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An insight to species abundance of periphyton community in Bhimtal Lake

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Abstract
Lake Bhimtal is a natural lentic water body in the Nainital District in the state of Uttarakhand, India. Well known for its vast size, socio-economic importance and aesthetic beauty the lake is a habitat for diverse micro and macro communities including Periphyton, attached to a fixed substrate. The present study was performed to observe the species abundance of periphyton in the lake. The dominant species of periphyton during the study *were Navicula, Cymbella, Amphora, Fragilaria, Tabellaria, Synedra and Cosmarium.* The study revealed that the diatom groups were dominant throughout the study period as compared to other groups. In that group, different genera like *Cymbella sp., Navicula sp.* and *Tabellaria sp*. were the major contributors to the overall density.

Keywords: Habitat, Lentic, Periphyton, Substrate

Introduction
Periphyton comprises the organisms living on the substrate which includes variable proportions of algae, fungi and bacteria. In latest studies it has found that periphyton is also important to increase the primary productivity of the lake ecosystem, by the fixation of carbon and essential nutrients such as nitrogen and phosphorus [1]. Its assemblages show variations in their nutritional quality. The community species composition and succession respond to environmental conditions [2]. Periphyton can be found in almost every type of aquatic ecosystems like pond, river, lake and ocean and in trophic conditions that range from the most oligotrophic to the most eutrophic [3]. It can also form a major food source for fish species and important part of the food chain in the aquatic ecosystem. Factors that are considered influential to periphyton ecology include nutrient concentrations, water chemistry, physical variables, etc which change seasonally throughout the year. The parameters like nutrient concentrations, water chemistry, physical variables etc affect the diversity of the periphyton which changes seasonally throughout the year. It is also affected by other factors like limited space, disturbance and basin shape of the lake [4]. Periphyton can be used to study environmental quality in rivers and streams as they respond rapidly to chemical and physical changes [5]. They can be used as ecological indicators for detecting the severity of pollution as they cannot avoid contact with waste effluents. The effect of light and nutrient is very important in primary productivity [6]. Both light and nutrients can affect growth and stoichiometry of periphyton separately [7]. The growth of periphyton can be light-limited [8] or nutrient-limited [9], or both and is influenced by temperature [10]. Grazing by invertebrates in lakes and streams has also a potentially significant influence on the composition and the proliferation of periphyton communities. The benefit of periphyton communities is to absorb dissolved, suspended and organic matter from the water column as well as reducing bottom accumulation. It also helps in removing nutrients from the water column and helps to control the dissolved oxygen concentration and pH of the surrounding water [11, 12]. The present study was done to assess the status of population density of the periphyton community in the lake Bhimtal.

Materials and methods
Periphyton study was done in the lake Bhimtal for a period of one year from January to December, 2014. Three sites (S_1, S_2, and S_3) were randomly selected for regular sampling and collection of the periphyton community. Site S_1 in was the boat stand of the lake which has a wide area with a small market and a few restaurants thus with maximum anthropologic activities, while site S_2 was the area in middle of the lake at the island and S_3 was 35 m away in

horizontal distance from S_1. The sampling was done fortnightly for assessment of periphyton estimations. For assessment of the periphyton, samples from the lake were collected throughout the year at three selected sites by scratching one square centimeter from the stones/boulders, stairs, boat, plantation which were submerged in the lake water by using brushes. The sample was collected in the sampling tube and make up the volume up to 10 ml. Collected samples were preserved in 4-5% lugol's iodine in separate tubes for taxonomic identification. Generic level identification was done with the help of [13]. The process of identification was carried out under the microscope. Analysis of periphyton at quantitative level was done through "Lacky's drop method". The number of organisms was counted with a help of a high powered microscope (Labomed OpticX).

Results and Discussion

According to the study, it was observed that some species were presented seasonally and some were dominant throughout the year. Their contribution is more in periphyton density as compared to others. The dominant species were *Navicula, Cymbella, Amphora, Fragilaria, Tabellaria, Synedra* and *Cosmarium*.

