

## Phytoplankton Zooplankton Interrelationship Between Two Ponds and Effect of Seasonal Fluctuations on their Abundance

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**Key words:** Physico-chemical parameters, phytoplankton, zooplankton, abundance, pond

**Abstract:** Physico-chemical parameter and plankton such as phyto and zooplankton have been studied in selected two ponds in Dumkiupazila in Patuakhali district. Physico-chemical parameter plays a vital role in aquatic community. Their growth and productivity rate directly affected by those parameters. Phyto and Zooplankton that constitute an important food supplier of many omnivorous and carnivorous fishes. Moreover, it has a great impacts to control biological activity, oxidation and organic compounds. The study was carried out both culture and non-culture aquatic resource. There are about 4 groups of zooplankton where Copepoda (40.08%), Maxillopoda (38.83%), Malacostraca (16.29%), Branchiopoda (4.8%) and 10 groups of phytoplankton were identified where Bacillariophyceae (29.65%), Euglenophyceae (1.34%), Spirotrichea (2.20%), Cyanophyceae (25.88%), Surirellaceae (0.74%), Chlorophyceae (1.13%), Zygnematophyceae (3.30%), Ulotrichaceae (10.85%), Ulvophyceae (24.88%). Nauplius (38.83%) are the most abundant among all Zooplankton and Fragillaria (22.02%) are most among all phytoplankton. Physico-chemical parameters has a great impacts on plankton abundance. Some physico-chemical parameters such as: temperature, transparency, dissolved oxygen, pH, alkalinity, hardness, nitrate, ammonia were observed monthly. Mean values of water temperature ( $^{\circ}\text{C}$ ), transparency (cm), dissolved oxygen ( $\text{mg L}^{-1}$ ), pH, alkalinity, hardness, nitrate ( $\text{mg L}^{-1}$ ) and ammonia ( $\text{mg L}^{-1}$ ) were  $29.35\pm 1.68$ ,  $36.71\pm 3.8$ ,  $4.90\pm 1.7$ ,  $7.19\pm 0.7$ ,  $95.14\pm 17.19$ ,  $10.72\pm 2.27$ ,  $0.16\pm 0.08$ , respectively. Water temperature, ammonia, pH and phosphorus were optimum range in the investigation time. But the concentration of nitrate was so,

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high. Nitrate, ammonia and dissolved oxygen were responsible for water quality deterioration and great effect on the whole plankton production system. So, plankton

abundance having a correlation with physico-chemical parameter and that has a diverse effect on the aquatic organisms.

## INTRODUCTION

Physico-chemical parameter has a great role on water body and aquatic organisms. These parameters also have advantage indirectly to balance food chain and ecosystem. But this type of parameter largely depends on climate, region and geological variance. As an example we can say that, the parameter of fresh water body that may vary from marine water. A number of studies have been done by many researchers. Bhuiyan *et al.*<sup>[1]</sup> observed the physico-chemical conditions in relation to meteorological conditions of a fish pond in Rajshahi. Phytoplankton and zooplankton are greatly influenced by seasonal variation and physico-chemical parameter. Moreover, plankton and physico-chemical parameter have a co-relationship and plankton survival rates largely depends on those factors. Changes in the physico-chemical parameters may positively or negatively affect the biota of water bodies in a number of ways such as their survival and growth rate and these may eventually result in disappearance of some species of organisms or its reproduction<sup>[2]</sup>.

Plankton has a great important role on water body basically as a food item of many fish species. The plankton community is comprised of the primary producers or phytoplankton and zooplankton; the secondary producers<sup>[3]</sup>. These types of plankton controls the food chain used as a primary or secondary producer. It is an integral component of fresh water body to maintain the food chain and also have quality and quantity criteria. It also indicates the water quality and succession of aquaculture operation. Their abundance may vary from location to location according to water quality and parameters. A lot of number research activities have been done on fish ponds. Fakruzzaman *et al.*<sup>[4]</sup> studied the zooplankton of some fish ponds in Barind Tract in relation to its physico-chemical variables. Biswas<sup>[5]</sup> studied the limnology of three fish ponds in Rajshahi hatchery while Rahman *et al.*<sup>[6]</sup> and Mumtazuddi *et al.*<sup>[7]</sup> worked on some fishponds in Mymensingh. According to Prasad and Singh<sup>[8]</sup>, the zooplankton forms the principal source of food for fish within the water body, zooplankton contributes about 82% of the food items of *Anabas testudineus*<sup>[9]</sup>, 32% of *Notopterus notopterus*<sup>[10]</sup>, 47.06% of *Catla catla* and 6.37% of *Labeo rohita*<sup>[11]</sup>, 24.19% of *Oreochromis nilotica*<sup>[12]</sup>, 38.5% of *Rohitaca matamoras*<sup>[13]</sup> and 30% of *Mystus vittatus*.

