

Diversity of Cyanophyceae in the Mirik Lake of Darjeeling Himalaya, India

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Abstract: *The present investigation was carried out for two years from October, 2010 to September, 2012 to study the Cyanophycean diversity in Mirik Lake of Darjeeling Himalaya, West Bengal, India. During the whole study period a total of eleven genera of Cyanophyceae were recorded, of which Spirulina sp., Arthrospira sp. and Anacystis sp. were found to be most frequent. The density varied from 33 to 1844/ml and the highest diversity was recorded at the point where waste water entering into the lake mainly from the market area.*

Keywords: Cyanophyceae, Mirik Lake, density, diversity

1. Introduction

Cyanophyceae are colonizing microorganisms that are found throughout the world. They are oxygenic photosynthetic and some of them are able to fix atmospheric nitrogen. Ecologists started giving them importance as primary producers and realized that without them no animal population exists. Cyanophyceae are by far the largest group of photosynthetic prokaryotes as judged by their widespread occurrence, frequency, abundance and morphological diversity. During the recent past, studies on Cyanophyceae have emphasized their important role in ecosystem. They grow at any place and in any environment where moisture and sunlight are available. However, specific algae grow in specific environment and therefore their distributional pattern, ecology, periodicity, qualitative and quantitative occurrence differ widely¹.

The Cyanophycean density and diversity of surface waters of various fresh water bodies have been studied by a number of investigators^{1, 2, 3, 4}. However a very few literature^{5, 6} has been found on the study of the plankton communities of freshwater bodies of Darjeeling Himalaya like Mirik Lake. Till date the density and diversity of Cyanophyceae population in the Mirik Lake was not reported elsewhere. Thus the present study was done to find out the density and diversity of Cyanophyceae in Mirik Lake of Darjeeling Himalaya.

2. Materials and Methods

“Sumendu Lake” which is popularly known as “Mirik Lake” is an artificial reservoir of Mirik Town, the famous hill resort in the Kurseang subdivision of Darjeeling Himalaya at an altitude of 1767 meters. It extends between 26° 53'N and 88° 10'E. The lake was constructed in 1979 under “Mirik Tourist Project” for the facilitation of commercial tourism in Darjeeling. This lake has been included under National Lake Conservation Programme, formulated by the Ministry of Environment and Forests, Government of India.

The lake covers an area of about 16.19 ha with approximate length of 1.25 km and the peripheral road is about 3.5 km. The arch-type over bridge across the lake is 24.38 m long. The maximum and minimum depths of the lake were recorded to be 7.92m and 1.83 m⁷ respectively at the initial stage. The lake is fed by both perennial streams and rainwater. Since the lake is situated in a valley encircled by hill ridges with extensive natural drainage network, it receives wastewater from human settlements through numerous inlets. There is one out-fall point through which the spillover water of the lake is discharged into the river Mechi, situated to the Western side of the lake. The catchment area consists of residential areas, vacant lands and commercial centers comprising of hotels, restaurants and other shops. Mirik Lake and its surroundings, as a whole, contain multifarious recreational features like boating, jogging, organizing fair, picnic and many others. This is the most beautiful lake of Darjeeling district where visitors come from different parts of the world. Besides attracting tourists, the lake water also serves as a major source of drinking water to the local people.

Density and diversity of Cyanophyceae collected from the surface water samples of Mirik Lake was studied for two years from October 2010 to September 2012. Seven sampling points were identified in the Lake considering the length of the lake as well as point and non-point sources of pollution. All the sampling points are shown in figure-1. Monthly basis sampling was done from these sites with the help of paddle-boat. The brief descriptions of the sites (S-1 to S-7) are as follows:

S-1 (26°53'08.49" N and 88°11'08.32" E): This site is situated at the point where wastes from hotels and residential area join into the lake. Car washing also takes place at this site.

S-2 (26°53'16.80" N and 88°11'14.95" E): It is located at the flank of the lake where tourists assemble to observe the fishes that agglomerate specifically here for consuming various food items thrown by the visitors. Wastes from hotels and residential areas also join at this site.

S-3 (26°53'20" N and 88°11'01" E): This site is situated at 100 m away from the concrete bridge of the lake towards South East. This site is situated near the proposed children park area. Human activity is comparatively lesser at this site.

S-4 (26°53'017" N and 88°10'927" E): This site is situated at the centre of concrete bridge over the lake. Some amount of surface runoff joins here.

S-5 (26°53'38.40" N and 88°10'55.11" E): It is located at 90 m away from the water intake point towards North East. This water intake well is used for water treatment plant under

PHED having a capacity of 1MGD (Million Gallon per Day) to cater the water supply for the people of Mirik Municipality area.

S-6 (26°53'27.99" N and 88°10'56.53" E): This is the point where waste water is discharged mainly from Mirik market area. Washing of clothes and bathing take place at this site.

S-7 (26°53'34.53" N and 88°10'51.89" E): This site is located near the outlet of Mirik Lake which joins to the Mechi River through weirs. Bathing and washing of clothes take place near this site.

