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A report on the study of zooplanktons of Mirik Lake in Eastern Himalayan biodiversity hotspot, Darjeeling India

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ABSTRACT

Mirik Lake is situated in Darjeeling Himalaya which is a hill station and incidentally one of the biodiversity hotspot in India. Studies on the occurrence of different zooplankton species has been done in different seasons for two years period during April, 2002 to March, 2004. A total of five zooplankton genera viz. *Bosmina*, *Chydorus*, *Alona*, *Macrothrix* and *Mesocyclops* have been recorded. Hydrobiological parameters viz. temperature, pH, hardness, alkalinity, dissolved oxygen and free carbon-dioxide have been measured. Level of ten different heavy metals has been estimated while the level of Lead and Selenium were above the maximum permissible limit. Being a tourist spot this hill lake is susceptible to be polluted by hotel wastes and other activities related to tourism. Existence of zooplankton belonging to such a few number of above mentioned genera is assumed to be related to the pollution of lake water. Possibility of considering *Bosmina longirostris* and *Macrothrix* sp. as bioindicator species could not be easily overruled. Since, no previous report is available on zooplankton composition of this lake; the present study is very interesting in the context of zooplankton biodiversity of Darjeeling Himalaya lakes.

Introduction

Hill lakes are interesting for study of aquatic biodiversity of high altitudes. Zooplanktons in general constitute an important part of biodiversity of the aquatic bodies found in hill areas (Dulmaa 1965; Buyantuyev et al. 1996; Bondarenko et al. 2002). Zooplanktons are the smallest herbivores in aquatic bodies, which consume phytoplankton directly and thus related to the productivity of the habitat concerned. Zooplankton community may act as good agents for giving an indirect estimate of productivity of the lakes and other aquatic bodies (Krebs 2001).

Mirik Lake is one of the interesting lakes situated in Darjeeling hills of West Bengal at an altitude of 1767 meters above the sea level (Jha and Barat 2003). The natural beauty of the lake attracts all tourists visiting Darjeeling hills and thus the lake became a victim of pollution caused by the activities of the tourists. Consequently, the natural occurrence of zooplankton is expected to be affected by tourism. Though the occurrence of different species of zooplankton in different hill lakes of the world is available (Watson 1974; Sharma 2001; Bondarenko et al. 2002; Sharma and Bhattarai 2005); yet there is no record till date available except on rotifers (Mondal et al 2012) on the zooplankton of Mirik lake of Darjeeling hills even when it is situated in one of the biodiversity hotspots in Indian subcontinent. In the present study the investigator tried to identify and enlist different members of zooplankton community occurring in Mirik

Lake, side by side keeping records on some of the hydrobiological parameters and the results have been communicated.

Materials and Methods

The study was conducted for 2 years period during April, 2002 to March, 2004. Samples were collected in different seasons of the year during the study period. Plankton samples of subsurface water were collected randomly from different spots of Mirik Lake using No. 25 Plankton Net following conventional method (Shegal 1983). Zooplanktons are fixed in 4% formalin and stained in alcoholic eosin after proper dehydration andmounted in entellan to make permanent slides for observation, identification and preservation of the same.

Water samples have also been collected at the time of zooplankton collection and the water samples were analysed following standard methods (Trivedy and Goel 1986; APHA 1995) for estimation of the hydrobiological parameters viz. dissolved oxygen, free carbon dioxide, alkalinity, salinity, chloride, hardness (for both calcium and magnesium). The temperature and pH of the water samples were also noted time to time. Part of the water samples were brought to Bose Institute, Kolkata, for testing the presence and quantification of heavy metals, if any. The zooplankton specimens were identified by the help of Scientists of Zoological Survey of India, Kolkata.

Results

A total of five zooplankton genera viz. *Bosmina*, *Chydorus*, *Alona*, *Macrothrix*, and *Mesocyclops* have been seen during different seasons of the two years observation period. All zooplanktons were under the class Crustacea of which four genera were under order Cladocera and one was under the Order Copepoda. The names and systematic position of the zooplankton species as identified by the Scientists of Zoological Survey of India, Kolkata is represented below.

Phylum – Arthropoda

Sub-Phylum – Mandibulata

Class – Crustacea

Sub Class – Branchiopoda

Order – Cladocera

I. Family : Bosminidae

Genus : Bosmina

Species : *longirostris and* others

II. Family : Chidoridae

i) Sub Family : Chydorinae

Genus : *Chydorus*

Species : *sphaericus* (O.F. Muller) and others

ii) Sub Family : Aloninae

Genus : Alona

III. Family : Macrothricidae

Genus : *Macrothrix*

Order : Copepoda

I. Family : Cyclopidae

Genus : *Mesocyclops*6

Results regarding some of the important physicochemical parameters of the water sample in different months of the study years are shown in Table 1 Level of a few heavy metals were higher than the maximum

permissible limit as prescribed by WHO and ICMR (Mukherjee 1997) while most of the detected heavy metals were present below the permissible limit. Level of some detected heavy metals present in the water has been presented in Table 2.

Discussion

No previous study is in hand regarding zooplankton composition except on rotifers (Mondal et al 2012) of Mirik lake. In the present study five genera of zooplankton has been identified. But the number of genera obtained in the present study is less than the number expected in freshwater lakes of hills in general (Rylov 1937; Shulga 1953; Dulmaa, 1965; Watson 1974; Klisko 1998; Bondarenko et al. 2002). Presence of zooplankton species belonging to such a less number of genera may be assumed to be an outcome or the impact of pollution.

