PLANKTON COMMUNITY AND THEIR INTER-RELATIONSHIP WITH PRIMARY PRODUCTIVITY OF KAPTAI LAKE

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Roll No.: 0122/02

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A thesis submitted in the partial fulfillment of the requirements for the degree of Master of Science in Fisheries Resource Management

Department of Fisheries Resource Management

Faculty of Fisheries

Chattogram Veterinary and Animal Sciences University

Chattogram-4225, Bangladesh

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This is to certify that we have examined the above Master's thesis and have found that is complete and satisfactory in all respects, and that all revisions required by the thesis examination committee have been made

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June 2023

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The Author

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List of Abbreviations

Short form	**Abbreviation**
ANOVA	One-way Analysis of Variance
C	Carbon
CVASU	Chattogram Veterinary and Animal Sciences University
g	Gram
GPP	Gross primary productivity
h	Hour
L	Liter
mg	Milligram
NPP	Net primary productivity
SD	Standard Deviation
mgC/m^3/d	Milligram carbon per meter cube per day
mgC/m^3/hr	Milligram carbon per meter cube per hour

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Abstract

The purpose of the study was to identify the plankton communities and establish a relationship between plankton abundance and primary productivity in Kaptai Lake from March to August, 2022. Sampling was done by monthly frequency. A total of 15 genera of phytoplankton were identified under the classes Chlorophyceae, Cyanophyceae, Dinophyceae and Euglenophyceae from Kaptai Lake; among which Chlorophyceae was the dominant class. Identified phytoplankton genera were *Actinastrum, Cosmarium, Chlamydomonus, Mougeotia*, *Pandorina*, *Pediastrum*, *Spirogyra*, *Staurastrum*, *Xanthidium*, *Zygnema*, *Anabaena*, *Aphanothece*, *Gleocapsa*, *Ceratium* and *Phacus.* The highest total phytoplankton abundance in Kaptai Lake was recorded in March at Shubholong Bazar station which was 26.7×10^3 cells/L whereas the lowest value was observed in July at Jolojan Ghaat station which was 8.96×10^3 cells/L. A total of 8 genera of zooplankton were identified under the groups Rotifera, Crustacea, Arthropoda and Protozoa; among which, Rotifera was the dominant group. Identified zooplankton genera were *Brachionus, Euchlanis, Keratella, Polyarthra, Asplanchna*, Nauplius, *Cyclops* and *Paramecium*. The highest total zooplankton abundance in Kaptai Lake was recorded to be (5.37×10^3cells/L) in the month of April at Shubholong Jhorna station whereas the lowest value (1.92×10^3cell/L) was observed in July at Jolojan Ghaat station. The mean gross primary productivity of Kaptai Lake throughout the period of study was 262.08±23.66) mgC/m^3/day and net primary productivity was (155.11±23.59) mgC/m^3/day. Phytoplankton abundance showed a statistically significant, strong positive correlation with zooplankton abundance; as well as a moderate positive correlation with gross primary productivity ($p < 0.05$).

Key words: Kaptai Lake, plankton community, primary productivity

Chapter- 1

Introduction

Kaptai Lake is one of the largest man-made freshwater lakes in outheast Asia largest in Bangladesh (Fernando, 1980). It was contained by damming the Karnaphuli River near Kaptai in the Chittagong Hill Tracts, mostly for the production of electricity. The lake has a surface size of between 58,300 hectares and 68,800 ha. (Ali, 1985). The water reserve is 524.7 $\times 10^6$ $m^{3.}$ The reservoir has a maximum depth of 35 meters and a mean depth of 9 meters. The average water level fluctuation is 8.14 meters (Aquatic Research Group, 1986). Fisheries, navigation, flood control, and irrigation were secondary uses of the lake, which served the primary goal of producing electricity. A distinctive freshwater ecology and a wide variety of fish have always existed in Kaptai Lake. This lake has small-scale fisheries with a variety of fish species (Mahmood, 1986). A study shows that 74 freshwater fish species and 2 prawn species are available in the Kaptai Lake (Chakma, 1986). It is crucial for navigation to the furthest reaches of the area, water supply to the communities that line the rivers, suburban and urban regions, and Chattogram City Region, freshwater fisheries, and flow control for the seaport and city of Chattogram (Mahmood, 1986). The lake contains 76 freshwater fish species, of which 68 are indigenous and 8 exotic species, also has a few species of freshwater prawn (Rahman et al., 1992). In the fiscal year of 2021-22, fish production was reported at 17937 metric ton, the reservoir's fishery resources began to be used commercially (DoF, 2022).

Plankton distribution and abundance are markers of a region's biodiversity and indicates characteristics of its ecology. management of an aquatic environment. It is well known that the world's richest fisheries are closely related to plankton production since fisheries and other species rely on it for nutrition. For effective research, understanding the amount and make-up of planktonic species is essential. Numerous nutrients are transported by Kaptai Lake, which also promotes the growth of a significant quantity of plankton. It is possible to target fishing exploitation based on abundance, composition in location, and time with an in-depth knowledge of phytoplankton and zooplankton. Recent studies have found a significant decrease in the number of huge fish produced in Kaptai Lake. Improving production levels requires maintaining a healthy aquatic environment in the lake, which is dependent on the abiotic characteristics of the water and the biodiversity of the ecosystem. To predictably simulate the environment, monitoring phytoplankton and zooplankton populations is mandatory (Deborah and Robert, 2009).

Aquatic habitats are characterized by phytoplankton, the autotrophic members of the plankton community. They have chlorophyll and need sunlight to survive and flourish, microalgae, also known as phytoplankton, are comparable to terrestrial plants. Most phytoplankton are buoyant and float in the water's upper layers, where sunlight can reach them. Phytoplankton also need inorganic nutrients including nitrate, phosphate, and sulfur, which they use to make proteins, lipids, and carbohydrates. They serve as the foundation of primary production in all aquatic bodies directly or indirectly. Plankton's abundance, both in terms of quality and quantity, determines whether a water body is oligotrophic or eutrophic and hence its productivity. To increase the production of fish, it is therefore crucial to have a solid understanding of phytoplankton abundance in relation to primary productivity. Phytoplanktons are autotrophic elements of the plankton community that float move with the currents of the ocean. They make up the planktonic food source on which almost all aquatic creatures rely, together with zooplanktons. Due to their connection between phytoplankton and greater tropic levels, zooplankton play a significant function in the aquatic system. Their consumption reduces phytoplankton populations, while their production of nutritious chemicals that are later digested promotes the growth of phytoplankton (Ketchum, 1962); and become prey for predators. Zooplankton is a rich source of vitamin A, which fish species need to increase their productivity. It is a crucial part of the Lake Ecosystem's food chain. It makes up the second and third tropic levels of the food chain, it is referred as both a primary and secondary consumer. These zooplanktons are eaten by the tertiary consumers in the food chain. Zooplanktons maintain this connection between primary producers and tertiary consumers, balancing the lake's ecology and ultimately leading to an increase in fish production. Zooplanktons stop a lake's bloom by grazing additional phytoplankton, which prevents the water from bloom. In the process of respiration, they emit CO_2. A key component of primary production based on photosynthesis is CO_2. In a nutshell, zooplanktons have an impact on lake ecological processes by feeding on an aquatic environment's primary output (phytoplanktons), function as a pathway for the transfer of energy through the food chain, recycle organic materials and nutrients, and act as prey for both vertebrate and invertebrate planktivores.

Primary productivity is the rate at which energy is converted to organic molecules by photosynthetic producers (photoautotrophs) and chemosynthetic producers (chemoautotrophs), who obtain their chemical energy from oxidation and food from sunlight. Primary productivity is the total quantity of organic matter that is produced by photosynthetic organisms. Heterotrophic organisms like fungus, fish, and bacteria depend on primary production for survival. Photoautotrophs are responsible for nearly all of Earth's primary productivity, which in this case, refers to the phytoplankton. Therefore, it is essential to research the plankton community's abundance and its connection to the primary productivity of Kaptai Lake. The results of this study will also aid future investigations into the relationship between Kaptai Lake's primary productivity and fish production.

Objectives

The key objectives of this research were:

- To identify the plankton community of Kaptai Lake
- To estimate the primary productivity of Kaptai Lake
- To establish an inter-relationship between plankton abundance and primary productivity of Kaptai Lake

Chapter- 2

Review of Literature

Kaptai Lake, one of the most significant freshwater bodies, has a diverse population of fish. This large man-made lake produces a significant number of fish each year, contributing greatly to our overall inland water harvest. Though understanding biological factors is crucial for sustaining a waterbody, Kaptai Lake's primary productivity and plankton composition have received very little attention. Therefore, a review of the literature on planktons and primary production of different aquatic bodies was conducted.

2.1. Phytoplankton

In their study of the phytoplankton in Kaptai Lake, Chowdhury and Khair identified 11 genera under the class Bacillariophyceae (1983), 16 genera under the class Chlorophyceae, 4 genera under the class Cyanophyceae (1983), 2 genera under the class Dinophyceae, and 1 genus under the class Euglenophyceae (1984).

In an experiment on the hydrobiology of the Kaptai reservoir conducted by the Aquatic Research Group in 1986, a total of 81 species of phytoplankton were identified, falling into the groups Cyanophyceae, Chlorophyceae, Euglenophyceae, Bacillariophyceae, Cryptophyceae, Dinophyceae, and Chrysophyceae.

In Ramsagar Lake, Dinajpur, Ferdoushi et al. (2015) conducted a limnological research and reported a total of 21 species of phytoplankton from the groups Euglenophyceae, Cyanophyceae, Bacillariophyceae, and Chlorophyceae. Throughout the research period, the total phytoplankton concentration ranged from 16.11×10^3 cells/L to 57.83×10^3 cells/L.

In Shuksagaor Lake, Dinajpur, Ferdoushi et al. (2019) found 22 species of phytoplanktons belonging to the groups Cyanophyceae, Bacillariophyceae, Chlorophyceae, and Euglenophyceae. Throughout the research period, the total phytoplankton abundance ranged from 5.07×10^3 cells/L to 25.90×10^3 cells/L.

Khondker et al. conducted the first limnological investigation of Lake Bogakain, Bandarban, in 2010. There were 40 different phytoplankton species found in the lake, with the Cynaophyceae, Bacillariophyceae, Cryptophyceae, Euglenophyceae, Dinophyceae, and Chrysophyceae families being the most numerous.

2.2. Zooplankton

From July 2013 to December 2014, Kaptai Lake's zooplankton population was studied in terms of water quality. In all, 10 taxa of zooplankton were cataloged by Bashar et al. (2015) within the Cladocera, Rotifera, and Copepoda orders. Throughout the research period, zooplankton diversity ranged from 2659 to 5313 individuals per liter.

Pre-monsoon (May), monsoon (August), and post-monsoon (November) zooplankton abundance in Kaptai Lake was studied in the year 2010 by Haque et al. (2018). During the three seasons' observation at pre-monsoon, monsoon, and post-monsoon, a total of 9 genera of zooplanktons under three major groups were identified. Rotifera, Copepoda, and Cladocera were the grouped organisms.

In Ramsagar Lake, Dinajpur, Ferdoushi et al. (2015) conducted a limnological research and identified eight different species of zooplankton that belongs to the Copepoda, Rotifera, Cladocera, and Crustacea groups. August had the highest average quantities of zooplankton, while January had the lowest.

In Shuksagaor Lake, Dinajpur, Ferdoushi et al. (2019) identified eight species of zooplanktons belonging to the Copepoda, Rotifera, Cladocera, and Crustacea families. According to the studies, Copepoda and Cladocera were the next-largest groups, followed by Rotifera.

2.3. Primary Productivity

From 1989 to 1991, Ahmed et al. (1994) studied primary production in the Kaptai reservoir. During 1989–1990, the net primary production was 183.2±62.0 mgC/m^3/d, whereas the yearly average gross primary productivity was 361.8±84.0 mgC/m^3/d. In 1990-91, the gross primary productivity averaged 242.7±70.8 mgC/m^3/d and 525.6±140.4 mgC/m^3/d annually.

Between May 1981 and April 1982, Bhouyain and Sen (1990) conducted an experiment on primary productivity in Foy's Lake, Chittagong, together with the effects of temperature and light penetration on it. During the research period, it was identified that the gross primary productivity ranged from 18.14 mgC/m^3/hr to 105.72 mgC/m^3/hr, whereas the net primary productivity varied from 1.87 mgC/m^3/hr to 66.93 mgC/m^3/hr.

The gross primary production of Dhanmondi Lake was quite poor, according to Khondker et al. (1988). Dhanmondi Lake's gross primary production ranged from 0.17 to 2.70 mg O_2/l/h.

