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DIURNAL MOVEMENT OF ZOOPLANKTON IN LAKHOTIA LAKE

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INTRODUCTION

Studies on diurnal variations in physico-chemical and biological factors have been carried out in Indian freshwaters by a number of workers (Ganapati, 1955 ; George, 1961 ; Krishnamoorthi and Visweswara, 1963 ; Michael, 1964 ; Verma, 1964 ; Sumitra, 1971, and Patil and Marathe, 1982). But most of the research work is centred around south and north Indian waters. In western India, Rajasthan is the largest state and inspite of the fact that the desert comprises nearly one-third of its area, there are few potential vast and varied freshwater resources, work on lakes has begun recently. Limnological studies on physico-chemical and biological Parameters contributed by Bohra (1976) and Dey and Misra (1978) are only for one season. Hence the present investigations were carried out in order to understand the diel movement of zooplankton in different seasons in a lake namely 'Lakhotia' located at Pali.

Lake and its environment :

Lakhotia is a man-made, rainfed, perennial lake of Pali. It is roughly triangular, having a maximum length of 1823 m in the east-west direction and breadth of 950m in the north-south direction. The maximum depth of the lake was 4.5 m. The vegetation around the vicinity of the lake consisting of xerophytic shrubs and trees, is confined mainly to the southern side. In the littoral zone an aquatic grass, *Scirpus tuberosus* grows on the eastern bank.

MATERIALS AND METHODS

Climate : According to Weather Report, Central Arid Zone Research Institution Jodhpur (1973), there are three seasons in Rajasthan viz,

Summer (March—June),

Monsoon (July—October) and

Winter (November—February).

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In order to understand the diurnal movement of zooplankton, three diurnal studies were conducted one in each season. In each study samples were collected at three hourly intervals for a period of 24 hours from surface, 1 m depth and bottom. The sampling site was chosen almost in the centre of the lake.

The surface and sub-surface water temperature was recorded with a mercury thermometer (0-50°C). Transparency was measured by a standard secchi disc of 20 cms diameter. For the collection of zooplankton, water from the surface was taken with a plastic bucket and from various depths taken with the aid of Van Dorn Sampler. In each case 50 litres of water was filtered through a nylobolting silk net (0.3mm mesh size) having a plankton collecting bottle at one end. Zooplankton thus collected in the collection bottle were transferred into polythene bottles and preserved in 4% formalin. The identification and counting was done on a counting chamber under a binocular microscope.

Results

The data on diurnal fluctuations of temperature in air and water and transparency in summer, monsoon and winter are given in Table—1.

The maximum air and water temperatures were recorded in May (summer) while minimum in January (winter). The air temperature ranged from 30.0° to 39.0°C in summer, 26.0° to 37.0°C in monsoon and 12.5° to 27.0°C in winter.

In summer, the water temperature varied from 28.4° to 32.1°C at the surface, 27.2° to 30.0°C at 1 m depth and 27.0° to 30.0°C at the bottom. The diurnal difference in water temperature between that of surface and 1m depth was in the range of 1.5° to 2.1°C during day hours and 1.0° to 1.5°C during night hours. This indicated the presence of an "epilimnional" thermal stratification in between surface and 1 m depth layers. However, isothermal conditions were observed between 1 m and bottom throughout the diel cycle.

In monsoon, the water temperature was at the maximum (32.1°C) at 1500 hrs and minimum (23.5°C) at 0300 and 0600 hrs at all depths. It was not influenced by ambient temperature during night (2100 to 0600 hrs) and during that period it was found higher than the ambient temperature. This might be due to high specific heat of water as it takes longer time to warm and cool than the air.

