Limnological study of *Shuksagaor* Lake in Dinajpur District

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Abstract. *Shuksagar*, a manmade lake and famous eco-park of Dinajpur district was studied from February to July 2018 in order to observe the present condition of physico-chemical water quality parametersas well as the abundance of planktonic community. Three sites inside the lake were selected for research purpose. Water samples were collected fortnightly from the selected sites and analyzed. Most of the parameters of water were found in suitable ranges. The observed ranged of water temperature of *Suksagar* reservoir was within the productive range (16° to 32°C). The average ($\pm$SD) values of transparency were 29.97 ± 5.17, 30.20 ± 4.99 and 30.53 ± 4.82 cm in three sites. The highest water temperature (35.5^0C) was recorded in the month of July while the lowest temperature was found 19^0C in February.The alkalinity ranged from 58 to 124 mg/l during the study period. While the maximum (10.60 mg/l) and minimum (4.8 mg/l) dissolved oxygen concentration occurred in site 1 during the month of April and February. The highest pH value was found as 10.70 at site 3 during the month of February and the lowest (5.5) at site 2 during the month of May. Twenty two phytoplankton species and 8 zooplankton species were detected in the lake. Total phytoplankton abundance was found higher (25.90×10^3cell/l) in the month of February, whereas the minimum value was observed (5.07×10^3cell/l) during April.Chlorophyceae was found to be dominant throughout the study period followed by Bacillariophyceae, Cyanophyceae and Euglenophyceae. The relative abundance of different planktonic groups and other limnological condition indicate that the *Shuksagar*reservoir is suitable for fish culture and for the survival of other aquatic life.
Keywords: *Shuksagar*reservoir*,*Physico-chemical, Phytoplankton, Zooplankton

Introduction

There are some manmade or artificial lakes available in different part of Bangladesh such as the *Gulshan* lake, the *Dhanmondi* lake in Dhaka city, *Dharma Sagar* of Comilla district, *Joy Sagar* of Sirajganj district and *Nilsagar* of Nilphamari district and the *Ramsagar, Shuksagar and Matasagar* lakes in Dinajpur district. The word 'Sagar' (= sea) represents large sized water body and is a legendary of the Hindu Zamindars of the Bengal under British India. The *Ramsagar, Shuksagar and Matasagar* lakes in Dinajpur district are some of the known water bodies of this category. *Shuksagar* lake in Dinajpur district is very old and situated in Rajbati of Dinajpur town. The total area of this lake is about 35 acres. Originally it was dug out manually to meet the demand of drinking and domestic water supply in the area and considered as a ritual wellbeing to the belief of the Hindu Zamindars. After the independence of Bangladesh, government declared the lake as public property. Now a days, it becomes an important tourist place in Dinajpur town for its natural beauty. Usually the local people have taken this reservoir

as lease for aquaculture and recreational business for past few years. Their farming practice mainly engage by stocking of commercial species such as rohu, catla, mrigal, grass carp, silver carpand tilapia. They are producing at least two crops per year from this lake. Different types of pre and post stocking management for fish culture are also observed from their farming practice during the study period. However, lack of baseline information about the water quality of this lake and lack of knowledge about the fish farming are reported during the sampling period.

The health of a lake and its biological diversity depends on the health of every component of the ecosystem. Both lentic and lotic water habitats in Bangladesh are now continuously getting deteriorated due to unplanned management, agricultural runoff, disposal of untreated public sewage water and other human activities. Due to lack of proper guideline water quality deterioration sometime occurred in lake or ponds resulting fish mortality and spread out some contagious diseases. In addition, major barriers in conservation of biodiversity for sustainable life in future include inadequate data base. Lack of limnological knowledge will create confusions and controversies for proper management and conservation of a reservoir. Moreover, monitoring water quality is of immense importance for successful fisheries management. It involves the assessment of physico-chemical parameters of water bodies, which is a function expressed as pollution parameters. Changes in the water quality result in changes in the biotic community structure. A good limnological knowledge will help develop any sustainable aquaculture. Moreover, the baseline information on water quality aspects will be helpful for raising public awareness towards the development of any water resource as well as conservation. There is no comprehensive work on the limnological aspects on *Shuksagar* lake of Dinajpur district. Hence, this research work has been undertaken to observe the physico-chemical and biological characteristics of water of Lake *Shuksagar*to understand the functional aspects of this recreational lake and to suggest ways and means for its conservation.

