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PLANKTON ABUNDANCE IN RELATION TO PHYSICO-CHEMICAL PARAMETERS: A STUDY ON CARP FISH NURSERY PONDS IN JASHORE, BANGLADESH

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Abstract

The quantity and diversity of plankton communities in the water directly affect the rearing of fish fingerlings. Therefore, the present study was conducted to estimate the abundance and diversity of plankton communities including both phytoplankton and zooplankton in relation to key water quality parameters of carp fish nursery ponds in Chachra, Jashore Sadar, Bangladesh for four months from August to November 2017. Both phytoplankton and zooplankton showed a significant variation during the study period. The most abundant phytoplankton was observed in October, followed by August, November, and September. In total, 12 genera of phytoplankton from 4 different groups, Bacillariophyceae (2), Cyanophyceae (3), Euglenophyceae (3), and Chlorophyceae (4) were recorded. Total 5 major groups of zooplankton containing 20 genera were recorded such as Copepoda (4), Isopoda (1), Cladocera (9), Branchiopoda (3), Rotifera (3), where Cladocera was the most dominant. The results of PCA suggest that phytoplankton abundance is positively associated with PC1, whereas the temperature (0.59) and pH (0.74) are positively associated with PC1, and nitrate (-0.73) and phosphate (-0.64) are negatively associated with PC1. Alkalinity (0.84) and hardness (0.87) are positively, and nitrite (-0.56) is negatively associated with PC2. The zooplankton abundance is associated with neither PC1 nor PC2 rather it is associated with PC3, where DO (0.56) is positively associated. The present study revealed that plankton abundance could vary with physico-chemical parameters of fish nursery ponds.

Keywords: Phytoplankton, Zooplankton, Water quality, Nursery ponds, Bangladesh

Introduction

The fisheries sector plays a vital role in nutrition supply and employment generation as well as foreign exchange earnings in Bangladesh. It contributes 2.43% to the national GDP, 22.14% to agricultural GDP, and fish supplements more than 60% of our daily protein intake (DoF, 2023a). Among various aquaculture species, carps contribute a lot to meet the domestic protein demand. Generally, the success of carp aquaculture production is primarily reliant on the continuous and timely supply of high-quality fish seed. Once, the demand for carp seed for carp aquaculture operations in Bangladesh was fulfilled from different rivers as the major natural sources causing huge biodiversity loss (Ahamed et al., 2012). Later, a good number of hatcheries have been established in various regions of the country to fulfill the present demand and for considering future potentials as well as sustainable development of the fisheries sector. At present, there are about 110 government hatcheries and 874 private hatcheries in Bangladesh which meet the carp seed demands (DoF, 2023a). Besides, there are 136 government nurseries and 13,749 private nurseries to rear the intermediate stage of hatchery-produced hatchlings before stocking them in the culture ponds (DoF, 2019).

The rearing of the early stage of fish is largely dependent on the abundance of plankton communities in nursery ponds. In general, plankton is the key entity to form the foundation of food chains in aquatic production systems (George et al., 2012; Khatun et al., 2023). They are mostly small, many of them are minute, and their structure can only be seen clearly under a compound microscope. Planktons are classified into two main categories based on their nature namely, phytoplankton and zooplankton. Phytoplankton are microscopic plant entity

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consumed by zooplankton and allows for the transformation of plant matter into animal tissues(McCauley & Briand, 1979; Tan et al., 2004; Timms & Moss, 1984), which then becomes the primary nourishment for higher aquatic animals, including fish, particularly their juveniles. As a result, plankton is one of the major sources of energy flow in fish nursery ponds serving as the primary food source during their larval and later stages (Alfasane et al., 2021; Anton-Pardo & Adámek, 2015; Nunn et al., 2012). Furthermore, phytoplankton plays a vital role in optimizing water quality by effectively maintaining oxygen levels, light regimes, bacterial numbers as well as zooplankton biomass and also assimilates NH_3 generated by fish excretion (Lorenzen et al., 1997).

The energy and material transfer in water bodies is enhanced by the consumption of phytoplankton by zooplankton (Degerman et al., 2018). Environmental and biological factors influence the growth and interaction between phytoplankton and zooplankton in a dynamic process that is controlled by multiple factors. Grazing is one of the most important factors controlling the relationship between the two communities (Aziz et al., 2006). The presence of zooplankton especially cladocerans are reported to give better larval development of carp fish (Singh, 2015). Therefore, plankton contributes mainly to the initial phases of fish development, being indispensable for most species of fish larvae (Soares & Hayashi, 2005).

