38.

GOPINATHAN, C. P. 1972. Seasonal abundance of phytoplankton in the Cochin Backwater. *J. mar. biol. Ass. India,* **14** (2): 568-577.

JOSEPH, K. J. AND V. KUNJUKRISHNA PILLAI 1975. Seasonal and spatial distribution of phytoplankters in the Vembanad Lake. *Bull. Dept. Mar. Sci. Uni. Cochin,* **7**: 171-180.

NAIR, P. V. R., K. J. JOSEPH., V. K. BALACHANDRAN AND V. KUNJUKRISHNA PILLAI 1975. A study of the primary production in the Vembanad Lake. *Ibid.*, 7-161-170.

QASIM, S. Z., P. M. A. BHATTATHIRI AND V. P. DEVASSY 1972. The influence of salinity on the rate of photosynthesis and abundance of some tropical phytoplankton. *Mar. Biol.*, **12**: 200-206.

STRICKLAND, J. D. H. AND T. R. PARSONS 1965. *A Manual of Sea Water analysis.* Fish. Res. Bd. Canada.

WILLIAMS, R. B. 1964. Division rates of marsh diatoms in relation to salinity and cell size. *Ecology*, **45**: 877-880.