

Monsoonal plankton distribution and physico-chemical water qualities in a rain-fed lake in Noakhali, Bangladesh

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Abstract. The study focused on the monsoonal distribution of plankton in a rain fed partial lake in Sonapur, Noakhali district, Bangladesh. Three sampling sites were chosen between Sonapur zero point and Noakhali Science and Technology University. Four groups of phytoplankton such as Chlorophyceae (11 genera), Bacillariophyceae (6 genera), Cyanophyceae (6 genera) and Euglenophyceae (3 genera) and four groups of zooplankton such as Rotifera (10 genera), Cladocera (3 genera), Copepoda (2 genera) and Crustacea (2 genera) were identified. The lake was found to be organic polluted (Palmer's algal pollution index value: 22.33). The average wet land zooplankton index (WZI) value of this lake was estimated 3.72 means moderate water quality. During the sampling periods some important physico-chemical parameters like temperature (29-30 °C), pH (7.8-8.2), transparency (6.5-13.50 cm), free CO₂ (8.00-12.00 mg/l), total alkalinity (13.00-14.50 mg/l), ammonia (0.1-0.5 mg/l), nitrate (0.05-0.25 mg/l), nitrite (0.03-0.07), phosphate (0.1-0.9 mg/l), dissolved oxygen (2-3.5 mg/l) and total suspended solids (4.0×10^{-4} - 5.3×10^{-4} mg/l) were also determined as supporting water quality statement.

Keywords: Rain fed lake, Palmer's algal pollution index, Wet land zooplankton index

Introduction

Lake as a lentic ecosystem supports diversified aquatic organisms. The physico-chemical water qualities in lake are comparatively stable than other lotic ecosystem as river, estuary and oceanic ecosystem. Lakes and canals are recognized as aquatic garden in both urban and rural areas. Lakes also contribute to the social economy by recreational and fisheries activities. The south-eastern district, Noakhali, is blessed with different types of freshwater aquatic bodies as ponds, lakes, canals and seasonal wetlands. The basic components as phytoplankton is the introducer to the primary productivity of water body (Veronica *et al.* 2014). Secondly, zooplankton makes a linkage between primary and secondary as fisheries production in lake trophic chain (Stire *et al.* 2014). The lake production is influenced by local organic and inorganic pollutant sources. The composition and density of plankton are controlled by several environmental factors as water temperature, rainfall, turbidity, hydrogen ion concentration and inorganic nutrients (Bordoloi *et al.* 2014). The distribution and diversity of plankton are seasonally fluctuated and is also influenced by nitrogenous and phosphorus nutrients in aquatic ecosystem (Rajkumar *et al.* 2014, Stire *et al.* 2014). The road side lakes are stated as critical aquatic habitat because of lot of anthropogenic activities. These lakes are compromised their water quality due to poor awareness of local people. Now a day's lake biodiversity is major concern to the researchers. To evaluate

and describe a lake plankton diversity many saprobic indexes are used by plankton researchers (Stire *et al.* 2014, Kshirsagar *et al.* 2013). Plankton are considered as tremendous bio indicator of aquatic environment. The most standard Plamer's algal pollution index up to date is a classic research outcome that helps to estimate the organic pollution level in freshwater aquatic bodies through most available and dominant algal species (Palmer *et al.* 1969). Another water quality evaluation index is Wetland Zooplankton Index (WZI) (Lougheed and Chow-Fraser 2002) used to evaluate freshwater lake water quality. The present study was sketched to evaluate the lake water quality through plankton and some specific water quality analysis. The conducting study focused to identify plankton and estimate the pollution level in water by employing algal and zooplankton index.

Materials and Methods

A total three sites in Sonapur Lake, Noakhali district, Bangladesh were selected for phytoplankton zooplankton sampling and estimation of water quality. This study was conducted from June 2018 to September 2018. This study aimed to analysis physico-chemical parameters (water temperature, total alkalinity, total suspended solids, free CO₂, ammonia, nitrate, nitrite, phosphorus and dissolved oxygen) in Sonapur Lake. The water temperature, pH and water transparency were measured directly on spot by thermometer, pH meter (HANNA-HI96107) and secchi disc respectively. In conducting study total alkalinity (mg/l), total suspended solids (mg/l), free CO₂ (mg/l), ammonia (mg/l), nitrate (mg/l), nitrite (mg/l), phosphorus (mg/l) and dissolved oxygen (mg/l) were determined according to guidelines from the American Public Health Association (APHA *et al.* 1995).

Plankton samples were collected from surface water through plankton net (mesh size: 30 μ m) and preserved in 150 ml plastic container with 7% formalin. Plankton were observed at 16 \times 10 and 16 \times 40 magnification using a light microscope in sedge wick-Rafter counting cell. The density and diversity of plankton were identified by following Van Vuuren *et al.* (2006).