The purpose of this study is to develop and understanding the phytoplankton and zooplankton community, their abundance, distribution and interrelationship with physico-chemical parameter in the water body.

## MATERIALS AND METHODS

**Sample collection:** The plankton sampling was carried out by plankton net in different location of two selected pond at different time. Then the collected sample were preserved in plastic bottle with % formalin. The collected samples were taken Sedgewick Rafter Counter Cell (SRC) and which was brought under digital microscope (Optica Microscope Italy) and observed carefully. With the help of identified book the plankton were identified.

Plankton abundance is the number of individuals or cells per units of volume. The number of individual plankton was calculated under the following equation:

$$K = \frac{1}{A} \times \frac{B}{C} \times \frac{V}{v} \times n$$

Where:

K : Phytoplankton abundance (cell m<sup>-3</sup>)

A : Volume of filtered water sample (2 L)

B : Total area/container area of Sedgewick rafter counting cell (mL)

C : Observed area (mm<sup>2</sup>)

V : Volume of filtered water (1.5 mL)

v : Concentration volume of Sedgewick rafter counting cell (mL)

n : Number of observed phytoplankton

Some of the physico-chemical studies were done on the spot while others were done in laboratory. The ponds were flown at Dumki city beside the market. It is a perennial and shallow water body and holds average water body almost 1.5-2 m around the year. The ponds gets sunlight around the year and the bottom soil of which contains clay and the ponds are highly charged. Run off containing sewage, detergents, animal dung silt and decomposed of organic matter enrich the ponds with nutrients that supports the growth of aquatic macrophytes. These ponds are dewatered every year during the rainy season.

Temperature was measured by a centigrade thermometer. Transparency was measured by a Secchi disc while pH. Dissolved Oxygen (DO) content of water was determined by DO meter (model-JENWAY-9015). Titrimetric methods was used to determine the alkalinity. Ammonia and nitrite were estimated using HACH water test kit.

Collection of samples and necessary preservation for various physico-chemical parameters and their estimation

were carried out following Standard Methods<sup>[14]</sup>. Qualitative and quantitative analysis of both phyto and zooplankton were done following drop count method<sup>[14]</sup>.

## RESULTS AND DISCUSSION

Physico-chemical parameter and abundance of plankton (Phytoplankton and zooplankton) were shown at different table. Physico-chemical parameter that has a great effects on aquatic organisms. On the other hand, phytoplankton plays an important role as a primary producer and zooplankton as a primary consumer. Moreover, they also serve as a main food source of higher aquatic organisms. Zooplankton provides main food for fisher at all the stages of life and can also be used as indicators of the trophic status of water body. In physico-chemical parameter are shown below:

**Water quality parameters:** Water quality parameter is very essential to survive any kind of organisms in aquatic water body. Various types of parameter such as water temperature (°C), Transparency (cm), Dissolved Oxygen (mg L<sup>-1</sup>), pH, Alkalinity (mg L<sup>-1</sup>), Hardness (mg L<sup>-1</sup>), nitrate-N (mg L<sup>-1</sup>) and Ammonia (mg L<sup>-1</sup>) were measured during the investigation area which are shown in Table 1.

**Water temperature:** During the investigation area, water temperature was recorded with the help of thermometer. The temperature was varying between 27.5-30.5°C in different location and month to month during the study period. The highest temperature was measured in the month of July (32.0±1.41°C) and the lowest temperature was in the month of October (26.5±0.71°C).

**Transparency:** Transparency has a vital role in the open or semi-closed water body for fish culture due to remaining soil particle in suspended condition in water. For measuring the water transparency, secchi disk is used during the study period and the ranges of transparency were varied between 31.5-44 cm which is shown Table 1.

The highest value (44.0±1.41) of transparency was recorded in the month of October and the lowest (31.5±0.71) was measured in the month of June.