The physico-chemical parameters of a fish pond can have a significant effect on quality and quantity of plankton(El Gammal et al., 2017; Ghosh et al., 2012) and negatively or positively impact the biota of water bodies that result in certain species of organisms disappearing or reproducing (Amanu, 2015). Therefore, strong knowledge of the pond's topography and its relation with the factors of water quality (such as chemical, physical, and biological) are important for successful aquaculture (Bhatnagar & Devi, 2013). Maintaining water quality for sustainable aquaculture is a priority, therefore, it is important to understand how plankton can vary in nursery ponds due to changes in the aquatic ecosystem. Many studies have been conducted before on the plankton abundance and water quality parameters of fish farms or different ponds in Bangladesh (Affan et al., 2005; Akter et al., 2018; Alfasane et al., 2021; Islam et al., 2008). However, the relationship between plankton diversity and water quality parameters in fish nurseries ponds is not well-established and data on it is scarce. Although the nursery owners prepare ponds and use fertilizer to increase plankton in nursing ponds, they do not have adequate knowledge about the species composition. Therefore, this study aims to explore the variability of plankton abundance based on key physico-chemical variables of water in carp fish nursery ponds.

Materials and Method

Study location and period

This study was carried out in carp nursery ponds at Chanchra, Jashore Sadar, Bangladesh (Fig. 1), where it was summer rainy monsoon to start cool dry winter. Detailed information on nursery management was collected initially with consultation with nursery owners and related officials. A total of 10 carp nursery ponds were randomly selected from the study area and samples were collected one-month intervals for a period of 4 months from August to November 2017. The analytical activities viz., key water quality analysis and plankton estimations were conducted at the Water Quality and Fish Biology Laboratory of Fisheries and Marine Resources Technology (FMRT) Discipline, Khulna University, Bangladesh.

Sample collections

Water samples were collected at the early morning (8.00-9.00 am) from each corner of the selected ponds using two different plastic bottles of 500 ml volume, in which water of one bottle was used for qualitative and quantitative analysis of plankton and water of another bottle was used for determining some physico-chemical properties of water quality parameters. A zooplankton net of 36 cm diameter having a mesh size of 55 µm was used for collecting zooplankton samples from the ponds, while the samples of phytoplankton were collected by a similar net having a mesh size of 25 µm. The method for obtaining both phytoplankton and zooplankton was to sieve 50 liters of water samples from 10 to 12 cm below the surface water level of each pond, pass them through respective mesh nets, and finally accumulated by concentrating them into 25 ml. The accumulated plankton samples (phytoplankton and zooplankton in separate container) were placed in appropriately labeled sample bottles and they were preserved in 4% lugol's solution (25g potassium iodide and 12.5g iodine crystals dissolved in 250 mL distilled water containing 25mL glacial acetic acid). Afterward, the samples preserved in lugol's solution were immediately transferred to the laboratory for plankton counting and identification.

