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RESEARCH ARTICLE

Taxonomic Survey of Phytoplankton in Manasbal Lake of Kashmir Himalaya, India

Jahangeer Mohd Reshi[1*] • Jaya Sharma[2] • Ishtiyaq Ahmed Najar[3]

[1*]*Department of Environmental Sciences, Madhyanchal Professional University, Bhopal, (M.P), India.*
E-mail: jahangeerevs@gmail.com

[2]*Department of Environmental Sciences, Madhyanchal Professional University, Bhopal, (M.P), India.*

[3]*Department of Environmental Sciences, Govt. Degree College, Ganderbal, Kashmir, (J&K), India.*

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ABSTRACT

The current study was conducted over a two-year study period at Manasbal Lake, which has a catchment area of 22 km^2 and is located in the district of Ganderbal, 30 kilometers north of the city of Srinagar in Jammu and Kashmir. The Manasbal catchment is defined by latitudes 34°14' - 34°16' N and longitudes 74°40' - 74°43' E, with an elevation of approximately 1551m a.s.l. During the present study, 101 phytoplankton species from six groups were identified from Manasbal Lake: Bacillariophyceae, Chlorophyceae, Cyanophyceae, Chrysophyceae, Dinophyceae, and Euglenophyceae. Among these, Bacillariophyceae formed the bulk of phytoplankton with 49 species, followed by Chlorophyceae (39), Cyanophyceae (7), Euglenophyceae (3), Dinophyceae (2) and Chrysophyceae (1). The Bacillariophyceae, the dominant group, was present at all six sites with the maximum diversity of species.

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Introduction

Phytoplanktons are tiny, unattached plants that are found uniformly distributed throughout the water column. They live in the euphotic zone of freshwater lakes, ponds, and other bodies of water because they rely on light and nutrients. Phytoplanktonic species may be found in all bodies of standing water, as well as in the middle and lower sections of rivers. These organisms are essential for primary production and biogenic oxygenation throughout the day in fresh water zones. Because of their short life cycle, phytoplanktonic communities respond very quickly to changes in the environment and so serve as bioindicators of pollution among the various aquatic groups.

* Corresponding author: jahangeerevs@gmail.com

Materials and Methods

Study Area

The valley of Kashmir is situated in the middle of the Himalayas between the northwest and southeast (33°01′-35°00′N latitude and 73°48′-75°30′ E longitude) at an altitude >1500 m above sea level. The high altitude valley is home to a diverse range of freshwater bodies that provide a wide range of ecological services, including food, fodder, aquatic game, and tourist recreation, in addition to being a rich repository of flora and fauna. However, owing to perturbations in the catchment areas, the lake environment has altered dramatically in recent decades and entered an aggravated trend.

Manasbal lake (34º 14’ 38" N to 34º 15’ 26" N latitude and 74º 39’ 07" E to74º41' 20" E longitude) is located at an of altitude of 1584 m above sea level at Safapur village in district Ganderbal, which is about 32 km northwest of Srinagar city, Jammu and Kashmir, India (Naik *et al.*, 2017).

The climate of the area is defined by warm summers and cold winters (Rashid *et al.,* 2013). According to Bagnoulus and Meher-Homji (1959), the climate of Kashmir may be classified into four seasons based on mean temperature and precipitation (winter, spring, summer, and autumn). The area receives an average annual precipitation of roughly 650 mm, which is distributed unevenly around the district throughout the year. From January to May, western disturbances are mostly responsible for precipitation and snowfall, but the southwest monsoon is responsible for showers in July and August. From September to mid-November, the region has a brief spell of dryness with little or no precipitation.