**Dissolved oxygen:** Dissolved oxygen is very important physical parameter for aquatic organisms both open, closed or semi-closed water body. This is measured by using a portable digital DO meter (DO 5509, AF. 11581, made in Taiwan) on the selected location. The ranges of dissolved oxygen were found more or less similar in different month at different time in the study area and it was varied between 4.26-5.75 (mg L<sup>-1</sup>) which is shown Table 1. The highest value (5.75±0.49) of dissolved oxygen was recorded in the month of June and the lowest value (4.26±0.07) was recorded in the month of September.

**pH:** Water pH is another important physical factor in any type of water body. Which is determined by using a direct reading digital pH meter (HANNA instruments, HI 96107, made in Italy) on the spot. The ranges of pH were varied between 6.8-7.6 at different location in the selected study area. The highest value was determined (7.6±0.14) in the month of April and the lowest value (6.8±0.00) was in the month of May which is shown in the Table 1.

**Alkalinity:** Alkalinity was determined by using alkalinity test kit (HANNA Instruments, made in Romania). The ranges of alkalinity were recorded between 77.5-125.0 in different months during the study period in the selected area. The highest values of alkalinity (125.0±21.12) were measured in the month of April and the lowest value was 77.5±6.36 in the month of August which is shown Table 1.

**Hardness:** Hardness was determined directly by using Hardness test Kit (HANNA Instruments, made in Romania). The ranges of hardness were varied between 76-101.5 in different months during the investigation area. The highest values (101.5±23.33) of hardness were observed in the month of April and the lowest values (76.0±8.49) in the month of August that are shown in the Table 1.

Table 1: Physico-chemical parameter are shown in different month

Parameters	April	May	June	July	August	September	October	Mean±SD
Temperature (°C)	28.0±1.41	29.0±0.00	31.5±0.71	32.0±1.41	29.0±1.41	29.5±0.71	26.5±0.71	29.35±1.68
Transparency (cm)	36.0± 2.81	34.5±9.19	31.5±0.71	33.0±5.6	36.0±1.06	42.0±5.66	44.0±1.41	36.71±3.8
Dissolved Oxygen (mg L <sup>-1</sup> )	5.15±0.07	4.4±0.14	5.75±0.49	4.65±0.35	5.7±0.21	4.26±0.07	4.40±0.07	4.90±1.7
pH	7.6±0.14	6.8±0.00	7.3±0.00	6.9±0.00	7.14±0.07	7.22±0.00	7.43±0.14	7.19±0.7
Alkalinity (mg L <sup>-1</sup> )	125.0±21.12	86.5± 3.36	92.5±31.2	99.5±31.82	77.5±6.36	89.5±10.61	95.5±10.61	95.14±17.19
Hardness (mg L <sup>-1</sup> )	101.5±23.33	96±6.36	78.5±4.24	82.5±4.24	76.0±8.49	92.5±2.12	86±10.61	87.57±1.17
Nitrate-N (mg L <sup>-1</sup> )	8.41	11.23	9.89	10.11	14.27	12.51	8.68	10.72±2.27
Ammonia (mg L <sup>-1</sup> )	0.09±0.35	0.15±0.00	0.10±0.35	0.08±0.35	0.05±0.07	0.7±0.14	0.09±0.02	0.18±0.08

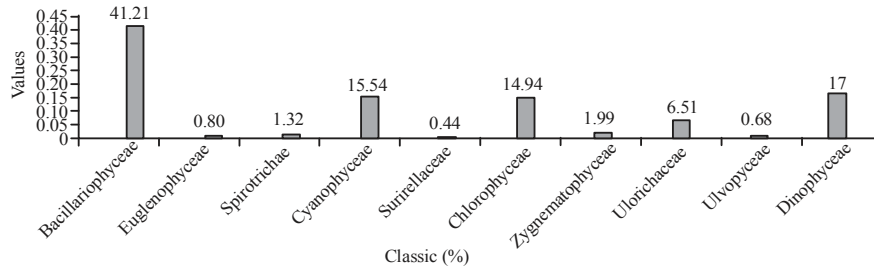


Fig. 1: Percentage of Phytoplankton abundance

**Nitrate:** Nitrate is another type of physical parameter which was measured by using a Nitrate test kit (HANNA Instruments, made in Romania). The ranges of Nitrate were measured between 8.41-14.27 in different months and the highest values was 14.27 in the month of August and the lowest value was 8.41 in the month of April which is shown in the Table 1.