Navicula sp

Monthly variation in density of *Navicula species* is presented in fig1. Observation on the seasonal variation in the density of *Navicula sp* for the entire study period indicated that its density fluctuated between 1000 individuals (ind.)/cm^{2}to10000 ind/cm^2 at S_1, 1400 ind.cm^2 to 8000 ind./cm^2 at S_2 and 2000 ind./cm^{2}to 10000 ind./cm^2 at S_3 respectively. The mean of all the three station was 7034 ind./cm^2. This species was found throughout the investigation. The peak period of this species was noticed in the month of March at station S_1, at station S_2 January, March, April and October while at station S_3 it was noticed in the month of January, February and October.

Cymbella sp

Monthly variation in density of *Cymbella sp*. is presented in fig 2. During the study period, it was noticed that the density of *Cymbella sp* fluctuated between 400 ind./cm^2 to 2000 ind./cm^2 at station S_1, 200 ind/cm^2 to 1600 ind/cm^2 at station S_2 and 200 ind./cm^2 to 1800 ind./cm^2 at station S_3 respectively. The annual mean of the density of the three stations was 861ind./cm^2. Seasonal variation in species was characterized by peak periods in the month of February and November in S_1, November in S_2 and November in S_3 respectively.

Amphora sp

Monthly variation in density of *Amphora sp*. is presented in fig 3. It was observed that the density of *Amphora sp.* varied between 1400 ind./cm^2 to 6000 ind./cm^2, 1200 ind./cm^2 to 7000 ind./cm^2 and 1600 ind./cm^2 to 6600 ind./cm^2 at station S_1, S_2 and S_3 respectively. The annual mean of the density of all the three stations were 3316 ind./cm^2. The seasonal variation was characterized by peak period of this species was noticed in the month of February and November in station S_1, February in station S_2 and November in station S_3 respectively.

Fragilaria sp

Monthly variation in density of *Fragilaria sp*. is presented in fig 4. During the investigation it was observed that the density of the species fluctuated between 1000 ind./cm^2 to 4000 ind./cm^2 at S_1, 800 ind./cm^2 to 3600 ind./cm^2 at S_2 while at S_3 it fluctuated between 600 ind./cm^2 to 3800 ind./cm^2. The mean of all the three station during the study period was 1783ind./cm^2. Seasonal variation in the species was observed highest in the month of December in all the three stations S_1, S_2 and S_3 respectively.

Tabellaria sp

Monthly variation in density of *Tabellaria sp*. is presented in fig 5. The density of this species varied between 200 ind./cm^2 to 1400 ind./cm^2 at station S_1, 200 ind./cm^2 to 1200 ind./cm^2 at station S_2 and 400 ind./cm^2 to 1400 ind./cm^2 at station S_3. The annual mean of all the three station during the study period was 622 ind./cm^2. Seasonal variation in the species was found the maximum in the month of September in station S_1, S_2 and S_3 respectively.

Synedra sp

Monthly variation in density of *Synedra sp*. is presented in fig 6. During the study period the observed density of this species fluctuated between 400 ind./cm^2 to 800 ind./cm^2 at S_1, 200 ind./cm^2 to 800 ind./cm^2 at S_2 while at S_3 it fluctuated between 200 ind./cm^2 to 800 ind./cm^2. The annual mean of all the three station was 561ind./cm^2. The peak of the density of this species was observed in the month of December at station S_1, May, October, November and December at station S_2 and May, July, September and November at station S_3.

Cosmarium sp

Monthly variation in density of *Cosmarium sp*. is presented in fig 7. The density of this species varied between 200 ind./cm^2 to 600 ind./cm^2 at station S_1, S_2 and S_3 respectively. The annual mean of all the three station was 355ind./cm^2. Seasonal variation in this species was observed highest in the month of November at S_1 and S_2 while at S_3 it was observed in the month of July, September, November and December**.**

The study showed that the *Bacillariophyceae* groups were dominant throughout the study period as compared to other groups. In that group, different genera like *Cymbella sp., Navicula sp.* and *Tabellaria sp.* were the major contributors to the overall density. During the study period, it was observed a seasonal change of the periphyton organisms. According to the study [14] reported in the Teno River that most diverse groups was Bacillariophyceae followed by Chlorophyceae and Cyanophyceae. The seasonal variation was also observed in the Kaunas Lagoon and the Nemunas River by the researcher. They also observed in their study that the dominance group was diatoms in comparison to others [15]. [16] also reported that the major contributors in the density in their study throughout the study period were *Cymbella sp, Navicula sp, Tabellaria sp, Synedra sp.* Amphora sp., *Fragilaria sp*. Bacillariophyceae dominance has also been reported in a number of streams studied for periphyton composition by [17, 18]. Dominance of Bacillariophyceae may be contributed to the presence of good concentration of SiO_2 in water bodies which probably helps in the frustule formation and its ability to thrive well in cold waters. Generally diatom comprises the major portion of primary producer in aquatic ecosystem.The other group which was present throughout the year was Chlorophyceae and the genera dominant in this group was *Cosmarium*. The most probable reason for the proportions of Chlorophyceae may be attributed to the clear water in the studied lake which provides better light conditions for the growth of group [19]. [18] Also found the