Results and Discussion

The conducting study was found 12 genera, 6 genera, 7 genera and 3 genera belongs to Chlorophyceae, Bacillariophyceae, Cyanophyceae and Euglenophyceae respectively (Table I). Previously a culture pond study was found also four groups of phytoplankton as Chlorophyceae (19 genera), Bacillariophyceae (9 genera), Cyanpphyceae (7 genera) and Euglenphyceae (3 genera) in Noakhali (Khan and Bari, 2019). Furthermore, the rain fed ponds were observed comparatively low algal diversity as Chlorophyceae (3 genera), Bacillariophyceae (4 genera), Euglenophyceae (2 genera) and one genera of Cyanophyceae (Khan and Islam, 2019). The algal diversity is more or less similar to other aquaculture ponds and lakes (Akter *et al.* 2018, Singh *et al.*, 2018). This study also aimed to evaluate the organic pollution level by using algae as bio indicator according to Palmer's Algal Pollution Index (Palmer 1969) in Table I. The Palmer's Index value was found 22.33 that indicates high organic pollution in Sonapur Lake. The algal evaluation was conducted separately in three sampling sites of this lake. The Site A & B showed highest Index value 25 followed by Site C (17) in Table I. All sampling sites of this lake dominated by Chlorophyceae among other algal groups as Bacillariophyceae, Cyanophyceae and Euglenophyceae respectively (Table I). The high altitude wetland was found lack or moderate

organic pollution by Singh *et al.* 2018. Furthermore, Khan *et al.* (2019) reported high organic pollution in ancient ponds in Noakhali, Bangladesh.

Table I. Phytoplankton abundance in three different sampling sites of Sonapur Lake

Phytoplankton	Index Value	Site A	Site B	Site C
Chlorophyceae				
<i>Ankistrodesmus</i>	2	2	A	2
<i>Chlorogonium</i>	-	P	A	P
<i>Chlorella</i>	3	3	3	3
<i>Characium</i>	-	P	A	A
<i>Chroodactylon</i>	-	A	P	A
<i>Closterium</i>	1	1	A	A
<i>Cosmarium</i>	-	P	A	A
<i>Oocystis</i>	-	P	A	P
<i>Pediastrum</i>	-	P	A	P
<i>Scenedesmus</i>	4	4	4	A
<i>Strombidinopsis</i>	-	A	P	A
<i>Volvox</i>	-	P	P	P
Bacillariophyceae				
<i>Cyclotella</i>	1	1	A	1
<i>Fragilaria</i>	-	A	P	P
<i>Navicula</i>	3	3	3	A
<i>Synedra</i>	2	2	2	A
<i>Melosira</i>	1	1	1	1
<i>Amphora</i>	-	P	A	P
Cyanophyceae				
<i>Aphanocapsa</i>	-	P	P	P
<i>Aphanothece</i>	-	P	P	P
<i>Goonphosphaeria</i>	-	P	A	P
<i>Merisinopedia</i>	-	A	A	P
<i>Microcystis</i>	-	P	P	P
<i>Nostoc</i>	-	P	A	A
<i>Oscillatoria</i>	5	5	5	5
Euglenophyceae				
<i>Euglena</i>	5	5	5	5
<i>Phacus</i>	2	A	2	A
<i>Trachelomonas</i>	-	P	P	A
Palmer's Algal Index	-	25	25	17
Palmer's Algal Index (Average)	22.33			
Water Organic Pollution	High Organic Pollution			

A total seven families of zooplankton were identified in Sonapur Lake as Rotifer, Chydoridae, Macrothricidae, Daphnidae, Bosminidae, Cyclopidae, Diaptomidae (Table II). The study observed 17 genera, 3 genera and 2 genera of Rotifer, Daphnidae and Diaptomidae respectively. The conducting study also found another three groups of zooplankton Chydoridae, Cyclopidae and Macrothricidae in Table II. The Wetland Zooplankton Index was employed to determine the water quality of three sampling sites of Sonapur Lake. The recorded Index value at Site C was 3.84 followed by Site A (3.81) and Site B (3.52) in Table II. According to WZI

PLANKTON DISTRIBUTION AND PHYSICO-CHEMICAL WATER QUALITIES IN A RAIN-FED LAKE

value the moderate water quality was indicated in Sonapur Lake. Hossain *et al.* (2015) described 6 genera of Rotifera, 2 genera of Copepoda and 3 genera of Cladocera. Rotifers are well recognized pollution tolerant zooplankton and commonly observed in nutrient rich water bodies (Jakhar 2013). The seasonal lake water quality was observed by using Wetland Zooplankton Index in Lake Nasser, Egypt (Khalifa *et al.* 2015).

