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Diversity and Seasonal Variation of Plankton Community in Ramsagar Lake, Bangladesh

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ABSTRACT

This study aims to explore diversity of plankton and their seasonal variation of density in the Ramsagar Lake, Bangladesh. Samples were collected monthly from three sites with three replications for each. This study revealed that phytoplankton abundance showed significant difference ($P<0.05$) among different seasons. The highest phytoplankton was observed in summer season and the lowest observed in winter. In terms of month the highest phytoplankton was observed in June-July and the lowest observed in December-January. On the other hand, 4 groups and 7 genera of zooplankton were found during the study period. Among the genera of

Rotifera, 2 genera of Copepoda, one genera of Cladocera and one genera of crustacean were found. Seasonal variation of total zooplankton was found in the study. Zooplankton abundance showed significant difference ($P<0.05$) among different seasons. Considering all the facts the total plankton production was found highest in summer season and the mean values were (9.78±1.70) and lowest in winter season and the mean values were (8.09±1.62). Seasonal variation of plankton abundance was found throughout the year. It might be suggested that Ramsagar is a water resource with a diversity of plankton which is an important primary producer and important for fish production.

Keywords: Aquaculture, fisheries management, Fish cultivation, fisheries management, fresh water fish

1. INTRODUCTION

Bangladesh is a country which is land of water (Sarker, 2016). The country has suitable geographical location with the expected fisheries resources such as coastal estuaries, rivers, haors, baors, canals, lakes, reservoirs, khal-beels and ponds (Nurullah & Sarker, 2020). These water resources are the very important for fish (Murugesan et al., 2015) and other aquatic animals, plants and other aquatic organism for their residence (Chen, Sui, et al., 2019). These water resources have higher economic importance and the resources plays an important role in the socio-economic elevation, alimentation, create opportunity of service or employment, poverty palliation etc (Magalhães et al., 2009). The fisheries resources also have a large number of foreign exchange earnings sectors which is important for the economy of Bangladesh (Bhuiyan & Khondker, 2017). Bangladesh has 3901900 ha area of water body. The total fish production by the water resources (River and Estuary) is 3878324 mt.

Planktons are microscopic and free non- partisan organisms in water body. The plankton can flows with the currents and winds (Li et al., 2012). The plankton can be divided into two types, one is the phytoplankton and the other is zooplankton (Biosci et al., 2020). The Plankton can be classified in different ways, this involve whether they are true or false plankton, their nutritional requirements (Phytoplankton and zooplankton), their size, their environments and their life history (Taluka & Nandurbar, 2019). There is illustrious diversity in the construction of plankton not only in various seasons and at different depths, but also at several hours, and likely even in different season in the same place and depth (Chen, Liu, et al., 2019). The plankton constitutes the primary producers in any certain water body (Kamruzzaman et al., 2020). Therefore, water quality administration has to monitor the phytoplankton content in order, for example to come up with prohibitive measures such as aeration to prevent fish kills during the corrosion of the planktonic biomass (Dede & Deshmukh, 2015). The allocation, abundance, species variation and construction of the phytoplankton are used to assess the biological fidelity of a water body (Amin et al., 2019). Plankton is the premier elementary creators in water bodies which influence formation and firmness of consumers and the distinctness of water. Besides of phytoplanktonic organisms which are impressible indicators, as phytoplankton formation and metabolism changes quickly in reaction to environmental changes (Shi et al., 2020). Outgrowth rate and stagnancy of phytoplankton are subject to cyclic changes restlessness and succession.

Phytoplanktons are called as autotrophic compounds of the plankton community which plays a vital role of the major part of seas and the freshwater ecosystem (Eloire et al., 2010). There are some kinds of plankton which are noticeable as colored patches on the water body due to present of green particles called as chlorophyll within their cells and various elements like phycobiliproteins or xanthophylls (Sharmin et al., 2014). The phytoplankton which are photosynthesizing microscopic organisms that inhibit the upper sunlight layer of the water of marine water or fresh water they are primary producers in water (Chen et al., 2020). The process of making of organic compounds from CO_2 dissolved in water. It is the process that sustains the water food chain (Pawar, 2016). A large number of phytoplankton species are obligate photo autotrophs, there are some types which are mix autotrophic and the others are non-pigmented species (Sarker, Yang, et al., 2020). Even if they have no quick effect on fish yield, they are at least categorically good indicators of the biological productivity (Sarker et al., 2019).