Gross primary productivity and net primary productivity of two freshwater lakes (Mombatta and Kagzipura) in the Aurangabad district of Maharashtra, India were measured by Sontakke and Mokashe (2014). Mombatta Lake's seasonal data indicated lower gross primary productivity during the monsoon (0.66 ± 0.17 gC/m^3/hr) and higher range (1.65 ± 0.15 gC/m^3/hr) during the summer, while Kagzipura Lake also showed minimum value (1.19 0.78 gC/m^3/hr) during the monsoon and maximum value (2.50 ± 0.90 gC/m^3/hr) during the summer. The seasonal record of net primary productivity at Mombatta Lake indicated lower values during the monsoon and higher values during the summer season (1.45 ± 0.23) gC/m^3/hr, while it also showed lower values during the monsoon (1.12 ± 0.73) gC/m^3/hr) but higher values during the winter (2.38 ± 0.88) gC/m^3/hr) at Kagzipura Lake.

2.4. Inter-relationship among parameters

In Muara Kuala Raja, Bireuen district, Aceh, Nurfadillah et al. (2019) studied the connection between primary productivity and phytoplankton abundance. The observed phytoplankton abundance and primary production indicated a close connection of 96% based on Principal Component Analysis.

Phytoplankton abundance is not correlated to net primary productivity and gross primary productivity, but there is a positive relationship between net primary productivity and gross primary productivity, according to research by Nurdin et al. (2020) on phytoplankton and the correlation to primary productivity, chlorophyll-a, and nutrients in Lake Maninjau, West Sumatra, Indonesia.

Chapter- 3

Materials and Methodology

3.1. Study Area

The current investigation was conducted in Kaptai Lake situated in Rangamati, Bangladesh. This reservoir stands as one of the largest man-made lakes across South-East Asia, encompassing an approximate area of 58,300 hectares, which expands to 68,800 hectares when at full surface capacity. The reservoir's maximum depth reaches 35 meters, while its average depth measures 9 meters.

Originally constructed to serve the purpose of hydropower generation, Kaptai Lake has since evolved to play a multifaceted role. In addition to its initial function, this waterbody has come to hold significant significance in various domains. Notably, it contributes to recreational activities, fisheries, navigation, flood control, irrigation, and tourism, thus underscoring its diverse and pivotal contributions to the region.

For the purpose of the study, four different sampling points were selected inside the lake (Figure - 1). They are as follows:

1. Jolojan Ghaat (22°39'29.45" N and 92°10'39.31" E)
2. Kandemu (22°39'41.46" N and 92°13'36.48" E)
3. Shubholong Jhorna (22°42'31.17" N and 92°14'33.16" E)
4. Shubholong Bazar (22°42'34.65" N and 92°15'56.50" E)

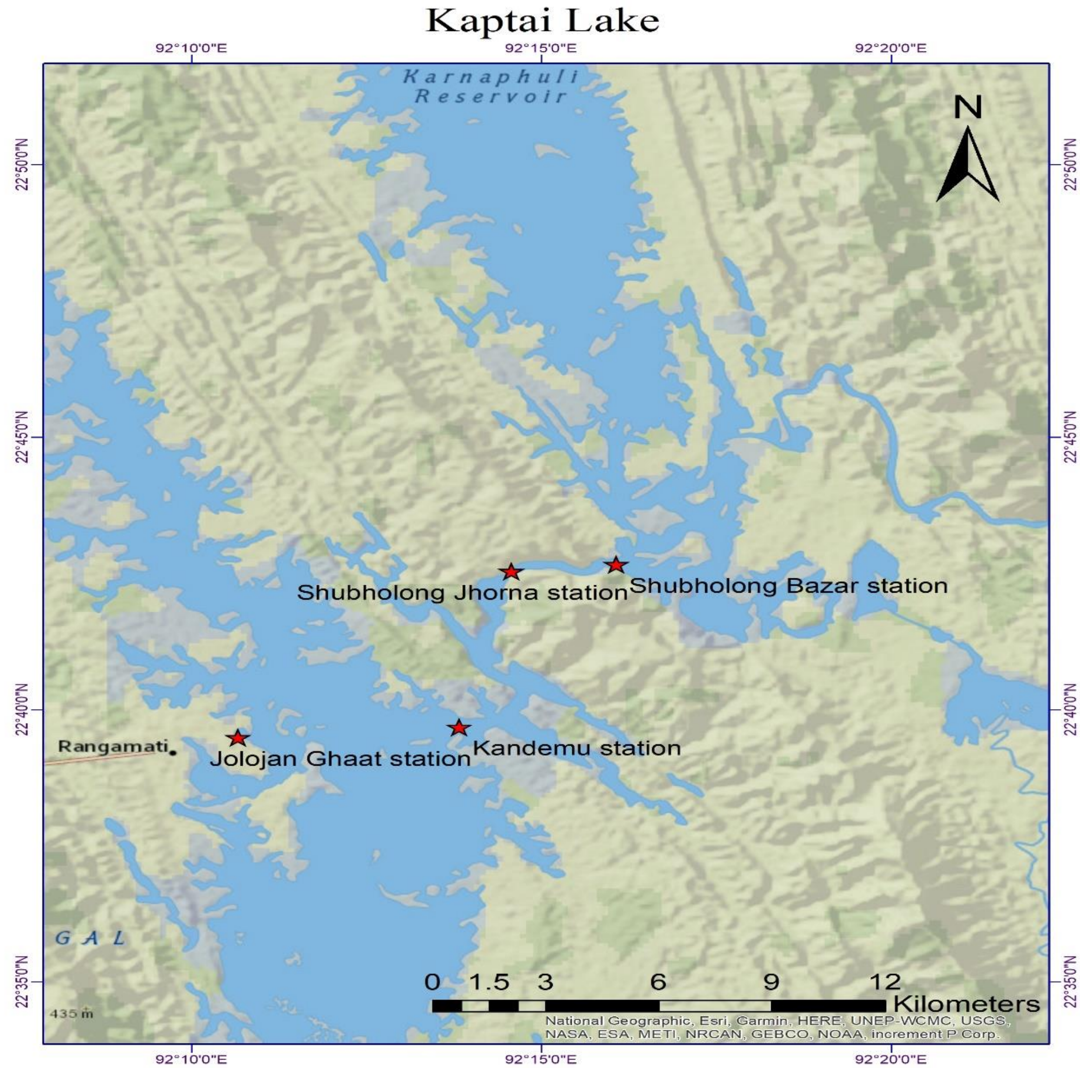

Figure 1: Map of the Study Area

3.2. Study period

The present study was conducted during March to August, 2022.

3.3. Sample collection

The sampling activities of the current study were conducted using the research vessel provided by Chattogram Veterinary and Animal Sciences University (CVASU).

3.3.1. Sampling for Planktonic Study: Water samples intended for the comprehensive examination of phytoplankton and zooplankton were procured from the uppermost layer of the lake water. The process encompassed both qualitative and quantitative investigations. To achieve accurate results, a specialized plankton net with a mesh size measuring 20 µm was employed. During sampling, the water was directed through the net against the natural water current. This was carried out while the research vessel maintained a steady velocity of 2 nautical miles per hour. For precise measurement, the water flow was meticulously gauged using a flow meter. To ensure the preservation of the sample's integrity, a prompt addition of 2-4 drops of 10% ethanol to the sample bottle was carried out immediately after collection.

3.3.2. Sampling for Primary Production Study: For the purpose of primary production analysis, a sampling protocol was followed. At each designated station, a total of two BOD (Biochemical Oxygen Demand) bottles, specifically one light bottle and one dark bottle, each with a capacity of 250 ml, were utilized. The preparation of the dark bottle involved encasing the BOD bottle in black tape to prevent any penetration of sunlight into the sample water. The water samples for both types of bottles were sourced from the uppermost layer of the water, at an approximate depth of 10 cm below the water surface. This meticulous procedure ensured the standardized collection of samples for subsequent primary production assessment.

3.4. Identification of Plankton Species

The laboratory-based identification of both phytoplankton and zooplankton was executed employing a Digital LCD microscope (Optika - B 190) set at a magnification of 40X. The taxonomic classification of phytoplankton up to the genus level was conducted in accordance with the guidelines outlined in the textbook authored by Belcher and Swale (1976). For the identification of zooplankton, the procedures described by Bhuyan et al. (2020) were meticulously followed. This systematic approach ensured accurate and consistent taxonomic identification for both phytoplankton and zooplankton specimens.

3.5. Determination of plankton abundance

The quantification of both phytoplankton and zooplankton abundance was executed utilizing a Sedgewick Rafter cell, adhering to the methodology outlined in Rahman et al.'s publication from 1992. The procedure can be summarized as follows:

1. Initially, a sample was collected and introduced into the Sedgewick Rafter (S-R) cell. Subsequently, the S-R cell, along with the sample, was positioned beneath a microscope at a magnification of 10X.
2. Within the Sedgewick Rafter cell, approximately 1000 individual quadrates were present. Out of these, a tally was taken of the number of plankton cells within ten randomly selected squares.
3. Then the number of plankton cells/L was calculated by using following equation-

   Number of plankton**, $\mathbf{N} = \frac{\mathbf{A \times C}}{\mathbf{F \times V \times L}} \times \mathbf{1000}$**

   Where,

   V = Volume of the Sedgwick Rafter cell field

   F = Number of field count

   C = Volume of final concentration of sample

   A = Total no. of plankton counted

   L = Volume of original water

   N = Number of plankton cells per litre

3.6. Determination of primary productivity

The estimation of primary productivity was carried out through the utilization of the light and dark bottle method, a technique pioneered by Gaarden and Gran in 1927.

Procedure:

1. **Preparation of Sample Bottles:** Two BOD (Biochemical Oxygen Demand) bottles were filled with water samples. Each set consisted of one light bottle, one dark bottle, and one light bottle. It was crucial to fill the bottles carefully to avoid the introduction of air bubbles.
2. **Dark Bottle Preparation:** The dark bottle was covered with aluminium foil to create a light-proof barrier. To ensure complete protection from light, the wrapped dark bottle was kept within a black bag.

3. **Control Light Bottle:** One of the light bottles served as a control bottle. It was used to measure the initial dissolved oxygen level in the sample before any incubation took place.
4. **Incubation Period:** The bottles were subjected to an incubation period. This phase lasted for approximately 3 hours, specifically between the periods of dawn to midday or sunset, corresponding to the respective depths of the water sample.
5. **Bottle Retrieval**: Once the incubation period elapsed, the bottles were retrieved from their respective incubation depths.
6. **Measurement of Oxygen Content:** The oxygen content within the sample was determined using a DO (Dissolved Oxygen) meter, specifically the EcoSense DO200A model.
7. **Calculation:** The following formulae was used to estimate Primary Productivity:

   Gross Primary Productivity (mgC/m^3/hr) =

$$\frac{(O_2\mathrm{LB}) - (O_2\mathrm{DB}) \times 1000}{\mathrm{PQ} \times \mathrm{t}} \times 0.375$$

   Net Primary Productivity (mgC/m^3/hr) =

$$\frac{(O_2\mathrm{LB}) - (O_2\mathrm{IB}) \times 1000}{\mathrm{PQ} \times \mathrm{t}} \times 0.375$$

Here,

O_2IB = Initial concentration of oxygen

O_2LB = Concentration of oxygen in the light bottle

O_2DB= Concentration of oxygen in the dark bottle

PQ = Coefficient of photosynthetic = 1.2

t = Time of incubation (3 hours)

0.375 = Conversion factor to convert oxygen production values into its carbon equivalents

3.7. Data analysis and interpretation

All data calculations and graphical evaluations were executed utilizing Microsoft Excel (Version 16). The statistical analysis component was facilitated through the application of SPSS (Version 25) software.

Photo Gallery

Plate 1: CVASU Research Vessel

Plate 2: Sample collection (Plankton)

Plate 3: Sample collection (Dark bottle)

Plate 4: Sample collection (Transparent bottle)

Plate 5: Measurement of dissolved oxygen

Plate 6: Plankton identification

Plate 7: Plankton cell count

Chapter- 4

Results

4.1. Phytoplankton

A study on Plankton was done on Kaptai Lake including phytoplankton species identification, their abundance, percentage of different class and monthly variation from March to August.

4.1.1. Phytoplankton identification

A total of 15 genera of phytoplankton were identified under 4 classes from 4 stations of Kaptai Lake. The identified classes were: Chlorophyceae, Cyanophyceae, Dinophyceae and Euglenophyceae. Plates 8 – 27 show the pictures of identified phytoplanktons along with their class genus name.