Like diurnal of monsoon, the water temperature in winter was not influenced by the ambient temperature during night hours and remained higher than that of ambient at all depths. During that time the

TABLE 1. Diurnal fluctuations in temperature and transparency in Lakhotia lake

Season	Parameter	Depth	Time in hours 1200	1500	1800	2100	2400	0300	0600	0900	1200
Summer 23rd & 24th May, 1977	Air temperature (°C)		39.0	38.5	35.6	32.2	32.0	30.0	31.7	36.1	38.5
	Water temperature (°C)	S	32.1	31.5	30.5	29.6	28.4	28.4	29.7	30.5	31.5
		M	30.0	30.0	29.0	28.3	27.3	27.2	28.0	29.0	30.0
		B	30.0	30.0	29.0	28.3	27.0	27.0	28.2	29.0	30.0
	Transparency (cms)		15	12	10	—	—	—	17	20	16
Monsoon 27th & 28th September, 1977	Air temperature (°C)		37.0	37.0	32.5	29.0	27.5	26.2	26.0	31.0	36.9
	Water temperature (°C)	S	31.0	32.1	31.0	30.5	30.0	29.0	29.0	29.6	31.4
		M	30.0	31.6	30.5	30.0	29.0	28.5	28.5	29.0	30.0
		B	29.5	31.2	29.5	29.0	28.5	28.5	28·5	29.4	29.9
	Transparency (cms)		45	45	45	—	—	—	55	60	60
Winter 25th & 26th January, 1978	Air temperature (°C)		27.0	27.5	22.0	16.5	16.0	13.0	12.5	18.5	25.0
	Water temperature (°C)	S	19.6	19.0	19.0	18.0	18.0	18.0	17.0	17·5	18.9
		M	18.6	18.5	18.0	18.0	18.0	17.0	17.0	17.5	18.0
		B	17.5	17.4	17.0	17.0	17.5	16.0	16.0	17.0	17.8
	Transparency (cms)		55	45	40	—	—	—	45	47	55

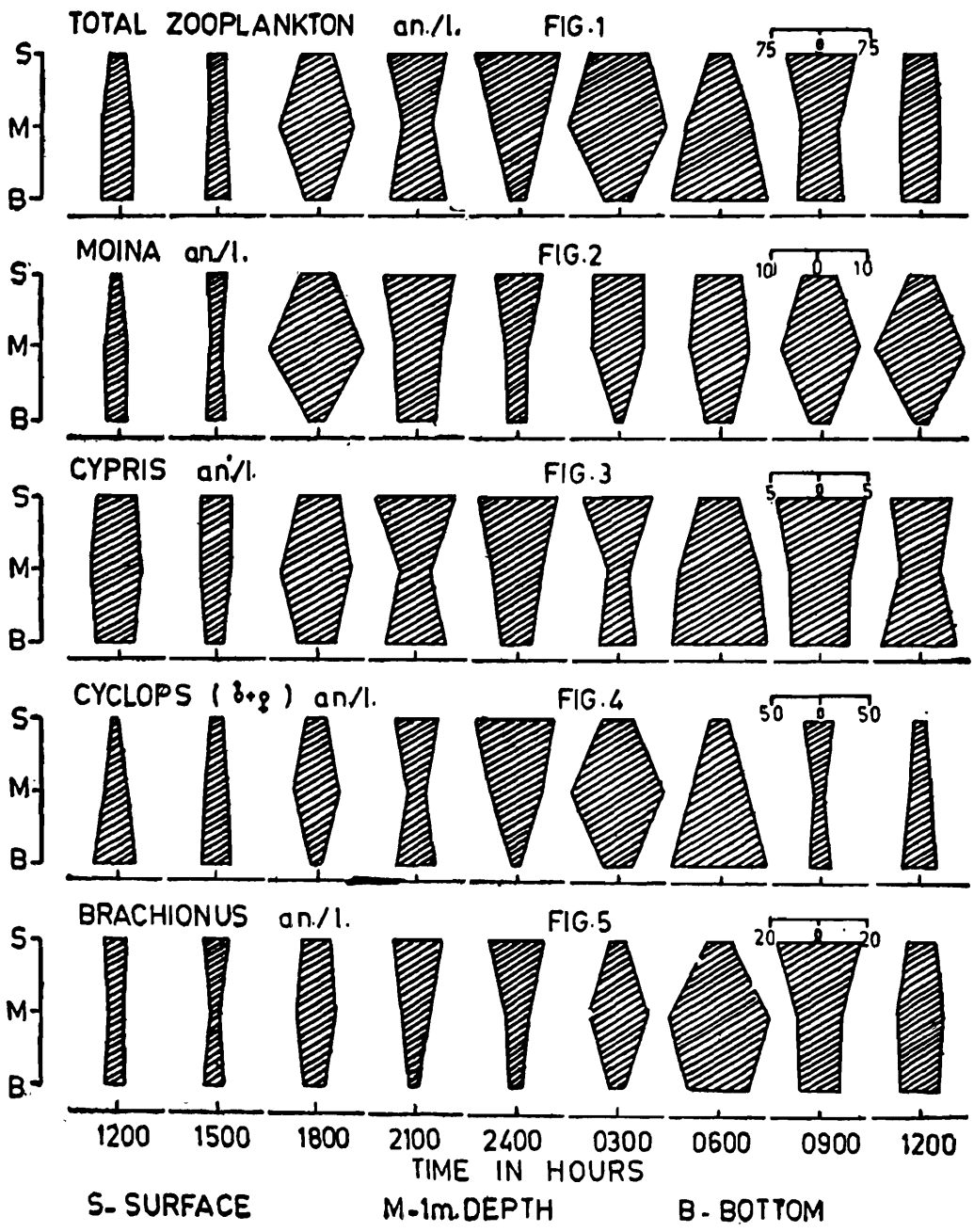
S—Surface. M—1 m depth. B—Bottom.