Any transformation in quality and quantity of food particles will affect the out growth rate of the fish (Md Shahidul Islam et al., 2015). The total production of fish largely depends on the plankton production (Kumari & Pathak, 2018). They play a vital role directly or indirectly in fish production (M. Islam et al., 2018). Various water quality parameters have been influences on the growth and production of both the phytoplankton and zooplankton (Manikandan et al., 2016). There are a number of researches works on ecological, limnological and biological aspects of pond and river is very much needed in Bangladesh for better management practices of the water body (Zhu et al., 2020). This will also protect the vulnerable fishery resources from environmental degradation through proper management practice that will enhance the total capture and culture production (Prodhan et al., 2017).

The most essential and one of the most enormous elements of the ecosystem is water. Almost all the organism which is living in nature directly depends on water for their growth and survival (Sarker, Peng, et al., 2020). Both plants and animals needed water for

their existence. For the growth of plankton in water body there are some parameters which can provide the best growth of plankton in water (Sarker, Wu, et al., 2020). Water temperature can control all the chemical reaction and affects the growth of plankton, fish growth, their metabolism, immunity and the reproduction (Ghosh et al., 2020). Changing heavy temperature can be dangerous to fishes and other aquatic animals living in water body (Taluka & Nandurbar, 2019).

Ramsagar lake is located in the village name is Tejpur in the district of Dinajpur. The Ramsagar Lake is situated about 8.1 km from the south of the Dinajpur town. It is an important resource not only for fish production but also for tourism aspects. While plankton community of a water body consists the basis of a food chain (Sarker, Ahmad, et al., 2020) and very essential for food production (Sharma et al., 2018), the study associated with plankton diversity (Md Saiful Islam et al., 2020) and their seasonal variation in relation to water quality parameters is very few. Considering the importance of plankton production this study was done to assess the diversity and seasonal variation of plankton in Ramsagar. In order to evaluate the present condition of Ramsagar Lake, this study intends to analyze the diversity and seasonal variation of density of plankton of Ramsagar Lake in Dinajpur, Bangladesh.

2. MATERIALS AND METHOD

Samples were collected monthly from three sites with three replications for a period of one year (12 months). Sampling were done in early morning as plankton are available in the morning. After two months of pre sampling finally three sites were selected according to availability of plankton.

2.1. Geographical features

A comparative study on Diversity of Plankton and their Seasonal Variation of Density was carried out in the Ramsagar Lake in Dinajpur District, Bangladesh. The experiment was done in the Ramsagar Lake which is located in the southern part of Dinajpur district. Ramsagar lake is situated about 8.1 kilometers from the south of the dinajpur town. The lake is coordinates $25^{0}38''$ N to $88^{0}39''$ E. The maximum length of the lake is 1.032 km or 0.641 mile and the maximum wide of the lake 0.364 km or 0.226 mile (Khondker et al., 2012).