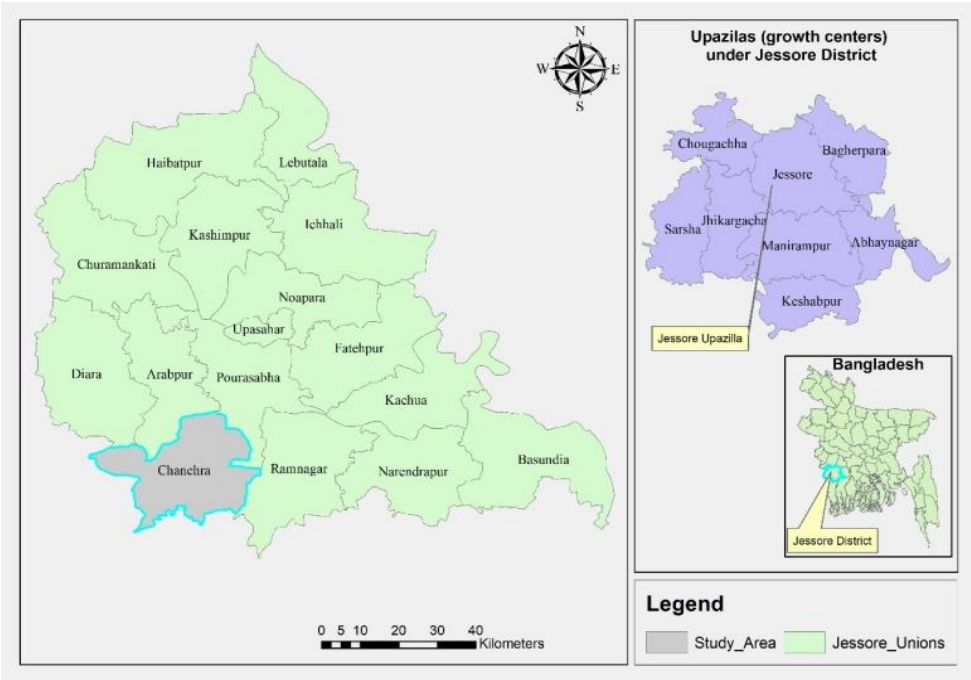

Figure 1. Selected study area for sample collection

Plankton biomass determination

The number of plankton was estimated using a Sedgwick Rafter (S-R) counting cell with a wide-mouth graduated pipette. Before estimating, each of the collected samples was mixed smoothly and one ml from the sample was placed in the S-R cell. The S-R cell was then placed under a microscope and the number of plankton (abundance) was estimated by counting numbers per focus of the microscopic field. Plankton was counted following the formula as: "no/ml = " "C ×1000 mm3" /"L ×D×W×S" ; where C is the number of individual organisms counted; L is the strip's length of S-R cell length in mm; D is the strip's depth (whipple grid image width) in mm; W is the strip's width in mm; S is the strip's number counted. Plankton taxa were identified according to dichotomy identification keys for phytoplankton and zooplankton by an experienced person.

Water quality parameters

Key physico-chemical parameters of water quality in fish nursery ponds such as temperature, pH, dissolved oxygen (DO), alkalinity and hardness, phosphate (PO4), ammonia (NH3), nitrate (NO3), and nitrite (NO2) were determined from the collected water samples. A digital thermometer (AME-K, UK) and a pH meter (DPH 2, Atago, Japan) were used for determining water temperature and pH, respectively. DO, alkalinity and hardness, PO4, NH3, NO3, and NO2were measured according to APHA (1985). DO was measured by Winkler methods, while alkalinity and hardness were determined by using the neutralization titration process and complex metric titration (EDTA titration), respectively. Phosphate was determined by the ascorbic acid method. Ammonia was measured by the nesslerization method. The nitrate and nitrite of the samples were measured by the ultraviolet spectrophotometric screening method.

Statistical analysis

Firstly, the data were checked for normality using Shapiro-Wilk test. The plankton's abundance data were processed using square root transformation before normality test. To determine differences of monthly water quality data and plankton's abundance of the ponds, analysis of variance (ANOVA) was performed followed by Turkey's multiple comparison tests. Pearson correlation and principal component analysis (PCA) were performed to analyze the relationship between plankton and key water quality parameters. The ANOVA and correlation analysis were performed using the statistical package for social science (SPSS, version 23.00) and the principal component analysis was performed using the R package "FactoMineR" (Husson et al., 2016) of the statistical programming language R(R Core Team, 2023).

Results

Phytoplankton abundance

The monthly variation of phytoplankton data is given in Fig. 2. The abundance of phytoplankton in October was significantly higher ($p<0.05$) compared to the abundance of both November and September. However, there was no significant difference ($p>0.05$) between the abundance of phytoplankton in October and August.

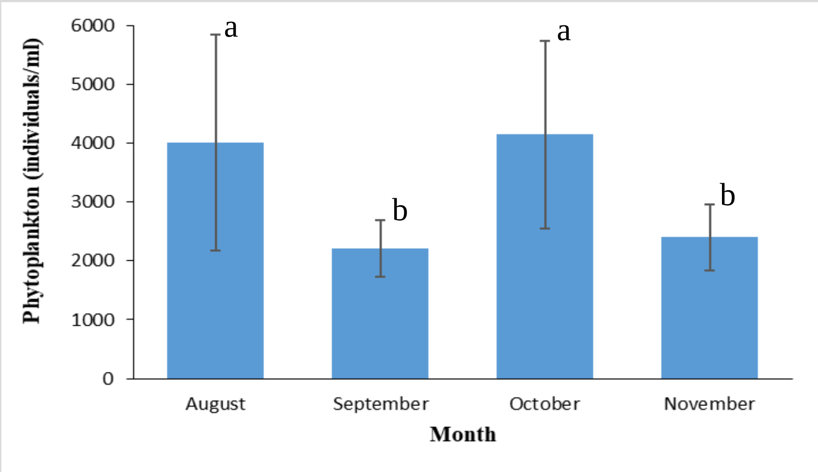

Figure 2. Monthly variations in phytoplankton abundance in fish nursery ponds. Different superscripts on the bar indicate significant differences among the months ($p< 0.05$).

Phytoplankton

A total of 12 genera of phytoplankton belonging to 4 different groups, Bacillariophyceae (2), Cyanophyceae (3), Euglenophyceae (3), and Chlorophyceae (4) were recorded (Table 1). Cyanophyceae was found as the most dominant group followed by Bacillariophyceae, Euglenophyceae, and Chlorophyceae (Fig. 3).