**Ammonia:** Ammonia has a great effect any type of water body. The ranges of ammonia varied between 0.05 to 0.15 in different months during the study period. The highest mean values ( $0.15 \pm 0.00$ ) of ammonia were recorded in the month of May and the lowest values ( $0.05 \pm 0.07$ ) were recorded in the month of August that are shown in the Table 1.

Phytoplankton is very essential for primary production. Fish and other aquatic organisms are depends on primary production. Abundance of phytoplankton that may vary from time to time and water body (Fig. 1). Generally samples are collected at different time, different location. In our study area it is visible that Bacillariophyceae (41.21%), Euglenophyceae (0.80%), Spirotrichea (1.32%), Cyanophyceae (15.54%), Surirellaceae (0.44%), Chlorophyceae (14.94%), Zygnematophyceae (1.99%), Ulotrichaceae (6.51%), Ulvophyceae (0.68%) and Dinophyceae (17%). Our findings are more or less similar to other researchers. The findings of this study are in agreement with the findings of Hossain *et al.*<sup>[15]</sup> and Verma and Shukla<sup>[16]</sup> recorded 30 genera of phytoplankton from Kamala Nehru Tank, Muzaffarnagar, India while Hossain found 17 genera belonging to Cyanophyceae (5 classes, 34.47%), Bacillariophyceae (3, 13.87%), Cyanophyceae (5, 34.48%), Euglenophyceae (3, 10.68%) and Dinophyceae (6.50%) from earthen fish ponds within the Rajshahi region, Bangladesh. From study analysis, 16 phytoplankton genera are recorded under 4 groups. But among of them *Fragillaria* (22.02%) is the highest rate and *surirella* (0.74%) has the lowest rate.

Zooplankton also has a great significance role on water body for maintaining the ecosystem and keep balance. Abundance of zooplankton mainly depends up

on the availability of food and temperature on phytoplankton. But zooplankton also may vary from seasonal fluctuation.

Zooplankton affects lake ecosystem processes by grazing on phytoplankton, recycling nutrients and organic material and serving as prey for both vertebrate and invertebrate planktivores. In the majority of lakes phosphorus availability limits the algal production<sup>[17]</sup> but see<sup>[18]</sup> which in turn determines the level of secondary production and affects also zooplankton species diversity<sup>[19, 20]</sup>. As primary production increases, the quantity of food for zooplankton increases but its quality frequently deteriorates<sup>[21]</sup>. At the same time the abundance of planktivore fish increases as primary production is enhanced<sup>[22, 23]</sup> but see Mehner *et al.*<sup>[24]</sup> Predation has a greater impact on zooplankton communities in the nutrient poor ecosystems<sup>[25, 26]</sup> where top-down factors are more important than bottom-up factors. In general, total zooplankton biomass increases with increasing eutrophication but the size structure of zooplankton communities is often independent of lake trophy<sup>[27]</sup>.

**Inter relationship between phytoplankton and zooplankton:** Phytoplankton and zooplankton has a diverse relationship in the water body. Zooplankton abundance depends on phytoplankton. If increasing the abundance of zooplankton at a certain rate, the productivity of phytoplankton rate will be decreased in water body and vice versa. The zooplankton grazing pressure could help the change in dominance of phytoplankton and. Moreover, Ismael and Abdel-Aziz<sup>[28]</sup> reported *Spirulina* as prey for cirripede larvae, the blue-green *Oscillatoria* spp. for the copepod *P. parvus* and *C. meneghiniana* for copepod nauplii, while Guergues found the diatom *Nitzschia* sp. in the gut of *A. americanus*. Finding results between two ponds during the study periods, its indicated that, phytoplankton is more dominant on zooplankton between pond A and pond B (Fig. 2, Table 2 and 3). Sometimes physic-chemical parameter has diversification effect on plankton abundance. Phytoplankton will decrease when increase in high temperature, salinity, nitrate, phosphorus in water body.