maximum difference between ambient and water temperature was of 5°C (Table-1).

Maximum transparency was recorded during monsoon and minimum during summer diurnal. Secchi disc reading varied from 10-20 cms in summer, 45 to 60 cms in monsoon and 40 to 45 cms in winter.

The total zooplankton population during summer was at its minimum (21 an./1) at 1200 hrs at the surface and then it increased from 1500 hrs onwards, attaining a peak (131 an./1) at 2400 hrs, thus, exhibiting a characteristic diurnal pattern of decrease in day and an increase

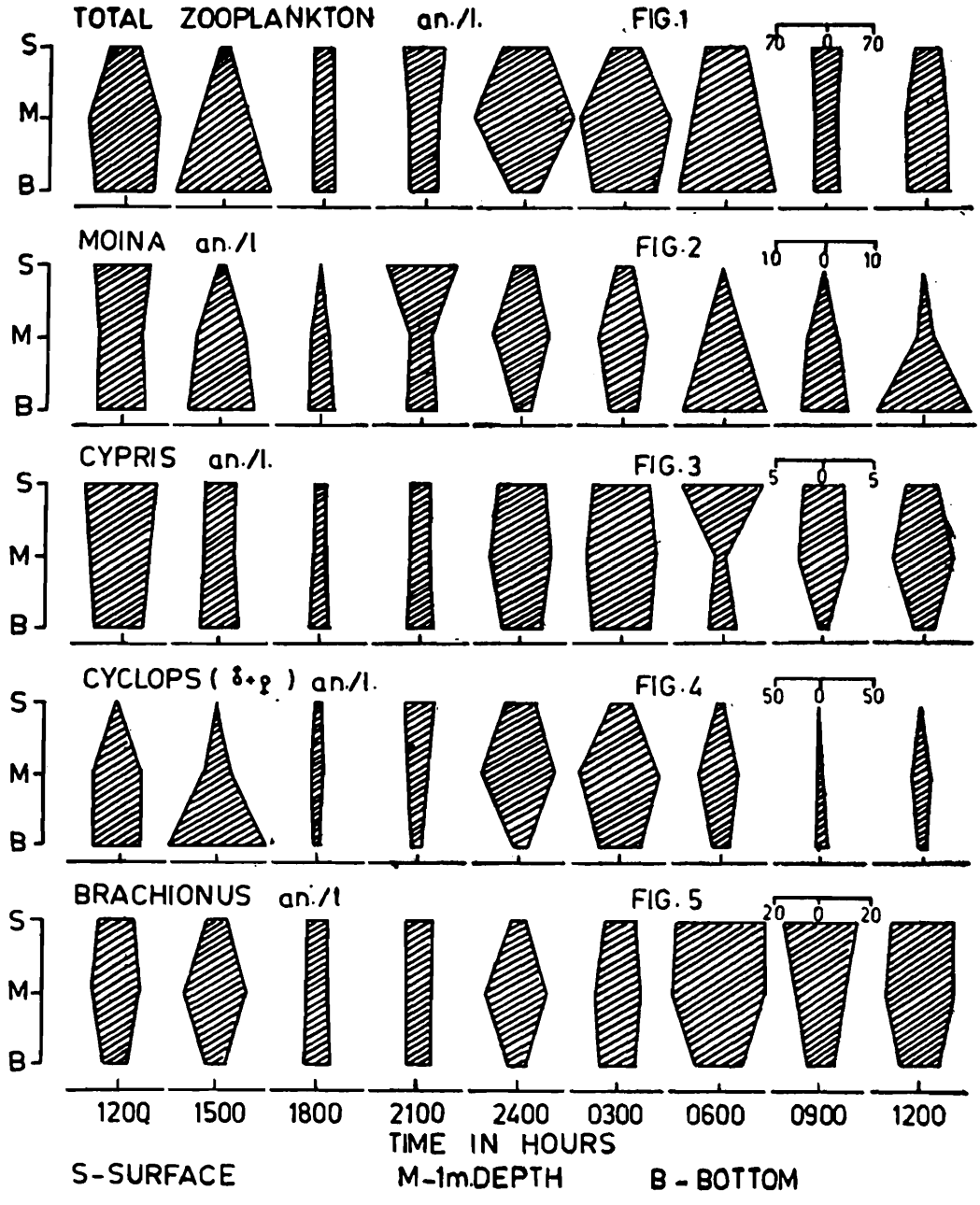
PLATE 1.



during night hours. The minimum numbers (22 an./1) at 1 m was at 1500 hrs and maximum (145 an./1) at 0300 hrs (next day). At the bottom, minimum (28 an./1) population was recorded at 2400 hrs and maximum (145 an./1) at 0600 hrs of the following day (Plate I, Fig. 1).

