

## STUDIES ON CIRCADIAN VARIATIONS IN A FRESHWATER POND IN RANCHI, BIHAR . II - BIOTIC FACTORS.

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### ABSTRACT

A general pattern of increase of phytoplankton in day time and decrease at night time and an increase of zooplankton at night and early morning hours and decrease in day time has been observed. The phytoplankton was mainly constituted by the Cyanophycean phytoplankters and these were responsible for the pronounced diurnal variations which may be attributed to the gas- vacuoles present among the Cyanophycean genera. The zooplankton showed a general tendency towards nocturnal upward movement. The present investigation concludes that various physico-chemical and biological factors account for daily vertical migration of the plankton.

### INTRODUCTION

'One cannot throw two stones ecologically in the same pond' as the abiotic factors of a water body changes every minute. Thus, for any scientific utilization of natural waters, the studies on diurnal and seasonal variations of the abiotic and biotic factors became a fundamental pre-requisite. Studies on diurnal variation specially of biotic factors in tropical and sub-tropical waters are meagre. In India, works on similar aspects by Bose (1968), Bohra et al. (1968), Govind (1969), Jana and Sarkar (1973), Vasisht and Sharma (1980), and Bose and Bose (1980), are worth quoting. However, there is insufficient literature pertaining to the diurnal variation of biotic factors on the aquatic biotopes of Chhotanagpur region. The present communication records the diurnal variations of biotic factors in a freshwater pond of Ranchi located between 83° 28' E long. and 25° 15' N Lat.

### MATERIAL AND METHODS

A series of three hourly collections were made between 7th and 8th October 1978. 20 litres of surface water was filtered everytime through a conical plankton net made of standard bolting cloth (no.25). The collected samples were preserved in 4% formaline. The plankton population was counted by the methods as outlined by A.P.H.A. (1971).

### RESULTS AND DISCUSSION

The data recorded of variation in phytoplankton and zooplankton population has been shown in Table-1

**Phytoplankton:** Unlike zooplankton, phytoplankton were recorded more in numbers during day time. Among phytoplankters Cyanophyceae was the dominating group, the maxima of which was (96.4% of the total phytoplankton population) recorded at 18.00 hours. But its minimum population density was recorded at 15.00 hours when the temperature was maximum. The peak of Chlorophycean plankters was recorded at 15.00 hours.

**Zooplankton:** The zooplankton in general were found more abundant during night and early morning hours but their population decreased after 09.00 hours and the minima of which was recorded at 15.00 hours from the surface water. The different genera and species showed their own species variation.

TABLE - 1

Diurnal variation in phyto and zooplankton population (per litre population presented in percent).

P l a n k t o n	T i m e i n h r s .							
	0 9 . 0 0	1 2 . 0 0	1 5 . 0 0	1 8 . 0 0	2 1 . 0 0	2 4 . 0 0	0 3 . 0 0	0 6 . 0 0
<i>Microcystis sp.</i>	50.3	72.3	40.1	84.3	61.2	59.3	59.1	57.8
<i>Anabaena sp.</i>	2.4	2.0	-	3.1	0.6	-	-	1.0
<i>Phormidium sp.</i>	3.1	4.6	2.2	6.2	3.1	1.3	1.1	2.1
<i>Nostoc sp.</i>	1.6	-	-	1.2	0.5	0.7	-	-
<i>Spirulina sp.</i>	-	-	-	1.1	-	0.3	-	-
<i>Spirogyra sp.</i>	20.1	10.1	26.8	-	20.4	22.6	25.3	23.2
<i>Chlorella sp.</i>	6.2	-	6.8	-	8.8	10.0	2.6	-
<i>Volvox sp.</i>	10.0	3.7	11.3	2.1	-	-	-	4.3
<i>Pleurococcus sp.</i>	-	1.1	4.9	-	4.2	-	-	1.2
<i>Nevicula sp.</i>	2.3	1.7	2.5	-	0.7	2.5	4.4	3.3
<i>Nitzschia sp.</i>	4.2	4.5	5.4	1.5	0.5	3.3	7.5	7.1
<i>Keratella sp.</i>	8.2	-	-	-	9.1	8.3	12.6	11.7
<i>Drachionus sp.</i>	20.7	16.1	11.2	18.4	14.2	11.6	8.3	9.2
<i>Nauplius sp.</i>	6.3	8.4	5.6	7.6	11.7	62.1	75.2	49.1
<i>Cyclops sp.</i>	10.3	10.4	-	12.7	17.3	6.2	-	11.4
<i>Moina sp.</i>	-	3.5	4.8	1.2	1.6	-	-	-
<i>Daphnia sp.</i>	36.4	39.8	26.2	60.1	46.1	11.8	3.9	16.1