Materials and Methods

Shuksagar lake, a rectangular shaped water reservoir with an area and a depth of 98456.25 m2 and 2 m (approximately) was selected for the research. It is located at Rajbati in Dinajpur lying between the latitude of 25°38'N and longitude of 88°39'E. Three sites (S1, S2 and S3) were selected for sampling to get representative data. Samplings were conducted for a period of 6 months from February to July2018.

Sampling: The water quality parameters were recorded fortnightly. Water temperature pH, transparency, DO were recorded in the field sites. For analyzing other water quality parameters such as alkalinity and plankton counting, water samples were brought to the laboratory of the Fisheries Management Department of HSTU, Dinajpur. Plankton samples were collected by filtration technique where ten liters of water samples were filtered through plankton net of 25 μm mesh size and plankton samples were preserved in 4% formalin solution.

Study of plankton population: Taxonomic identification up to genus level of plankton was carried out under the binocularmicroscope with the help of taxonomic keys from the text book of Bellinger (1992), Pontin (1978), Lind and Brook (1980). Then plankton abundance was calculated using the formula by Rahman (1992):

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

Where,

N = No. of plankton cells per liter
A = Total no. 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

Taxa of plankton were identified to genus level using keys from APHA (1992) with magnification of 10×0.25 under the binocular microscope.

Statistical Analysis: The comparison between means $\pm$ SD (standard deviation) was tested for significance by using one-way ANOVA analysis and Tukey's test. The statistical analyses were calculated, using SPSS 15.

Results

Physico-chemical parameters: The mean values and ranges of different water quality parameters of *Shuksagar* reservoir are presented in Table I. The fortnightly variations of different physico-chemical parameters at different sites are shown in Fig. 1 (a-g). The maximum air temperature was 32.5^0C in July while minimum was 16^0C in February. Similarly the highest water temperature (35.5^0C) was recorded in the month of July at site 3 while the lowest temperature was found 19^0C during February at site 1. Among different parameters only water level was found to vary significantly with the sites (Table I).

**Table I. Mean values ($\pm$SD) and ranges of water quality parameters
in different sampling sites throughout the study period**

Parameters	Site1	Site2	Site 3	F- value	Level of significance
Air temperature (^{0}C)	25 $\pm$ 4.93 (16-32)	25.13 $\pm$ 4.87 (16-32)	25.45 $\pm$ 4.83 (17-32)	0.084	NS
Water temperature (^{0}C)	27.58 $\pm$ 5.08 (19-35)	26.95 $\pm$ 4.90 (19.5-35.5)	28.37 $\pm$ 4.92 (20-35.5)	0.228	NS
Transparency (cm)	29.97 $\pm$ 5.17 (22.5-44.5)	30.20 $\pm$ 4.99 (23.5-42.5)	30.53 $\pm$ 4.82 (24-43.5)	0.018	NS
Water level (m)	1.77 $\pm$ 0.22[a] (0.85-1.99)	1.23 $\pm$ 0.22[a] (0.91-1.58)	2.12[b] $\pm$ 0.34 (1.55-2.6)	135.40	**
Dissolved oxygen (mg/l)	7.69 $\pm$ 1.39 (4.80 –10.6)	7.65 $\pm$ 1.39 (4.90 -10)	7.64 $\pm$ 1.11 (5.70 – 9.90)	0.115	NS
pH	8.65 $\pm$1.05 (6.2- 10.3)	8.59 $\pm$ 1.38 (5.5- 10.20)	8.62 $\pm$ 1.36 (5.90- 10.7)	0.025	NS
Alkalinity (mg\l)	80.05$\pm$ 14.61 (62 -122)	79.33 $\pm$ 15.90 (58 –124)	74.44 $\pm$ 12.32 (60 -108)	1.627	NS

