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LIMNOLOGY OF LAKE ASHURA, DINAJPUR, BANGLADESH

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Abstract

Results of limnological investigation of lake Ashura showed that air and water temperatures were 31.5 ± 0.25ºC and 30.0 ± 0.45ºC, respectively in the month of April, 2011. pH, alkalinity, conductivity, dissolved oxygen and TDS of water were 7.11 ± 0.02, 2.96 ± 0.58 meq/l, 760.67 ± 8.08 µS/cm, 7.72 ± 0.41 mg/l and 104.67 ± 1.53 mg/l, respectively. The concentration of NO_3-N, SRP and SRS were 63.33 ± 25.16 µg/l, 11.60 ± 1.60 µg/l and 14.36 ± 0.25 mg/l, respectively. Phytoplankton biomass as chl *a* and concentration of phaeopigment were 5.33 and 3.41 µg/l, respectively. The density of phytoplankton was 552.84 × 10^3 ind/l. A total of 35 species of phytoplankton were recorded of which 15 belonged to Euglenophyceae, followed by Chlorophyceae (8), Bacillariophyceae (7), Cyanophyceae (4) and Cryptophyceae (1). Macrophyte flora was represented by 31 species. The dominant species were *Eichhornia crassipes* (Mart.) Solms, *Ludwigia adscendens* (L.) Hara. and *Oryza sativa* L.

Introduction

Occurrence of natural lakes or true lakes in Bangladesh is scarce. There are only three true lakes namely, Rainkhyongkine, Bogakain and Ashuhila Beel or Ahshula Beel (Khan *et al*. 1994, Rashid 1991, Khondker *et al*. 2010). Islam and Uddin (1969) published an algological report on Lake Rainkyhongkine and recently, limnology of Lake Bogakain has been carried out by Khondker *et al*. (2010). The exact location of the above mentioned two natural lakes of Bangladesh was known (Khan *et al*. 1994, Rashid 1991). But the location of the third natural lake of Bangladesh i.e., Ashuhila Beel or Ahshula Beel was not clearly mentioned in either of the two literature (Khan *et al*. 1994, Rashid 1991). In both the literature, it is mentioned that the lake is situated in the northern fringe of eastern Barind. Since Barind tract (part of the Rajshahi division) is a vast area it was difficult to find the exact location of the lake. However, Alam and Begum (2005) studied the community based participatory fisheries management in a wetland named Ashurar Beel. It is situated in a remote area of Nawabganj Upazila of Dinajpur district and at an altitude of 27 m from the mean sea level. Ashurar Beel lies closer to the river Karotoa (Alam and Begum 2005) and it is aligned along the north-west-south-east direction of the Karotoa fault (Rashid 1991), Ashurar Beel could be the third natural lake of Bangladesh, hereinafter called Lake Ashura. The present attempt was made to investigate the water quality along with phytoplankton and macrophyte flora of Lake Ashura.

Materials and Methods

Water sample was collected from the south eastern fringe of the lake in April, 2011. A one liter capacity plastic bottle was dipped manually under the surface to collect water sample for physicochemical analyses. A total of two liter water sample was collected and from it, one liter was fixed by using Lugol's Iodine and sedimented for concentrating plankton. The second one liter sample was transported in a Cool Box to the Laboratory for analyses. The time necessary to

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transport the sample was 18 hours after collection. Field meters were used to measure conductivity, TDS and pH *in situ* (HANNA Instruments HI 9033, 9044 and). Triplicate BOD bottles (120 ml cap., Jena Schott) were filled with sample water from the lake and fixed *in situ* for DO analysis. Macrophyte population was estimated by applying one meter quadrat.

Chlorophyll *a* (chl *a*), soluble reactive phosphorus (SRP), soluble reactive silicate (SRS), dissolved oxygen (DO) and alkalinity were determined on the same day after reaching Dhaka following standard methods (Marker *et al*. 1980, Murphy and Riley 1962, Wetzel and Likens 1979). However, an overnight digestion of samples for the analysis of nitrate nitrogen was required (Müller and Wiedemann 1955). Hence, nitrate determination was completed after 48 hours. Phytoplankton cell number was counted using a Hawksley microplankton counting chamber with improved Neubauer Ruling (Hawksley Ltd., Lancing, England) under a Nikon compound microscope (Japan) at a magnification of 400×.