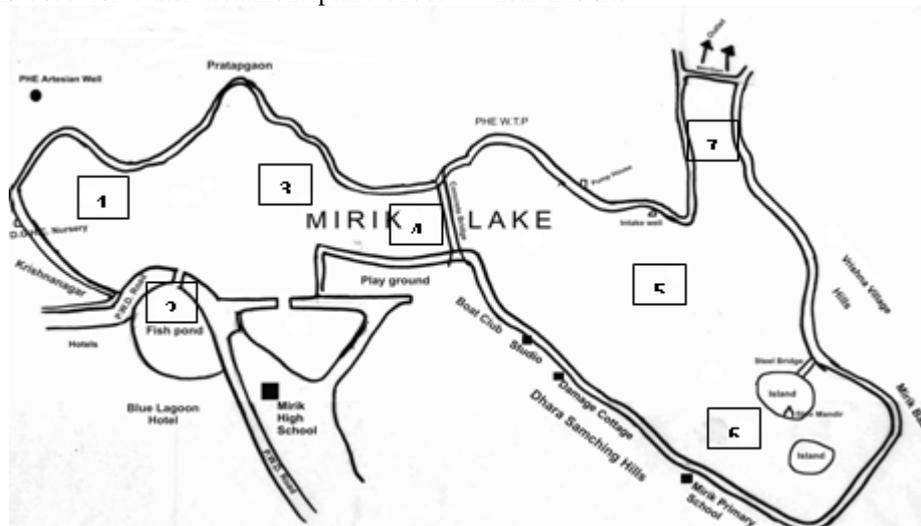


Figure 1: Location map of sampling sites at Mirik Lake, Darjeeling Himalaya

The water samples containing Cyanophyceae were collected without filtering the surface water. To preserve the sample, 0.3 mL Lugol's Iodine solution was added to 100 mL of water. Water samples were centrifuged at 1500 r.p.m. for 15 minutes and then studied under microscope (Olympus CK2, Japan) in the Laboratory. Different Cyanophyceae genera were identified with the help of Standard books^{8, 9, 10, 11, 12.}

3. Results and Discussion

The range of various physico-chemical parameters recorded during the whole study period are given in table-1. Maximum density of Cyanophyceae was found at a

temperature range of 6.00-23.0°C. pH is one of the important parameters as it plays an important role in the acid-base neutralization and water softening. The maximum density of Cyanophyceae was recorded in the pH range of 6.50-7.80. It was reported by many workers that high values of BOD with very low Dissolved oxygen (DO) favoured the growth of cyanophyceae^{13, 14, 15, 16, 17.} In the present study also, the higher population of Cyanophyceae were recorded at the Sites with increased level of BOD along with low DO level. The present investigation depicts maximum abundance of total rotifers at bicarbonate alkalinity of 22.00-52.00 mgL⁻¹.

Table 1: Range of physico-chemical parameters of surface water of seven sampling sites of Mirik Lake

Parameters	Sampling Stations						
	S-1	S-2	S-3	S-4	S-5	S-6	S-7
Air Temperature (°C)	7.0-26.0	8.0-26.0	8.0-25.5	8.0-25.0	10.0-26.0	10.0-26.5	8.5-25.0
Water Temperature (°C)	5.0-25.0	5.0-25.0	5.0-24.0	5.0-24.0	6.0-23.0	9.0-25.0	5.5-23.5
pH	6.5-7.5	6.4-7.5	6.4-7.7	6.6-8.1	6.5-7.8	6.7-8.1	6.3-7.8
Conductivity (µmhos)	31.0-126.0	77.5-163.2	49.3-116.6	48.9-138.1	52.3-116.7	56.8-116.4	51.3-117.1
Dissolved Oxygen (mgL ⁻¹)	5.0-7.7	4.6-7.8	4.6-10.6	4.2-12.6	4.4-13.6	4.0-9.0	4.2-13.5
Free CO ₂ (mgL ⁻¹)	4.0-14.0	6.4-16.0	4.8-12.0	3.6-14.0	4.0-9.0	4.0-9.8	3.8-8.0
Total alkalinity (mgL ⁻¹)	20.0-52.0	24.0-60.0	20.0-60.0	24.0-44.0	22.0-52.0	20.0-56.0	22.0-48.0
Total hardness (mgL ⁻¹)	8.0-30.0	8.0-38.0	11.0-30.0	10.0-32.0	8.0-32.0	10.0-36.0	9.0-28.0
Chloride (mgL ⁻¹)	9.0-28.0	10.0-26.0	9.2-26.0	12.0-31.0	10.0-26.0	11.0-31.0	9.5-26.0
Biological Oxygen Demand (BOD) (mgL ⁻¹)	1.8-6.4	2.3-5.6	1.2-5.0	1.0-5.0	1.0-4.6	2.0-5.4	1.0-4.6

All the Cyanophyceae genera recorded from the Mirik Lake are presented in table-2. A total of eleven Cyanophyceae genera were recorded during the whole study period. *Spirulina* sp., *Arthrospira* sp. and *Anacystis* sp. were the

most common and dominant genera of Cyanophyceae in the lake. The highest diversity of Cyanophyceae was found at S-6 having eleven genera of Cyanophyceae while lowest diversity was recorded at S-5 and S-7 with eight genera. The

Cyanophycean diversity was higher at S-6 was probably due to inflow of waste water into the lake from Mirik market area¹⁸.