10 genera were identified under the class Chlorophyceae: *Actinastrum, Cosmarium, Chlamydomonus*, *Mougeotia*, *Pandorina*, *Pediastrum*, *Spirogyra*, *Staurastrum, Xanthidium and Zygnema* (Plate 8 – 22); 6 species were identified under the genera *Staurastrum* which are: *Staurastrum gracile, S. johnsonii, S. leptocladum, S. manfeldti*, *S. pingue* and *S. rotula*. 3 genera were identified under the class Cyanophyceae: *Anabaena*, *Aphanothece* and *Gleocapsa* (Plate 22 – 25). Genus *Ceratium* (Plate - 26) and *Phacus* (Plate – 27) were identified under the class of Dinophyceae and Euglenophyceae respectively.

Class - Chlorophyceae

Plate 8 – *Actinastrum*

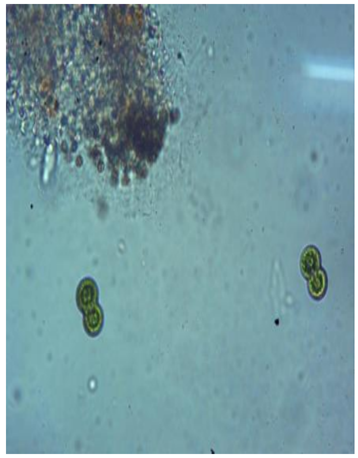

Plate 9 – *Cosmarium*

Plate 10 – *Chlamydomonus*

Plate 11 – *Mougeotia*

Plate 12 – *Pandorina*

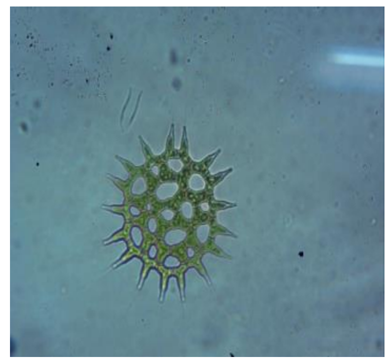

Plate 13 – *Pediastrum*

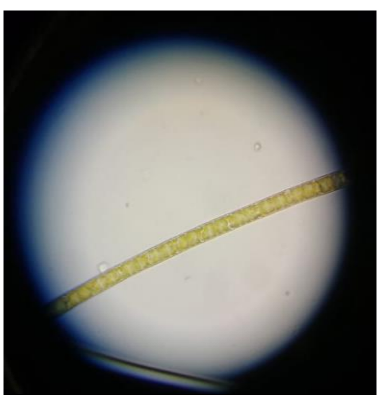

Plate 14 - *Spirogyra*

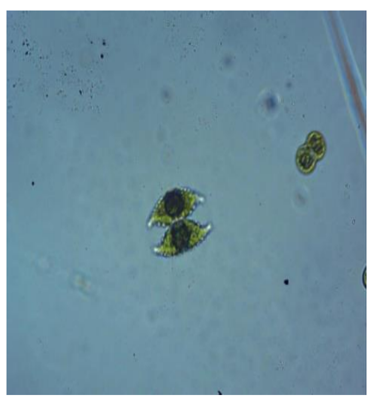

Plate 15 - *Staurastrum gracile*

Plate 16 - *Staurastrum johnsonii*

Plate 17 - *Staurastrum leptocladum*

Plate 18 - *Staurastrum manfeldti*

Plate 19 - *Staurastrum pingue*

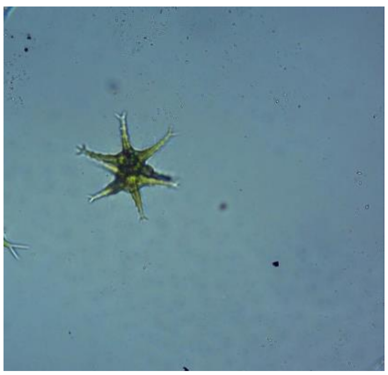

Plate 20 - *Staurastrum rotula*

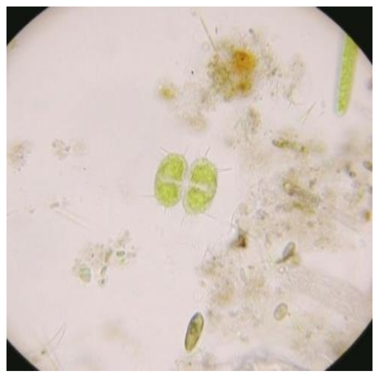

Plate 21 - *Xanthidium*

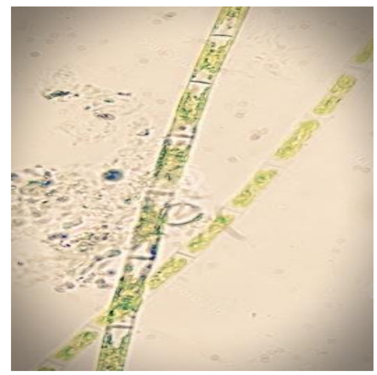

Plate 22 – *Zygnema*

Class – Cyanophyceae

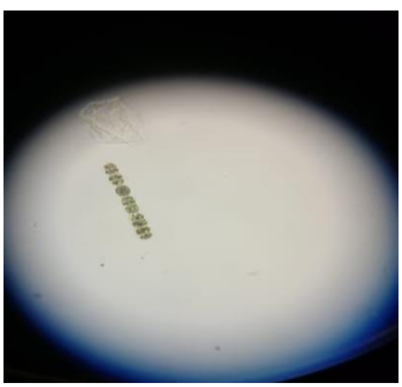

Plate 23 - *Anabaena*

Plate 24 - *Aphanothece*

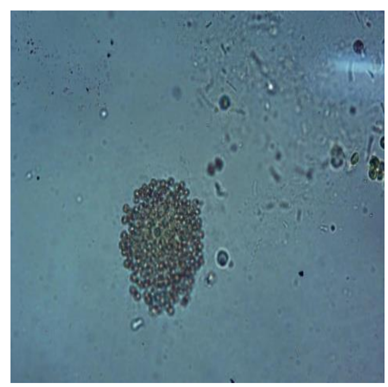

Plate 25 – *Gleocapsa*

Class – Dinophyceae

Plate 26 - *Ceratium*

Class – Euglenophyceae

Plate 27 - *Phacus*

4.1.2. Phytoplankton Abundance

Figure - 2 shows the total phytoplankton abundance in four stations of Kaptai Lake throughout the study period.Total phytoplankton abundance in Kaptai Lake was found highest in March at Shubholong Bazar station which was recorded to be 26.7×10^3 cells/L. The minimum value was observed in July at Jolojan Ghaat station which was 8.96×10^3 cells/L.

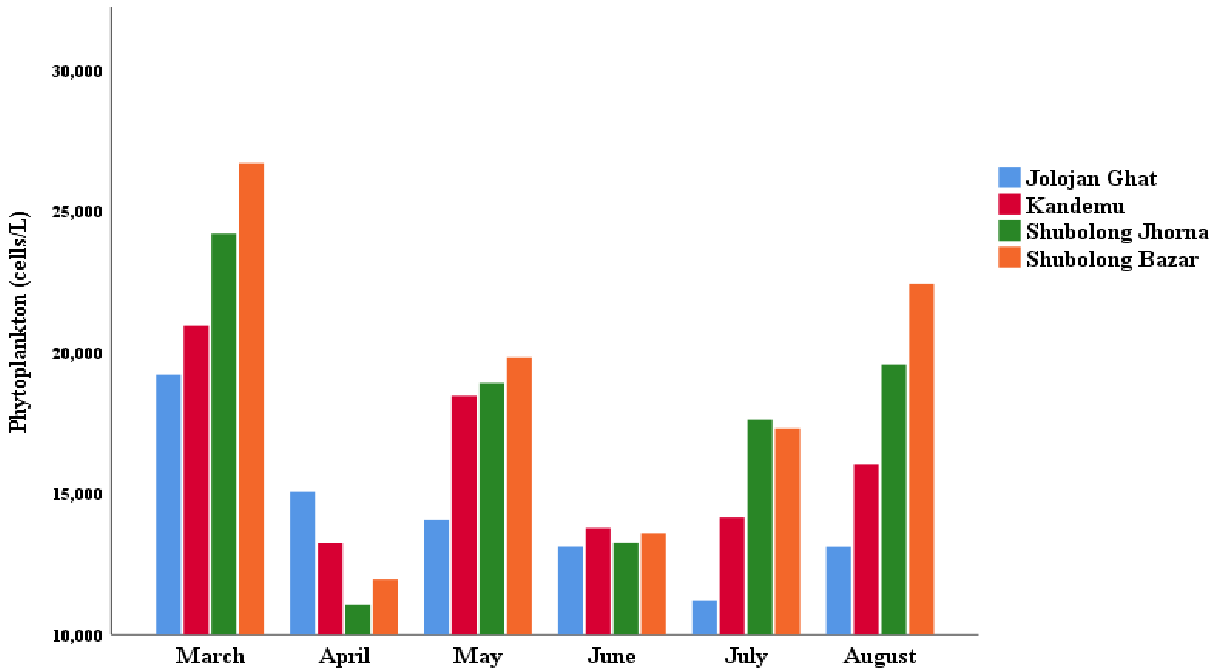

Figure - 2: Total phytoplankton abundance in sampling stations

Table - 1 is showing the mean values and ranges of different plankton species in four sampling stations. The highest mean phytoplankton abundance was (1.242±0.828) ×10^3 cells/L which was recorded in Shubholong Bazar station whereas the lowest value was observed in Jolojan Ghaat station which was (0.952±0.784) ×10^3 cells/L. No significant variance of mean phytoplankton abundance was found among the sampling stations. Figure-3 is showing the mean phytoplankton abundance with standard deviation in four stations of Kaptai Lake.

Table - 1: Mean values (±SD) of phytoplankton abundance

Month	Class	Jolojan Ghaat (×10^3 cells/L)	Kandemu (×10^3 cells/L)	Shubholong Jhorna (×10^3 cells/L)	Shubholong Bazar (×10^3 cells/L)
March	Chlorophyceae	1.323±1.011	1.543±1.057	1.618±1.085	1.762±1.291
	Cyanophyceae	1.285±0.378	1.109±0.443	1.639±0.911	1.891±1.039
	Dinophyceae	1.512±0.543	1.664±0.986	2.193±1.503	2.496±1.593
	Euglenophyceae	0.605±0.205	0.529±0.197	0.907±0.455	0.907±0.576

April	Chlorophyceae	1.201±.402	0.998±0.607	0.665±0.322	0.756±0.548
	Cyanophyceae	0.504±0.485	0.579±0.231	0.680±0.308	0.756±0.272
	Dinophyceae	1.210±0.673	1.285±0.769	1.891±1.138	1.891±1.112
	Euglenophyceae	0.302±0.115	0.226±0.096	0.435±0.290	0.226±0.109
May	Chlorophyceae	0.922±0.639	1.145±0,669	1.225±0.565	1.157±0.694
	Cyanophyceae	0.958±0.157	1.361±0.272	1.412±0.191	1.613±0.265
	Dinophyceae	1.134±0.543	2.496±0.1.324	1.815±1.206	2.420±1.704
	Euglenophyceae	0.832±0.452	0.529±0.204	0.605±0.329	0.983±0.632
June	Chlorophyceae	0.878±0.760	0.905±0.499	0.965±0.619	0.878±0.438
	Cyanophyceae	0.821±0.443	0.887±0.138	0.821±0.203	0.954±0.213
	Dinophyceae	0.931±0.534	1.730±1.283	0.332±0.108	1.131±0.788
	Euglenophyceae	0.931±0.574	0.332±0.095	0.798±0.482	0.798±0.597
July	Chlorophyceae	0.597±0.386	0.735±0.479	1.105±0.652	1.003±0.599
	Cyanophyceae	1.324±0.866	1.437±0.687	1.717±1.006	1.796±1.408
	Dinophyceae	0.708±0.389	1.118±0.798	0.904±0.495	1.376±0.976
	Euglenophyceae	0.550±0.421	1.316±0.759	0.511±0.289	0.511±0.373
August	Chlorophyceae	0.857±0.661	1.011±0.589	1.244±0.719	1.473±0.849
	Cyanophyceae	1.065±0.924	1.397±1.103	1.442±1.103	1.642±1.428
	Dinophyceae	0.532±0.258	0.732±0.359	0.865±0.471	1.397 ±0.995
	Euglenophyceae	0.798±0.481	0.998±0.398	1.940±1.112	1.730 ±1.112

