

## **Effects of Solar Eclipse on Zooplanktonic Diel Periodicity and Primary Productivity in fresh water ponds**

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### **Abstract**

Solar eclipse was observed to initiate changes in primary productivity and diel periodicity in zooplanktonic surface crowding. Eclipse effect was more pronounced on loricate, illoricate rotifers and a copepoda *Mesocyclops leuckarti*. Total and partial eclipse were observed to have certain differences in bringing about changes in zooplanktonic diel periodicity. Total solar eclipse at the early or later part of the day might have different impact on fresh water biota.

**Key Words :** Solar eclipse, Primary productivity, Zooplanktonic diel periodicity

### **Introduction**

Copepoda, cladocerans, rotifers, larval forms etc., which make up the most floating life in the open waters generally move toward the surface at night and downward during the daylight hours. However, a reverse migration have also been reported. Although these diel movements are complex and different physico-chemical factors of the environment and prey-predator relationships together with other biological influences are observed to regulate diel vertical migration of zooplanktonic organisms, yet it may be pointed out that light intensity is the most important factor to influence the vertical migration of a number of species (Stearns, 1975; Gophen, 1979; Patil *et al.*, 1984). It is evident that the extent to which vertical migration takes place varies not only from one water body to the other but from species to species within a given aquatic ecosystem (Dumont, 1968; Babu Rao *et al.*, 1981; Mukhopadhyay *et al.* 1981). The types of movements are also dependent on season and age and sex of the organisms (Dumont, 1972; Williamson and Magnien, 1982; Meena *et al.*, 1995). Sunlight is also the most important factor to influence primary productivity of the aquatic ecosystems. Present study

was made to find out the impact of light depletion during solar eclipse on the primary productivity of a pond ecosystem and on heliozooplanktonic diel periodicity.

## Materials and Methods

Two perennial ponds, one at Chinsurah (Lat. 22.53° N, Long, 88.27° E), just outside the totality zone (99% obliteration) and the other at Uluberia (Lat. 22.26° N, Long, 88.12° E), within the totality zone were studied. The Chinsurah pond had an average depth of 1.74 m and an area of 418.05 sq m. while the Uluberia pond had mean depth 2.03m and the area 401.33 sq.m.

Limnological studies were made in the Chinsurah pond on pre-eclipse (23.10.95), eclipse (24.10.95) and post-eclipse (25.10.95) days. Zooplankton samples were collected on each day at 6.48 hrs. 8.48 hrs. and 10.48 hrs. covering pre-eclipses, 99% obliteration and post-eclipse hours. Air and water temperature (digital Celsius thermometer), pH (Systronics digital pH Metre) and dissolved O<sub>2</sub> content (Winkler's method) of the surface water were also noted at the sampling time. For the measurement of primary productivity light dark bottle technique was employed (Winberg 1963) allowing an incubation period of four hours.

As the Uluberia pond was within the totality zone, more intensive sampling was made at 45 minutes interval between 7.20 hrs and 10.20 hrs on the total solar eclipse day. Illuminance values in Lux were recorded on the spot using Kyoritsu illuminometer.

Studies were made in two fixed sampling stations in each pond and the collected data were averaged. Zooplankton samples were collected, narcotised, preserved and counted following Mukhopadhyay *et al.* (1981).

## Results and Discussion

Table 1. Diel fluctuations of the physico-chemical factors, net-zooplankton in surface water and Gross-and Net-primary productivity and community respiration (GPP, NPP & CR) in Chinsurah pond.