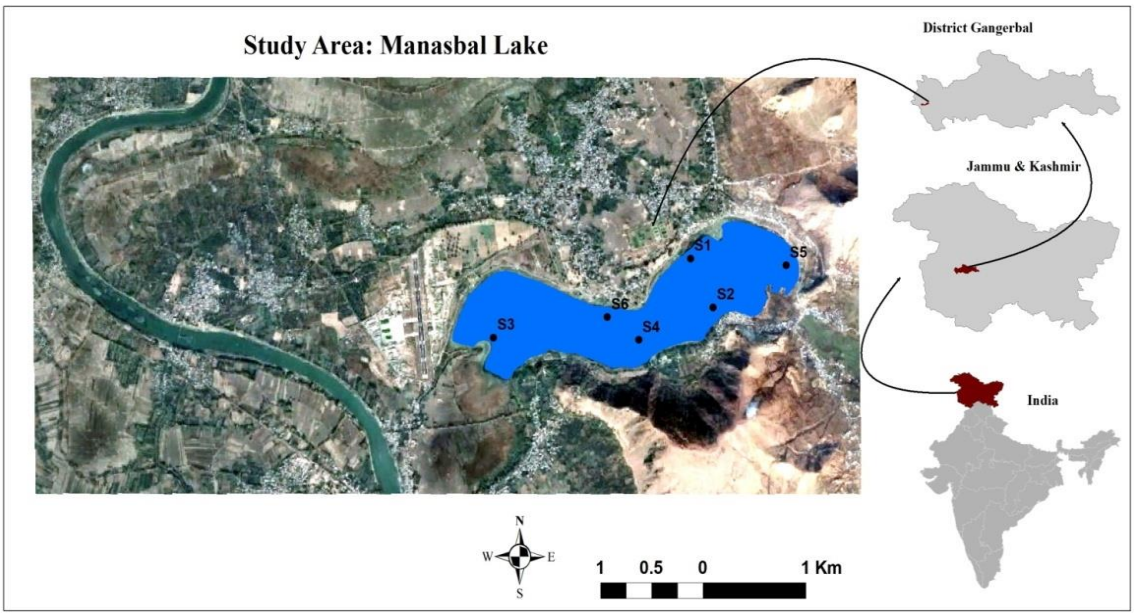

Figure 1. Six sampling locations in Manasbal lake

Sample Collection and Analysis

Water samples were collected monthly from six different locations throughout a two-year study period (2019 – 2020). Phytoplanktons were obtained by filtering 50 litres of water through plankton net with a mesh size of 70m. The filtrate was transferred to glass vials and preserved in 5% formalin. Edmondson and Winberg (1971), Pennak (1978), and Adoni (1985) methodologies were employed for their qualitative analysis. The drop count method was used for quantitative examination, and the number of plankton (phytoplankton) per litre of concentrate was determined.

Results and Discussion

During the present study, a total of 101 phytoplankton species belonging to six groups were recorded from the Manasbal lake, namely, Bacillariophyceae, Chlorophyceae, Cyanophyceae, Chrysophyceae, Dinophyceae and Euglenophyceae. Among these, Bacillariophyceae formed the bulk of phytoplankton, followed by Chlorophyceae, Cyanophyceae, Euglenophyceae, Dinophyceae and Chrysophyceae. Out of the total of 101 phytoplankton species recorded in the lake, 49 belonging to the Bacillariophyceae, 39 to the Chlorophyceae, 07 to the Cyanophyceae, 03 to the Euglenophyceae, 02 to the Dinophyceae, and 01 to the Chrysophyceae, indicating the diverse nature of phytoplankton in general and that of Manasbal lake in particular (Table 1, Figure 2).

Table 1. Taxonomic distribution of phytoplankton at various study sites in Manasbal lake

Sr.no.	Classes	Sites						Total taxa
		S1	S2	S3	S4	S5	S6	
1	**Bacillariophyceae**	27	28	40	39	37	29	49
2	**Chlorophyceae**	24	23	29	22	35	25	39
3	**Cyanophyceae**	5	3	6	5	4	5	07
4	**Euglenophyceae**	2	2	3	3	3	2	03
5	**Dinophyceae**	2	2	3	3	3	2	02
6	**Chrysophyceae**	-	1	1	1	1	1	01
	Total	**60**	**59**	**79**	**71**	**81**	**64**	**101**

In an earlier study by Abubakr *et al.,* (2008), a total of 125 phytoplankton species were reported from the Manasbal lake and still in other studies carried out by Akhter *et al.,* (2014), a total of 56 phytoplankton species were reported from four sites of Manasbal lake. Thus, the present study on

Manasbal lake presents a better species diversity as compared to earlier studies.