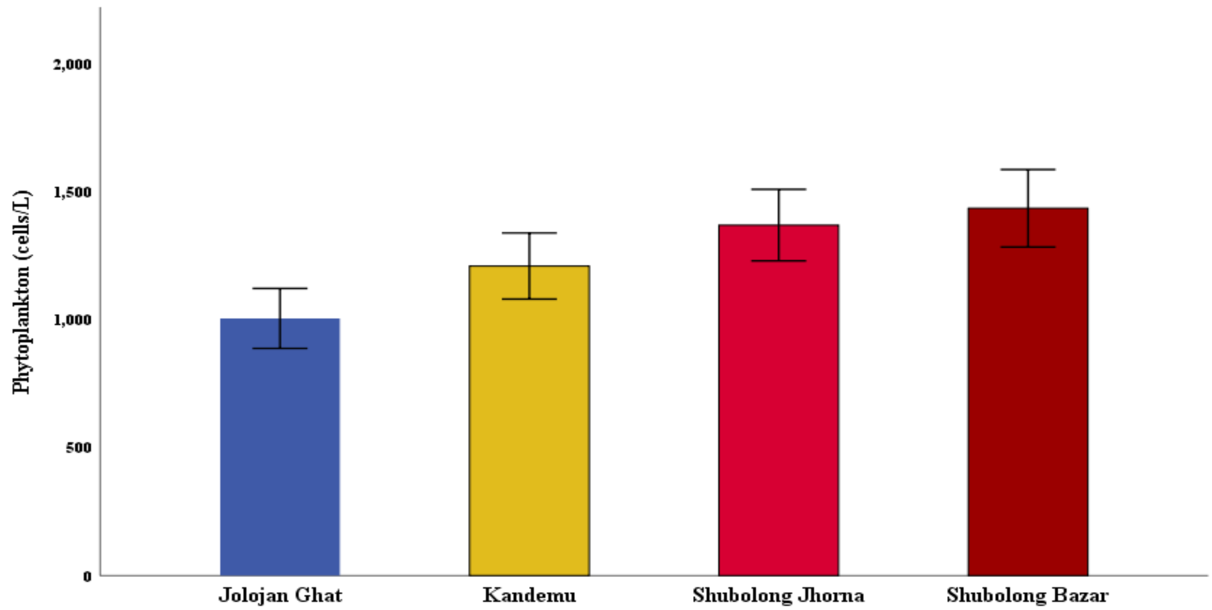

Figure - 3: Mean values (±SD) of phytoplankton abundance in four stations

4.1.3. Phytoplankton community composition

Figure - 4 is showing the percentage of different phytoplankton classes throughout the study period. In the present study, Chlorophyceae was the highest abundant class of phytoplankton which varied from 62.31% to 70.65% of total phytoplankton composition; followed by Cyanophyceae (14.75% to 22.51%), Dinophyceae (6.32% to 12.24%) and Euglenophyceae (2.36% to 6.20%).

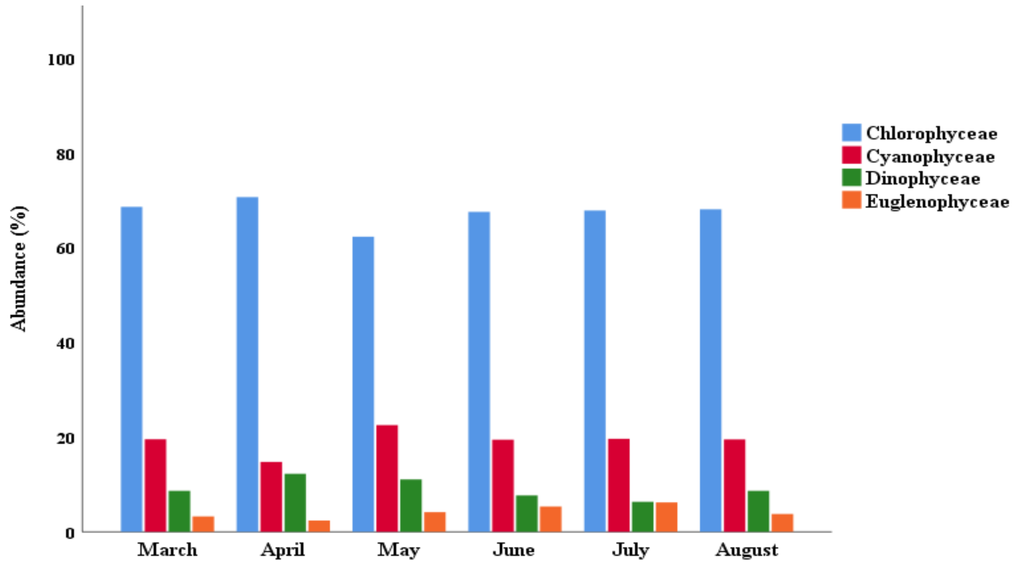

Figure - 4: Percentage of different classes of phytoplankton

Figure - 5 shows the percentage of different phytoplankton genus. The most abundant phytoplankton of Kaptai Lake was found to be *Cosmarium* which varied from 6.07% to 25.52% of total phytoplankton composition; while the least abundant phytoplankton was *Mougeotia* which varied from 0.00% to 4.46%.

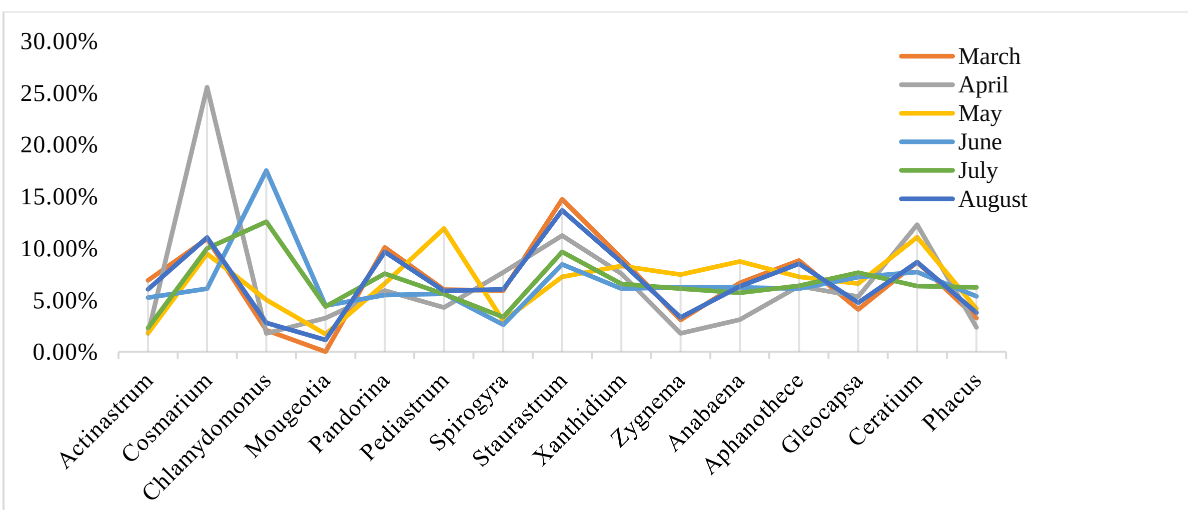

Figure - 5: Percentage of different genera of phytoplankton

4.1.4. Temporal and spatial variation of phytoplankton abundance

There were no outliers, as assessed by boxplot; data was normally distributed for each group, as assessed by Shapiro-Wilk test ($p > .05$); and there was homogeneity of variances, as assessed by Levene's test of homogeneity of variances ($p = 0.860$). Data is presented as mean ± standard deviation. Tukey post hoc analysis revealed that the mean decrease of phytoplankton abundance of March to phytoplankton abundance of June (0.622×10^3 cells/L, 95% confidence interval [1.15×10^3 cells/L, 2.42×10^3 cells/L], $p = 0.041$) was statistically significant; the mean increase of phytoplankton abundance of June to phytoplankton abundance of August (0.290×10^3 cells/L, 95% confidence interval, $p = 0.041$) as well as phytoplankton abundance of April to phytoplankton abundance of July (1.22×10^3 cells/L, 95% confidence interval [1.03×10^3 cells/L, 1.99×10^3 cells/L], $p = 0.005$) and February (0.93×10^3 cells/L, 95% confidence interval [1.14×10^3 cells/L, 2.46×10^3 cells/L], $p = 0.045$). No other group differences were statistically significant. Figure – 6 is showing the temporal and spatial variation of total phytoplankton abundance.

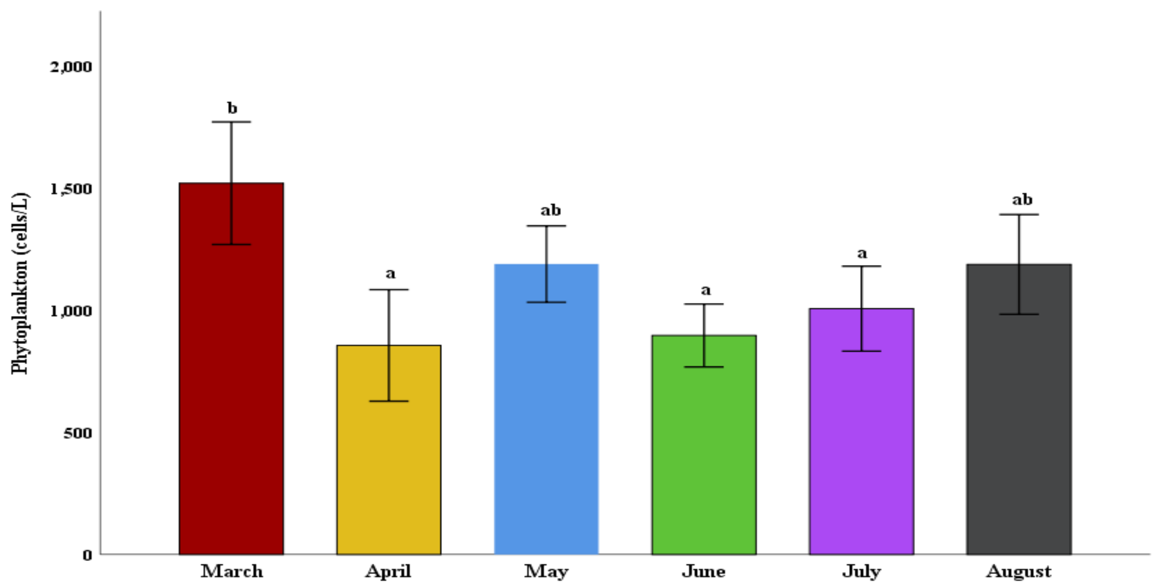

Figure - 6: Temporal and spatial variation of phytoplankton abundance (Mean ± SD)

4.2. Zooplankton

Planktonic study was done on Kaptai Lake including zooplankton species identification, their abundance, percentage of different class and monthly variation.

4.2.1. Zooplankton identification

A total of 8 genera of zooplankton were identified under 4 groups. The identified groups were: Rotifera, Crustacea, Arthropoda and Protozoa. 5 genera: *Brachionus, Euchlanis, Keratella, Polyarthra and Asplanchna* were identified under the group Rotifera which was the dominant group. Nauplius, *Cyclops* and *Paramecium* were identified under the group Crustacea, Copepoda and Protozoa respectively. Plates 28 - 35 show the pictures of identified zooplanktons with their groups and genus name.

Group - Rotifera

Plate 28 - *Brachionus*

Plate 29 - *Euchlanis*

Plate 30 – *Keratella*

Plate 31 - *Polyarthra*

Plate 32 – *Asplanchna*

Group - Crustacea

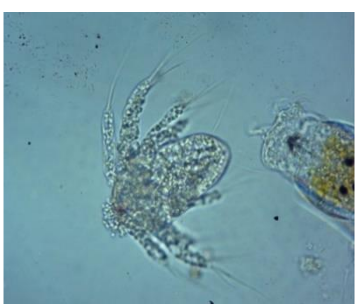

Plate 33 - Nauplius

Group - Copepoda

Plate 34 - *Cyclops*

Group – Protozoa

Plate 35 – *Paramecium*

4.2.2. Zooplankton abundance

Figure - 7 shows the total zooplankton abundance in four stations throughout the study period. Total zooplankton abundance was found highest (5.37×10^3cells/L) in the month of April at Shubholong Jhorna station while the minimum value (1.92×10^3cell/L) was observed in July at Jolojan Ghaat station.

