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Phytoplankton community structure of commercial earthen aquaculture ponds

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Abstract
An investigation was carried out to study the qualitative and quantitative status of the phytoplankton community of commercial tilapia-carp polyculture ponds in the Muhuri project area of Mirsharai, Chittagong. A total of 40 phytoplankton genera under 10 classes were identified. Chlorophyceae was noticed to be the most abundant (22.5%) class followed by Zygnematophyceae (17.5%), Trebouxiophyceae (15%), Bacillariophyceae (12.5%), Cyanophyceae (12.5%), Euglenoidea (10%), Ulvophyceae (2.5%), Crysophyceae (2.5%), Dinophyceae (2.5%) and Tentaculata (2.5%). The class Bacillarophyceae among 10 classes and the genera *Cyclotella* among all the 40 genera were found in highest concentration in the present investigation.

Keywords: tilapia-carp aquaculture ponds, phytoplankton, Muhuri project

1. Introduction
Phytoplankton plays a central role in the structure and functioning of freshwater ecosystems [1] serve as food and maintain the biological balance along with the quality of the water [2]. Aquatic life forms also figure on them for their survival as they nearly produce half of all the oxygen available in water and in the atmosphere [3]. They form the aquatic food chains and represent the productivity [4] as well as the biological wealth of the water body [5]. In most cases, multiplications of phytoplankton enhance the fish production [6]. However, in some situations, algal blooms can have a negative effect, causing severe economic losses to aquaculture operations [7]. Maintaining a stable relationship among the water quality, cultured species, and microscopic community in commercial aquaculture ponds is a great challenge while natural carrying capacities are exceeded [8]. Thus planktonic study is very useful tool for the assessment of water quality in any type of water body and also contributes to an understanding of the basic nature and general economy of concerned habitats. The commercial fish pond ecology and phytoplankton community study is vital for effectively manage such artificially dense pond system for the successful aquaculture operations [8].

2. Materials and methods
2.1 Study area
Muhuri project located in Mirsharai upazilla of Chittagong district is a large freshwater ecosystem with an area of about 300-350 acres. It started primarily with the aim to support irrigation in 1978 and ended in 1986, and now it is under commercial aquaculture [9]. The present study is designed to perceive the phytoplankton status of the project area, which may help to manage the pattern of fertilizer and feed use in the culture pond to minimize cost as well as to maximize productivity and profit. The study was carried out in two tilapia-carp poly culture ponds, in the Muhuri project area, Mirsharai, at latitude 22039´N-22059´N and longitude 91026´E-91038´E. There were two types of water sources in the selected site, river water in the month of October to April from three rivers namely Feni, Muhuri, Kalidaspahalia and ground water in the rest of the year. Muhuri project is largely a freshwater environment lesser extent of brackish water intrusion during October to April around 2 ppt salinity. The stocking density of the culture pond was 20,000 Tilapia (*Oreochromis niloticus*, GIFT monosex strain) and 1,000 Indian major carp and Chinese carps as 500 Rui (*Labeo rohita)*, 300 Mrigel (*Cyprinus mrigala)*, 100 Catla (*Catla catla)* and 100 Calbasu (*Labeo calbasu*) in per acre water area. Both the ponds were treated with fertilizer before stocking and artificial balanced formulated diet was given as required regularly.

2.2. Data collection
Samples were collected in three seasons, post-monsoon (December 2014), pre-monsoon (March 2015) and monsoon (August 2015). Water samples were collected in 2.5 L plastic bottles for qualitative and quantitative analysis of phytoplankton. Sampling was done between 10:00 am to 12:00 pm from the surface water. Water samples for the phytoplankton analysis were fixed with 2% neutralized formalin [10] and brought to the laboratory for further analysis. In the laboratory, concentration of phytoplankton in the samples were increased by general decreasing of water from different size of cylinders (2.5 L, 1000 ml, 500 ml, 100 ml, 50 ml) of course after settlement for at least 24 hours at each phase. Siphoning with medical saline pipe accomplished the whole procedure. At the end of the last phase of settlement at 30 ml by careful filtration and decantation according to [11] and

taken into plastic Jar.