The mean ($\pm$SD) values of transparency were 29.97$\pm$5.17, 30.20$\pm$4.99 and 30.53$\pm$4.82 cm (Table I) at site 1, site 2 and site 3 respectively. The highest transparency observed was 44.50 cm at site 3 during the month of February. In the contrary, lowest transparency was recorded 22.50 cm at site 1 in the month of May. The highest and lowest water level was observed at site 3 and the lowest was observed at site 1. While the maximum (10.60 mg/L) and minimum (4.8 mg/L) dissolved oxygen concentration occurred at site 1 during the month of April and February respectively.
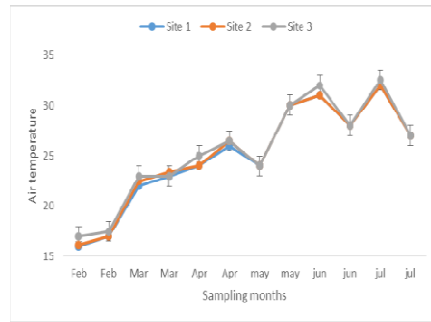
Fig. 1a. Air Temperature
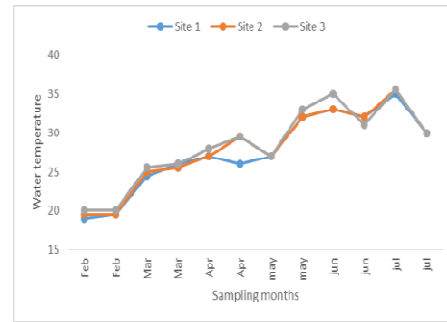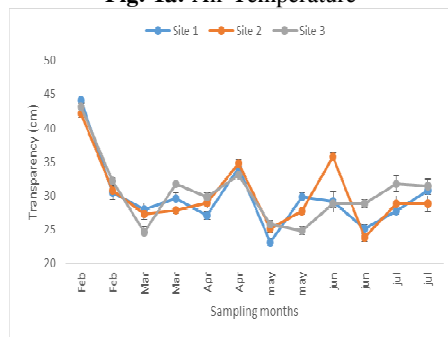

Fig. 1b. Water temperature

Fig. 1c. Transparency
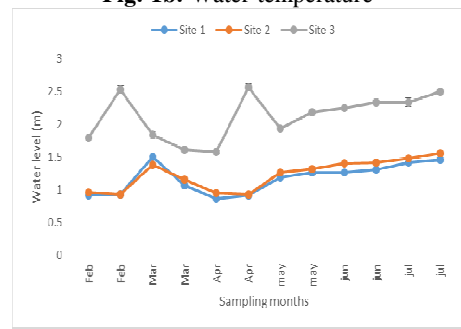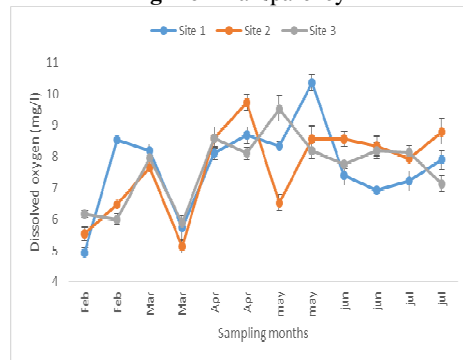