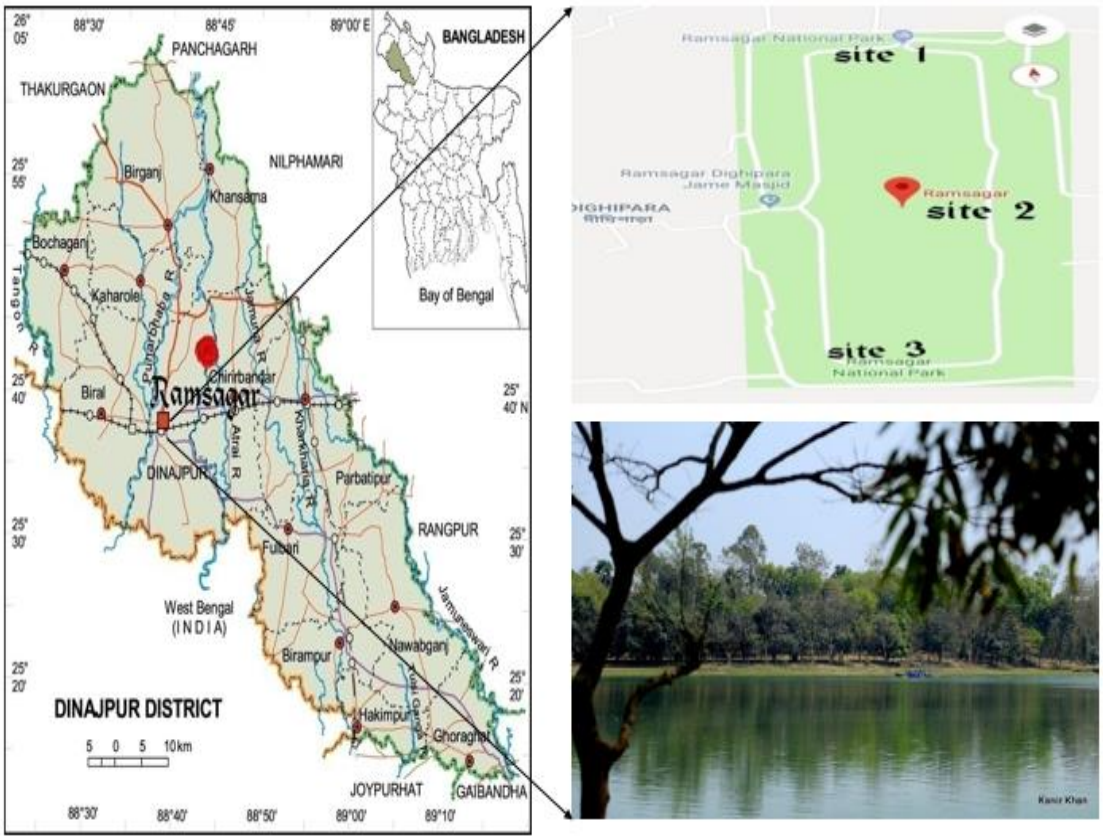

Figure 1. Map of Study area

2.2. Sampling technique

The volume of each water sample bottles was 250 milliliter capacity. Each bottle then labeled by its collection point name, as for example site 1 and point 1 sample the labeled was S-1, P-1. The sample then kept in the laboratory for identification the phytoplankton, HSTU, Dinajpur, Bangladesh. Digital Celsius Thermometer was used to taken the reading of air and water temperature. After collection the water for sample reading of temperature was taken immediately. For determination of transparency of water, the secchi disk was used. The secchi disk was dipped into the water on a calibrated line until it disappeared. The reading was recorded when the disk disappeared and the depth where it is recrudesced. The secchi disk reading is the average of these two readings. The calculation has been done by the following equation.

$$S.D.R\ (cm) = \frac{A - B}{2}$$

Where, A denotes depth of disappears level, and B denotes depth of Secchi disc recrudesce level, and 2 = standard value

pH meter (HANNA instruments, model: H1-8140) was used to determine the pH of water of the study points. For the determination of dissolved oxygen, a digital dissolved oxygen meter (YK-22D0) was used. The reading also taken immediately after collection of samples.

2.3. Plankton calculation

Water sample were collected from the Ramsagar lake research area. The samples were collected from three points of the study sites with three replications for each site. 0.04 mm mesh size plankton net was used to collect the phytoplankton. For the collection of water sample ten liters container was used. After taken the water physico-chemical factor the samples were kept in plastic bottle or vials immediately. Then ten percent buffered formalin solution added with it for preservation the water for laboratory for subsequent studies. At the lab filtered plankton water samples were surveyed into a measuring cylinder and checked the water level cautiously. Then the data put on notebook for further analysis.

2.4. Analysis of phytoplankton

For the qualitative analysis a binocular microscope used which magnification was 10× 0.25. For quantitative study of plankton, S-R (Sedgwick-Rafter) cell were used. 1 ml of concentrated plankton sample from each preserved sample was taken in S-R cell. The Sedgwick-Rafter cell which was used to counting phytoplankton was approximately 50 mm in length and 20 mm wide. The depth of the cell is 1 mm deep and the entire volume is 1000 mm^3 or 1 ml. The S-R cell was allowed to stand at least fifteen minutes to settle the planktons on the cell. The cell was then set on an electric microscope (XSZ-1O7BN). Planktonic organisms present in 10 fields from the total 1000 fields which was randomly chosen for phytoplankton counting. After that the plankton abundance was calculated by the formula as follows.

$$N=\frac{A\times 1000\times c}{V\times F\times L}$$

Where,

N= number of plankton cells per liter
A= Total number of plankton counted
C= Volume of final concentrate of samples in ml
V= Volume of a field in cubic millimeter
F= Number of the fields counted
L= Volume of original water in liter

2.5. Statistical analysis

For the analysis of data one-way ANOVA (Analysis of variance) at 5% significance level was done by using SPSS (Statistical analysis for social science) version 16.0 for windows. For the analysis purpose Microsoft Excel-2007 were used.