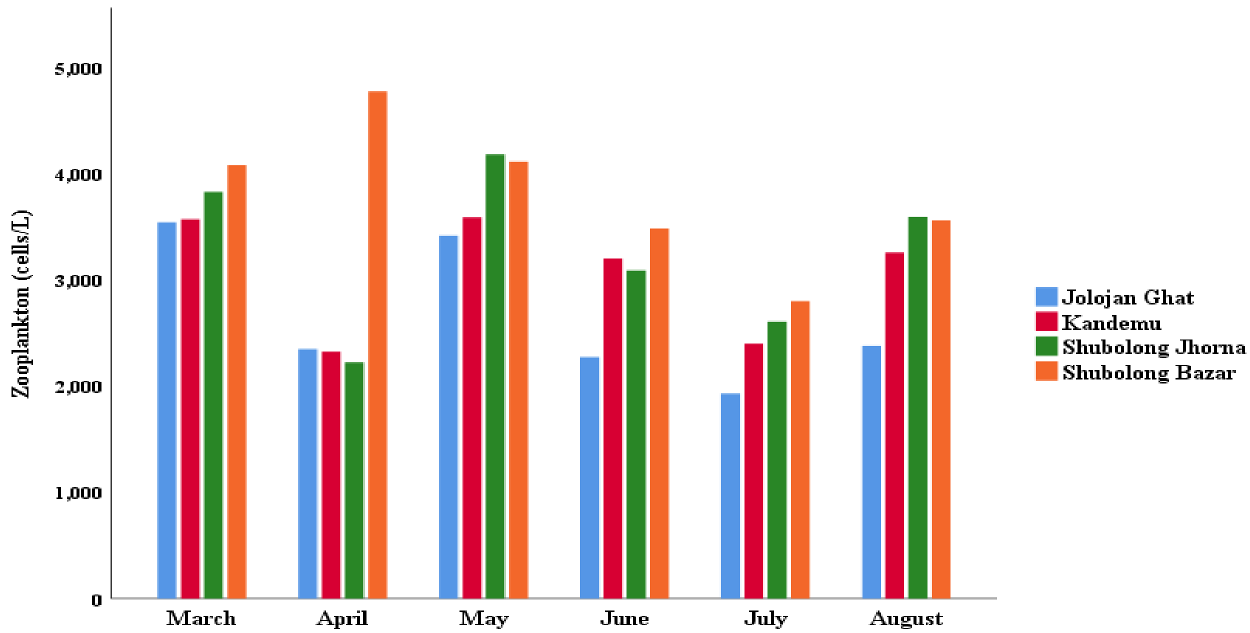

Figure - 7: Total zooplankton abundance in sampling stations

Figure - 8 is showing the mean zooplankton abundance with standard deviation in four stations of Kaptai Lake. The highest mean zooplankton abundance was $(0.474 \pm 0.389) \times 10^3$ cells/L which was recorded in Shubholong Bazar station whereas the lowest value was observed in Jolojan Ghaat station which was $(0.330 \pm 0.208) \times 10^3$ cells/L. No significant variance of mean zooplankton abundance was found among the sampling stations.

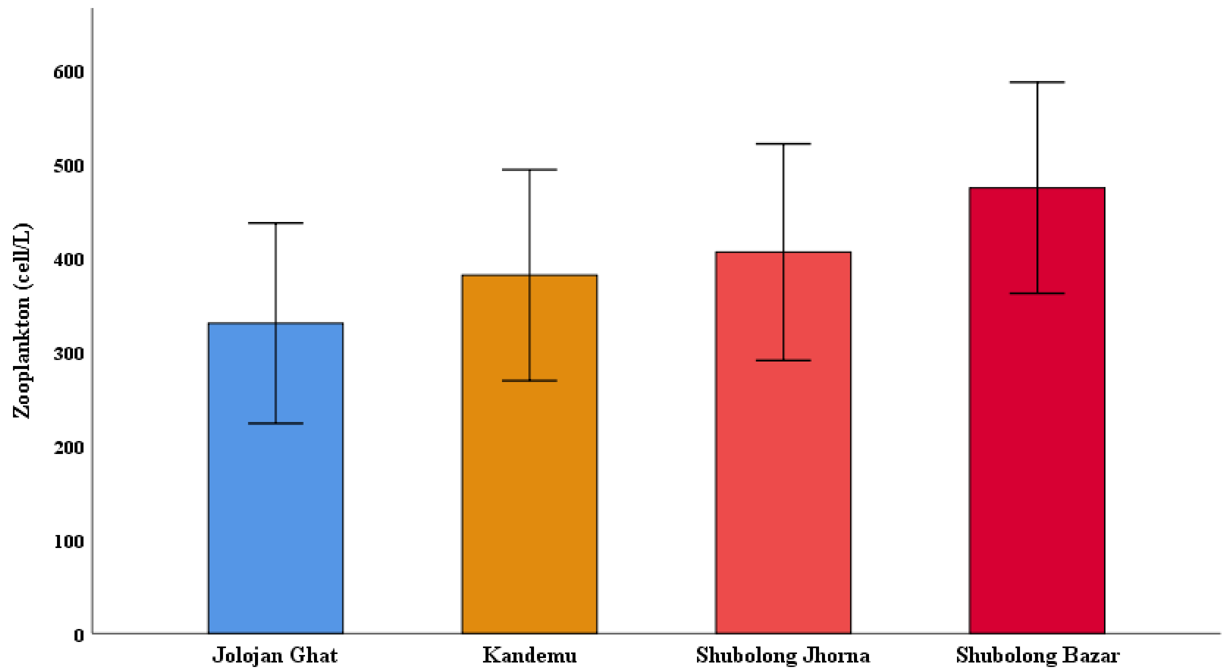

Figure - 8: Mean values (±SD) of zooplankton abundance in four stations

Table - 2: Mean values (±SD) of zooplankton abundance

Month	Group	Jolojan Ghaat ($\times10^3$ cells/L)	Kandemu ($\times10^3$ cells/L)	Shubholong Jhorna ($\times10^3$ cells/L)	Shubholong Bazar ($\times10^3$ cells/L)
March	Brachionus	0.151±0.091	0.226±0.112	0.453±0.213	0.453±0.183
	Keratella	2.118±1.345	2.345±1.346	2.571±1.692	2.571±1.421
	Polyarthra	1.285±-0.899	1.437±0.912	1.739±1.131	1.739±1.121
	Asplanchna	0.226±0.087	0.151±0.089	0.378±0.065	0.378±0.065
	Nauplius	0.378±0.065	0.226±0.012	0.302±0.021	0.302±0.122
	Cyclops	0.226±0.117	0.453±0.211	0.226±0.097	0.226±0.097
	Paramecium	0.151±0.078	0.226±0.102	0.151±0.091	0.151±0.086
April	Brachionus	0.075±0.007	0.075±0.007	0.151±0.023	0.151±0.023
	Keratella	1.210±0.78	1.664±0.987	1.361±0.889	1.361±0.933

	Polyarthra	0.378±0.112	0.0000	0.075±0.008	0.075±0.004
	Asplanchna	0.226±0.117	0.075±0.005	0.226±0.096	0.226±0.117
	Nauplius	0.151±0.0954	0.378±0.176	0.151±0.095	0.151±0.0988
	Cyclops	0.151±0.074	0.226±0.076	0.226±0.068	0.226±0.076
	Paramecium	0.151±0.087	0.302±0.087	0.226±0.087	0.226±0.049
May	Brachionus	0.145±0.0354	0.075±0.037	0.157±0.033	0.157±0.039
	Euchlanis	0.290±0.094	0.151±0.023	0.236±0.098	0.236±0.032
	Keratella	1.307±0.953	1.739±1.321	1.573±1.112	1.573±0.993
	Polyarthra	0.363±0.066	0.605±0.038	0.708±0.276	0.708±0.365
	Asplanchna	0.145±0.077	0.075±0.007	0.236±0.067	0.236±0.115
	Nauplius	0.944±0.433	1.134±0.687	1.652±0.786	1.652±1.112
	Cyclops	0.0000	0.151±0.023	0.157±0.012	0.157±0.054
	Paramecium	0.217±0.135	0.151±0.021	0.157±0.054	0.157±0.076
June	Brachionus	0.226±0.127	0.338±0.211	0.272±0.981	0.272±0.108
	Euchlanis	0.272±0.132	0.387±0.151	0.317±0.211	0.317±0.198
	Keratella	0.408±0.219	0.338±0.198	0.499±0.278	0.499±0.277
	Polyarthra	0.272±0.118	0.435±0.217	0.363±0.195	0.363±0.196
	Asplanchna	0.136±0.012	0.290±0.972	0.226±0.112	0.226±0.112
	Nauplius	0.816±0.354	1.016±0.879	1.043±0.833	1.043±0.661
	Cyclops	0.045±0.006	0.145±0.007	0.226±0.117	0.226±0.117
	Paramecium	0.090±0.005	0.242±0.122	0.136±0.081	0.136±0.081
July	Brachionus	0.226±0.112	0.157±0.935	0.254±0.116	0.254±0.113
	Keratella	0.869±0.398	0.590±0.312	0.730±0.312	0.730±0.312
	Polyarthra	0.189±0.022	0.590±0.212	0.603±0.232	0.603±0.232

	Asplanchna	0.113±0.011	0.078±0.007	0.127±0.011	0.127±0.011
	Nauplius	0.453±0.187	0.826±0.312	0.794±0.366	0.794±0.366
	Cyclops	0.075±0.007	0.157±0.066	0.095±0.016	0.095±0.016
August	Brachionus	0.073±0.021	0.146±0.026	0.265±0.0.032	0.265±0.032
	Keratella	1.060±0.816	1.170±0.572	1.429±0.977	1.429±0.1.112
	Polyarthra	0.548±0.212	0.841±0.322	0.698±0.322	0.698±0.322
	Asplanchna	0.073±0.009	0.109±0.011	0.132±0.076	0.132±0.076
	Nauplius	0.475±0.154	0.804±0.218	1.163±0.799	1.163±0.729
	Cyclops	0.146±0.067	0.182±0.068	0.099±0.009	0.099±0.008

4.2.3. Zooplankton community composition

Figure - 9 shows the percentage of different zooplankton groups throughout the study period. Rotifera was the highest abundant group of zooplankton which varied from 56.52% to 82.28% in the present study, followed by Crustacea (6.62% to 31.30%), Arthropoda (0.06% to 7.06%) and Protozoa (0.00% to 8.24%).

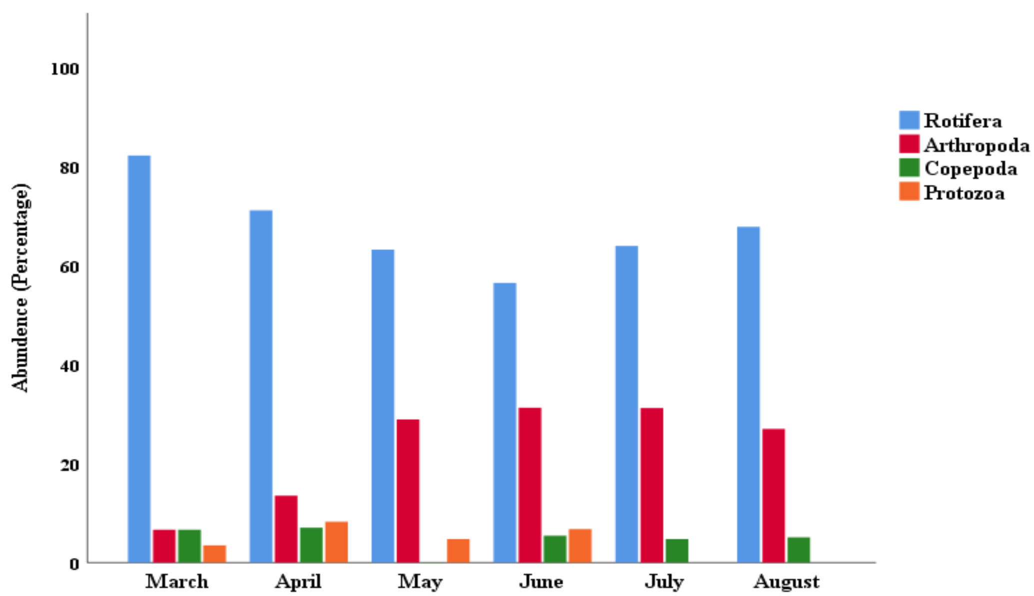

Figure - 9: Percentage of different groups of zooplankton

The most abundant zooplankton was Keratella which varied from 15.87% to 46.47% of total zooplankton composition; while the least abundant zooplankton was *Euchlanis* which varied from 0.00% to 11.10% throughout the study period. Figure – 10 shows the percentage of different zooplankton genus.