Fig. 1d. Transparency
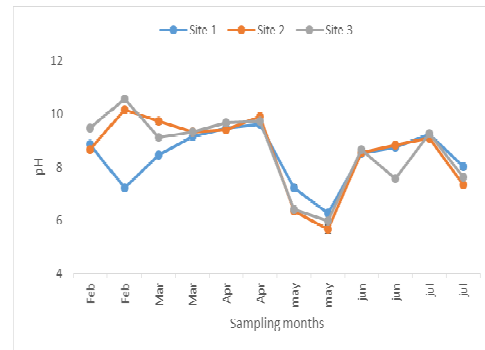

Fig. 1e. Dissolved oxygen
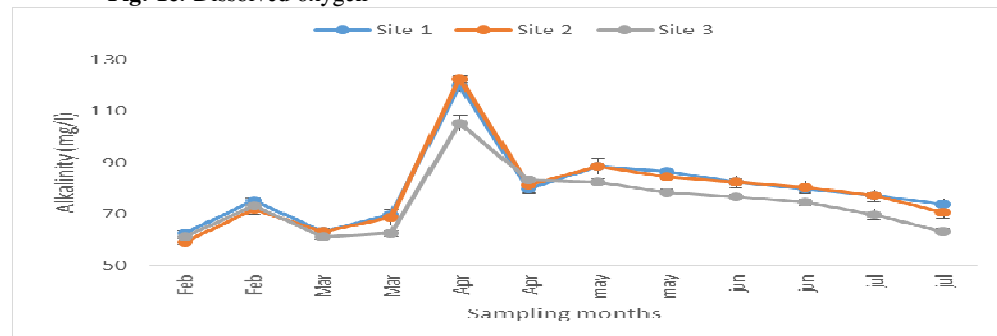

Fig. 1f. pH

Fig. 1g. Alkalinity

Fig. 1(a- g). Fortnightly variation in different water quality parameters at three sites

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The highest pH value was found as 10.70 at site 3 during the month of February and the lowest (5.5) at site 2 during the month of May. The average values of alkalinity from three study sites were 80.05 ± 14.61, 79.33 ± 15.90 and 74.44 ± 12.32 mg /l, respectively (Table I).

Biological Parameters: The total plankton, total phytoplankton and total zooplankton were found to vary significantly with the sites during the sampling period ($p < 0.05$) (TableII). However,different groups of phytoplankton did not vary significantly ($p > 0.05$) among the three sampling sites (Table III). Among the zooplankton only the rotifer and cladocerans varied significantly (Table IV). Total plankton abundance was found higher (25.90×10^3cell/l) in the month of Februaryat site 3 while the minimum value was observed (5.07×10^3cell/l) during April at site 2 (Fig. 2a). Similarly,maximum abundance of total phytoplankton wasobservedin the month of February (24.10×10^3cell/l) while minimum abundance was found in April (3.30×10^3cell/l) in site 3 and 2, respectively.

Table II. Mean values ($\pm$SD) and ranges of total plankton, total zooplankton and total phytoplanktonat different sampling sites

Parameters	Site1 (x10³ cell/l)	Site2 (x10³ cell/l)	Site 3 (x10³ cell/l)	F- value	Level of significance
Total Plankton	12.63+0.65 (8.16-21.77)	10.67+0.67 (5.07-22.45)	12.76+0.73 (7.94-25.90)	2.89	**
Total Zooplankton	2.05+0.13 (1.14-4.94)	1.60+0.14 (0.71-4.88)	1.84+0.12 (1.10-3.83)	2.42	**
Total phytoplankton	10.57+0.60 (6.78-19.50)	9.06+0.67 (3.90-21.30)	10.92+0.70 (6.72-24.10)	2.21	**

Table III. Mean values ($\pm$SD) and ranges of different phytoplankton groups in different sampling sites

Parameters	Site1 (x10³ cell/l)	Site2 (x10³ cell/l)	Site 3 (x10³ cell/l)	F- value	Level of significance
Cyanophyceae	2.77+0.19 (1.45-6.55)	2.74+0.24 (1.18-7.45)	2.98+0.22 (1.06-6.94)	0.36	NS
Bacillariophyceae	3.72+0.27 (1.18-8.05)	3.51+0.29 (1.45-8.50)	3.53+0.33 (1.06-10.08)	0.14	NS
Euglenophyceae	0.31+.05 (0.00-1.10)	0.31+0.04 (0.00-.90)	0.42+0.04 (0.00-1.17)	1.58	NS
Chlorophyceae	3.76+0.23 (2.23-7.60)	3.76+0.21 (1.84-8.14)	3.98+0.25 (1.84-7.32)	0.30	NS