3. RESULTS AND DISCUSSION

3.1. Water quality parameters

In the experimental study, seasonal variations of various physical and chemical parameter of Ramsagar lake were measured under Summer, Autumn, Winter and Spring season where each season consist in three months. The physical parameters (Temperature in

air and water, transparency) and the chemical parameters (DO and P^H) were measured during the sampling period and three sites were selected for sampling. The mean values of different water quality parameters are shown in Table 1, Table 2 and Table 3.

Table 1. Mean values (SD±) and ranges of physical parameters in four seasons

Indicators	Parameters	Sampling season			
		Summer	Autumn	Winter	Spring
Physical parameters	Air temp	31.23±2.72	33.33±3.99	24.45±3.99	20.88±2.54
	Water temp	31.42±1.92	31.66±1.89	23.45±2.56	22.23±2.17
	Transparency	43.72±5.76	47.52±4.37	43.42±2.89	36.91±6.53
Chemical parameters	Dissolved Oxygen	7.25±0.42	7.33±0.23	8.01±0.42	6.98±1.06
	pH	7.27±0.36	6.85±0.25	7.26±0.27	7.51±0.27

Table 2. Comparison of physical parameters (mean) of four seasons

Parameters	Sampling Season					Sig.
	Summer	Autumn	Winter	Spring	F value	
Air temp	31.23^c	33.33^c	24.45^b	20.88^a	38.59	*
Water temp	31.42^b	31.66^b	23.45^a	22.23^a	56.05	*
Transparency	43.72^b	47.52^b	43.42^b	36.91^a	7.74	*

* 5% significance level

Table 3. Comparison of chemical parameters (mean) of four seasons

Parameters	Sampling season				F value	Sig.
	Summer	Autumn	Winter	Spring		
DO (mg/l)	7.25^a	7.33^{ab}	8.01^b	6.98^a	4.48	*
pH	7.27^b	6.85^b	7.26^b	7.51^a	7.66	*

* 5% significance level

3.2. Physical parameters

3.2.1. Air temperature

Figure 2 represents the variation of temperature monthly consequent to the season during the study period. The temperature of air gradually decreased from summer to winter season and after the winter the temperature again increase. The highest value was 35.20 which was found in June month of summer season at site 2 and the lowest value was 18.23 which was found in January month of spring season at site 1. The mean values (±SD) of temperature of air was found in four seasons were summer (31.23±2.72˚C), autumn (33.33±3.99˚C), winter (24.45 ±3.99˚C) and spring (20.88 ±2.54˚C). According to the season, the temperature of air was varied at 5% level of significance (Figure 2).

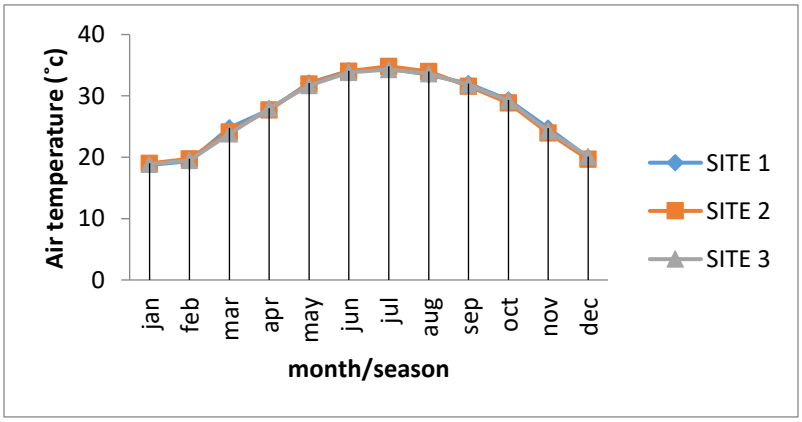

Figure 2. Monthly variation of Air temperature according to sites and season

3.2.2. Water temperature

Figure 3 represents the variation of temperature monthly consequent to the season during the study period. The temperature of water gradually decreased from summer to winter season and after the winter the temperature again increase. The highest value was which was found in June month of summer season at site 2 and the lowest value was which was found in January month of spring season at site 1. The mean values (±SD) of temperature of air was found in four seasons were summer (31.42±1.92˚C), Autumn (31.66±1.89˚C), Winter (23.45±2.56˚C) and spring (22.23±2.17˚C). The variation of air temperature represents by the Figure 3. According to the season, the temperature of water was varied at 5% level of significance (Figure 3).