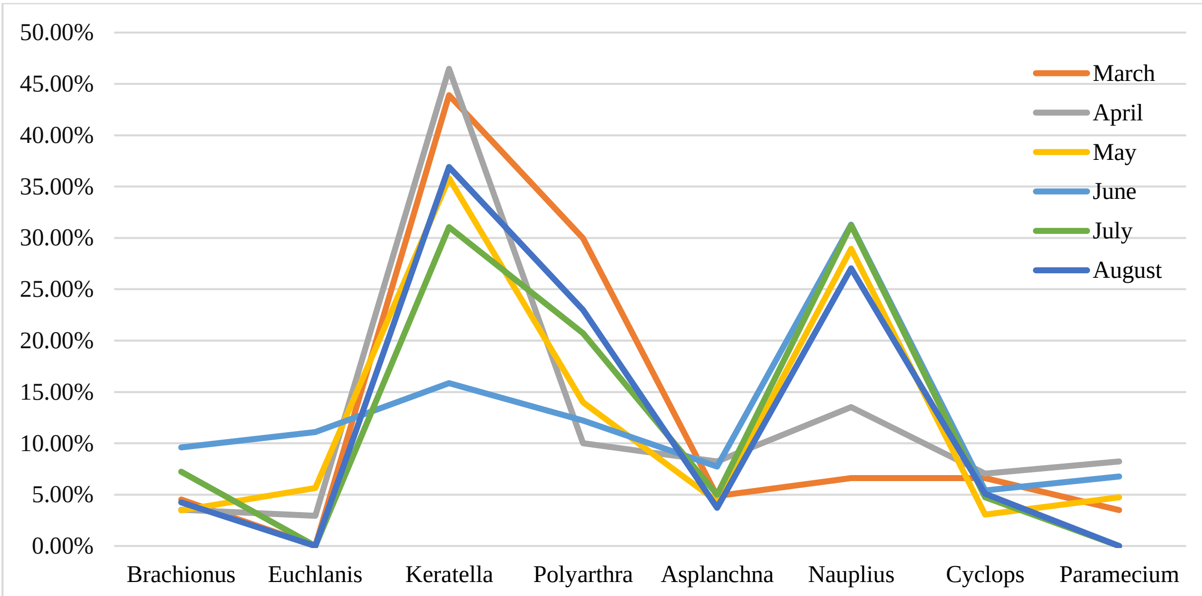

Figure - 10: Percentage of different genera of zooplankton

4.2.4. Temporal and Spatial variation of zooplankton abundance

Figure - 11 is showing the temporal and spatial variation of total zooplankton abundance (Mean ± SD) of Kaptai Lake. There were no outliers in the zooplankton data, as assessed by boxplot; data was normally distributed for each group, as assessed by Shapiro-Wilk test ($p > .05$); and there was homogeneity of variances, as assessed by Levene's test of homogeneity of variances ($p = 0.9$). Data is presented as mean ± standard deviation. Tukey post hoc analysis revealed that the mean decrease of zooplankton abundance of March to zooplankton abundance of July, (0.165 $\times 10^3$ cells/L, at 95% confidence interval) was statistically significant ($p = .003$);and decrease of zooplankton abundance of March to zooplankton abundance of April , (0.105 $\times 10^3$ cells/L, at 95% confidence Interval, as well as the decrease from May to July (0.189 $\times 10^3$ cells/L, at 95% confidence interval, $p = 0.014$) and January (1.94 $\times 10^3$ cells/L, at 95% confidence interval, $p = 0.001$) but no other group differences were statistically significant.

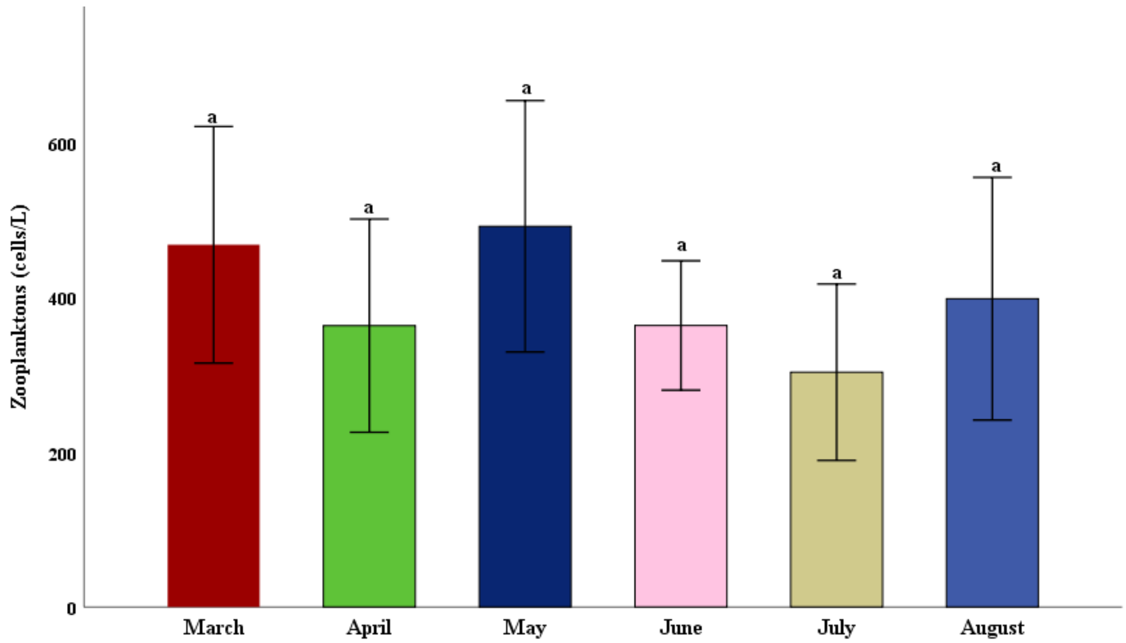

Figure - 11: Temporal and spatial variation of zooplankton abundance (Mean ± SD)

4.3. Primary productivity

In Kaptai Lake, gross primary productivity varied from 218.75 mgC/m^3/day to 302.08 mgC/m^3/day (Figure-12) and net primary productivity varied from 114.58 mgC/m^3/day to 196.25 mgC/m^3/day (Figure-13) throughout the study period. The highest values of GPP (218.75 mgC/m^3/day) in Kandemu during March and June and Shubholong Jhorna during march whereas the lowest values (302.08 mgC/m^3/day) were observed in Kandemu during may. Figure - 12 is showing the gross primary productivity of Kaptai Lake.The mean gross primary productivity of four stations of Kaptai Lake throughout the period of study was (262.08± 23.66) mgC/m^3/day whereas net primary productivity was recorded to be (155.11 ±23.59) mgC/m^3/day. Statistical analysis revealed no significant difference ($P > 0.05$) among gross primary productivity records from different months.

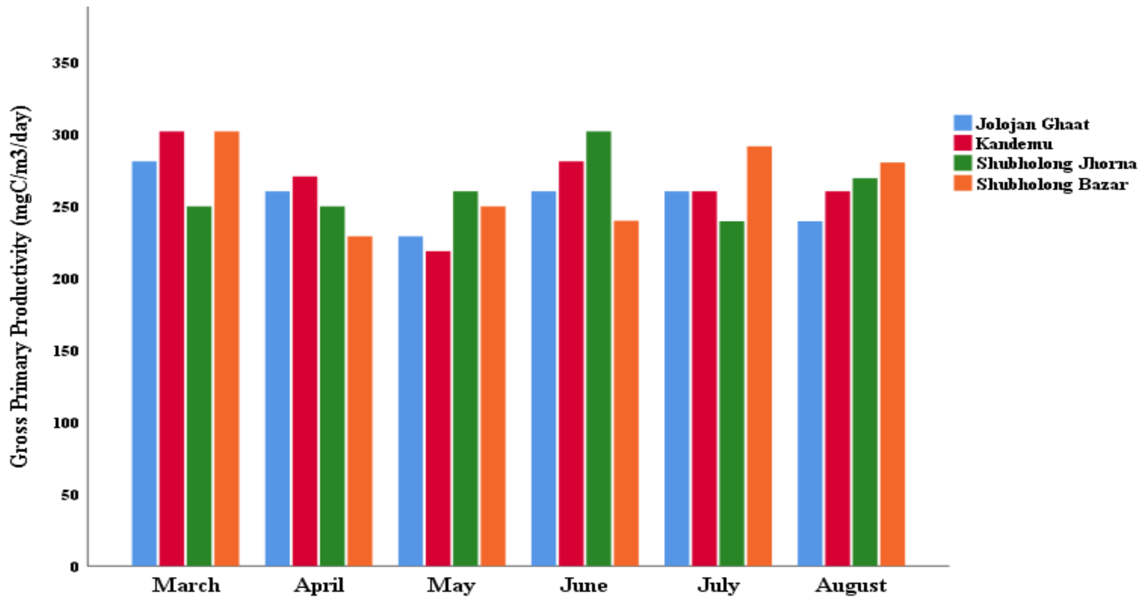

Figure - 12: Gross primary productivity of four sampling stations

Figure - 13 is showing the gross net productivity of Kaptai Lake.The highest value (196.25 mgC/m^3/day) of NPP was in Kandemu during August whereas the lowest value (114.58 mgC/m^3/day) were observed in Shubholong Bazar during April and Kandemu during June.

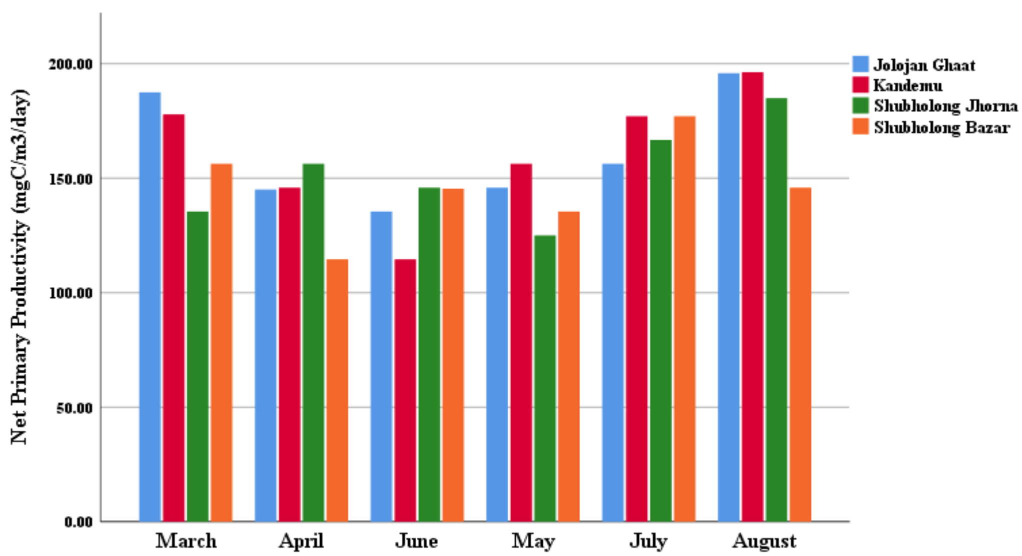

Figure - 13: Net primary productivity of four sampling stations

4.4. Inter-relationship among parameters

A Pearson's product-moment correlation analysis was conducted to examine the associations among the subsequent variables: abundance of phytoplankton, abundance of zooplankton, gross primary productivity and net primary productivity. Initial examinations indicated a linear relationship, and all variables exhibited a normal distribution as confirmed by the Shapiro-Wilk's test ($p > .05$) with no presence of outliers. The results revealed a statistically significant and robust positive correlation between phytoplankton abundance and zooplankton abundance, with a correlation coefficient of $r (24) = 0.031$ and a p-value of 0.00, reaching significance at a 0.01 level. Additionally, a moderate positive correlation was observed between phytoplankton abundance and gross primary productivity, with a correlation coefficient of $r (24) = 0.066$ and a p-value of 0.027, significant at the 0.05 level. A statistically significant moderate positive correlation emerged between zooplankton abundance and gross primary productivity, yielding a correlation coefficient of $r (24) = 0.002$ and a p-value of 0.024, also significant at the 0.05 level. Furthermore, a significant strong positive correlation was detected between gross primary productivity and net primary productivity, displaying a correlation coefficient of $r (24) = 0.334$ and a p-value of 0.00, reaching the 0.05 significance level. Refer to Figure 14 for a visualization of the correlation matrix plot involving phytoplankton abundance, zooplankton abundance, gross primary productivity, and net primary productivity.