Table 2: Cyanophyceae genera recorded from the surface water samples of seven sampling sites of Mirik Lake (October, 2010-September, 2012)

Cyanophyceae genera	Sampling Stations						
	S-1	S-2	S-3	S-4	S-5	S-6	S-7
<i>Anabaena</i> sp.	+	+	+	+	+	+	+
<i>Anacystis</i> sp.	+	+	+	+	+	+	+
<i>Arthrospira</i> sp.	+	+	-	+	-	+	+
<i>Chroococcus</i> sp.	+	+	+	+	+	+	+
<i>Merismopedia</i> sp.	+	+	+	+	+	+	+
<i>Microcystis</i>	+	+	+	+	+	+	+
<i>Nostoc</i> sp.	+	+	+	+	+	+	+
<i>Oscillatoria</i> sp.	+	-	+	+	-	+	-
<i>Phormidium</i> sp.	+	+	+	-	+	+	-
<i>Spirulina</i> sp.	+	+	+	+	+	+	+
<i>Synechocystis</i> sp.	-	-	-	+	-	+	-
Total no.	10	09	09	10	08	11	08

+ Present, - Absent

During the whole study period a total of four Cyanophycean genera of Mirik Lake, *Anacystis*, *Microcystis*, *Oscillatoria*, *Phormidium* are found to be pollution tolerant¹³. Among these *Oscillatoria* sp. and *Phormidium* sp. as reported to be very tolerant to pollution^{19, 20}. Some of the useful genera such as, *Anabaena* sp., *Chlorella* sp. and *Nostoc* sp. which were reported²¹ to be involved in bioremediation, were found from the lake. Colouration causing genera like *Anabaena* sp. and *Microcystis* sp.²¹ were also present in low to moderate numbers to play a significant role as primary producers.

Seasonal variations in population density of Cyanophyceae in Mirik Lake during October 2010 to September 2012 are represented in figure-2. The highest density of Cyanophyceae (1844/ml) was observed at S-5 during winter in the second year, while lowest density was recorded at S-2 during monsoon of the first year (33/ml) of study period. In general, Cyanophyceae density was relatively higher during summer months. It was observed that higher concentration of oxidisable organic matter and longer period of sunshine appeared to be more responsible for the growth of blue green algae *i.e.* Cyanophyceae during summer²².

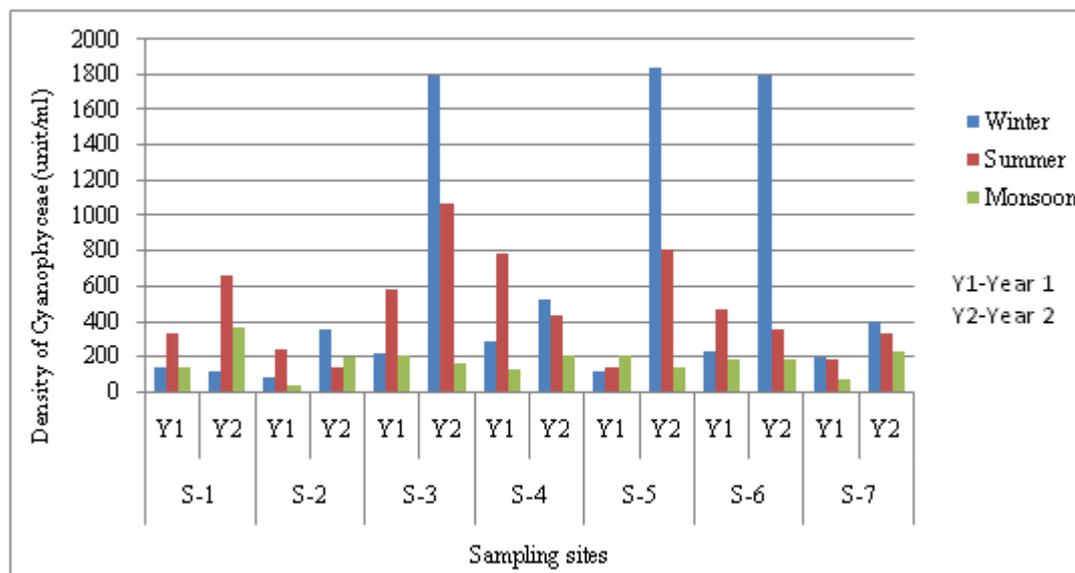


Figure 2: Seasonal variations in population density of Cyanophyceae in Mirik Lake (October 2010-September 2012)

4. Conclusions

The results found during the present study show that the Cyanophyceae population of Mirik Lake showed considerable fluctuations with water quality parameters. Analysis also shows some pollution tolerant genera of Cyanophyceae like *Anacystis*, *Microcystis*, *Oscillatoria* and *Phormidium* sp. Hence there is need of regular monitoring of water before it is used for drinking and domestic purposes.

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