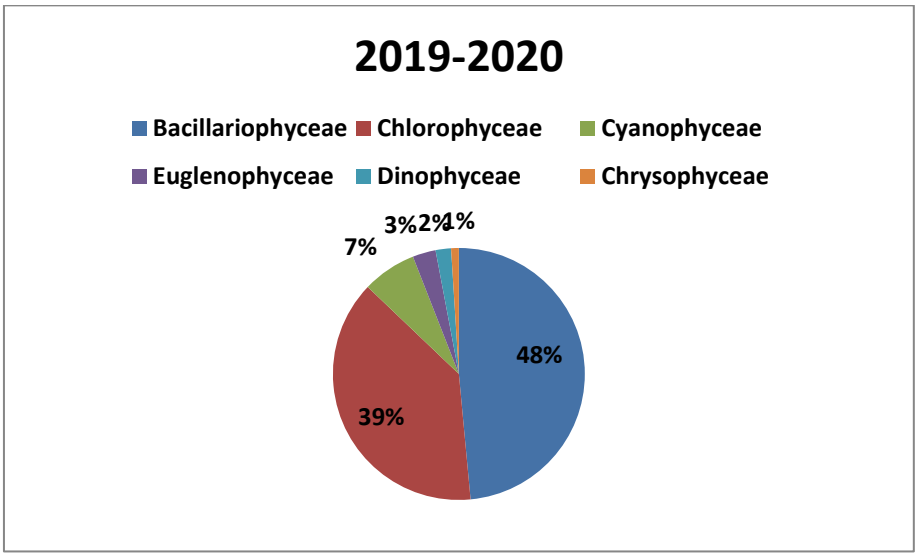

Figure 2. Percent contribution of different classes of phytoplankton in Manasbal lake

Bacillariophyceae was the most dominant group in terms of diversity and density and showed its peak growth in summer and spring at most of the sites. In general, the highest population diversity of phytoplankton was observed during warm months extending from spring to summer (Figure 3). The findings are in full agreement with the findings of Lund (1965) and Munawar (1974).