Table II. Zooplankton abundance in three different sampling sites of Sonapur Lake

Zooplankton	Site A Yi	Site B Yi	Site C Yi	Optimum Ui	Tolerance Ti
Rotifers					
<i>Anuraeopsis</i>	15	-	8	3	1
<i>Ascomorpha</i>	18	-	5	1	1
<i>Brachionus</i>	22	30	5	2	2
<i>Kellicotia</i>	5	-	15	3	3
<i>Keratella</i>	25	-	-	3	1
<i>Lecane</i>	12	-	-	5	2
<i>Lepadella</i>	-	25	-	4	2
<i>Monostyla</i>	2	-	4	5	2
<i>Mytilina</i>	-	-	5	5	3
<i>Notholca</i>	15	-	-	3	1
<i>Platylas</i>	-	-	5	4	2
<i>Platyonus</i>		30	15	-	-
<i>Polyarthra</i>	20	-	-	3	1
<i>Pompholyx</i>	-	-	3	1	1
<i>Scardium</i>	-	-	16	5	1
<i>Trichocerca</i>	12	20		4	2
<i>Trichotria</i>	-	-	9	5	2
Chydoridae	2	-	5	4	2
<i>Monospilus dispar</i>	3	4	-	2	1
<i>Macrothricidae</i>	-	-	-	5	3
Daphnidae	-	-			
<i>Diaphanosoma brachyurum</i>	-	-	10	5	2
<i>Scapholeberis</i>	-	-	6	4	2
<i>Simocephalus</i>		2		5	3
Bosminidae	-	-	3	3	1
Cyclopidae	-	-		-	-
<i>Thermocyclops</i>	-	-	10	-	-
Diaptomidae	-	-		-	-
<i>Heliodiaptomus</i>	-	-	6	-	-
<i>Neodiaptomus</i>	-	-		-	-
WZI = $\sum Y_i T_i U_i / \sum Y_i T_i$	3.81	3.52	3.84		
WZI (Average)	3.72				
Water Quality	Moderate				

In Sonapur Lake several physico-chemical parameters such as temperature (29-30 °C), pH (7.8-8.2), transparency (6.5-13.5 cm), free CO₂ (8.0-12.00mg/l), total alkalinity (13.00-14.50 mg/l), ammonia (0.1-0.5 mg/l), nitrate (0.05-0.25 mg/l), nitrite (0.03-0.07 mg/l), phosphate (0.1-0.9 mg/l), dissolved oxygen (2.0-3.5 mg/l) and total suspended solids (4.0×10^{-4} - 5.3×10^{-4}

mg/l) were recorded (Table III). Water transparency indicates the intensity of aquatic primary productivity (Joseph *et al.* 2011).

Table III. Physico-chemical parameters in three different sampling sites of Sonapur Lake

Parameters	Site A	Site B	Site C
Temperature ($^{\circ}\text{C}$)	29.5-30	29-29.5	29.5-30
p ^H	7.8-8	8.1-8.2	7.9-8.1
Transparency (cm)	6.5-7	13-13.5	7.5-8
Free CO ₂ (mg/l)	8.0-8.5	11.99-12.00	11.50-12
Total Alkalinity (mg/l)	14.00-14.50	13.60-14.00	13.0-13.5
Ammonia (mg/l)	0.1-0.2	0.3-0.4	0.4-0.5
NO ₂ (mg/l)	0.05-0.06	0.2-0.25	0.05-0.07
NO ₃ (mg/l)	0.03-0.05	0.05-0.06	0.05-0.07
PO ₄ (mg/l)	0.1-0.15	0.1-0.2	0.1-0.9
Dissolved Oxygen (mg/l)	2.0-2.5	3.0-3.5	2.0-2.5
TSS (mg/l)	5.0×10^{-4} - 5.3×10^{-4}	4.5×10^{-4} - 5.0×10^{-4}	4.0×10^{-4} - 4.5×10^{-4}

The water pH used in estimating density and diversity of aquatic organisms. Neutral to alkaline water pH is favorable to planktonic composition. The alkaline pH is supportive to the growth and development of aquatic organisms (Roy *et al.* 2010). Free CO₂ has ability to limit the primary productivity through providing nutrients to phytoplankton. The favorable range of total alkalinity to the maximum aquatic organisms is 50-150 mg/l CaCO₃ but not below than 20 mg/l (Roy *et al.* 2010). Dissolved oxygen is known as most sensitive requirement to the aquatic organisms. The byproduct of phytoplankton as dissolved oxygen is most essential necessity to the zooplankton. The inorganic nitrogen components: ammonia, nitrate and nitrite are performed as food sources to the phytoplankton (Boyd *et al.* 1998). The water nutrients (ammonia, nitrate and nitrite) also plays a crucial role in zooplankton diversity in aquatic body (Mar galef 1964).

Conclusions

The plankton assemblages introduces the fertility of lakes. Now a days maximum lakes are not properly treated and faced poor management in Bangladesh. However, lakes can be one the most productive aquatic body by expanding fisheries and recreational economy. Therefore, this study aimed to determine Sonapur Lake water quality through estimating phytoplankton and zooplankton distribution. The plankton assemblage is one of the most important requirement for fisheries production.

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PLANKTON DISTRIBUTION AND PHYSICO-CHEMICAL WATER QUALITIES IN A RAIN-FED LAKE

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