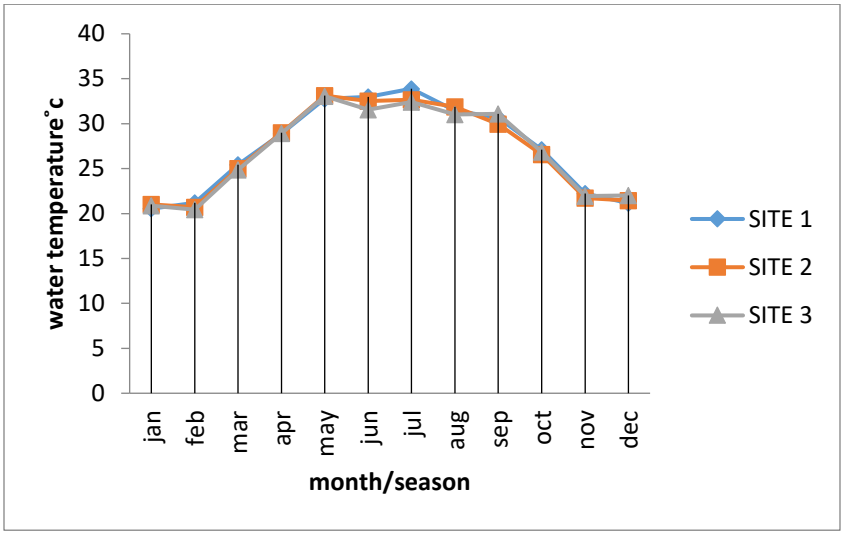

Figure 3. Monthly variation of Water temperature according to sites and season

3.2.3. Water transparency

Figure 4.3 represents the variation of transparency monthly consequent to the season during the study period. The values of transparency were from 28.50 to 54.43cm in Ramsagar lake water and showed highest value in. The highest values of transparency were found (54.43) in the July month at site 2 and the lowest value (28.50 cm) was recorded in March. The mean (±SD) value of transparency in four season was found summer (43.72±5.76cm), Autumn (47.52±4.37cm), winter (43.42±2.89) and spring (36.91±6.53). There the significance (P<0.05) of transparency among the four seasons was observed (Figure 4).

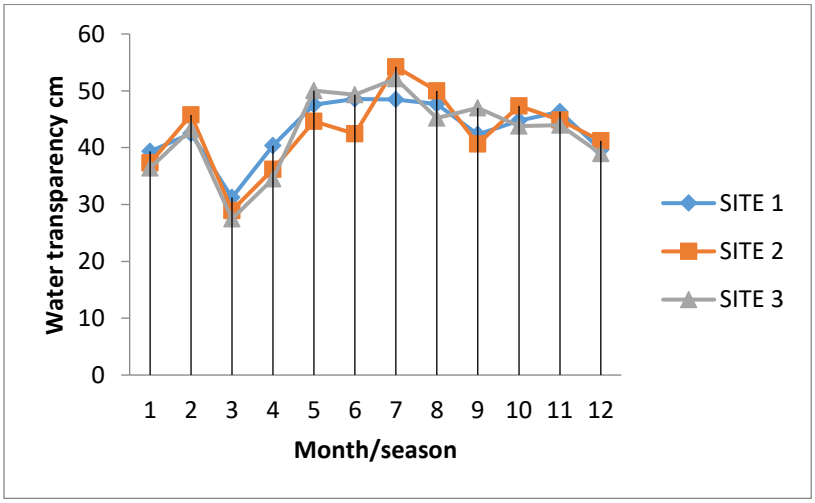

Figure 4. Monthly variation of Water transparency according to sites and season

3.3. Chemical parameters

3.3.1. Dissolved oxygen (mg/l)

In Ramsagar, the dissolved oxygen concentrations under various treatments observed to fluctuate from 5.25 to 8.67 mg/l in October (site1) to January (site3). The highest mean values of dissolved oxygen concentration were 8.01mg/l in winter season and the lowest

value of mean observed 6.98mg/l in spring season. The Dissolved oxygen was varying significantly among the sampling sites. The mean values of four season were (7.25±0.42) in summer, (7.33±0.23) in autumn, (8.01±0.42) in winter and (6.98±1.06) in spring season. Figure 5 represents the seasonal variation of transparency in different season (Figure 5).

