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Ashura beel in Dinajpur district: Limnological aspect

Z. Ferdoushi*, Y. Ara, T. Khatun and K. K. U. Ahmed[1]
Department of Fisheries Management, Faculty of Fisheries, Hajee Mohammad Danesh Science and Technology University, Dinajpur and [1]Bangladesh Fisheries Research Institute, Shrimp Research Station, Bagerhat-9300, Bangladesh, *E-mail: zannatul99bd@yahoo.com

Abstract

An investigation was carried out on the limnological aspects of Ashura *beel at* Dinajpur district in Bangladesh. Several limnological parameters were evaluated from March 2013 to October 2013 from three sampling sites namely Kajladoho, Burirdoho and Sonnasydoho. Physical, chemical and biological parameters were analyzed fortnightly both at the field level and departmental laboratory of Fisheries Management, Hajee Mohammad Danesh Science and Technology University, Dinajpur. Findings revealed that only water level in three sampling sites varied significantly. The ranges of water temperature, transparency, water level at three sampling sites were 24 to 35.50°C, 17 to 27.50 cm and 0.58 to 2.44 m, respectively. Moreover, the dissolved oxygen concentration, pH, total alkalinity, total hardness and phosphate-phosphorus concentration were also remained within optimum ranges. Thirty four genera were recorded where phytoplankton includes 29 genera belonging to four groups such as euglenophyceae, cyanophyceae, bacillariophyceae and chlorophyceae and five genera of zooplankton in the four groups namely copepoda, rotifera, cladocera and crustacean larvae. Phytoplankton was dominated by chlorophyceae and zooplankton dominated by copepoda. The abundance of phytoplankton was positively correlated with water temperature, water level, dissolved oxygen, alkalinity, hardness, pH, and phosphate-phosphorus. On the other hand, abundance of zooplankton negatively correlated with water temperature, transparency and water level. However, from the findings of this study suggested that the water quality parameters of the selected sites were found to be suitable for the survival of aquatic organism.

Keywords: Water quality, Phytoplankton, Zooplankton

Introduction

Bangladesh is the delta of Ganga-Brahmaputra river system, transected by rivers, *beels, haors,* and numerous wetlands which are part and parcel of the people living in the delta. They serve as natural habitat, breeding, feeding and spawning ground of large and small indigenous fishes of different food habits (Jha, 1989). Ashura *beel* having no exception from the above supports to the livelihood of many fishermen in Dinajpur district in Bangladesh. A number of threatened fishes available in the *beel* are rarely found in other parts of the country (Amin *et al.*, 2009).

Though the *beel* harbors a great variety of fishes and other aquatic plants and animals, due to increasing practice of agriculture activities and adverse climatic condition, many lotic and lentic waterbody of Bangladesh have already lost their characteristics of basin. As a result viability of aquatic resources is seriously threatened (Chakraborty and Nur, 2009). Virtually very few fundamental researches have been carried out on the *beel* ecosystem. However, for any sustainable fishery, study on limnological aspects becomes a major concern for environmentalist. In addition, a well planned and systematic study is required to assess water quality of the *beel* in order to take an appropriate action to manage the ecosystem which will ultimately increase the total inland fish production.

During 2005, the non-government organization CARITAS had completed a project on Ashura *beel* focusing the co-management aspects of the local community. On the other hand, Alfasane *et al.* (2012) examined some physico-chemical characteristics of water of Ashura *beel*. Different limitations of their researches have been marked including short sampling duration, lack of limnological information etc. By considering the importance of this wetland and limitation of the previous work, the present limnological investigation was undertaken to assess the following objectives:

- To study the physico-chemical properties of water quality of the Ashura *beel*
- To determine the qualitative and quantitative abundance of plankton of study *beel*
- To observe the interrelationship between the plankton abundance and some physico-chemical parameters of the water body

Materials and Methods

Description of the Study Area

The selected study area Ashura *beel,* is originated from river Karotoa. It is located at Nawabgonj and Birampur subdistrict, 70 kilometers away from the Dinajpur district (Ahmed *et al.,* 2008). Total area is about 251.78 hectare (142.00 ha. in Nawabgonj upazilla and 109.78 ha. in Birampur upazilla) which supports as feeding, breeding and spawning ground of many large and small indigenous fishes of different food habitat (Fig. 1). Three sampling sites named Kajladoho, Burirdoho, Sonnasydoho within the Ashura *beel* were selected for the purpose of sample collection. Before selecting these sites several field trips and focus group discussions were done. Finally, three sampling sites were randomly selected for the study purpose.

