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Phytoplankton Dynamics of Manasbal Lake in Kashmir Himalaya

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Abstract:
Phytoplankton have been studied with respect to their population growth, species diversity and composition in the Manasbal Lake.The study was carriedout for six months starting from May2005 to October 2005.A total of 56 phytoplankton taxa were recorded, 24 belonged to Bacillariophyceae, 16 Chlorophyceae, 14 Cyanophyceae, and one each to Euglenophyceae & Chrysophyceae.Bacillariophyceae appeard as a dominant group.Abundance of Cyanophyceae & presence of Euglenophyceae near sewage disposal sites indicated the organic enrichment of these habitats.Both the oligotrophic(e.g., Nitzchia sp.) & eutrophic (e.g.,Synedra sp.) Forms were recorded in the lake showing moderate levels of pollution.

Key words: *Bacillariophyceae, Nutrient enrichment, Trophic evolution*

1. Introduction

Phytoplankton is a microscopic, unattached plants found relatively homogenously mixed throughout the freshwater column. Being dependent upon light & nutrients, they populate the euphotic zone of freshwater lakes, reservoirs & ponds.
The phytoplanktonic organisms are present in all types of standing water bodies as well as in the middle & lower reaches of rivers. The primary productivity & the day time biogenic oxygenation in the freshwater zones are depending upon these organisms. Of the various aquatic groups, the phytoplankton communities respond very quickly to the changes in their environment because of their short life cycle, therefore, could provide an insight into the quality of the lakes in which they live (APHA, 1985) & act as indicators of the lake status. Phytoplanktonic organisms are sensitive indicators of environmental stresses (Hutchinson, 1967).

2. Material and Method

2.1. Selection of sites

Four sampling sites were selected in the lake differing in various environmental variables(depth, vegetation,& human interferences).Site-I: close to inlet(1.5m depth), SiteII:near outlet (1m depth),highly infested with submerged weeds, Site-III : lake centre (6m depth),& Site-IV: near residential area(1.5m depth), with a thick growth of macrophytic vegetation and abundantly covered with obnoxious weeds of *Lemna and Salvinia* species.

2.2. Collection of Samples

The sampling was carried out once in a month for a period of six months starting from May,2005 to Oct.2005.For the quantitative estimation of phytoplankton, five litres of water were sieved through plankton net (64nm). The content was collected in the plankton tube attached to the lower end of the net. The collected content was transferred into a separate polythene tube and preserved with 4% formaldehyde (APHA,1998).
The identification of phytoplankton was done with the help of a binocular stereoscopic microscope by adopting standard works of Edmondson(1992) Prescott(1968),Palmer(1980) & Cox(1996).Counting was done with the help of Sedgewick-Rafter-cell of 1ml capacity. The unicellular algae were counted as individuals, where as in the filamentous forms, each filament was taken as unit. Similarly, in colonial forms counting unit was the colony (Jumppanen,1976). The phytoplankton density was expressed as units per litre.

2.3. Calculation

No. of organisms/ml=$\frac{C \times A1}{A2 \times S \times V}$

Where,
C=No. of organisms counted
A_1=Area of cover slip,mm^2
A_2=Area of one strip,mm^2
S=No. of strips counted, and
V=Volume of sample under the coverslip, ml.

3. Results and Discussion

A total of five major groups of phytoplankton were recorded in the lake during the course of investigation namely Bacillariophyceae, Chlorophyceae, Cyanophyceae, Chrysophyceae and Euglenophyceae. Among these Bacillariophyceae (60.17%) formed the bulk of phytoplankton followed by Chlorophyceae(25.29%),Cyanophyceae(12.95%),Euglenophyceae(0.86%) and Chrysophyceae(0.06%) (Figure 1).