Results and Discussion

Mean air and water temperatures of Lake Ashura were 31.5 ± 0.25ºC and 30.0 ± 0.45ºC, respectively. The pH of water was closer to neutral and showed a value of 7.11 ± 0.02. The alkalinity, 2.96 ± 0.58 meq/l is higher than a mesotrophic water body (Khondker and Kabir 1995). Dissolved oxygen concentration of water shows an optimum value 7.72 ± 0.41 mg/l. Among the dissolved nutrients, NO_3-N was 63.33 ± 25.16 µg/l and SRP was 11.60 ± 1.60 µg/l. SRS concentration was relatively low 14.36 ± 0.25 mg/l. The mean values of TDS and conductivity were 104.67 ± 1.53 mg/l and 760.67 ± 8.08 µS/cm, respectively. The total density of phytoplankton was 552.84 × 10^3 ind/l, however, their biomass values as chl *a* and phaeopigment were 5.33 and 3.41 µg/l, respectively.

A comparative analysis of physiographic, morphometric and limnological data for two natural lakes of Bangladesh namely, Lake Ashura (sampled in April, 2011) and Lake Bogakain (sampled in March, 2010, Khondker *et al*. 2010) showed both the lakes are dissimilar in many aspects. The GPS of Lake Ashura is 25°25′- 25°29′ N and 89°00′-89°05′ E and for Lake Bogakain it is 21°58′49″ N and 92°28′11″ E. Lake Ashura a shallow water body ($Z_{max,}$10 m, Alam and Begum 2005) low altitude (27 m) lake on the other hand, Bogakain is considered to be a high altitude (457-610 m) and deepest ($Z_{max,}$ 46.54 m, Khondker *et al*. 2010) natural lake of Bangladesh. Compared to area, Lake Ashura (400 ha) is about 50 times bigger than Bogakain (8-9 ha). TDS, conductivity, alkalinity and NO_3-N were higher than Bogakain while water temperature, pH and DO were closer in both the lakes. The high value of PO_4-P was observed in lake Bogakain (Khondker *et al*. 2010) compared to Lake Ashura. In lake Bogakain, the total density of phytoplankton varied from 686.62×10^3 - 409381.73×10^3 ind/l (Khondker *et al*. 2010).

Species contributing the phytoplankton community of the Lake Ashura have been listed in Table 1 with their taxonomic divisions and abundance. The community was represented by five divisions namely, Cyanophyta, Chlorophyta, Euglenophyta, Chrysophyta and Cryptophyta with a total of 21 genera. Under these, 35 species were recorded which are common to the aquatic algal flora of Bangladesh (Siddiqui *et al*. 2007, Ahmed *et al*. 2008, 2009). From blue-green algae, *Oscillatoria* sp. was found abundant followed by *Anabaena variabilis, Pseudanabaena mucicola* and *Pelonema aphane*. Green algae was represented by *Actinastrum hantzschii, Ankistrodesmus falcatus*, *Chlamydomonas pulchra, Crucigenia quadrata, Eudorina elegans*, *Mougeotia* sp., *Scenedesmus denticulatus* and *S. bijuga*. Their population density was relatively low (2.97×10^3 ind/l). Among euglenoids, *Trachelomonas volvocina* was dominant followed by *T. raciborskii*, *T. oblonga* and *Euglena* sp. (Table 1). Cell densities of *Trachelomonas* sp., *Phacus pseudonordstedtii*, *Strombomonas rotunda* and another eight euglenoid species varied from

2.97×10^3 - 8.92×10^3 ind/l (Table 1). Among diatoms, *Navicula pupula* was abundant in respect to *Nitzschia longissima*, *Navicula radiosa*, *Pinularia microstauron* and *Synedra linearis*. In Cryptophyceae, the only recorded genus was *Cryptomonas* (Table 1).