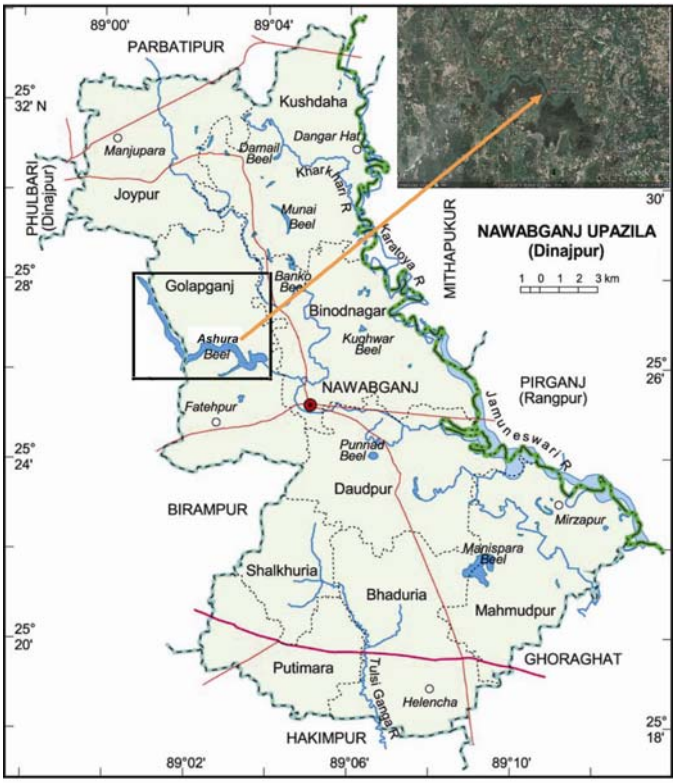

Fig. 1. Geographical position and Satellite image of Ashura *beel*

Sampling Duration and Procedure

Samplings were done fortnightly at three different sampling sites from March to October 2013. Water quality parameters like temperature, transparency, dissolved oxygen, pH, hardness and phosphate-phosphorus were determined in the field level. For determining other water quality parameters (chlorophyll-a, alkalinity) samples were carried into the laboratory of the department of Fisheries Management for further analysis as prescribed by APHA (1992).

Plankton Analysis

Plankton samples were collected by filtration technique. Ten liters of water samples was collected in a plastic bucket and filtered through plankton net of 25 µm mesh size. Then concentrated sample preserved in 4% formalin solution. Taxonomic identification up to genus level of plankton was carried out with the help of taxonomic keys from the text book of Barbar and Haworth (1981), Bellinger (1992), Pontin (1978), Lind and Brook (1980) under the binocular microscope. 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

Statistical Analysis

An analysis of variance (One Way ANOVA) and Tukey's test was applied to data for determining significant variation among the three sampling sites by using SPSS version 20. Statistical significances were assessed using a probability level of P=0.05. An estimation of possible relation between physico-chemical and plankton abundance was developed by correlation analysis and also performed with the SPSS version 20 program.

Results and Discussion

Physico-chemical Parameters

Table 1 is showing the mean values and ranges of different physico-chemical parameters of Ashura *beel* during the study period. Among different physical parameters only the water level varied significantly with the sampling points. Comparatively higher (2.44 m) water level was found in Burirdoho point (site 2) of Ashura *beel* followed by Kajladoho (1.95 m) and Sonnasydoho (2.13 m). However, almost similar values of water level were also observed by Joarder (2009) in *beel* Joshi of Bangladesh.

According to Rahman (1992) suitable water temperature for aquatic life should be between 26.0 to 31.0°C. The average water temperatures of the three sampling sites were found to remain within this suitable ranges (Table 1). The maximum water temperature (35.50°C) was found in the month ofJuly in site 2, while minimum (24.00°C) water temperature was found in October in site 3. Dewan (1973) also recorded the highest water temperature in July and the lowest in January.