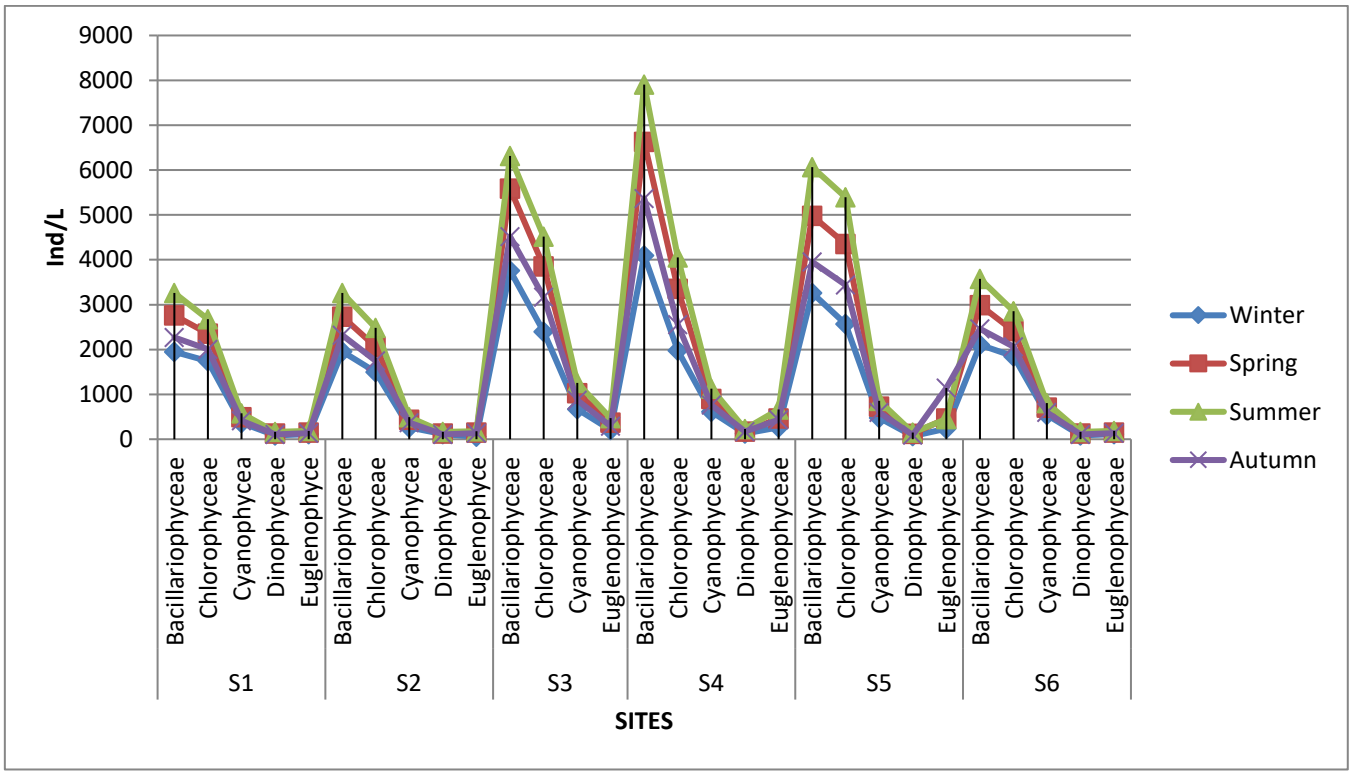

Figure 3. Seasonally population density in different taxa of Phytoplankton (ind./L) at different sites during Jan. 2019- Dec. 2020.

The Chlorophyceae was the second dominant group of phytoplankton after Bacillariophyceae. The total Chlorophyceae species recorded from the lake was 39, out of which 13 taxa were recorded from all the sites which include *Ankistrodesmus falcatus, Closterium sp., Closterium setaceum, Closterium subalatum, Coelastram cambricum, C. sphaericum, C. minimum, C. reniforma, Oocystis sp., Scenedesmus armatus, Scenedesmus quadricauda, Selenastrum pilosum,* and *T. minimum*. On seasonal basis, Chlorophyceae revealed its peak growth in summer and spring. The spring bloom of Chlorophyceae was also recorded by Sommer (1989). Khan (1978) also reported spring and summer peak of Chlorophyceae in his study on two Kashmir valley lakes viz., Naranbagh and Trigam. Spring peak of Chlorophyceae can be attributed to absence of macrophytic bloom due to which chlorophyceans are able to

absorb the nutrients well from the increased phosphorus and nitrate pool and may be also due to the increasing temperature. The abundance of Chlorophyceae during summer may be due to the favorable environmental conditions viz. light temperature and nutrients, as it is generally believed that Chlorophyceae have a rather lower limit optimum for phosphorous (Rhode 1948). Swingle (1947) has also reported that inorganic fertilization results in large generation of Chlorophyceae. Abundance of Chlorophyceae encountered within the present study during summer may also be due to use of detergents and fertilizers in the immediate surroundings of the lake which often reach into the lake. The class, however, showed restricted growth during the cold water period extending from December to February.