Table 1. List of the species of phytoplankton and their individual densities.

Division	Species	Density ($\times10^3$ ind/l)
Cyanophyta	*Anabaena variabilis* Kütz. *ex* Born. *et* Flah.	2.97
	Oscillatoria sp.	53.51
	Pseudanabaena mucicola (Huber-Pestalozzi and Naumann) Bourrelly *emend* Chang	2.97
	Pelonema aphane Skuja	2.97
Chlorophyta	*Actinastrum hantzschii* Lagerheim	2.97
	Ankistrodesmus falcatus (Corda) Ralfs	2.97
	Chlamydomonas pulchra Skvortz.	2.97
	Crucigenia quadrata Morren	2.97
	Eudorina elegans Ehrenberg	2.97
	Mougeotia sp.	2.97
	Scenedesmus denticulatus Lagerheim	2.97
	S. bijuga (Turp.) Lagerheim	2.97
Euglenophyta	*Euglena oblonga* Schmitz	2.97
	Euglena sp.	11.89
	Phacus pseudonordstedtii Pochm.	5.95
	Phacus sp.	2.97
	Strombomonas rotunda (Playf.) Defl.	5.95
	Strombomonas sp.	2.97
	Trachelomonas sp.	8.92
	Trachelomonas crebea Kellicott *cf.* Lemm. in Pascher	2.97
	T. lacustris Drez.	2.97
	T. oblonga Lemm.	17.83
	T. scabra var. *pygmea* Playfair	2.97
	T. playfairii Defl.	2.97
	T. stokesiana Palmer	2.97
	T. raciborskii Wolosz.	47.56
	T. volvocina Ehrenberg	243.74
Chrysophyta	*Cyclotella meneghiniana* Kütz.	2.97
	Navicula pupula Kütz.	23.78
	N. radiosa Kütz.	14.86
	Nitzschia longissima (Bréb.) Grunow	20.81
	Pinularia gibba Ehr.	8.92
	P. microstauron (Ehr.) Cleve	14.86
	Synedra ulna (Nitzsch) Ehr.	11.89
Cryptophyta	*Cryptomonas* sp.	2.97
Total phytoplankton		552.84

Except two species of aquatic ferns, macrophyte population of the lake was represented by angiosperms. Total species of macrophytes recorded were 31 with vast floating masses of *Eichhornia crassipes* intersected by *Ludwigia adscendens* and *Oryza sativa*. Second dominant group was composed of *Cyperus* sp., *Hygrorhiza aristata*, *Ipomoea aquatica*, *Marsilea quadrifolia, Nymphaea nouchali*, *Nymphoides cristatum*, *Potamogeton crispus*, *Polygonum* sp. and *Salvinia cucullata*. Third dominant group of macrophytes were *Alternanthera philoxeroides*, *Aponogeton* sp., *Ceratophyllum demersum*, *Enhydra fluctuans*, *Eleocharis dulcis*, *Elatine triandra*, *Euryale ferox*, *Hydrilla verticillata*, *Limnophila sessiliflora*, *Limnocharis flava*, *Lemna perpusilla*, *Monochoria hastata*, *Ottelia alismoides*, *Pistia stratiotes*, *Sagittaria guayanensis*, *Schoenoplectus articulatus*, *Spirodela polyrhiza*, *Trapa maximowiczii* and *Utricularia stellaris* (Table 2).

Table 2. Abundance of macrophytes of Lake Ashura.