Boyd (1982) suggested the suitable transparency for fish culture is about 15 to 40 cm. The average values of transparency were almost found similar in all points and within suitable range. Islam and Chowdhury (2014) observed water transparency at Trimohini *beel* in Rajshahi District from 20 to 110 cm. The mean values of dissolved oxygen were 6.94±0.40 mg/L, 6.97±0.39 mg/L and 6.96 ±0.44 mg/L in site 1, site 2 and site 3 which are slightly higher (5.57 ± 0.16 mg/L) than the value of Trimohini *beel* of Bangladesh (Islam and Chowdhury, 2014). The pH values of Ashura *beel* were found in alkaline ranges (Table 1). Islam and Chowdhury (2014) observed the pH at Trimohini *beel* ranges from 7.2 to 7.5 which has the conformity with the present findings.

Table 1. Mean values (±SD) and ranges of water quality parameters in different sampling sites throughout the period of study

Parameters	Sampling sites			ANOVA Significance
	Site 1	Site 2	Site 3	
Water temperature (°C)	28.90± 2.75 (24.50-33.50)	29.35 ± 3.14 (24.00-35.50)	29.24± 3.05 (24.00-34.50)	NS
Transparency (cm)	21.23 ± 2.34 (18.20-25.75)	22.28 ± 2.84 (17.00-26.00)	22.37 ± 3.01 (17.00-27.50)	NS
Water level (m)	1.30^{b} ± 0.41 (0.58-1.95)	1.53^{a}± 0.37 (0.67-2.44)	1.30^{b}± 0.37 (0.58-2.13)	*
Dissolved oxygen (mg/L)	6.94 ± 0.40 (5.90-7.80)	6.97 ± 0.39 (5.90-7.83)	6.96 ±0.44 (6.00-7.83)	NS
pH	7.33 ± 0.66 (6.10-8.42)	7.33 ± 0.66 (6.10-8.42)	7.48± 0.42 (6.80-8.50)	NS
Alkalinity (mg/L)	114.25± 19.38 (84.00-146.00)	112.15 ±19.84 (80.00-142.00)	113.19 ± 18.99 (72.00-146.00)	NS
Hardness (mg/L)	214.48 ± 17.97 (183.00-247.00)	211.81 ± 9.54 (180.00-243.00)	208.56 ± 19.60 (150.00-240.00)	NS
PO_4-P (mg/L)	0.75 ± 0.09 (0.60-0.88)	0.75 ± 0.09 (0.50-0.90)	0.75± 0.08 (0.60-0.90)	NS
Chlorophyll *–a* (µg/L)	29.55 ± 9.43 (11.90-47.60)	29.20± 9.35 (11.90-47.60)	29.57± 9.59 (11.90-47.60)	NS

NS= Values are not significantly different (P> 0.05)
* values with different superscript letters in the same row indicate a significant difference at 5% significance level based on the one-way ANOVA followed by Tukey's test

In addition, the mean (±SD) values of total alkalinity in site 1, site 2 and site 3 were 114.25±19.38 mg/L, 112.15±19.84 mg/L and 113.19±18.99 mg/L respectively. The average range of total alkalinity level of Ashura *beel* was 72 to 146 mg/L which may be comparable with the range of Chanda *beel* (72 to 196 mg/L) at the Faridpur-Madaripur areas of Bangladesh (Ehshan, 1997). In addition, comparatively higher values of total hardness were recorded in three sampling sites (Table 1). The average values of phosphate-phosphorus in all sampling sites were comparatively similar and remained within the productive range (Table 1). Islam and Saha (1975) observed that the PO_4-P ranged from 0.2 to 2.8 mg/L which were favorable for growth of blue green algae and diatoms. Findings of the present study were also found to be favorable for aquatic life. Measurement of chlorophyll-a is a mechanism for rating a lake's productive state. Concentration of chlorophyll-a was found higher in the month of April (47.60 µg/L) in site 2 followed by site 1 and 2 in the month of October (11.90 µg/L) which is almost similar with the finding of Maharet *et al*. (2000) in Manchhar lake of Pakistan.

Plankton Abundance

A total of 34 genera of plankton were identified from Ashura *beel* (Table 2). Table 3 is showing the mean values and ranges of different plankton groups in three sampling sites along with their level of significance. Fortnightly variations of the abundance of different plankton groups of Ashura *beel* are shown in Fig. 2 (a-i). Comparatively higher abundance of plankton (9.88 $\times 10^3$ cells/L) was observed in site 1 in July followed by site 2 (2.73$\times 10^3$ cells/L) in the month of October (Fig. 2e).