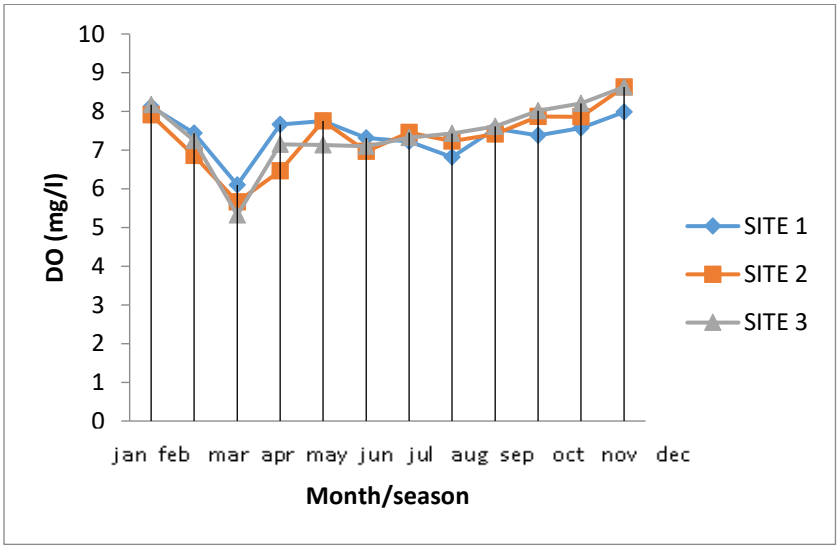

Figure 5. Monthly variation of DO according to sites and season

3.3.2. pH

The highest value of p^H was found in January (8.00) of spring season and the lowest values of p^H was found in August (6.25). The sampling was done in the morning (8am-10 am). The highest mean (±SD) values of water were 7.51±0.27 in spring season. The mean (±SD) values were of p^H in (7.27±0.36) summer, (6.85±0.25) in autumn, (7.26±0.27) in winter and (6.98±1.06) in spring. According to the season the p^H of water was varied at ($P<0.05$) significantly. Figure 6 represents the seasonal variation of transparency in difference season (Figure 6).

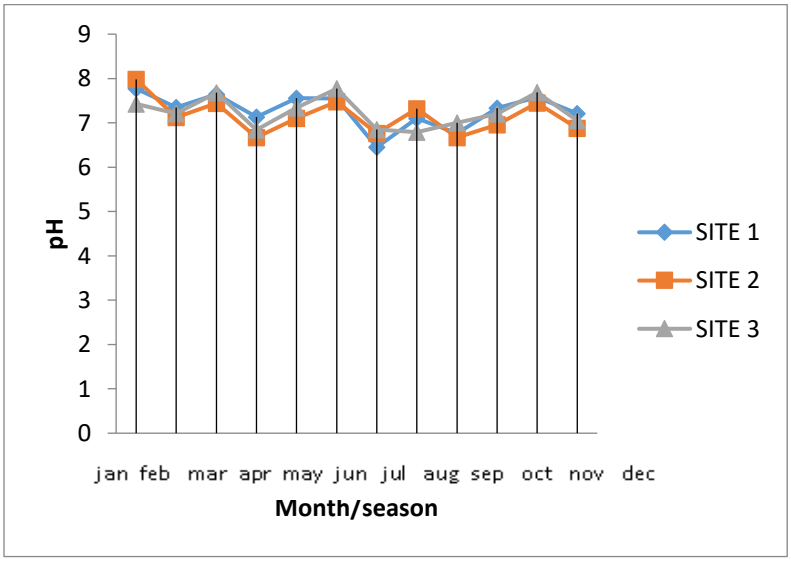

Figure 6. Monthly variation of pH according to sites and season

3.4. Seasonal variation of plankton community

Chlorophyceae, Bacillariophyceae, Cynophyceae and the Euglenophyceae are the phytoplankton groups of Ramsagar Lake and Cladocera, Copepoda, crustacean and Rotifera are the zooplankton. About 31 species of phytoplankton and 7 species of zooplankton were found in the lake. Among the phytoplankton fifteen species of Chlorophyceae, eight species of Bacillariophyceae, seven species of cyanophyceae and one species of euglenophyceae were identified the lake and among the zooplankton three

species of Rotifera, one species of cladocera and crustacean and two species of copepod were found. The correlation matrix of plankton community is given below in Table 4.