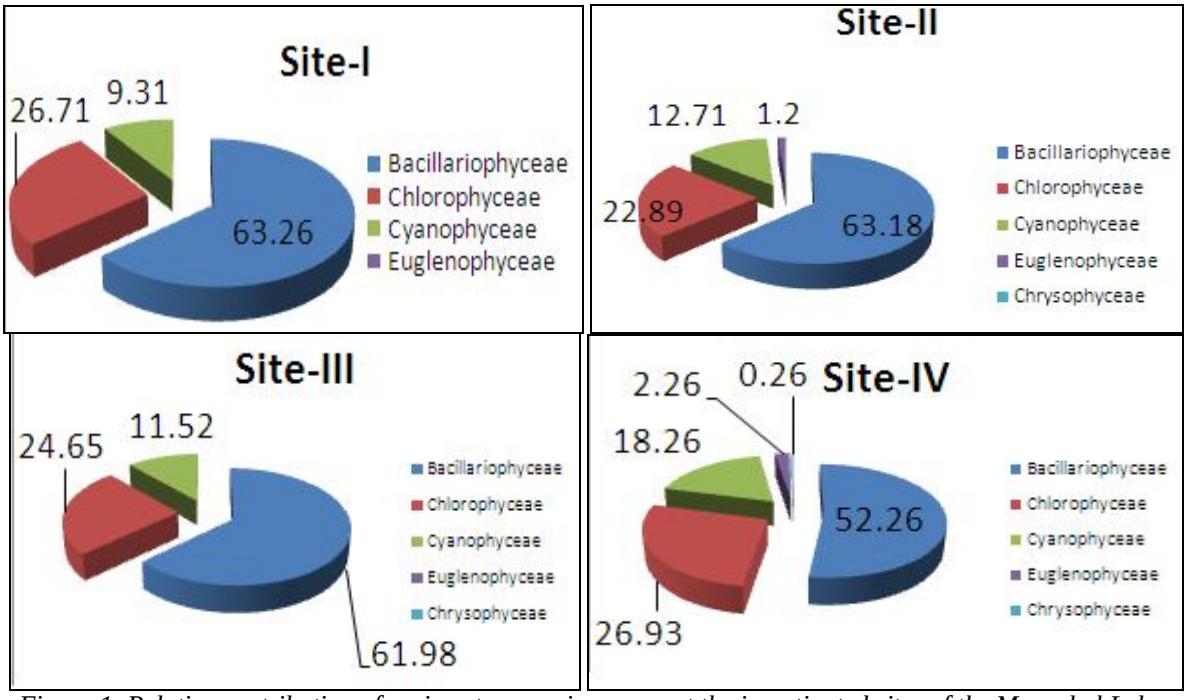

Figure 1: Relative contribution of various taxonomic groups at the investigated sites of the Manasbal Lake

In all,56 phytoplankton taxa were encountered from the lake. Among these, 24 taxa belonged to Bacillariophyceae and were found distributed at four sites of the lake with 20 each at Site-I and Site-II, 21 at Site-III and 22 at Site-IV. Chlorophyceae comprised of 16 taxa in all, with 15 at Site-I, 10 at Site-II, 13 at Site –III and 08 at Site-IV. In case of Cyanophyceae, a total of 14 taxa were recorded, with 6 at Site-I, 10 at Site-II,08 at Site- III and 14 at Site- IV.A single taxa of Euglenophyceae was recorded at Site-II and Site-IV. Also single taxa of Chrysophyceae was recorded at Site-IV only (Table 1).

Class	Total taxa	S-I	S-II	S-III	S-IV
Bacillariophyceae	24	20	20	21	22
Chlorophyceae	16	15	10	13	08
Cyanophyceae	14	06	10	08	14
Chrysophyceae	01	-	-	-	01
Euglenophyceae	01	-	01	-	01
TOTAL	56	41	41	42	46

Table 1: Total no. of phytoplankton Taxa recorded from the four investigated Sites of the Manasbal Lake

3.1. Bacillariophyceae

The Bacillariophyceae being dominant group showed its presence at all the sites with maximum number of species.The dominant nature of Bacillariophyceae in the present lake was also recorded by Zutshi and Wanganeo(1984). Mir and Kachroo(1982) based on the data of 1974-76 reported diatoms to be the most dominant phytoplankton of the lake Manasbal. According to Hutchinson (1967)

diatoms are the most important members of the freshwater plankton, being nearly always present in considerable numbers. The Bacillariophyceae taxa recorded from the lake are shown in Table 2.