Table 2. Different groups of plankton identified in various sampling sites of Ashura *beel*

Phytoplankton		Zooplankton
Bacillariophyceae	**Chlorophyceae**	**Crustacean Larvae**
Cosmarium	*Ankistrodismus*	Nauplius
Cyclotella	*Asterionella*	**Copepoda**
Diatoma	*Chlamydomonas*	*Cyclops*
Fragillaria	*Chlorella*	*Diaptomus*
Melosira	*Closteridium*	**Cladocera**
Navicula	*Closterium*	*Daphnia*
Nitzschia	*Crucigenia*	**Rotifera**
Cyanophyceae	*Microspora*	*Asplanchna*
Anabaena	*Pediastrum*	*Brachionus*
Chrococcus	*Scenedesmus*	
Gloeocapsa	*Spirogyra*	
Microcystis	*Staurastrum*	
Nostoc	*Synedra*	
Oscillatoria	*Volvox*	
Spirulina	**Euglenophyceae**	
	Euglena	
	Phacus	

Table 3. Mean values (±SD) and range of biological parameters in different sampling points throughout the period of study

Plankton groups	Sampling sites			ANOVA Significance
	Site1 ($\times10^3$cells/L)	Site2 ($\times10^3$cells/L)	Site3 ($\times10^3$cells/L)	
Euglenophyceae	0.49± 0.15 (0.31– 0.80)	0.53 ± 0.22 (0.31 – 1.29)	0.50 ± 0.18 (0.31 – 1.17)	NS
Cyanophyceae	0.97 ± 0.41 (0.35 – 1.98)	0.99 ± 0.43 (0.32 – 2.28)	0.97 ± 0.42 (0.35 – 1.95)	NS
Bacillariophyceae	1.70 ± 0.49 (0.78–3.06)	1.76 ± 0.54 (0.39 –2.70)	1.73 ± 0.52 (0.70 – 2.80)	NS
Chlorophyceae	2.17 ± 0.65 (0.78 – 3.51)	2.08 ± 0.65 (0.64–3.36)	1.98 ± 0.56 (0.70–3.12)	NS
Total Phytolankton	5.37 ± 1.52 (2.34–8.58)	5.42 ±1.52 (1.92 -8.36)	5.22 ± 1.45 (2.10-8.19)	NS
Copepoda	0.65 ± 0.32 (0.00 – 1.29)	0.61 ± 0.28 (0.00 –1.24)	0.63 ± 0.23 (0.34–1.05)	NS
Crustacea	0.76 ± 0.36 (0.00 – 1.68)	0.69 ± 0.27 (0.00 – 1.28)	0.66 ± 0.30 (0.00 – 1.12)	NS
Total Zooplankton	1.40 ± 0.62 (0.39–2.94)	1.30 ± 0.51 (0.34–2.48)	1.31 ± 0.47 (0.37 – 2.10)	NS
Total Plankton	6.76 ± 1.70 (2.73–9.60)	6.73 ± 1.77 (2.73–9.88)	6.55 ± 1.74 (2.8–9.75)	NS

NS= Values are not significantly different (P> 0.05)

Among the four identified phytoplankton groups, chlorophyceae was found to be the most abundant and euglenophyceae was the scanty group. The abundance of total plankton ranged from 2.73×10^3 cells/L to 9.88×10^3 cells/L which is almost similar to the findings of Hasan, (2004). The highest density of phytoplankton was found in the month of June at site1 and lowest in the month of October at site 3. Both bacillariophyceae and cholophyceae were the dominant and most diversified groups among all sampling sites. There were seven genera under the group of bacillariophyceae and thirteen genera of chlorophyceae. Singh (1960) reported that high atmospheric or water temperature along with the bright sunshine is an important factor in the periodicity of chlorophyceae (green algae). Most common genera of

chlorophyceae were *Coelestrum, Pediastrum, Spirogyra*, *Staurustrum, Scenedesmus, Synedra* etc. Das *et al.,* (2011) stated that chlorophyceae was dominant group in the oxbow lake in Assam. The abundance of cyanophyceae was in the third position and the available genera were *Spirulina, Anabaena* and *Microcystis*. On the other hand, the abundances of euglenophyceae in all three sites were more or less similar throughout the study period.