Species	Abundance
Alternanthera philoxeroides (Mart.) Grisco.	+
Aponogeton sp.	+
Ceratophyllum demersum L.	+
Cyperus sp.	++
Eichhornia crassipes (Mart.) Solms	+++
Enhydra fluctuans Lour.	+
Eleocharis dulcis (Burm.f.) Trin *ex* Hensch.	+
Elatine triandra Schkuhr.	+
Euryale ferox Salisb.	+
Hygrorhiza aristata (Retz.) Nees *ex* Wight & Arn.	++
Hydrilla verticillata (L.f.) Royle	+
Ipomoea aquatica Forsk.	++
Limnophila sessiliflora Blume.	+
Limnolcharis flava (L.) Buch.	+
Lemna perpusilla Torrey.	+
Ludwigia adscendens (L.) Hara.	+++
Marsilea quadrifolia L.	++
Monochoria hastata (L.) Solms	+
Nymphaea nouchali Burm. f.	++
Nymphoides cristatum (Roxb.) O. Kuntze	++
Oryza sativa L.	+++
Ottelia alismoides (L.) Pers.	+
Pistia stratiotes L.	+
Potamogeton crispus L.	++
Polygonum sp.	++
Salvinia cucullata Roxb.	++
Sagittaria guayanensis H. B. K. ssp.	+
Schoenoplectus articulatus (L.) Palla.	+
Spirodela polyrhiza (L.) Schleid.	+
Trapa maximowiczii Korshinsky	+
Utricularia stellaris L.f.	+

+ = 0 - 2 ind/quadrat, ++ = 3 - 6 ind/quadrat and +++ = 7 - 10 ind/quadrat.

In Lake Ashura, percentage composition among different genera shows that Chlorophyta dominates and occupied 33.33% followed by Chrysophyta (23.81%), Cyanophyta and Euglenophyta (19.05%) and Cryptophyta (4.76%). Cryptophyta can be treated as minor group (Table 3). Maximum number of species (42.86%) among the phytoplankton population was represented by Euglenophyta. Next was Chlorophyta followed by Chrysophyta, Cyanophyta and Cryptophyta (Table 3).

The proportion (%) of recorded species of Cyanophyceae, Chlorophyceae and Cryptophyceae was lower in Lake Ashura than Lake Bogakain (Khondker *et al*. 2010). Recorded species of Euglenophyceae in Bogakain is lower where diversity is highest in Lake Ashura. Members of Dinophyceae were absent in Lake Ashura. On the other hand, two members of Dinophyceae were present in Bogakain (Khondker *et al*. 2010). However, the total number of taxa recorded in Lake Ashura is closer to Lake Bogakain (Lake Ashura, 35 taxa; Bogakain, 39 taxa of phytoplankton, Khondker *et al*. 2010).

Table 3. Number of genera and species of phytoplankton and their percentage composition of Lake Ashura.

Division	No. of genera	Percentage of genera	No. of species	Percentage of species
Cyanophyta	4	19.05	4	11.43
Chlorophyta	7	33.33	8	22.86
Euglenophyta	4	19.05	15	42.86
Chrysophyta	5	23.81	7	20.00
Cryptophyta	1	4.76	1	2.86
Total	21		35	

Class wise distribution of the species of Lake Ashura were Euglenophyceae 15, Chlorophyceae 8, Bacillariophyceae 7, Cyanophyceae 4 and Cryptophyceae 1 (Table 3). A total of 40 species of phytoplankton were recorded from the lake Bogakain (Khondker *et al*. 2010) of which 21 belonged to Chlorophyceae followed by Cynaophyceae (5), Bacillariophyceae (4), Cryptophyceae (4), Euglenophyceae (3), Dinophyceae (2) and Chrysophyceae (1).

On the other hand lake Bogakain occupied a few members of macrophytes like *Nymphaea nouchali*, *Egeria densa*, *Potamogeton crispus* and *Polygonum* sp. (Khondker *et al*. 2010, Alfasane *et al*. 2010).

Lake Ashura, the third natural lake of Bangladesh has a different limnology compared to another natural lake namely, Bogakain. River Karotoa has a direct influence on Lake Ashura as the water from the former flows through the latter during rainy season. The lake holds a riverine character rather than a lacustrine one, shape elongated and overall area large and water depth is highly variable (0-10 m, Alam and Begum 2005). About 30 cm thick and soft mud in the littoral was evident because of high densities of macrophyte population. The ionic load of water was also higher with a low value of phytoplankton chl *a*. The total number of phytoplankton species recorded in Lake Ashura is slightly lower than Lake Bogakain. Qualitatively, the phytoplankton flora of Lake Ashura has been found to be dominated by euglenoid algae whereas in Lake Bogakain green algae were predominant.

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