Table 2: Abundance of plankton in fishponds (Phytoplankton)

Groups	Plankton name	Pond A 2016		Pond B 2017		Individual percentage	Total percentage
		SS <sub>1</sub>	WS <sub>1</sub>	SS <sub>2</sub>	WS <sub>2</sub>		
Bacillariophyceae	Navicula	++++	+	++	+++	3.30	41.21
	Bacteriastriumsp	++	-	++++	+++	4.14	
	Cyclotellasp	+	-	+++	-	1.08	
	Biddulphiasp	-	+++	+	-	0.60	
	Bacillariasp	+++	-	++	+	0.80	
	Melosirasp	-	+++	-	++	0.40	
	Gyrosigmasp	+	++	+	+++	0.95	
	Cymbellasp	-	-	+++	-	1.62	
	Thalassiphraxsp	+	++++	-	++	2.98	
	Streptotheca	++	+	++	+++	2.10	
	Rhizosoleriasp	+++	-	+++	+	2.51	
	Stepharopsisssp	++	-	++++	+	6.20	
	Fragillaria	++++	++	++	-	13.24	
	Tabellaria	-	+	-	+++	0.62	
	Nitzschia	++	+	+	+++	0.67	
Euglenophyceae	Euglena	+++	-	++	-	0.80	0.80
Spirotrichea	Codonela	-	+++	+++	+	1.32	1.32
Cyanophyceae	Anabaena sp.	-	+	+++	+++	2.54	15.54
	Nostoc sp.	++++	++	-	++	3.24	
	Oscillatoria	+++	++	++++	+	7.93	
Surirellaceae	Aphanizomenon	++	-	+	+++	1.83	0.44
	Surirella	-	++	+	+++	0.44	
Chlorophyceae	Closterium	++	+	+++	-	12.85	14.94
	Rhizoclonium sp.	-	+++	++	+	2.09	
Zygnematophyceae	Gonatozygon	-	+++	++	-	1.99	1.99
Ulotrichaceae	Ulothrix	++++	++	+++	++++	6.51	6.51
Ulvophyceae	Cladophora	++	-	+	+++	0.68	0.68
Dinophyceae	Gymnodiumsp	+++	+	+++	++	5.10	17
	Dinophysissp	++++	++	-	++++	10.69	
	Ceratiumsp	-	+++	+	++	0.73	

SS<sub>1</sub> = Summer Season1; WS<sub>1</sub> = Winter Season1; SS<sub>2</sub> = Summer Season<sub>2</sub>; WS<sub>2</sub> = Winter Season<sub>2</sub>; (-): 0 cell m<sup>-3</sup>; (+): 1-100 cell m<sup>-3</sup>; (++) : 100-1000 cell m<sup>-3</sup>; (+++) : 1001-10000 cell m<sup>-3</sup>; (++++) : 10001-100000 cell m<sup>-3</sup>; (+++++) : 100000cell m<sup>-3</sup>

Table 3: Abundance of plankton in fishponds (Zooplankton)

Groups	Plankton name	Pond A 2016		Pond B 2017		Individual percentage	Total percentage
		SS <sub>1</sub>	WS <sub>1</sub>	SS <sub>2</sub>	WS <sub>2</sub>		
Copepoda	Cyclops	+++	-	++	-	28.80	40.08
	Diaptomus	+++	++++	+	++++	11.28	
Maxillopoda	Nauplius	-	+++	+++	+	38.83	38.83
Malacostraca	Crab larvae	+++	++	++++	+++	16.29	16.29
Branchiopoda	Daphnia sp.	+++	++	+++	++	3.77	4.8
	Moina	++	-	+++	+	1.03	

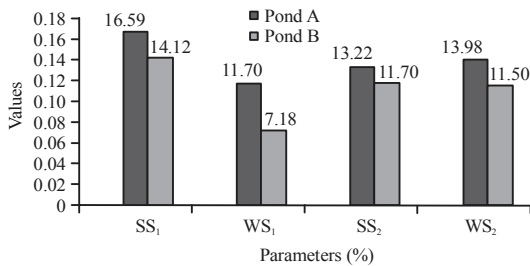


Fig. 2: Abundance of plankton between two ponds

### CONCLUSION

The obtained results show that physic-chemical parameter has a great influence over the plankton community. Their abundance, growth and distribution that may vary on that parameter. No single factor is

responsible for this variability. However, temperature, sunlight exposure period, sunlight penetration, water pH, wind, transparency, seasonal variations, water characteristics, nutrient enrichment and prey-predator may be related to variable changes in the plankton distribution and their abundance in ponds' water. Those parameters also depend on the seasonal fluctuation. So, they are inter connected with each other's. All those information are very useful for further research activities and introduced as a main foundation of related study criteria in this Patuakhali district, Bangladesh.

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