One of the most striking phenomena manifested by plankton is the diurnal vertical migration of certain prominent plankters (Welch, 1952). In the present observation, both phytoplankton and zooplankton showed clear diurnal variation. Similar observations have also been made by Bose (1968), Govind (1969), Bohra et al (1978), Kumar et al (1978) and Bose and Bose (1980) in different freshwater bodies of India. A general pattern of increase of phytoplankton during day hours and decrease at night and an increase of zooplankton at night and morning hours and decrease in day time surface water, as observed, is in agreement with the reports of Bose (1968), Bohra et al (1973), Kumar et al (1978), Bose and Bose (1980) but contradicts Vasisht and Sharma (1980), who recorded higher number of both phytoplankton and zooplankton during night hours. The causes of diurnal variations (movements) are but partly understood (Welch, 1952). For zooplankters, however, it is not very difficult to explain the diurnal variation by vertical migration as the phytoplankton since the former have some locomotory capacity while the latter do not.

The bulk of phytoplankton as observed (upto 95.9%) was constituted by Cyanophyceae plankton causing the apparent diurnal variation in phytoplankton population. The so pronounced diurnal variation in the group may be attributed to gas-vacuoles present among the Cyanophyceae genera. Fogg (1972) has shown that the gas vacuoles are more commonly produced under low intensity of light and sudden collapse under high intensity of light. This result according to Fogg (1972) is due to an increase in the photosynthesis rate which produces more quantity of sugar and increases the osmotic pressure so that there is a quick collapse of gas vacuoles at the surface of water in planktonic species. After collapse the filaments sink down. They come to the surface of water again and the process is continued. The Cyanophyceae share 78.9%, 42.3% and 95.9% at 12.00, 15.00 and 10.00 hours respectively, of

the total phytoplakton population, confirm the finding of Fogg (1972). Further more the minimum percentage, i.e. 42.3% during the hottest part of the day is totally in agreement with his (Fogg's) observation. It seems reasonably certain that light is the most important factor responsible for the diurnal movements, but it is not known whether the response is due to intensity per se or to change of intensity Welch (1952). However, on the basis of Fogg's (1972) observation, the change of light intensity is probably the reason, atleast in the case of Cyanophyceae plankters.

Vertical migration is extremely wide spread among the freshwater zooplankton (Hutchinson, 1967) and a general tendency toward nocturnal upward movement is the most common pattern (Lewis Jr., 1979), which is in accordance with the present finding. Various factors viz., temperature, light, dissolved gases, wind action, gravity (Welch, 1952) have been put forward to explain the variation. The phenomena behind the changes in physico-chemical factors is governed by geophysical cycle and the daily rhythms of 24 hours in length are locked or 'entrained' to this frequency mainly by light-dark cycles generated by rotation of the earth round its axis. However, no single factor alone can be said to be the limiting factor of planktonic diurnal movements. The distinct diurnal variations during the present study may also be attributed to the homothermal nature of the pond.