Table IV. Mean values ($\pm$SD) and ranges of different zooplankton groups in different sampling sites

Parameters	Site1 (x10³ cell/l)	Site2 (x10³ cell/l)	Site 3 (x10³ cell/l)	F- value	Level of significance
Copepode	0.51+.03 (0.30-0.94)	0.49+.03 (0.30-0.96)	0.46+0.04 (0.24-0.93)	0.63	NS
Cladocera	0.55+0.05 (0.23-1.41)	0.38+0.02 (0.00-0.98)	0.38+0.02 (0.00-0.88)	7.08	**
Crustaceae	0.33+.05 (0.04-1.68)	0.36+007 (0.04-2.00)	0.36+0.07 (0.13-2.00)	0.22	NS
Rotifera	0.65+0.04 (0.37-0.96)	0.36+0.07 (0.04-2.00)	0.60+0.04 (0.28-1.05)	7.77	**

Fortnightly variations in abundance of different plankton groups of *Shuksagar* lakeare shown in Fig. 2 (a-j). A total of 30 genera of plankton were identified from *Shuksagar* lake throughout the period of the study.Among 22 genera of phytoplankton, Chlorophyceae was the dominant group in terms of diversity and numbers followed by Bacillariophyceae, Cyanophyceae and Euglenophyceae. Euglenophyceae was the least abundant phytoplankton group. Chlorophyceae consisted of 9 genus such as *Ceratium, Spirogyra, Coelestrum, Stigeoclonium, Pediastrum, Scenedesmus, Staurastrum, Ulothrix* and *Zygnema*, Bacillariophyceae consisted of 5 genera such as *Cosmarium, Cyclotella, Fragillaria, Navicula* and *Asterionella,* Cyanophyceae included *Anabaena, Gloeocapsa, Microcyctis, Nostoc, Oscillatoria, Spirulina* and *Gloeotrichia* and Euglenophyceae included only one genus, *Euglena*. Abundance of euglenophyceae in all three sites was more or less similar with its highest abundance in the month ofJune. While, the abundance of chlorophyceae was found to be higher during the month of February. Average fortnightly variations in abundance of total zooplankton are shown in Fig. 2f. A total of 8 genera of zooplankton were observed such as *Cyclops, Diaptomus, Calanus, Asplancha, Brachionus, Keratella, Daphnia* and Nauplius belonging to the groups of Crustacea and Rotifera. Rotifera was the most dominant group followed bycladocerans and copepoda. Comparatively the maximum abundance of crustacean and cladocerans were found in the month of July while the rotifera was most dominant throughout the study period.
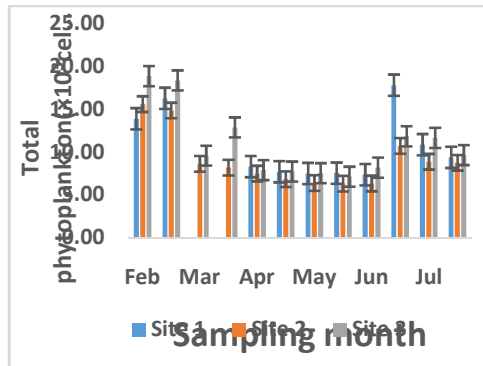
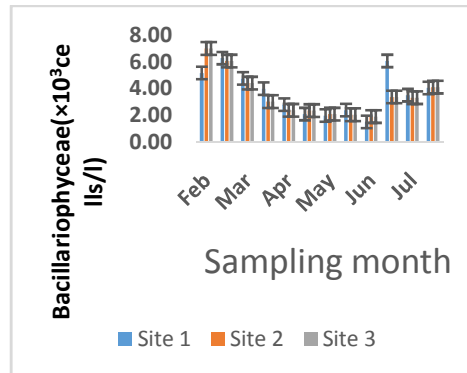