Among different groups of zooplankton Copepoda, *Cyclops* and *Diaptomas* were the most common in all sampling sites. Nauplius was found higher in number than Rotifera and Cladocera in all sampling sites. An average fortnightly variation in abundance of total zooplankton is shown in Fig. 2(h). The highest average number of zooplankton was found at site 1 in March and the lowest average number at site 2 in October which is more or less similar to the finding of Chowdhury *et al.,* (2008).

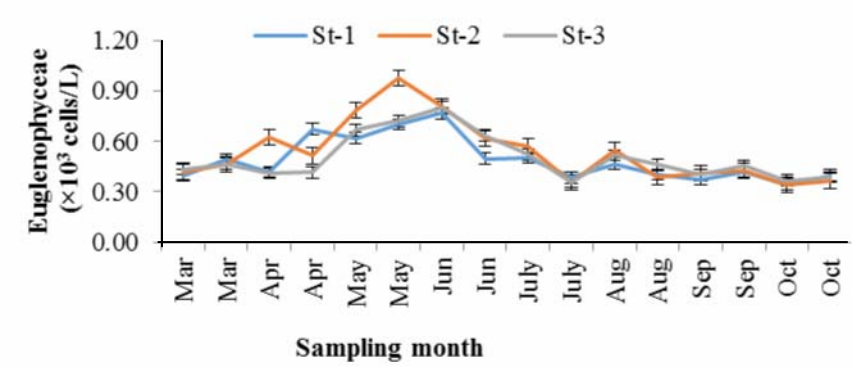

Fig. 2(a). Euglenophyceae

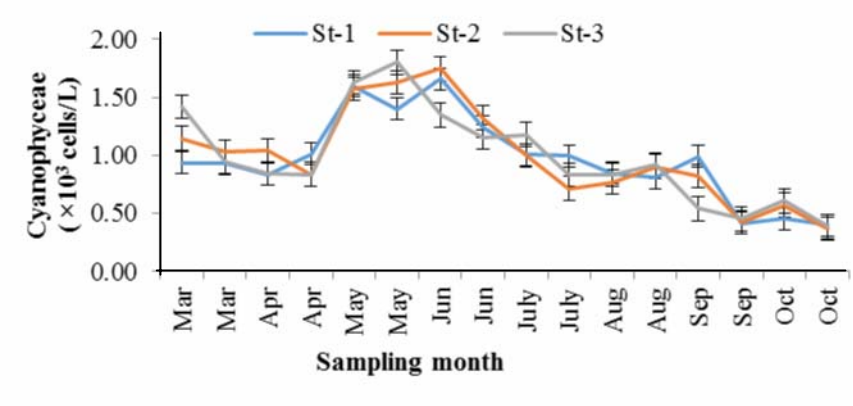

Fig. 2(b). Cyanophyceae

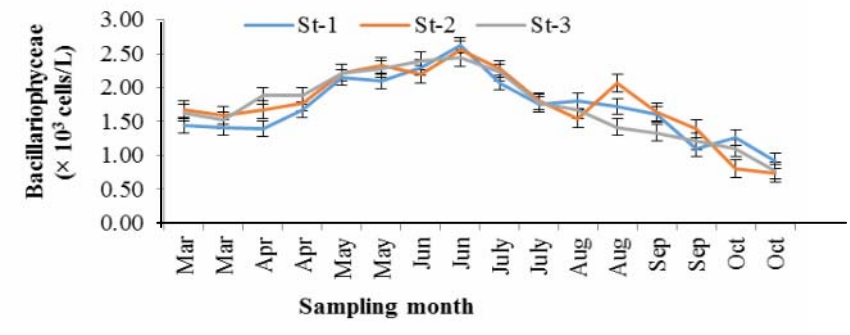

Fig. 2(c). Bacillariophyceae

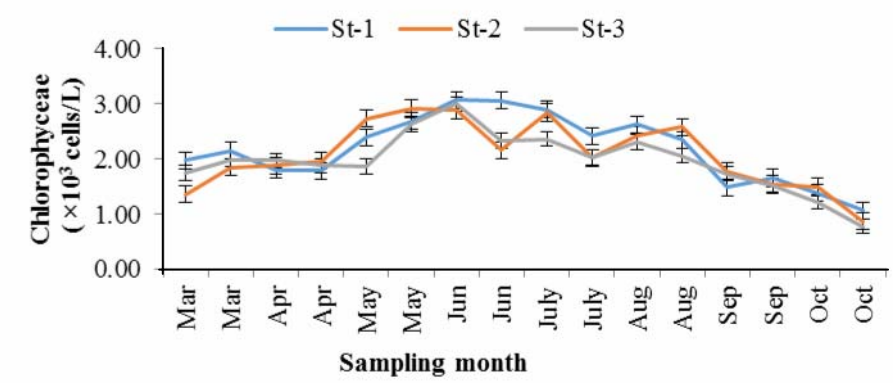

Fig. 2(d). Chlorophyceae

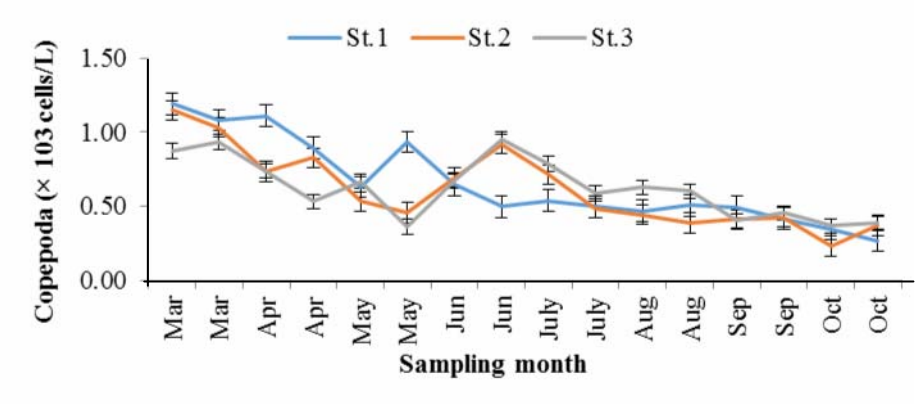

Fig. 2(e). Copepoda

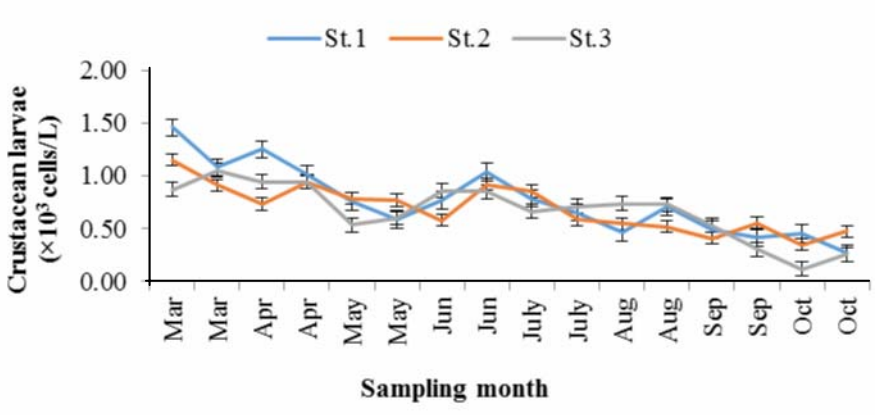

Fig. 2(f). Crustacea

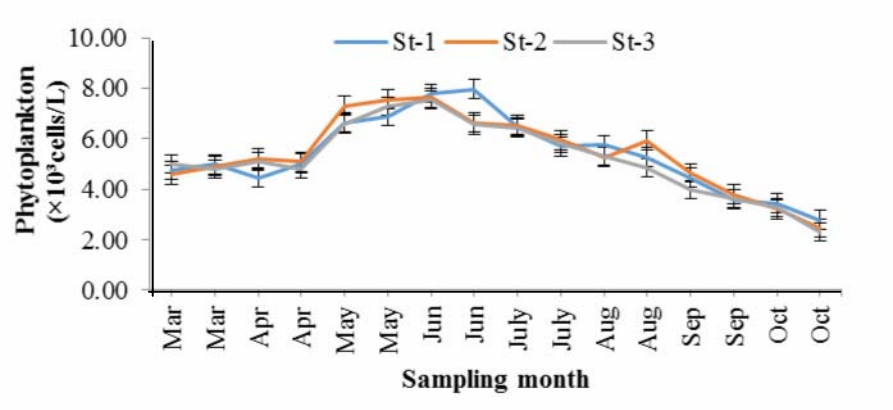

Fig. 2(g). Total phytoplankton

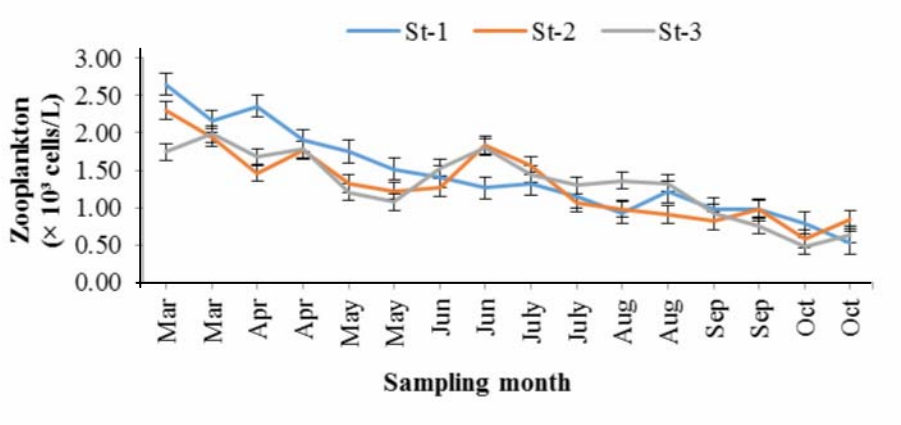