In the present observation, different zooplankters showed different pattern of diurnal variations. A similar observation has also been reported by Vasisht and Sharma (1980), Michael (1966), Bose and Bose (1980). Different species of *Brachionus*, i.e. *B. caudatus*, *B. plicatilis*, *B. quadridentata* and *B. calyciflorus* almost behaved similarly, being present in the large numbers at 09.00 hours. Some of the crustaceans however, did not show marked fluctuation although high number was found during night and morning hours. Nauplii were present throughout the period but more at night. Apart from the physico-chemical factors, the reason of diurnal variation has been explained variously such as Lewis Jr. (1979) attributed it to the nocturnal habit of the zooplankton while Jana and Sarkar (1973), Vasisht and Sharma (1980) observed it to be governed by their feeding habits. Lane (1975) observed diurnal variations in zooplankton enforced by resource based competition while Zaret and Suffern (1976) concluded that predation is the general evolutionary cause of migration and they explained it as predator-avoidance mechanism. However, on the basis of the present investigation it is concluded that both physico-chemical and biological factors account for the daily redistribution of the plankton through changing of niche of plankters.

## REFERENCES

- A.P.H.A. 1971. Standard Methods for the Examination of Waste and Waste Water. - **Am. Public Health Assoc.** New York.
- Bohra, O.P., Bhagat, M.J. and Iftakhar, M. 1978. Observation on diurnal variations in hydrobiological factors at Powai Lake, Bombay. - **Comp. Physiol. Ecol.** 3(4) : 200-215.
- Bose, S.K. 1968. Ecological studies of some food fishes of Ranchi with special reference to hydrology, plankton and pedon (bottom fauna). - Ph.D. Thesis, Ranchi University, Ranchi.
- Bose, S.K. and Bose, K.C. (1980). Diurnal variation of limnoplankton correlated with physico-chemical factors of Ranchi Lake, Ranchi. - 1st. Indian Conference of Ecology and Env. Sci. Jaipur, 108-112.
- Fogg, G.E. 1972. Gas vacuoles and their ecological significance. In Desikachery, T.V. (ed.). - **Inter Symp. Taxon. And Biol. of Bluegreen algae**. London, 300 p.
- Govind, B.V. 1969. Planktological studies on plankton of the Tungabhadra Reservoirs and its comparison with other storage reservoirs in India. - Proc. of the Seminar on the Ecology and Fisheries of freshwater reservoirs at CIFRI, Barrackpore. 72-88.
- Hutchinson, G.E. 1967. **Treasure on Limnology**, Vol. II - John Wiley, New York.
- Jana, B.B. and Sarkar, H.L. 1973. Diurnal rhythm of limnoplankton in a tropical freshwater pond in Santiniketan, India. - **Proc. 60th Indian Sci. Congr.** (3), 180-185.
- Kumar, J.K., Khan, M.A., Aziz Hussain, M. and Mahmood, M. 1978. Observation on diurnal variation in hydrological conditions of two fish ponds of Hyderabad, India. - **Comp. Physiol. Ecol.** 3: 111-114.

- Lanc, P.A. 1975. The dynamics of aquatic ecosystem : A comparative study of the structure of four zooplankton communities. - *Ecol. Monog.* 45: 307-336.
- Lewis, W.M. Jr. (1979). *Zooplankton community analysis*. - Springer Verlag, New York.
- Michael, R.G. 1966. Diurnal variation in physico-chemical factors and zooplankton in the surface layer of three freshwater fish ponds - *Indian J. Fish.* 13: 48-82.
- Vasisht, H.S. and Sharma, B.K. 1981. Diurnal variation in a freshwater pond in Ambala City, Haryana, India. - *Proc. Zool. Sci. Calcutta.* 31: 63-68.
- Welch, P.S. 1952. *Limnology*. - Mc Graw Hill Book Comp. Inc. New York.
- Zaret, T.M. and Suffern, J.S. 1976. Vertical migration in zooplankton as a predator avoidance mechanism. - *Limnol. Oceanogr.* 21: 804-813.