2.3. Data analysis

The phytoplankton 's were identified under a light microscope at 10×10 with bright field and phase contrast illumination on samples preserved with formalin. Identification of different organisms was undertaken with the help of keys given by [12-17]. The quantitative enumerations of phytoplankton were carried out with the help of a Sedgewick Rafter (S-R) counting cell under a light microscope. This S-R cell was washed with water and dried properly. Then 1ml of concentrate was taken into the Sedgewick Rafter counting cell. After pouring the sample counting chamber was covered with a cover slip in order to eliminate the air bubbles and left to stand for a few minutes to allow the plankton settle down. To achieve a random sampling each time fields were examined for each sample and an average of the counts had been recorded. The organisms thus counted were expressed as cells per liter (cells/L). The percentage compositions of phytoplankton were calculated. The abundance of phytoplankton were calculated according to the formula, $N = \frac{A \times 1000 \times C}{V \times F \times L}$ [18]. Where, N=Number of phytoplankton in cells per litter, A=Total number of plankton counted, C=Volume of final concentrate of samples in ml, V= Volume of a field in ml, F=Number of the fields counted and L=Volume of original water in L.

3. Results & Discussion

In the present study, 40 phytoplankton genera were identified under 10 classes (Table 1) of which Chlorophyceae belongs to 9 genera, Zygnematophyceae (7), Trebouxiophyceae (6), Bacillariophyceae (5), Cyanophyceae (5), Euglenoidea (4), Chrysophyceae (1), Dinophyceae (1), Tentaculata (1) and Ulvophyceae belongs to 1 genera. Their abundance and population density are shown in Table 1.

Table 1: Details of phytoplankton genera identified.

Class	Genera	Concentration (cells/L) in lacs (100,000)	Relative % of concentration
Chlorophyceae	*Scenedesmus* (2)	296	16.11
	Golenkinia (5)	125	6.80
	Hyaloraphidium (11)	51	2.78
	Pediastrum (12)	43	2.34
	Ooedogonium (17)	30	1.63
	Monoraphidium (19)	20	1.09
	Eudorina (23)	12	0.65
	Tetraedron (36)	1	0.05
	Ankistrodesmus (36)	1	0.05
Zygnematophyceae	*Spirogyra* (3)	143	7.78
	Pleurotaenium (9)	61	3.32
	Gonatozygon (14)	37	2.01
	Closterium (18)	28	1.52
	Cosmarium (29)	6	0.33
	Hyalotheca (31)	6	0.33
	Zygnema (35)	6	0.33
Trebouxiophyceae	*Gloeotila* (4)	125	6.80
	Cruicigenia (8)	61	3.32
	Actinastrum (20)	18	0.98
	Oocystis (25)	12	0.65
	Dictyosphaerium (30)	6	0.33
	Micractinium (36)	1	0.05
Bacillariophyceae	*Cyclotella* (1)	297	16.17
	Nitzschia (7)	81	4.41
	Melosira (15)	36	1.96
	Cymbella (22)	12	0.65
	Gyrosigma (36)	1	0.05
Cyanophyceae	*Anabaenopsis* (16)	32	1.74
	Anabaena (21)	14	0.76
	Microcystis (24)	12	0.65
	Nostoc (32)	6	0.33
	Planktothrix (36)	1	0.05
Euglenoidea	*Euglena* (6)	111	6.04
	Strombomonas (26)	12	0.65
	Trachelomonas (27)	12	0.65
	Phacus (13)	43	2.34
Chrysophyceae	*Synura* (34)	6	0.33
Dinophyceae	*Peridinium* (33)	6	0.33
Tentaculata	*Chlorella* (10)	60	3.27
Ulvophyceae	*Chaetomorpha* (28)	6	0.33

In the 2nd column position of each genera on the basis of concentration is given in parentheses.

This result resembles with the findings of [6] where 39 phytoplankton genera were identified in two culture ponds of Mymensingh, Bangladesh, there were Bacillariophyceae (8), Chlorophyceae (16), Cyanophyceae (10), Euglenophyceae (3) and Dinophyceae (2). The total phytoplankton genera found in the present investigation is also in agreement with [19], where 27 genera and 45 phytoplankton species of Cyanophyceae (30), Chlorophyceae (7), Bacillariophyceae (5) and Euglenophyceae (3) from four aquaculture ponds of Mymensingh, Bangladesh were enlisted. Akhter [20] enlisted 42 phytoplankton genera of Bacillariophycota (28), Volvophycota (7), Dinophycota (2), Cyanophycota (4) and Euglenophycota (1) in the brackish water body of Cox's Bazar district, Bangladesh. Present research also pointed out that, especially in the dry season, slight brackish water body of Muhuri Project area (2 ppt salinity) also reveals the identical outcomes with the above mentioned work. Hoque[21] inscribed 38 genera of phytoplankton belonging to Bacillariophyceae (9), Cyanophyceae (7), Euglenophyceae (2), Chlorophyceae (20) in *Amblypharyngodon mola* monoculture fish pond of Mymensingh, Bangladesh for a period of four month from July to October, which is comparable with the present findings.