Fig. 2a. Total phytoplankton
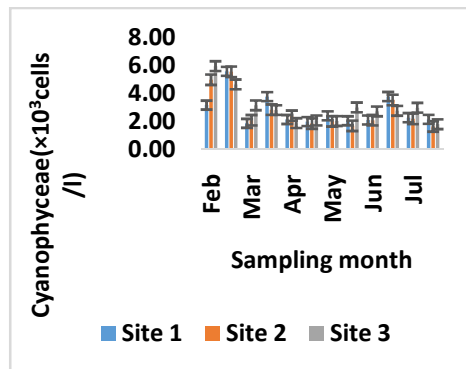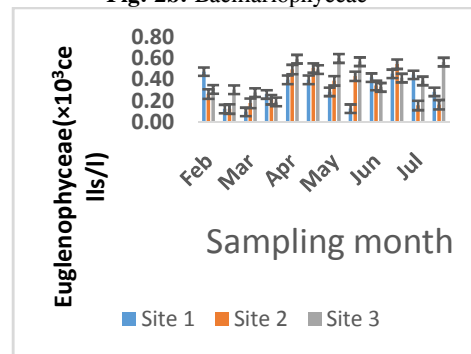

Fig. 2b. Bacillariophyceae
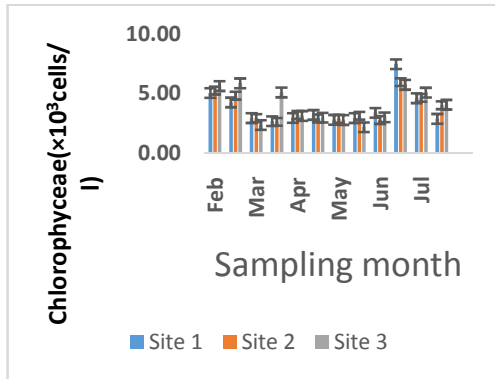

Fig. 2c. Cyanophyceae
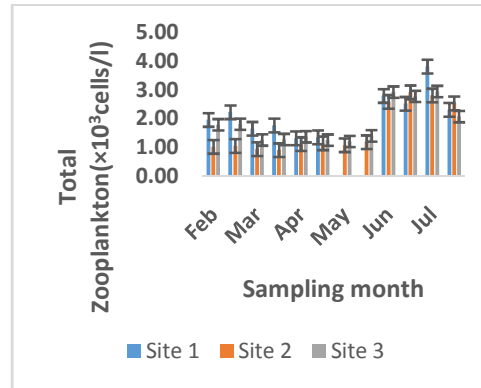

Fig. 2d. Euglenophyceae

Fig. 2e. Chlorophyceae
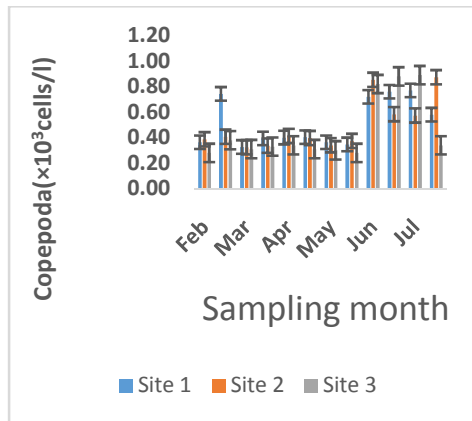

Fig. 2f. Total zooplankton
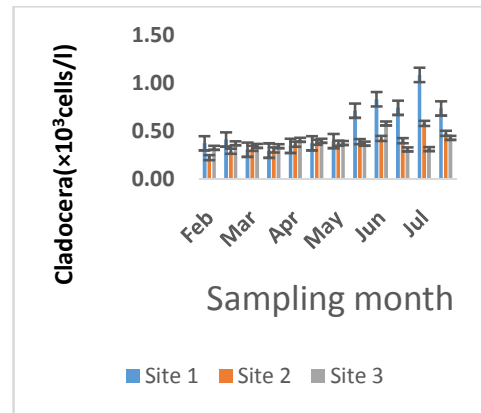

Fig. 2g. Copepoda

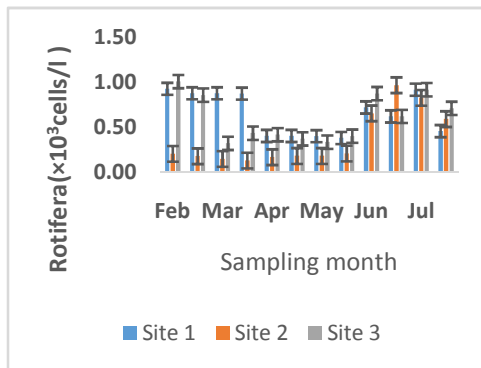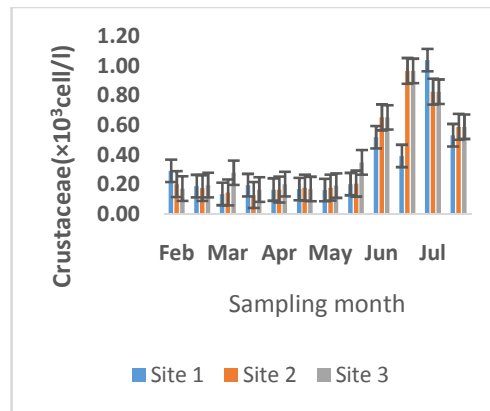**Fig. h.** Cladocera

Fig. 2i. Rotifera

Fig. 2j. Crustacea

Fig. 2. Fortnightly variations in abundance of different plankton groups in three sites.

Discussion

Water temperature regulates the growth, reproduction and metabolism as well as feeding intensity of aquatic organisms.The optimum temperature for productivity is 25°-30°C in sub-tropical region (Lee *et al.* 2007). The observed ranged of water temperature of *Suksagar* reservoir was within the productive range (16° to 32°C). Islam *et al.* (2013) recorded average water temperature of *Nilsagar* lake of Nilphamari district as 22.22°C. Moreover, transparency level in the present study varied with time.The variation is occurred for the presence of plankton and for pre- and post-stocking management of existing fish culture practice in the study lake. The transparency level of *Ramsagar* lake in Dinajpur district was found to range from 18 to 79 cm (Ferdoushi *et al.*2015), which is the same type of reservoir located in same district.On the other hand, the water level varied due to weather condition. The lowest water level observed in winter season while the maximum water level was occurred in rainy season. The water supply from Girajanath channel greatly affects the water level of *Sukhsagar*. Settled particle might be another factor affecting the water level.