Date	23.10.95			24.10.95			25.10.95		
	06.48	08.48	10.48	06.48	08.48	10.48	06.48	08.48	10.48
Time (Hrs.)									
Physico-chemical Factors									
Illuminance (Lux)	32800	57600	89040	32400	720	89200	33600	57520	89320
Air Temperature (°C)	28.5	29.5	31.0	26.0	25.0	31.0	25.5	31.0	31.0
Water Temperature (°C)	29.0	30.0	30.0	30.0	29.0	30.0	29.0	29.0	31.0
pH	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9	7.9
Dissolved O <sub>2</sub> (mg. l <sup>-1</sup> )	2.0	4.0	5.0	2.0	2.0	3.0	2.0	4.0	7.0
Community Respiration									
(mg. C. m <sup>-3</sup> .h <sup>-1</sup> )			78.13			117.19			15.63

## Primary Productivity

(mg. C. m<sup>-3</sup>.h<sup>-1</sup>)

GPP	312.5	195.31	406.25
NPP	234.38	78.12	390.62

## Zooplanktonic Community (%)

<i>Asplanchna brightwelli</i>	4.9	1.4	1.7	6.1	4.6	1.2	4.3	1.0	2.7
<i>Brachionus</i> spp.	0.6	2.9	2.8	1.0	1.7	1.9	0.8	0.9	1.5
<i>Filinia longicaeta</i>	0.8	0.0	0.0	0.6	0.2	0.0	0.9	0.2	0.2
<i>Moina micrura</i>	25.0	20.3	14.9	37.8	36.9	15.6	23.8	20.6	16.9
<i>Haliolaptomus viduus</i>	7.7	5.2	4.8	2.2	4.0	4.1	4.9	5.6	4.5
<i>Mesocyclops leuckarti</i>	17.1	21.6	23.0	10.3	18.1	16.7	13.1	16.4	17.6
Nauplii	21.3	27.4	21.2	19.4	16.4	28.1	28.6	23.5	25.2
Copepodids	22.6	31.2	31.6	22.5	18.0	32.3	23.6	31.7	31.4

Tables 1, 2 and 3 depict the hour wise fluctuations of the physico-chemical factors and the percentage composition within the zooplanktonic community present in the surface water. It is apparent from the Tables 1 and 3 that air temperature gradually increased through the sampling hours on the pre and post-eclipse days. However on the eclipse day air temperature of 26.0°C at 6.48 hrs dropped to 25.0°C at 8.48 hrs in the Chinsurah pond while in the Uluberia pond, air temperature of 28.0°C at 7.20 hrs dropped to 24.5°C at 8.49 hrs. Water temperature, on the other hand, was fairly constant and did not vary much; a drop by a degree in surface water temperature was recorded from both ponds at the end of eclipse. In the Chinsurah pond pH was recorded as 7.9 and did not vary during the study period while dissolved O<sub>2</sub> content of the surface water increased steadily through the sampling hours possibly for photosynthetic activity of primary producers. On the eclipse day, however, dissolved O<sub>2</sub> increased from the early morning value only at 10.48 hrs. i.e. after the eclipse was over.

Table 2. Diel fluctuation in surface crowding of zooplanktonic community (expressed as percentage composition) in Uluberia pond within total solar eclipse zone.

Time (hrs)	07:20	08:05	08:50	09:35	10:20
<i>Asplanchna priodonta</i>	3.7	3.2	2.9	3.6	1.5
<i>Filinia longicaeta</i>	0.6	1.1	2.4	2.0	0.8
<i>Keratella tropica</i>	0.6	0.6	0.0	0.4	2.5
<i>Brachionus</i> spp	4.5	4.0	1.3	1.1	4.1
<i>Ceriodaphnia cornuta</i>	0.7	0.3	0.8	0.4	0.4
<i>Moina micrura</i>	6.3	5.7	7.2	5.3	5.3
<i>Diaphanosoma sarsii</i>	5.0	6.4	8.2	8.6	4.5
<i>Haliolaptomus viduus</i>	6.0	6.2	6.2	5.4	5.6
<i>Mesocyclops leuckarti</i>	10.9	9.5	8.2	8.2	9.7
Nauplii	23.9	24.4	28.9	30.9	28.2
Copepodids	37.7	38.5	33.9	34.0	37.4