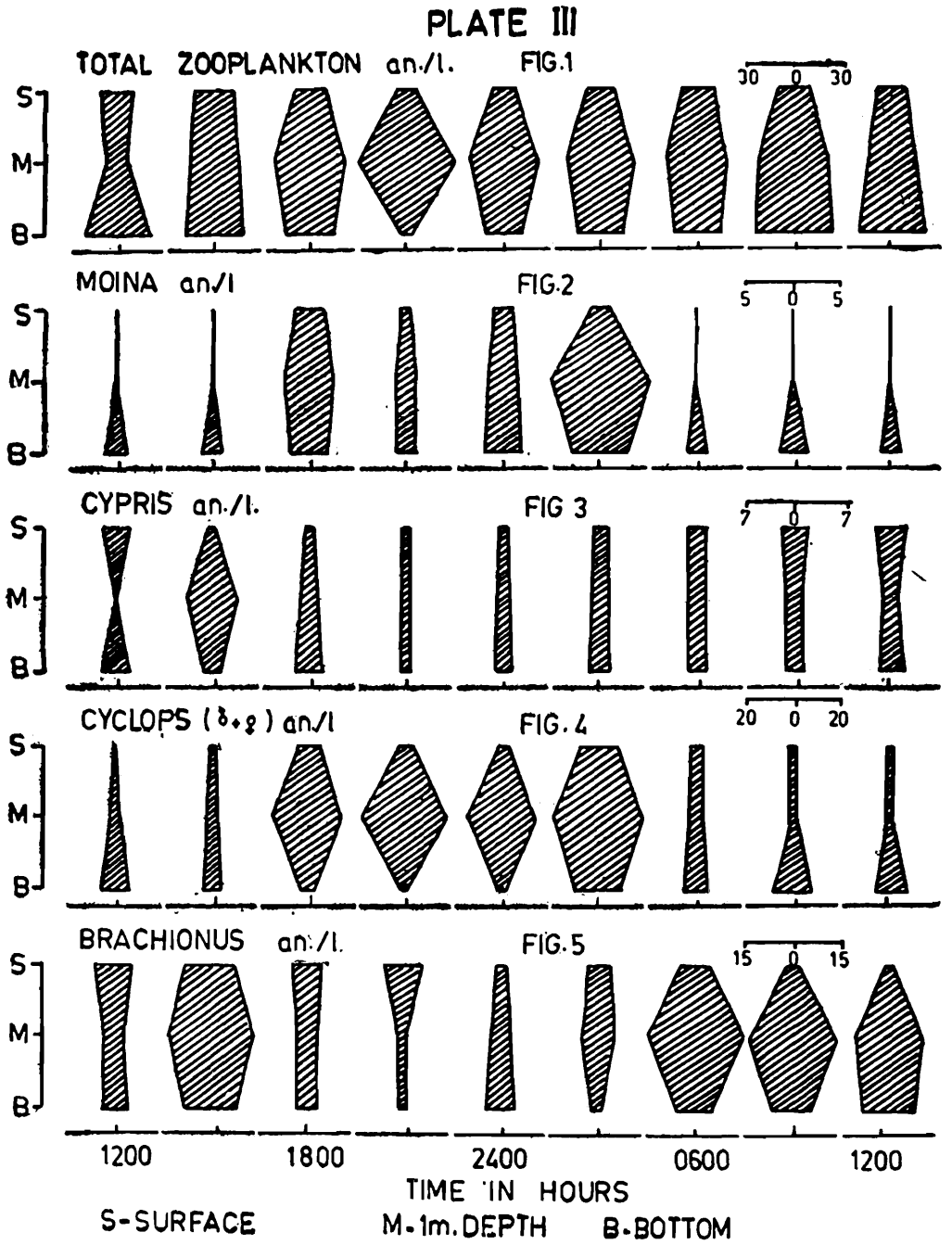
During monsoon total zooplankton showed a gradual increase at the surface from 1800 hrs onwards, reaching its maximum at 2400 hrs. (Plate II, Fig. 1). The same trend was observed at the bottom from 2100 hrs which continued till the population attained its peak (0600 hrs). However, at 1 m depth, zooplankton did not show any definite trend.

PLATE II



In winter, the population of zooplankton was poor in comparison to that observed in the diurnal studies of summer and monsoon and showed a reverse trend of decrease during night at the surface. The minimum population was at 2100 hrs at the surface and the bottom, while at 1 m depth it was at its peak (Plate III, Fig. 1). The maximum number was observed during daytime at the surface (1500 hrs) and bottom (0900 hrs), whereas at 1 m it was at its minimum (1200 hrs).

Zooplankton population comprised of members of Cladocera, Ostracoda, Copepoda and Rotifera. Their distribution in different seasons are given in Table-2. The diurnal fluctuations in population during various seasons along vertical profile of the lake, of the genera mentioned in Table-2, are represented in Plates I to III, Figs. 2 to 5.



During summer *Cyclops* sp showed an increasing trend from 1500 hrs onwards till it reached its maximum at 2400 hrs at the surface, then the population moved to 1 m and finally to the bottom at 0600 hrs (Plate I, Fig. 4). During monsoon the population of *Cyclops* sp at the surface was poor, ranging from nil to 5 an./1. It then showed a sudden increase at 2400 hrs but in the following hours it again declined, whereas at 1 m depth and the bottom a reverse trend of increase in number was observed from 2100 hrs to 0300 hrs (Plate II, Fig. 5). The

population of *Cyclops* sp during winter varied from nil to 16 an./1 at the surface, 1 to 37 an./1 at 1 m and 2 to 18 an./1 at the bottom (Plate III, Fig. 4). The population was found to be concentrated at 1 m depth during night hours and at the bottom during day time.