S. NO.	Taxa	Site –I	Site-II	Site-III	Site-IV
1.	Amphora sp.	-	+	+	+
2.	Achnanthes sp.	+	+	+	+
3.	Asterionella sp.	+	+	+	+
4.	Cymbella ventricosa Kutz	+	+	+	+
5.	Ceratoneis arcus	-	+	+	+
6.	Cyclotella comensis	+	+	+	+
7.	Diatoma elongatum Agardh	+	+	+	+
8.	Diatomella balfouriana	_	_	_	+
9.	Denticulla thermalis	_	_	_	+
10.	Epithemia sp. Breb	+	+	+	+
11.	Eunotia robusta	+	+	+	+
12.	Fragilaria sp.	+	+	+	+
13.	Gomphonema sp Ag	+	+	+	+
14.	Gyrosigma accuminatum	+	+	+	+
15.	Meridion circulare	+	+	+	+
16.	Melosira graulata Kutz	+	+	+	+
17.	Navicula radiosa Kutz	+	+	+	+
18.	Nitzschia sp.	+	+	+	+
19.	Pinnularia sp.Her	+	+	+	+
20.	Stauronies sp.Her	+	+	+	+
21.	Surirella sp.Turpin	+	+	+	+
22.	Synedra ulna(Nitz) Her	+	+	+	+
23.	Synecocystis sp.	+	_	+	_
24.	Tabellaria sp. Lyng	+	_	_	_

Table 2: Bacillariophyceae taxa recorded from the investigated sites of the Manasbal Lake
+ (Present); _ (Absent)

The entire investigation of Bacillariophyceae indicated that species composition is not much variable at different sites. Out of total of 24, 18 taxa have been found to be present at all the sites. The most frequently encountered were *Achnanthes* sp., *Cymbella ventricosa, Cyclotella comensis, Diatoma elongatum, Eunotia robusta, Fragilaria* sp., *Gomphonema* sp., *Navicula radiosa, Nitzchia* sp., *Pinnularia* sp., *and Synedra ulna*. Presence of these at all the sites indicates that the lake water is favourable for their growth at all the sites. According to Hickman(1975*) Cymbella ventricosa, Synedra ulna, Fragilaria capucina,Diatoma elongatum, Gomphonema*

olivaceum, Cocconies placentula and Navicula sp. are the species which are commonly found in organically polluted water. Vollendweider(1968) considers *Fragilaria crosonensis* to indicate eutrophy. Most of these genera were found in the present lake, which clearly indicates the advanced trophic level of the water body.

The Bacillariophyceae taxon recorded exclusively from the Site –I is *Tabellaria* sp. The *Amphora* sp. and *ceratoneis arcus* were found to be absent at Site-I but present at rest of the sites showing their preference for nutrient rich water.A high density of genera of *Navicula* sp., *Cymbella* sp., *Cyclotella* sp.,and *Pinnularia* sp. are recorded at Site-II,Site-III and Site-IV. High levels of nutrients at these sites seem to be suitable for their growth. A high density of *Achnanthes* sp. has been recorded at Site-II and Site-IV. Sarwar (1991) has related the dominance of this species to overall nutrient enrichment of the lake. *Diatomella balforiana* and *Denticulla thermalis* have been found at Site –IV only, the sewage receiving site, showing their tolerance to sewage pollution. *Synedra ulna* is reported with low densiy at Site-I and Site-III, the least polluted sites, whereas the species is reported with a high density at Site-II and Site-IV, the polluted sites.A comparatively high density of *Nitzchia* sp.has been recorded at the siteI.According to Lowe (1972) *Nitzchia linearis* is an oligotrphics form while as *Synedra ulna* is a eutrophic form.

3.2. Chlorophyceae

The Chlorophyceae is the second dominant group of phytoplankton after Bacillariophyceae.Yousuf et al.(2002) also reported the same trend in Anchar lake.The Chlorophyceae taxa recorded from the lake are shown in Table 3.

S. NO.	Taxa	Site-I	Site-II	Site-III	Site-IV
1.	Chlorella sp.	+	+	+	+
2.	Chlorococcum sp.	+	+	+	+
3.	Cosmarium sp.	+	+	+	+
4.	Coelastrum sp.	+	_	+	_
5.	Cladophora sp.	+	+	+	+
6.	Crucigenia tetropodia	+	_	_	_
7.	Diadesmis sp.	+	+	+	_
8.	Euastrum sp.	+	+	+	_
9.	Mougeotia sp.	+	+	+	+
10.	Oedogonium sp.	_	+	+	+
11.	Oocystis sp.	+	+	+	+
12.	Pediastrum duplex	+	_	+	_
13.	Planktosphaeria sp.	+	_	_	_
14.	Tetraedon sp.	+	_	+	_
15.	Ulothrix sp.	+	+	+	+
16.	Zygnema sp.	+	_	_	_

Table 3: Chlorophyceae Taxa Recorded from the investigated sites of the Manasbal Lake
+ (Present); _ (Absent)

Out of 16 ,7 taxa are recorded from all the sites which include *Chlorella* sp., *Chlorococcum* sp., *Cosmarium* sp., *Cladophora* sp., *Mougeotia* sp., *Oocystis* sp., *Ulothrix* sp. Their maximum density is recorded at Site-I, the highly transparent and least polluted site.According to Kaul et al.(1978) higher transparency is conducive for the growth of Chlorophyceae. The species restricted to Site-I include *Crucigenia tetropodia, Planktospharia* sp. and *Zygnema* sp. Absence of these species at others sites, the Site II,Site-III and Site IV indicate their low tolerance to organic pollution.