The group Cyanophyceae ranked third after Bacillariophyceae and Chlorophyceae in order of number of species and population density. A total of 07 taxa were recorded from the lake including *Anabaena globosa, Aphanocapsa sp., Merismopedia elegans, M. punctata, Microcystis aeruginosa, Spirulina sp.,* and *Oscillitoria sp*. Cyanophyceae in the present study depicted its peak growth during summer at most of the sites, whereas low densities were recorded during cold water periods. Blooms of some Cyanophyceans like *Merismopedia elegans, Microcystisa aeroginosa* were noticed in summer. The dominance of this group during summer months indicates the influence of temperature on this group. George (1960) has suggested that high temperatures act as a principal factor causing blooms of Cyanophyceae, in agreement with Tripathi and Pandey (1995), who also observed a maximum number of blue-greens during the summer and a minimum number in the winter.

Only 03 taxa of Euglenophyceae, *Euglena acus*, *Phacuscerantus* and *P. makii* have been recorded from the lake. Euglenophyceae in the present study showed its peak growth in spring except at some sites, where the peak growth was observed in summer. Kant and Kachroo (1977) recorded maximum occurrence in spring and autumn in their study on Dal lake, while as Nygaard (1977) observed that Euglenophyceae attained their maximum growth in spring and summer.

Dinophyceae formed the least represented group in the phytoplankton community, being represented by *Ceratium hirundinalla* and *Peridium purillium,* which were recorded in the lake. Rawson (1956) classified *Ceratium* as a mesotrophic algal form. According to Findenegg (1971) some of the Australian lakes which get rapidly polluted due to human influence enter into a phase of dense population of *Ceratium* which is followed by *Oscillatoria* bloom. The presence of *Ceratium* in fairly good numbers is an indication that the lake under discussion has higher trophic evolution due to discharge of waste water.

Chrysophyceae, the least represented group in the phytoplankton community, being represented by a lone taxa of *Dinobryon sp.,* assumes a lesser importance as far as population size is concerned. According to Hunter (1980), the presence of Chrysophytes in combination with one or two other algal groups, indicates oligotrophic or mesotrophic conditions. However, Hutchinson (1967) stated that *Dinobryon sp.* may appear in productive lakes when nutrients are largely exhausted by other biotic components. This is probably the reason for the low density of *Dinobryon sp.* in the present study.

In the present study, the total phytoplankton depicted high diversity and density during summer followed by spring. According to many authors like Singh (1960), Pandit (1998), the phytoplankton densities usually remain high throughout the year but two peaks are common in spring and summer. Peak growth of phytoplankton during these two seasons may be as a result of moderate water temperature conditions, regeneration and availability of minerals (Brraich and Kaur, 2015) which in turn is an outcome of decomposition of organic matter in sediments during these two peak periods. Kant and Kachroo (1973, 74) while studying the ecology of phytoplankton with respect of their distribution at different depths in Dal lake observed three peaks of phytoplankton growth viz. March - April, July – Aug and Oct-Nov. Phytoplankton count was minimum in winter months which may be attributed to low water as well as ambient temperature in the lake. The present results are also in conformity with results of other workers, who carried studies on phytoplankton of some freshwater bodies in India (Sreenivasan *et al.*, 1974; Pandit, 2002).

Conclusion

It is evident from the present study that Bacillariophyceae was the dominant class in the Manasbal lake followed by Chlorophyceae, with just a little contribution from Cyanophyceae and Euglenophyceae, as has been the case in the majority of Valley lakes. Bacillariophyceae and Chlorophyceae were found to be about similar in terms of species composition, although Cyanophyceae and Euglenophyceae contributed fewer phytoplanktons to the Manasbal lake over the research period. The cell counts discovered in the lake were quite high, demonstrating a clear impact of sewage on the growth and multiplication of phytoplankton in the lake. The thick mats of algae were observed in several locations, possibly as a result of excessive enrichment from sewage of adjacent residential hamlets and houseboats. During the sample visits at these sites, signs of floating human waste, bad odors presumably caused by hydrogen sulphide, decomposition of organic materials in the form of macrophytes but dominated by algal mats, and anoxic conditions in the water were quite obvious. Because there are several elements influencing phytoplankton growth and multiplication, the species dynamics must be thoroughly analyzed and monitored in order to achieve any meaningful findings.

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