dominance of *Gomphonema sp*., *Cymbella sp*. and *Fragilaria sp* in their study, they observed that the density of *Fragilaria* in August and September at all stations while the dominance of *Cymbella sp*. was observed in the month of October and November. [20] Also observed the dominance of Bacillariophyceae and Chlorophyceae over other groups of periphytic algae. The genera numerically dominant during the entire study period were *Closterium sp, Amphora sp, Cymbella sp*., *Navicula sp*., and *Tabellaria sp*. The dominance of Chlorophyceae and Bacillariophyceae indicated the presence of a good amount of nitrate-nitrogen and phosphorus. Nitrogen (N) and phosphorus regulate the growth of periphyton.

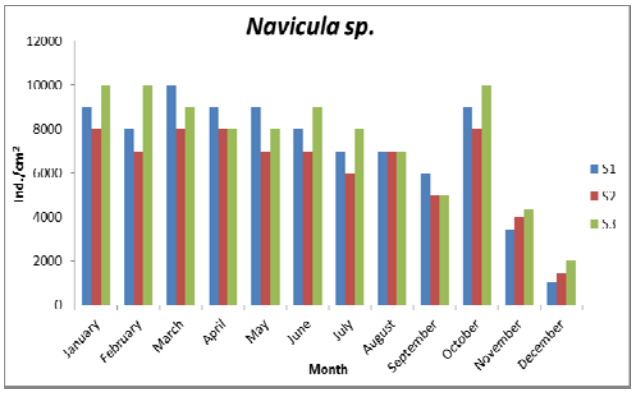

Fig 1: Monthly variation in the population of *Navicula sp.* in the Lake Bhimtal during the study period.

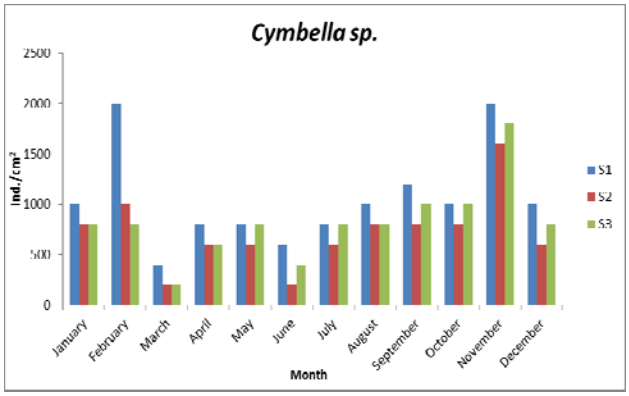

Fig 2: Monthly variation in the population of *Cymbella sp.* in the Lake Bhimtal during the study period**.**

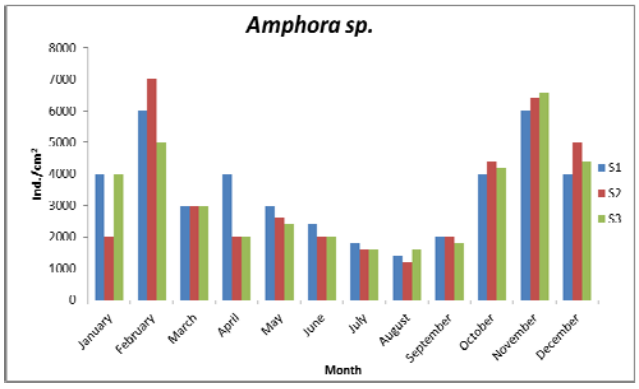

Fig 3: Monthly variation in the population of *Amphora sp.* in the Lake Bhimtal during the study period.