Fig. 2(h). Total Zooplankton

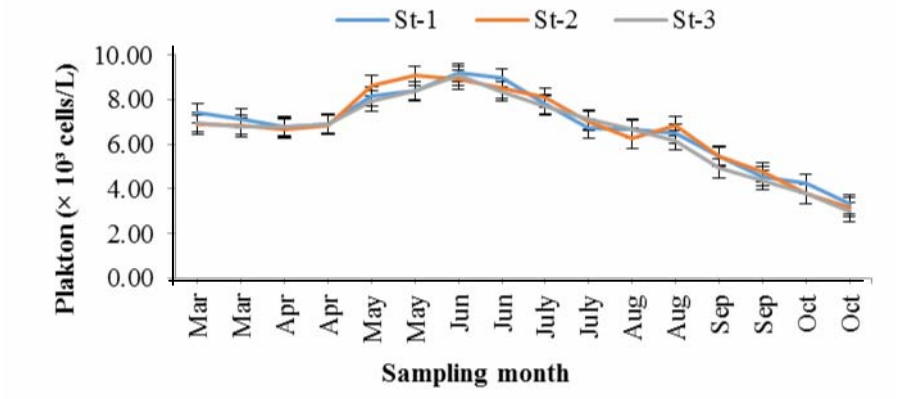

Fig. 2(i). Total Plankton

Fig. 2. Fortnightly variations in abundance of different groups of plankton in three sampling sites: a. Euglenophyceae, b. Cyanophyceae, c. Bacillariophyceae, d. Chlorophyceae, e. Copepoda, f. Crustacea, g. Total Phytoplankton, h. Total Zooplankton, i. Total Plankton

Effects of Some Physico-chemical Parameters on Plankton abundance of the Ashura *Beel*

Effects of different water quality parameters on the abundance of plankton community were analyzed by correlation matrix. Findings from the analysis revealed that the abundance of total phytoplankton and plankton was positively correlated with water temperature, water level, dissolved oxygen, alkalinity, hardness, pH and phosphate-phosphorus. Whereas, abundance of total zooplankton was negatively correlated with water temperature, transparency and water level and positively correlated with other chemical parameters (Table 4). Significant positive and negative correlations between the abundance of plankton and different water quality parameters were also observed in several water bodies in Bangladesh and other parts of the world (Alam and Kabir 2003; Veerendra *et al*. 2012; Rajagopal *et al*. 2010; Patra and Azadi 1987).

Table 4. Correlation among different physico-chemical parameters and plankton groups

	Total Phytoplankton	Total Zooplankton	Total Plankton
Water Temperature	0.53**	–0.04	0.44**
Transparency	–0.72**	–0.50	–0.66**
Water level	0.21*	–0.51**	0.01
Dissolved Oxygen	0.28**	0.54**	0.42**
Alkalinity	0.88**	0.15	0.81**
Hardness	0.85**	0.45**	0.85
pH	0.86*	0.41**	0.87**
Phosphate-phosphorus	0.77**	0.23**	0.77**

Conclusion

The limnological status of Ashura *beel* indicates that *beel* is conducive to enhanced fisheries and biological production. Considering this some conservation measures must be taken by the government to protect the *beel* from environmental pollution.

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