Table 4. Correlation matrix between different physico-chemical parameters and phytoplankton, zooplankton and total plankton

	Parameters	Total phytoplankton			
		Summer	Autumn	Winter	Spring
Phytoplankton	Water temperature	0.688*	0.192	-0.688*	-0.383
	DO	0.939	-0.707*	-0.691*	-0.266
	P^H	-0.397	0.297	0.388	-0.139
	Transparency	-0.575	0.027	0.768*	0.211
Zooplankton	Water temperature	-0.595	0.759*	0.809*	-0.076
	DO	0.852*	0.443	-0.396	0.880**
	P^H	-0.559*	-0.794	-0.691*	0.100
	Transparency	-0.678*	0.442	-0.359	0.889*
Total plankton	Water temperature	-0.559	0.528	-0.993*	-0.107
	DO	-0.470	-0.794*	0.809*	-0.143
	P^H	-0.833*	0.081	-0.404	-0.877**
	Transparency	0.983*	0.759*	0.474	0.880**

**correlation is significant at 0.01 levels (2-tailed)

*correlation is significant at 0.05 levels (2-tailed)

3.4.1. Chlorophyceae

Figure 7 represent the variation of chlorophyceae cell density per liter during the experimental period. The Chlorophyceae mean in four seasons were Summer (4.25±0.93) Autumn (3.68±0.67), Winter (3.68±0.67) and Spring (3.20±0.79) Cells/l. Chlorophyceae seasonal variation occurs significantly seasonally (Figure 7).

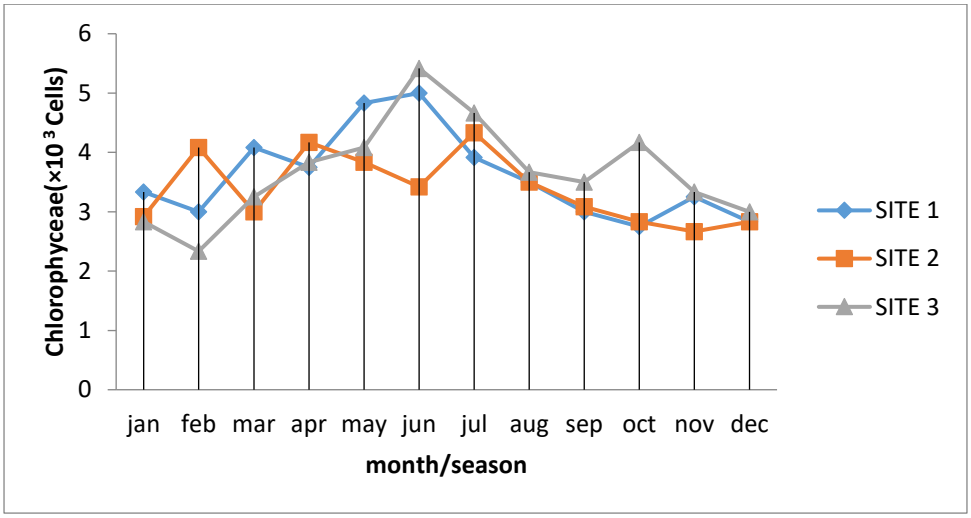

Figure 7. Monthly variation of Chlorophyceae (×10 3 Cells) according to sites and season.

3.4.2. Bacillariophyceae

Figure 8 represent the variation of Bacillariophyceae cell density per liter during the experimental period. The Bacillariophyceae range lowest counts (0.25×10^3) Cells/l in the autumn season. The highest range counts (2.50×10^3) Cells/l in summer. The highest amount of plankton found in the June month of summer season and the lowest was found in September month the Bacillariophyceae mean in four seasons were summer (1.62±0.36) Autumn (0.97±0.44), Winter (1.11±0.32) and Spring (1.07±.36) Cells/l. Bacillariophyceae seasonal variation occurs significantly seasonally (Figure 8).