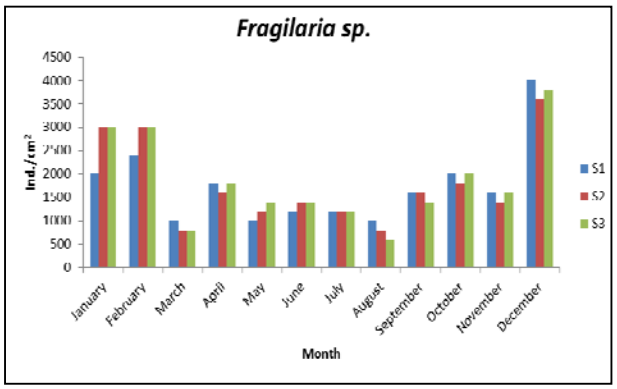

Fig 4: Monthly variation in the population of *Fragilaria sp.* in the Lake Bhimtal during the study period**.**

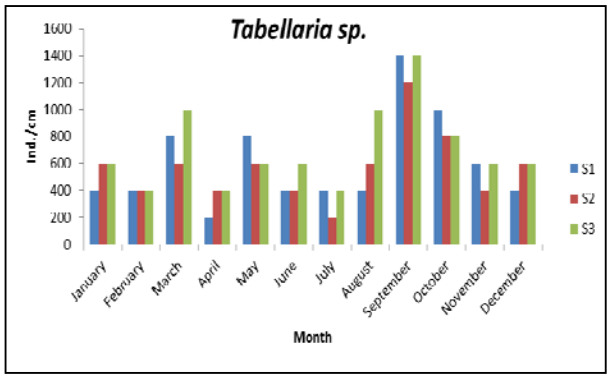

Fig 5: Monthly variation in the population of *Tabellaria sp.* in the Lake Bhimtal during the study period**.**

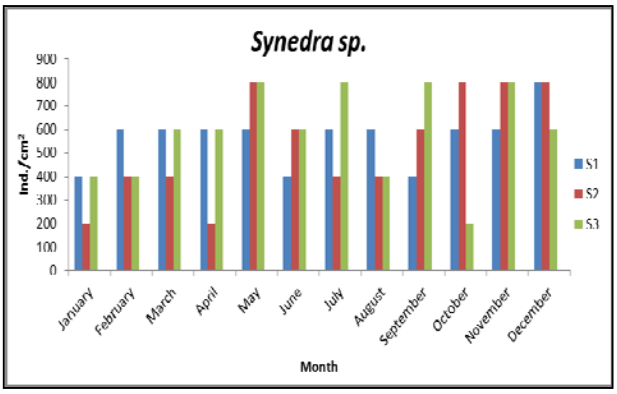

Fig 6: Monthly variation in the population of *Synedra sp.* in the Lake Bhimtal during the study period.

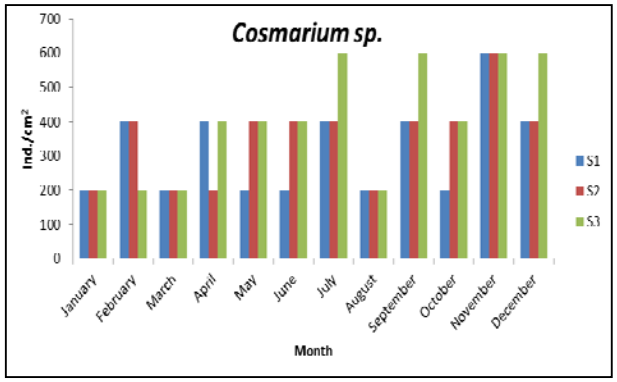

Fig 7: Monthly variation in the population of *Cosmarium sp.* in the Lake Bhimtal during the study period**.**

Conclusion

The present study was carried out in Lake Bhimtal of Kumaun region of district Nainital, which is the largest lake of the Kumaon region in Uttarakhand. From the study, it can be concluded that the dominant group was *Bacillariophceae* followed by *Chlorophyceae* as compare to other groups. The dominant species were *Navicula, Cymbella, Amphora, Fragilaria, Tabellaria, Synedra* and *Cosmarium*. It was observed that these species were present throughout the year. The dominance of the diatom showed that the presence of a good concentration of silican dioxide in water bodies which probably helps in the frustule formation and other nutrients which are required for the growth of the periphyton community.

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