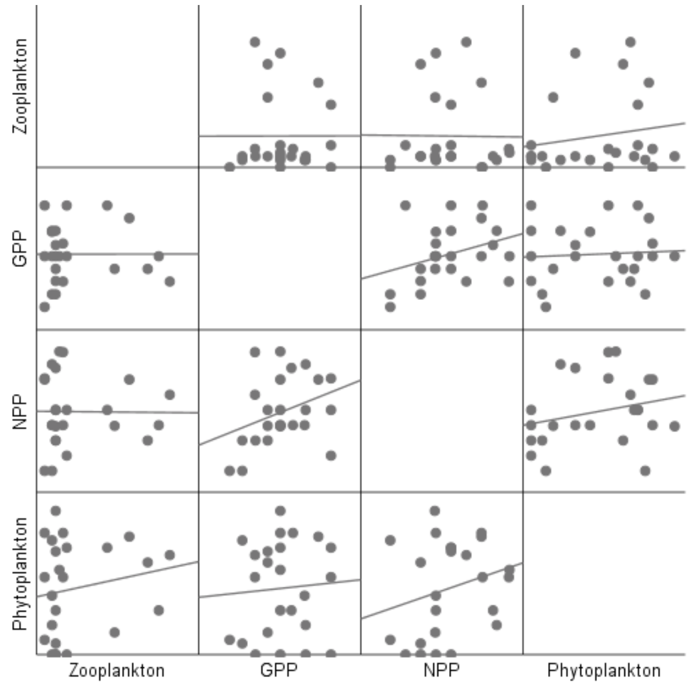

Figure - 14: Correlation matrix plot among different parameters

Chapter – 5

Discussion

5.1. Phytoplankton

The current investigation revealed the presence of 15 genera of phytoplankton in Kaptai Lake, belonging to the classes Chlorophyceae, Cyanophyceae, Dinophyceae, and Euglenophyceae. Among these, 10 genera under Chlorophyceae were identified, including *Actinastrum, Cosmarium, Chlamydomonus, Mougeotia, Pandorina, Pediastrum, Spirogyra, Staurastrum, Xanthidium,* and *Zygnema*. Additionally, within the *Staurastrum* genus, six species were identified*: Staurastrum gracile, S. johnsonii, S. leptocladum, S. manfeldti, S. pingue*, and *S. rotula*. Under the class Cyanophyceae, the species *Anabaena* sp., *Aphanothece* sp., and *Gleocapsa* sp. were recorded. Furthermore, the classes Dinophyceae and Euglenophyceae were represented by the species *Ceratium* sp. and *Phacus* sp., respectively. These findings are consistent with a previous study conducted by Chowdhury and Khair (1983), where they recorded similar phytoplankton taxa, such as 16 genera and 22 species under Chlorophyceae, 11 genera and 28 species under Bacillariophyceae, 4 genera and 8 species under Cyanophyceae, 2 genera and 4 species under Dinophyceae, and 1 species under Euglenophyceae. However, in the present study, no phytoplankton species under the class Bacillariophyceae were observed. Additionally, the Aquatic Research Group (ARG) reported a total of 81 phytoplankton species from various classes, including Cyanophyceae (5 species), Chlorophyceae (21 species), Euglenophyceae (3 species), Bacillariophyceae (4 species), Cryptophyceae (4 species), Dinophyceae (2 species), and Chrysophyceae (1 species) during their hydrobiological study in Kaptai reservoir in 1986.

The overall abundance of phytoplankton in Kaptai Lake exhibited variations ranging from 8.44×10^3 cells/L to 26.703×10^3 cells/L during the study period. The highest phytoplankton abundance was observed in March at the Shubholong Jhorna station, while the lowest value was recorded in August at the Jolojan Ghaat station. Among the different classes of phytoplankton, Chlorophyceae was found to be the dominant group in Kaptai Lake.

In a relevant study conducted by Ferdoushi et al. (2015) in Ramsagar Lake, the highest phytoplankton abundance (57.83×10^3 cells/L) was reported in July, and the lowest abundance (16.11×10^3 cells/L) was observed in January. Similarly, Ferdoushi et al. (2015) conducted a limnological study in Shuksagar Lake, where the total phytoplankton abundance was higher (25.90×10^3 cells/L) in February, while the minimum value was observed (5.07×10^3 cells/L) during April. In both Ramsagar Lake and Shuksagar Lake, Chlorophyceae was identified as the dominant group among the phytoplankton classes.

Additionally, Khondhker et al. (2010) recorded Chlorophyceae as the dominant group of phytoplankton in Bogakain Lake and Kaptai Lake in Bangladesh.

5.2. Zooplankton

The current study documented a total of 8 genera of zooplankton distributed among 4 groups: Rotifera, Crustacea, Arthropoda, and Protozoa. Within the group Rotifera, the dominant group, the identified genera were *Brachionus, Euchlanis, Keratella, Polyarthra*, and *Asplanchna*. Under the group Crustacea, the genera Nauplius and Cyclops were identified, while the group Protozoa was represented by the genus *Paramecium*. Additionally, the group Copepoda was also identified in the present study.

In a study conducted by Bashar et al. (2015), 10 genera of zooplankton were recorded in Kaptai Lake, classified under 3 orders: Cladocera, Rotifera, and Copepoda. Haque et al. (2018) reported the presence of 9 genera of zooplankton in Kaptai Lake, distributed among the groups Rotifera, Copepoda, and Cladocera.

It is noteworthy that the present study did not find any zooplankton belonging to the group Cladocera, but it identified the genus *Paramecium* under the group Protozoa, which was not mentioned in the previous studies.

The overall abundance of zooplankton in Kaptai Lake varied from 1.92×10^3 cells/L to 5.06×10^3 cells/L over the study period. Bashar et al. (2015) previously reported different results, with the highest zooplankton abundance (5313 individuals/L) recorded in June and the lowest abundance (2659 individuals/L) observed in March in Kaptai Lake. However, in the present study, the highest value was found in October, and the minimum value was observed in January.

It is worth noting that the Aquatic Research Group (ARG) conducted an extensive study on zooplankton in Kaptai Lake in 1986. According to their findings, the overall percentage composition of the total number of zooplankton in the lake was reported as 94,793 individuals/m^3, which is significantly higher than the zooplankton abundance reported in the present study.

The differences in the results could be attributed to various factors, such as variations in sampling techniques, seasonal changes, and differences in the years of data collection. It is essential to consider these factors when comparing results from different studies.

5.3. Primary productivity

The mean gross primary productivity (GPP) of Kaptai Lake across the study duration was reported as (262.08±23.66) mgC/m^3/day. This outcome aligns with the research conducted by Ahmed et al. in 1994, where they documented an annual average GPP of (361.8±84.0) mgC/m^3/day for Kaptai Lake during the years 1989-90. Interestingly, a notably higher annual average GPP of (525.6 140.4) mgC/m^3/day was recorded during the subsequent period of 1990-91, which significantly surpasses the GPP observed in the present study

The mean net primary productivity (NPP) of Kaptai Lake over the study duration was documented as (155.10±23.59) mgC/m^3/day. This trend aligns with the findings of Ahmed et al. (1994), where they reported an annual average net primary productivity of (183.2±62.0) mgC/m^3/day for Kaptai Lake during the years 1989-90 and (242.7±70.8) mgC/m^3/day during 1990-91. The slight disparity between the current study and Ahmed et al. (1994) could likely be attributed to the variance in the study durations. Ahmed et al. (1994) conducted their investigation over a span of two years, whereas the present study had a shorter duration of only six months

Sontakke and Mokashe (2014) investigated the primary productivity of two freshwater lakes, namely Mombatta and Kagzipura, located in the Aurangabad district of Maharashtra, India. In their study, they reported the gross primary productivity of Mombatta Lake and Kagzipura Lake during the winter season as (1.53±0.19) gC/m^3/hr and (2.50±0.90) gC/m^3/hr, respectively. Additionally, the net primary productivity was documented as (1.46±0.19) gC/m^3/hr for Mombatta Lake and (2.38±0.88) gC/m^3/hr for Kagzipura Lake. Their findings suggested that both water bodies were polluted and exhibiting signs of eutrophication.

Comparatively, when examining the results from this study in relation to Kaptai Lake, it becomes apparent that Kaptai Lake is not undergoing eutrophication and displays a relatively healthy condition.

5.4. Inter-relationship among parameters

In the present study, Phytoplankton abundance showed a statistically significant, a moderate positive correlation with gross primary productivity, r (24) = .066, *p* = .027 at significant level of 0.05. There was a statistically significant, moderate positive correlation between zooplankton abundance and gross primary productivity, r (24) = .002, *p* = .024 at significance level of 0.05. The result demonstrated that phytoplankton and zooplankton abundance had significant effect on the gross primary productivity of Kaptai Lake in the present study. A similar conclusion was reached by Nurfadillah et al. (2019) where a close relationship of 96% was seen between the recorded phytoplankton abundance and primary productivity based on Principal Component Analysis in Muara Kuala Raja, Bireuen district, Ace; meaning abundance of phytoplankton has a positive correlation to primary productivity. Also, a statistically significant, strong positive correlation was observed in the present study between gross primary productivity and net primary productivity, r (24) = 0.110, *p* = 0.00 at significant level of 0.05.

Chapter – 6

Conclusions

This research endeavor was undertaken to unravel the intricate dynamics of the planktonic community in Kaptai Lake, encompassing their compositional structure, abundance patterns, primary productivity, and the intricate interconnections that interweave these crucial parameters. Phytoplankton, being the cornerstone of aquatic ecosystems, form the bedrock of the entire food web, upon which the entire ecological balance rests. Zooplankton, in their role as consumers of phytoplankton, play a pivotal role in transferring energy through the trophic hierarchy, thereby sustaining the intricate equilibrium of the ecosystem.

Significantly, this investigation sheds light on the palpable impact of plankton abundance upon the primary productivity within Kaptai Lake. Notably, the research findings unveil a comparative moderation in both plankton abundance and primary productivity rates when juxtaposed against analogous freshwater ecosystems. The discernible correlation between plankton abundance and primary productivity underscores a symbiotic relationship. Furthermore, to comprehensively fathom the implications of potential diminutions in plankton abundance and primary productivity, a prolonged and in-depth inquiry becomes imperative. Such protracted analyses hold the promise of elucidating the potential ramifications for the broader piscine yield and overall ecological dynamics of Kaptai Lake.

Chapter- 7

Recommendations and Future Perspective

According to this research work, the following recommendations are suggested:

- **Regular Monitoring of Physical, Chemical, and Biological Attributes:** A consistent regimen of monitoring can be imperative to comprehend the dynamic interplay of physical, chemical, and biological aspects within Kaptai Lake.
- **Implementing Remedial Measures for Enhanced Lake Condition:** Adequate measures need to be instituted to enhance and sustain the overall well-being of Kaptai Lake.
- **Exploration of Primary Productivity and Fish Yield Relationship:** Future research endeavours should delve into establishing a correlation between primary productivity and the piscine yield of Kaptai Lake.
- **Raising Public Awareness about Kaptai Lake's Significance:** Public education initiatives can be vital in elucidating the profound significance of Kaptai Lake and its role in the ecosystem.
- **Informative Value for Future Research:** The insights gleaned from this study are poised to serve as a valuable resource for subsequent research undertakings.