According to Banarjee(1967),dissolved oxygen concentration should be ranged from 5 to 7 mg/L for suitable aquatic life. Khondoker *et al.*(2010) observed DO concentration lying between 0.61 to 11.39 mg/l at Lake Bagakain, Bandarban, Bangladesh. The dissolved oxygen level in the present study was found in optimum level with slight variation. The variation could happen due to respiration of aquatic organism. According to Swingle (1967) pH value of 6.5-9 is suitable for fish culture. Moreover, pH ranged between 5.0 and 8.5 is best for plankton growth (Umavathi *et al.*2007).The pH value in the water of *Sukhsagar* was found slightly acidic to alkaline ranges. Furthermore, alkalinity ranged from 58 to 124 mg/l. The wide range of pH and alkalinity values might be due to the periodic lime application during the fish culture practice. Khondhker*et al.(*2010) recorded Chlorophyceae as the dominant group of phytoplankton in Bogakain lake and Kaptai lake of Bangladesh. Das *et al.*(2011) also stated that Chlorophyceae was dominant group in the oxbow lake of Assam. Chlorophyceae identified as a dominant group followed by Bacillariophyceae in *Ramsagar* lake of Dinajpurdistrict (Ferdoushi *et al.* 2015). Similar finding was also reported in the present survey. On the other hand, among zooplankton,Rotifera was reported as a dominant group followed by copepoda and cladocera in the present study. Ahmed *et al.* (1992) also reported rotifer as a dominant group followed by copepoda and cladocera in Kaptai lake of Bangladesh. Findings from research revealed that water quality is suitable for aquaculture as well as for eco-tourism that will allow visitors, both local and international, to enjoy the natural beauty of the country, provides local communities with a sustainable income.

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