Primary productivity of the Chinsurah pond showed marked difference on the eclipse day when compared to pre and post eclipse days (Table 1). Both gross and net primary production rates were observed to be significantly higher on pre and post eclipse days than the rates recorded on the eclipse day. A difference of  $210.94 \text{ mg.C.m}^{-3} \text{ h}^{-1}$  in GPP and of  $312.5 \text{ mg C.m}^{-3} \text{ h}^{-1}$  in NPP were noted between the values recorded on eclipse and post-eclipse days. However, Jana and De (1981) showed that during 1981 solar eclipse no such variations in primary productivity were recorded. It may be pointed out that in 1981 total solar eclipse was experienced at past mid day. Therefore a solar input for about eight hours possibly brought about optimum light saturation at the primary producer level so that the brief solar obstruction at afternoon was efficiently compensated. During the recent total solar eclipse at the early hours, there was a significant decline in solar input which might have influenced primary productivity.

Table 3. Changes in the illumination at the water surface and air and water temperature during total solar eclipse in Uluberia pond.

Time (IST)	Illumination (Lux)	Air Temp (°C)	Water Temp. (°C)
07:10	34000	28.0	32.0
07:20	36400	28.0	32.0
07:45	38400	27.5	32.0
08:12	32600	27.5	32.0
08:15	32000	27.0	32.0
08:25	20800	26.5	32.0
08:35	12000	26.0	32.0
08:38	8800	26.0	32.0
08:41	6400	26.0	32.0
08:44	4000	25.5	32.0
08:48	720	25.0	32.0
08:48:20	400	25.0	32.0
08:49:20	040	24.5	31.5
08:50	320	25.0	31.5
08:53	1200	25.0	31.0
08:55	2400	25.0	31.5
09:15	20800	26.5	31.5
09:35	38400	28.5	31.5
10:10	71200	29.0	32.0
10:20	79600	30.5	32.0

Some of the zooplanktonic species were also observed to respond to solar eclipse showing changes in their availability in the surface water when compared to their densities on the pre and post eclipse days. In the present study illoricate rotifers (recorded species were *Asplanchna brightwelli*, *A. priodonta*, *Filinia longiseta*) were observed to be present in surface water in larger densities during the eclipse time. Patil *et al.* (1984) Mukhopadhyay (1984) and Meena *et al.* (1995) showed the higher surface crowding by illoricate rotifers during the dimly illuminated part of the day. On the other hand, Loricata rotifers were found in high numbers

between 10 hrs. and 18 hrs. depending on the seasons (Sharma *et al.* 1978; Mukhopadhyaya *et al.* 1981). In the present study, no definite trend was observed in surface crowding of loricate rotifers in the Chinsurah pond. However, in Uluberia pond, loricate species appeared in higher number in surface water at 10.20 hrs. samples while these were fewer when the sunlight depleted during the eclipse.

Microcrustaceans did not show any major response to the changes in illumination during eclipse. Cladocerans usually show crepuscular surface crowding responding to the light of dawn and dusk which have maximum red light (Stearns, 1975). Sunlight impediment during eclipse, therefore had not much effect on the diel periodicity of cladocera. *Mesocyclops leuckarti*, a cyclopoid copepoda, however were observed to appear in lesser number during eclipse (at 8.50 hrs and 9.35 hrs) in the Uluberia pond. Gophen (1979) observed that heavy clouds sometimes initiated reverse vertical migration in these species showing surface crowding during day time. Surprisingly, in the present study *M.leuckarti* showed an opposite behaviour leaving the surface water when the illumination depleted due to total solar eclipse.

Shoal of fish fingerlings of the species *Tilapia mossambica*, *Catla catla* and *Labeo rohita* were at the surface near the margin of the Uluberia pond since morning but disappeared in deeper water as the eclipse totality approached. They were absent in surface water between 8.44 and 8.55 hrs. They all surfaced again when the illumination increased rapidly just following totality.

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