3.3. Cyanophyceae

The Chlorophyceae group is followed by Cyanophyceae.The group is mostly associated with nutrient rich waters. The Cyanophyceae taxa recorded from the lake are shown in Table 4.

S. NO.	Taxa	Site-I	Site-II	Site-III	Site-IV
1.	Anabaena sp.	_	_	_	+
2.	Anacystis cyanea	_	+	_	+
3.	Aphanothece sp.	_	+	_	+
4.	Coccochloris stagnina	_	_	_	+
5.	Crococcus sp.	+	+	+	+
6.	Gloeocapsa sp.	+	+	+	+
7.	Gomphosphaera sp.	_	+	+	+
8.	Lyngbia sp.	+	+	+	+
9.	Merismopedia punctata	_	_	_	+
10.	Microcystis sp.	_	_	_	+

11.	Nostoc sp.	+	+	+	+
12.	Oscillatoria sp.	_	+	+	+
13.	Phormidium sp.	+	+	+	+
14	Spirulina sp.	+	+	+	+

Table 4: Cyanophyceae Taxa Recorded from the investigated sites of the Manasbal Lake
+ (Present); _ (Absent)

Out of 14, 6 taxa have been recorded from the all sites including *Crococcus* sp.,*Gloeocapsa* sp., *Lyngbia* sp., *Nostoc* sp.,*Phormidium* sp., and *Spirulina* sp. Their density has been found to be high at Site –IV, where water is contaminated with sewage and faecal matter. The taxa recorded absent from Site-I(the least polluted site) include *Gomphosphaera* sp. and *Oscillatoria* sp. Parveen(1988) and Yousuf and Parveen(1990) reported the dominance of Oscillatoria sp. in polluted waters.All of the 14 taxa have been recorded at site-IV. The taxa recorded particularly from Site-IV, and found absent from Site-I, Site-II and Site-III include *Microcystis* sp., *Anabaena* sp.,*Coccochloris stagnina* and *Merismopedia punctata*. According to Rawson(1956) eutrophic lakes are characterized by *Microcystis* sp. and *Anabaena* sp. The dynamics of blue green algae in the freshwater plankton has been discussed by a number of workers (Prescott 1939; Ganapathi 1940; Singh 1960; Zaffar 1967; Seennaya 1982). Most of these workers have related the appearance of blue green with the eutrophication process.

3.4. Euglenophyceae
The Euglenophyceae taxa recorded from the lake are shown in Table 5.

S.NO.	Taxa	Site-I	Site-II	Site-III	Site-IV
1.	Euglena sp.	-	+	-	+

Table 5: Euglenophyceae Taxa Recorded from the investigated Sites of the Manasbal Lake
 # + (Present); _ (Absent

Only a single taxa of Euglenophyceae, *Euglena* sp. has been recorded from the lake. The taxa is recorded at Site-II and Site-IV, the polluted sites, whereas, found absent from Site-I and Site-III, the least polluted sites. Hutchinson, 1967 attributed the presence of Euglenophyceae with a high level of organic matter.

3.5. Chrysophyceae
The Chrysophyceae taxa recorded from the lake are shown in Table 6.

S. NO.	Taxa	Site-I	Site-II	Site-III	Site-IV
1.	Synura sp.	_	_	_	+

Table 6: Chrysophyceae Taxa Recorded from the investigated Sites of the Manasbal Lake
+ (Present); _ (Absent)

A single taxa of Chrysophyceae, S*ynura* sp. has been recorded from the lake. The taxa is recorded at Site-IV only.

4. Conclusion
The overall study of Phytoplankton dynamics in Manasbal lake indicates that the water body is undergoing trophic evolution.The presence of both the eutrophic and oligotrophic forms(like *Synedra* and *Nitzchia*) depicts moderate levels of eutrophication.
The positive signs of eutrophication are:

- The dominance of Bacillarophyceae over other algal groups.
- Development of blue green forms at sites receiving sewage outfall.
- The presence of Euglenoids indicates the rise in organic matter content.

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