TABLE 2. Distribution of various genera in Lakhotia lake

S. No.	Season	Cladocera	Ostiacoda	Copepoda	Rotifera
1.	Summer	*Daphnia* sp *Ceriodaphnia* sp *Moina* sp	*Cypris* p	*Cylops* sp* *Diaptomus* p	*Brachionus* sp
2.	Monsoon	*Daphnia* sp *Moina* sp	"	*Cyclops* sp * and nauplius larvae	"
3.	Winter	"	"	*Cylops* sp* and nauplius larvae	*Brachionus* sp

*Dominant.

Brachionus sp was mostly concentrated at the surface and 1 m depth from 1500 hrs of the first day to 0300 hrs of second day during summer and population varied from 6 to 34 an./1 at surface, 3 to 40 an./1 at 1 m depth and 6 to 25 an./1 at the bottom. During monsoon maximum population of *Brachionus* sp was recorded at 0600 hrs at all depths while minimum at 1500 hrs at the surface, 1800 hrs at 1 m and 2400 hrs at the bottom. In winter minimum population recorded at 2100 hrs at 1 m and bottom and at 2400 hrs at the surface. At surface and 1 m one maxima was observed but at the bottom two (1500 hrs and 1200 hrs next day).

The diurnal movement of *Moina* sp and *Cypris* sp along vertical profile of the lake in summer, monsoon and winter are shown in Plates I to III Figs. 2 to 3.

DISCUSSION

Zooplankton showed a definite diurnal movement of an increase in population during night hours and decrease during day hours at the surface in summer and monsoon seasons. Increase at the surface during night hours is attributed to their vertical migration from 1m and bottom layers. Reduction in the zooplankton density during day time at the surface is due to their descent to 1m and bottom layers. In winter a reverse trend of an increase in population of zooplankton

during day time and decrease at night hours at the surface, was recorded. It seems that during summer and monsoon high temperature and bright sun light check the movement of zooplankton at the surface whereas in winter the surface temperature attracts zooplankton from sub-surfaces. Thus temperature and light both may be responsible for vertical movement of zooplankton. Sumitra (1971) mentioned the similar observations in her studies. Tash and Armitage (1960) reported that light, overturn, size, thermocline and gravity were important factors affecting vertical distribution of zooplankton. Michael (1964) stated that in addition to light, probably dissolved oxygen and free carbon-dioxide also effect the planktonic movements. No such correlations are evident in the present investigations (Khatri, 1981).

Zooplankton comprised of Cladocera, Ostracoda, Copepoda and Rotifera, of these Copepoda were dominant in all the seasons, while Rotifer shared dominancy during winter. *Cyclops* sp, *Brachionus* sp, and *Moina* sp exhibited a definite diurnal pattern of an increase at the surface during night and decrease during day time in all the seasons (except *Brachionus* sp in monsoon). George (1961), Michael (1964), Verma (1967), Sumitra (1971), Bohra (1976), Dey and Misra (1978) and Patil and Marathe (1982) also observed similar pattern in diurnal migration of zooplankton population, whereas Krishnamoorthy and Visweswara (1963) reported a reverse pattern—a daytime rise of daphnids and copepods to the surface and their descent to the bottom during night hours. On the other hand Andersen (1974) observed no vertical migration of Copepoda and Cladocera.

Summary

Three diurnal studies one each in summer, monsoon and winter were conducted on zooplankton movement in a tropical lake of western Rajasthan namely 'Lakhotia'. Zooplankton population comprised of members of the Rotifera, Cladocera, Ostracoda and Copepoda out of which Copepods were dominant during all the seasons. *Cyclops* sp and *Moina* sp showed definite diurnal movement of decrease at the surface during day time and increase during night hours in all seasons, while *Brachionus* sp only during summer and winter. Light and temperature seem to be responsible for the vertical movement of zooplankton.

Acknowledgements

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