Level of the important physicochemical parameters in different seasons of the year as appeared in Table 1 reveals the following facts. The dissolved oxygen varied from 3.43 to 8.72 mg/L. During the months of May and August it is well below the normal range perhaps due to increase in organic load during this period which happens to be a peak season for the tourists; ensuring high inflow of tourists and crowding in hotels producing a large amount of organic pollutants. Alkalinity ranges from 37.5 to 100.0mg/L, however the levels during different seasons are within the normal range (Kendeigh 1974). Lowest level was recorded during the late monsoon period might be due to increase in water volume and the highest level was recorded during the winter presumably due to the decrease in water volume as well as temperature. Hardness, Ca++ and Mg++ level gradually decreased from summer to monsoon to winter. Salinity (Chloride) varied from 21.30 to 44.02 mg/L showing decreasing trend during monsoon due to increase in water volume. The pH of water varied from 2.61 to 7.02, the water becomes highly acidic during the winter and again become neutral to alkaline during the rainy season. The average temperature of the water body ranges from 20.1 to 23.1ÚC in the present study but earlier reported maximum temperature was 29?C and minimum was13?C during summer and winter respectively(Jha and Barat, 2003). Present study reveals that highest temperature is prevalent during summer as well as monsoon and during winter it was lowest and around 20ÚC.

Lower level of dissolved oxygen, free carbon dioxide, hardness, temperature and pH and higher level of alkalinity (Table 1) favours *Bosmina longirostris* and other species of genera *Bosmina* and *Macrothrix*. During summer and monsoon seasons relatively higher level oxygen, free carbon dioxide, hardness, temperature and pH and lower level of alkalinity is somehow favourable for *Bosmina longirostris*, *Chydorus sphaericus*, and other species of genera *Chydorus* (species not identified), *Alona* and *Mesocyclops*.

The levels of different heavy metals recorded during the entire study period have been represented in Table 2. Out of the 10 metals

concentration of Cadmium, Mercury, Chromium and Nickel is below the detective level. The concentration of Copper, Arsenic, Zinc and Manganese are well below the maximum permissible limit. However the concentration of Lead and Selenium are very high compared to the permissible limit. The maximum permissible limits are 0.05 and 0.01 mg/L (ICMR 1975; WHO 1986) while observed levels are 0.95 and 0.58 mg/L for Lead and Selenium respectively. The source of Lead and Selenium might be the rocks of the hill. The physicochemical factors and level of heavy metals may have some role on the zooplankton community but the nature and confirmation of the exact impact needs further detailed study.

Two years study revealed that pollution caused by organic and inorganic matters as well as heavy metals must have some impact on biology of zooplanktons which may lead to extermination of some of the zooplankton species at least from the water body of Mirik Lake. The species occurring in different seasons are not similar, some of the species occurring in all seasons while some others restricted to some seasons only. Seasonal variation in zooplankton diversity in perennial lakes of Tamilnadu is reported by Manickam et al, 2017. In the present study several species under five genera of crustacean zooplankton have been identified. *Bosmina longirostris* has been seen throughout the year whereas other species of genus *Bosmina* is seen during winter. During summer and monsoon seasons the species seen are *Bosmina longirostris*, *Chydorus sphaericus*, and other species of genera *Chydorus* (species not identified), *Alona* and *Mesocyclops*. During post monsoon and winter season the species seen are *Bosmina longirostris* and other species of genera *Bosmina* and *Macrothrix*. Since *Bosmina longirostris* is seen throughout the year it may be presumed that they are tolerant to all kinds of pollution occurred during different seasons. Due to increase in water level/volume during rainy season more number of species appeared as mentioned above. This can be explained in this way that level of pollution fell down due to dilution in the concentration of pollutants with the increase in water volume thus inviting more species by providing more healthy condition. It is also to be noted that during rainy season chance of loading of pollution materials to the lake water becomes very less since tourists do not prefer to visit during rainy season. The occurrence of less number of species during winter condition may be due to the rise in level of pollutants with the fall of water level as well as temperature. Thus some species of genus *Macrothrix* seems to act as good bioindicator specifically for winter season exhibiting fair pollution tolerance ability in adverse situations while other species could not survive except some species of the genus *Bosmina*. However confirmation of the bioindicator property of any species requires details study about its ecology. So confirmation of the fact – whether the above mentioned species are acting as bioindicators or not - demands further extensive study on the bioecology of the species especially in the particular habitat concerned.

Table 1. Physicochemical parameters of Mirik Lake water during different months of the study period.

MONTH				PHYSICOCHEMICAL PARAMETERS					
Dissolved O2 (mg/L)	Free CO2 (mg/L)	Alkalinity (mg/L)	Hardness (mg/L)	Ca++ (mg/L)		Mg++ (mg/L)	Chloride (mg/L)	pH	Average Temperature (°C)
March	8.72	19.98	47.5	31.5	6.81	3.53	29.11	6.82	21.5
May	3.43	8.69	65.0	24.0	4.41	3.17	44.02	7.02	20.1
June	7.56	10.99	55.0	24.0	5.61	2.44	22.72	7.01	23.1
August	4.94	11.23	37.5	16.0	2.81	2.19	21.30	4.60	23.0
September	6.15	2.30	100.0	14.0	1.60	2.44	28.40	2.61	20.5

Table 2. Level of some heavy metals (mg/L) in the water of Mirik Lake, Darjeeling, W.B., India.

Heavy metal	Mirik Lake	Maximum permissible limit (WHO, 1984)
Copper	0.008	0.500
Lead	0.950a	0.050
Arsenic	0.030	0.050
Zinc	0.101	1.500
Manganese	0.050	5.000
Selenium	0.580a	0.010
Cadmium	BDL	0.010
Mercury	BDL	0.001
Chromium	BDL	0.500
Nickel	BDL	-

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