The Chlorophyceae constituted the largest group in terms of genus diversity and makes up 22.5% of the total genus found. The average population density of Chlorophyceae in the culture pond has been found 5111×10^3cells/L. Present findings agreed with the findings of [21]. Begum [22] reported Chlorophyceae as a dominant group in a large pond receiving effluents from two textile industries. Chlorophyceae was the first dominant group in respect to the number of genera and second in respect to the abundance among to phytoplankton population. Among 20 genera of Chlorophyceae [21] enlisted *Chlorella, Scenedesmus*, *Tetraedron* and *Stichococcus* to be the most dominant.

In the present study concentration of cyanophyceae was found 1300×10^3 cells/L. This is in agreement with the findings of [20]. Cyanophyceae was correlated with high concentration of organic matter and nutrients. She found 4 genera of cyanophyceae and *Anabaena, Gloeotrichia, Nostoc* and *Oscillatoria* were common genera in the Fari Khal area of Cox's Bazar. Blue-green algae were the most dominant group among the microalgae and maintained their dominance through the study period, which agreed with the findings of [19]. Cyanobacterial blooms are due to a combination of interacting factors. High temperature together with increased nutrient loading into the water bodies has been considered the most important environmental factor that controls the dominance of Cyanophytes [23].

The concentration of Dinophyceae was found 600×10^3 cells/L. Akter [20] observed that Dinophyceae prefers oligotrophic water, *Peridinium sp.* and *Gymnodium sp*. were common in the Fari Khal area of Cox's Bazar. The concentration of Euglenoidea was found 4450×10^3 cells/L. Affan [19] found 3 genera of Euglenophyceae named of *Euglena, Phacus* and *Trachelomonas* were found. Hoque [21] found *Euglenophyceae* were to be represented mainly by the genera of *Euglena* and *Phacus*. They were unable to exhibit their dominance over other algal groups that might be due to higher grazing pressure and different environmental conditions. The concentration of Chrysophyceae, Tentaculata, Trebouxiophyceae and Ulvophyceae were 600×10^3 cells/L, 6000×10^3cells/L, 4450×10^3 cells/L, 600×10^3 cells/L respectively. The Zygnematophyceae constituted the second largest group in terms of genus diversity. The average population density of Zygnematophyceae in the culture pond has been found 4100×10^3 cells/L where *Spirogyra* occurred most frequently. The water sources of the studied ponds were river in the month of October to April and ground water in the rest of the year, water quality parameters observed are represented in Table 2.

Table 2: Water quality parameters.

Parameters	Range
water depths (m)	1.5 - 2
transparency (cm)	20 - 35
Temperature (^{0}C)	17 - 34.09
salinity (ppt)	1 - 2
soil pH	6.7 - 7
water pH	7.5 - 8.5
hardness (mg/L)	180 - 190
ammonia (mg/L)	0.25 - 0.5
Iron (mg/L)	11.14
NO_2-N (mg/L)	0.12

Physical and chemical parameters mainly temperature, intensity of stratification, light and nutrient availability have a controlling effect on the phytoplankton dynamics in fresh water system (Pannard *et al.* 2007). Phytoplankton varies considerably in distribution with respect to different seasons, nutrient and pollution loads.

4. Conclusion

The concentration of Bacillarophyceae was found as densely populated (8540×103 cells/L), class in the investigated area, followed by Tentaculata (6000×103 cells/L), Chlorophyceae (5111×103 cells/L), Euglenoidea (4450×103 cells/L), Zygnematophyceae (4100×103 cells/L), Trebouxiophyceae (4450×103 cells/L), Cyanophyceae (1300×103 cells/L), Ulvophyceae (600 ×103 cells/L), Chrysophyceae (600×103 cells/L), and Dinophyceae (600×103 cells/L) respectively. Among 40 genera population density of Cyclotella (16.17%) was found most concentrated followed by Scenesdesmus (16.11%).

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