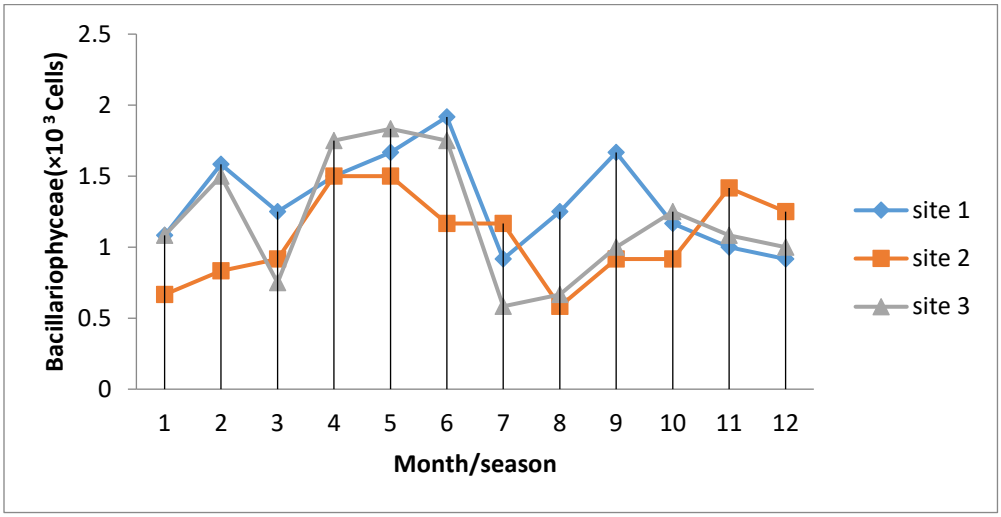

Figure 8. Monthly variation of Bacillariophyceae (×10 3 Cells) according to sites and season

3.4.3. Cyanophyceae

Cynanophyceae comprised of 4 genera had ranked third in respect of abundance. Among7 genera *Anabaena, Microcystis Nostoc oscillatoria* were dominant. Cynanophyceae seasonal variation occurs significantly seasonally. The cynanophyceae range lowest counts (0.25×10^3) Cells/l in the winter season. The highest range counts (1.69×10^3) Cells/l in summer. The highest amount of plankton found in the June month of summer season and the lowest was found in December month the cynanophyceae mean in four seasons were summer (1.69±0.46) Autumn (1.05±0.44), Winter (0.86±0.31) and Spring (1.21±0.40) (Figure 9).

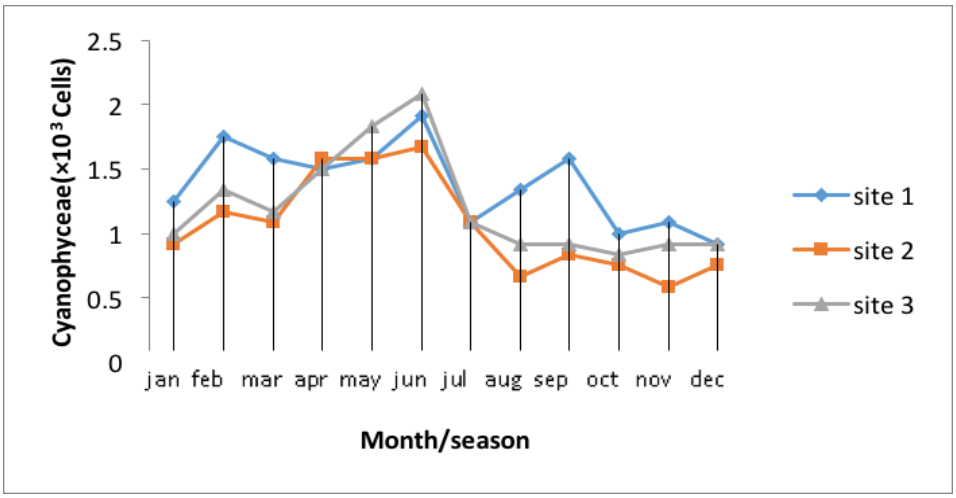

Figure 9. Monthly variation of Cyanophyceae (×10 3 Cells) according to sites and season

4. CONCLUSION

The highest phytoplankton was observed in June-July and the lowest observed in December-January. In seasonally highest abundance were found in summer and lowest in winter. 15 genera of Chlorophyceae, 8 genera of Bacillariophyceae, 7 genera of Cynophyceae and one genera of Euglenophyceae were found during the study period. The Bacillariophyceae range lowest counts (0.25×10^3) Cells/l in the Autumn season. The highest range counts (2.50×10^3) Cells/l in summer. The Cynanophyceae range lowest counts (0.25×10^3) Cells/l in the winter season, while highest (1.69×10^3) Cells/l in summer. The lowest range of Euglenophyceae counts (0.34×10^3) Cells/l in the summer season and the highest amount of Euglenophyceae were found in the June month of summer season. The seasonal variation of plankton density was observed during the study period significantly. In summer season plankton density were found highest abundance (mean values 9.78±1.70) and the winter season the plankton abundance was lowest mean (mean values 6.66±1.08). From the present study it is suggested that Ramsagar is a water resource with a diversity of plankton which is an important primary producer and important for fish production. While more and more research will be needed. This research gives guideline to the researcher for future study of Ramsagar Lake.

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Conflict of Interest:
The authors declare that there are no conflicts of interests.

Peer-review:
External peer-review was done through double-blind method.

Data and materials availability:
All data associated with this study are present in the paper.

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