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Appendices

Appendix 1: Phytoplankton abundance data of March

Class	Genus	Jolojan Ghaat (cells/L)	Kandemu (cells/L)	Shubholong Jhorna (cells/L)	Shubholong Bazar (cells/L)
Chlorophyceae	*Actinastrum*	605.17	1588.58	1891.16	2193.75
	Cosmarium	2950.21	2496.33	2118.10	2345.04
	Chlamydomonus	226.94	302.59	907.76	453.88
	Mougeotia	0.00	0.00	0.00	0.00
	Pandorina	2193.75	2496.33	2042.46	2420.69
	Pediastrum	1588.58	1739.87	907.76	1210.34
	Spirogyra	378.23	1588.58	1437.28	1966.81
	Staurastrum	1739.87	3252.80	3933.62	4463.14
	Xanthidium	2420.69	1588.58	2193.75	2042.46
	Zygnema	1134.70	378.23	756.47	529.53
Cyanophyceae	*Anabaena*	907.76	1285.99	1739.87	2118.10
	Aphanothece	1285.99	1437.28	2496.33	2798.92
	Gleocapsa	1664.22	605.17	680.82	756.47
Dinophyceae	*Ceratium*	1512.93	1664.22	2193.75	2496.33
Euglenophyceae	*Phacus*	605.17	529.53	907.76	907.76
	Total	19214.21	20954.08	24206.88	26703.22

Appendix 2: Phytoplankton abundance data of April

Class	Genus	Jolojan Ghaat (cells/L)	Kandemu (cells/L)	Shubholong Jhorna (cells/L)	Shubholong Bazar (cells/L)
Chlorophyceae	*Actinastrum*	226.94	378.23	226.94	75.65
	Cosmarium	5143.96	4160.56	1891.16	1891.16
	Chlamydomonus	75.65	226.94	302.59	302.59
	Mougeotia	529.53	378.23	226.94	529.53
	Pandorina	1059.05	529.53	302.59	1134.70
	Pediastrum	529.53	680.82	378.23	605.17
	Spirogyra	1664.22	983.40	680.82	605.17
	Staurastrum	1891.16	1437.28	1285.99	1134.70
	Xanthidium	756.47	907.76	1134.70	1059.05
	Zygnema	151.29	302.59	226.94	226.94
Cyanophyceae	*Anabaena*	302.59	378.23	378.23	529.53
	Aphanothece	1059.05	832.11	680.82	680.82
	Gleocapsa	151.29	529.53	983.40	1059.05
Dinophyceae	*Ceratium*	1210.34	1285.99	1891.16	1891.16
Euglenophyceae	*Phacus*	302.59	226.94	453.88	226.94
	Total	15053.66	13011.20	11044.39	11876.50

Appendix 3: Phytoplankton abundance data of May

Class	Genus	Jolojan Ghaat (cells/L)	Kandemu (cells/L)	Shubholong Jhorna (cells/L)	Shubholong Bazar (cells/L)
Chlorophyceae	*Actinastrum*	151.29	302.59	529.53	302.59
	Cosmarium	1210.34	1588.58	1739.87	2193.75
	Chlamydomonus	378.23	1285.99	1134.70	756.47
	Mougeotia	453.88	302.59	302.59	151.29
	Pandorina	832.11	1361.64	1285.99	1210.34
	Pediastrum	2118.10	2496.33	2193.75	1664.22
	Spirogyra	151.29	529.53	832.11	605.17
	Staurastrum	1285.99	1134.70	1588.58	1134.70
	Xanthidium	1361.64	1437.28	1437.28	1664.22
	Zygnema	1285.99	907.76	1210.34	1891.16
Cyanophyceae	*Anabaena*	1134.70	1588.58	1588.58	1891.16
	Aphanothece	907.76	1437.28	1210.34	1588.58
	Gleocapsa	832.11	1059.05	1437.28	1361.64
Dinophyceae	*Ceratium*	1134.70	2496.33	1815.52	2420.69
Euglenophyceae	*Phacus*	832.11	529.53	605.17	983.40
	Total	14070.25	18457.75	18911.63	19819.39

Appendix 4: Phytoplankton abundance data of June

Class	Genus	Jolojan Ghaat (cells/L)	Kandemu (cells/L)	Shubholong Jhorna (cells/L)	Shubholong Bazar (cells/L)
Chlorophyceae	*Actinastrum*	399.41	732.26	732.26	931.97
	Cosmarium	1131.67	865.40	532.55	732.26
	Chlamydomonus	2795.90	2130.21	2596.19	1863.93
	Mougeotia	599.12	465.98	732.26	599.12
	Pandorina	532.55	798.83	998.53	599.12
	Pediastrum	865.40	931.97	465.98	732.26
	Spirogyra	199.71	266.28	599.12	332.84
	Staurastrum	1331.38	798.83	1131.67	1264.81
	Xanthidium	332.84	1198.24	732.26	998.53
	Zygnema	599.12	865.40	1131.67	732.26
Cyanophyceae	*Anabaena*	599.12	998.53	865.40	865.40
	Aphanothece	532.55	931.97	998.53	798.83
	Gleocapsa	1331.38	732.26	599.12	1198.24
Dinophyceae	*Ceratium*	931.97	1730.79	332.84	1131.67
Euglenophyceae	*Phacus*	931.97	332.84	798.83	798.83
	Total	13114.08	13779.77	13247.22	13580.06

Appendix 5: Phytoplankton abundance data of July

Class	Genus	Jolojan Ghaat (cells/L)	Kandemu (cells/L)	Shubholong Jhorna (cells/L)	Shubholong Bazar (cells/L)
Chlorophyceae	*Actinastrum*	196.68	272.33	236.02	275.35
	Cosmarium	944.07	1043.92	1062.08	1219.42
	Chlamydomonus	1337.43	1316.25	1416.10	1298.09
	Mougeotia	314.69	408.49	511.37	629.38
	Pandorina	668.72	590.04	904.73	1062.08
	Pediastrum	472.03	726.21	511.37	668.72
	Spirogyra	196.68	363.10	432.70	432.70
	Staurastrum	865.40	1134.70	983.40	1140.75
	Xanthidium	590.04	635.43	708.05	865.40
	Zygnema	511.37	680.82	747.39	668.72
Cyanophyceae	*Anabaena*	511.37	499.27	590.04	826.06
	Aphanothece	590.04	635.43	668.72	826.06
	Gleocapsa	708.05	862.37	826.06	865.40
Dinophyceae	*Ceratium*	511.37	816.98	590.04	786.72
Euglenophyceae	*Phacus*	550.71	726.21	629.38	747.39
	Total	8968.65	10711.55	10817.45	12312.23

Appendix 6: Phytoplankton abundance data of August

Class	Genus	Jolojan Ghaat (cells/L)	Kandemu (cells/L)	Shubholong Jhorna (cells/L)	Shubholong Bazar (cells/L)
Chlorophyceae	*Actinastrum*	255.96	511.91	767.87	987.26
	Cosmarium	1279.78	1133.52	987.26	1206.65
	Chlamydomonus	402.22	146.26	329.09	292.52
	Mougeotia	73.13	146.26	255.96	0.00
	Pandorina	804.43	950.69	1060.39	1206.65
	Pediastrum	511.91	841.00	402.22	694.74
	Spirogyra	255.96	694.74	767.87	804.43
	Staurastrum	767.87	1133.52	1535.73	2267.04
	Xanthidium	987.26	841.00	877.56	914.13
	Zygnema	402.22	146.26	475.35	365.65
Cyanophyceae	*Anabaena*	292.52	621.61	804.43	914.13
	Aphanothece	621.61	694.74	950.69	1279.78
	Gleocapsa	877.56	255.96	329.09	511.91
Dinophyceae	*Ceratium*	511.91	841.00	914.13	1352.91
Euglenophyceae	*Phacus*	402.22	182.83	511.91	475.35
	Total	8446.54	9141.27	10969.53	13273.13

Appendix 7: Zooplankton abundance data of March

Group	Genus	Jolojan Ghaat (cells/L)	Kandemu (cells/L)	Shubholong Jhorna (cells/L)	Shubholong Bazar (cells/L)
Rotifera	*Brachionus*	151.29	226.94	453.88	151.29
	Euchlanis	0.00	0.00	0.00	0.00
	Keratella	2118.10	2345.04	2571.98	2496.33
	Polyarthra	1285.99	1437.28	1739.87	2042.46
	Asplanchna	226.94	151.29	378.23	302.59
Crustacea	Nauplius	378.23	226.94	302.59	529.53
Copepoda	*Cyclops*	226.94	453.88	226.94	529.53
Protozoa	*Paramecium*	151.29	226.94	151.29	226.94
	Total	4538.79	5068.32	5824.78	6278.66

Appendix 8: Zooplankton abundance data of April

Group	Genus	Jolojan Ghaat (cells/L)	Kandemu (cells/L)	Shubholong Jhorna (cells/L)	Shubholong Bazar (cells/L)
Rotifera	*Brachionus*	75.65	75.65	151.29	151.29
	Euchlanis	0.00	0.00	0.00	378.23
	Keratella	1210.34	1664.22	1361.64	1739.87
	Polyarthra	378.23	0.00	75.65	832.11
	Asplanchna	226.94	75.65	226.94	529.53
Crustacea	Nauplius	151.29	378.23	151.29	1059.05
Copepoda	*Cyclops*	151.29	226.94	226.94	302.59
Protozoa	*Paramecium*	151.29	302.59	226.94	378.23
	Total	2345.04	2723.27	2420.69	5370.90

Appendix 9: Zooplankton abundance data of May

Group	Genus	Jolojan Ghaat (cells/L)	Kandemu (cells/L)	Shubholong Jhorna (cells/L)	Shubholong Bazar (cells/L)
Rotifera	*Brachionus*	145.24	75.65	157.34	213.32
	Euchlanis	290.48	151.29	236.02	284.43
	Keratella	1307.17	1739.87	1573.45	1493.26
	Polyarthra	363.10	605.17	708.05	711.08
	Asplanchna	145.24	75.65	236.02	284.43
Crustacea	Nauplius	944.07	1134.70	1652.12	1208.83
Copepoda	*Cyclops*	0.00	151.29	157.34	213.32
Protozoa	*Paramecium*	217.86	151.29	157.34	284.43
	Total	3413.17	4084.91	4877.69	4693.11

Appendix 10: Zooplankton abundance data of June

Group	Genus	Jolojan Ghaat (cells/L)	Kandemu (cells/L)	Shubholong Jhorna (cells/L)	Shubholong Bazar (cells/L)
Rotifera	*Brachionus*	226.94	338.90	272.33	290.48
	Euchlanis	272.33	387.31	317.72	326.79
	Keratella	408.49	338.90	499.27	617.28
	Polyarthra	272.33	435.72	363.10	363.10
	Asplanchna	136.16	290.48	226.94	254.17
Crustacea	Nauplius	816.98	1016.69	1043.92	798.83
Copepoda	*Cyclops*	45.39	145.24	226.94	217.86
Protozoa	*Paramecium*	90.78	242.07	136.16	326.79
	Total	2269.40	3195.31	3086.38	3195.31

Appendix 11: Zooplankton abundance data of July

Group	Genus	Jolojan Ghaat (cells/L)	Kandemu (cells/L)	Shubholong Jhorna (cells/L)	Shubholong Bazar (cells/L)
Rotifera	*Brachionus*	226.94	157.34	254.17	66.57
	Euchlanis	0.00	0.00	0.00	0.00
	Keratella	869.93	590.04	730.75	832.11
	Polyarthra	189.12	590.04	603.66	632.40
	Asplanchna	113.47	78.67	127.09	166.42
Crustacea	Nauplius	453.88	826.06	794.29	965.25
Copepoda	*Cyclops*	75.65	157.34	95.31	133.14
Protozoa	*Paramecium*	0.00	0.00	0.00	0.00
	Total	1928.99	2399.51	2605.27	2795.90

Appendix 12: Zooplankton abundance data of August

Group	Genus	Jolojan Ghaat (cells/L)	Kandemu (cells/L)	Shubholong Jhorna (cells/L)	Shubholong Bazar (cells/L)
Rotifera	*Brachionus*	73.13	146.26	265.93	66.48
	Euchlanis	0.00	0.00	0.00	0.00
	Keratella	1060.39	1170.08	1429.36	1130.19
	Polyarthra	548.48	841.00	698.06	897.51
	Asplanchna	73.13	109.70	132.96	166.20
Crustacea	Nauplius	475.35	804.43	1163.43	1063.71
Copepoda	*Cyclops*	146.26	182.83	99.72	232.69
Protozoa	*Paramecium*	0.00	0.00	0.00	0.00
	Total	2376.73	3254.29	3789.47	3556.79

Appendix 13: Net primary productivity data

Month	Jolojan Ghaat mgC/m^3/day	Kandemu mgC/m^3/day	Shubholong Jhorna mgC/m^3/day	Shubholong Bazar mgC/m^3/day
March	187.5	177.83	135.41	156.25
April	145.08	145.82	156.25	114.58
May	135.41	114.58	145.83	145.41
Jun	145.83	156.25	125	135.41
July	156.25	177.08	166.67	177.08
August	145.83	156.25	125	145.83

Appendix 14: Gross primary productivity data

Month	Jolojan Ghaat mgC/m^3/day	Kandemu mgC/m^3/day	Shubholong Jhorna mgC/m^3/day	Shubholong Bazar mgC/m^3/day
March	281.25	302.08	250	302.08
April	260.41	270.83	250	229.17
May	229.17	218.75	260.41	250
June	260.41	281.25	302.08	240
July	260.41	260.41	239.58	291.67
August	239.58	260.41	239.58	260.41

Brief Biography of the Author

Kaji Mohammad Sirajum Monir passed the Secondary School Certificate Examination in 2013 with GPA 5.00 followed by Higher Secondary Certificate Examination in 2015 with GPA 4.75. He graduated in 2020 from the Faculty of Fisheries, Chattogram Veterinary and Animal Sciences University (CVASU), Khulshi – 4225, Chattogram. Now, he is a candidate for the degree of MS in Fisheries Resource Management under the Department of Fisheries Resource Management, Faculty of Fisheries, CVASU. He has immersed interest in work on the identification of the plankton community and its inter-relationship with primary productivity of Kaptai Lake.