Table 1. Diversity of phytoplankton in fish nursery ponds

Group	Family	Genus	Group	Family	Genus
Bacillariophyceae	Delesseriaceae	*Heteronema, Tolypothrix*	Euglenophyceae	Euglenaceae	*Phacus, Petalomonas, Spondylamourum*
Cyanophyceae	Oscillatoriaceae	*Oscillatoria*	Chlorophyceae	Rabdominidae	*Rabdomonas, Micromonas,*
	Nostaceae	*Nostosolenus, Monoidium*			*Treubaria, Trachelmonas*

The highest number of Cyanophyceae was estimated in November whereas the highest number of Bacillariophyceae was recorded in September. In August, Euglenophyceae was the highest dominant group (Fig. 3).

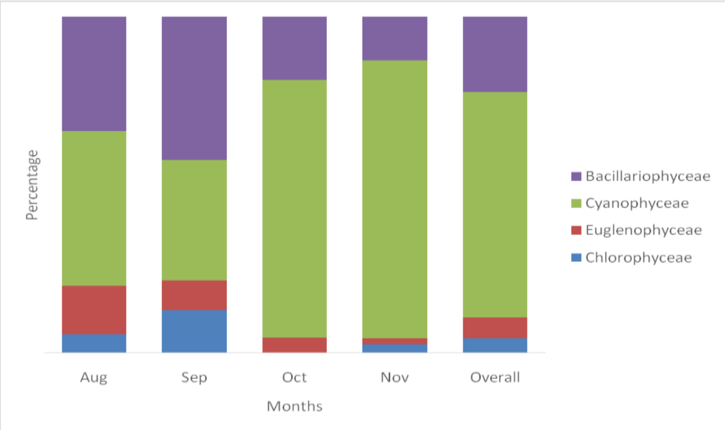

Figure 3. Monthly and overall variations (%) of different phytoplankton groups in fish nursery ponds.

Zooplankton abundance

The monthly variation of zooplankton abundance was displayed in Fig. 4. The results reveal that the zooplankton abundance was significantly different among the months ($P<0.05$). The highest number of zooplankton was recorded in August and the lowest was in November.

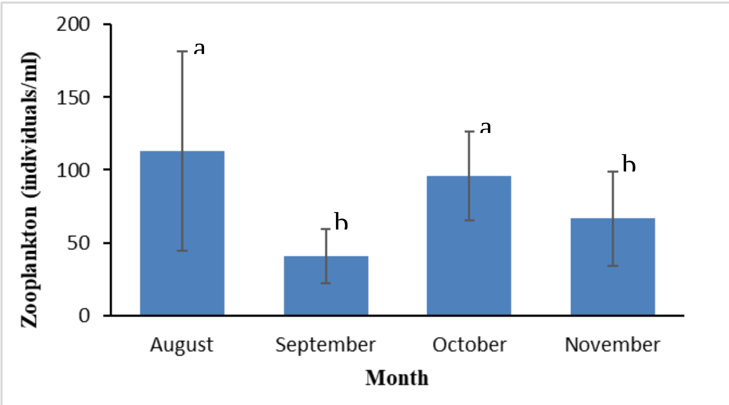

Figure 4. Monthly variations of zooplankton abundance in fish nursery ponds. Different superscripts on the bar indicate significant differences among the months ($p < 0.05$).

Zooplankton

A total of 20 genera of zooplankton belonging to 5 major groups were recorded, Copepoda (4), Isopoda (1), Cladocera (9), Branchiopoda (3), Rotifera (3) (Table 2).

Table 2. Diversity of zooplankton in fish nursery ponds

Group	Family	Genus	Group	Family	Genus
Copepoda	Cyclopidae	*Halicyclops*	Cladocera (continued…)	Daphnidae (continued…)	*Ceriodaphnia, Daphniopsis, Simocephalus*
	Ergasilidae	*Ergasilus*			
	Diaptomidae	*Diaptomus*			
	Canthrocamptidae	*Canthrocamptus*		Cercopagididae	*Parophryoxus*
Isopoda	Cymothoidae	*Lemaea*	Branchiopoda	Leptodoridae	*Leptodoa*
Cladocera	Macrothricidae	*Wlassicsia*		Macrothricidae	*Drepanothrix*
	Cyclopidae	*Cyclops, Eucyclops*		Branchinectidae	*Branchinecta*
	Cyclopinidae	*Mesocyclops*	Rotifera	Testudinellidae	*Filinia*
	Daphnidae	*Daphnia,*		Synchaetidae	*Polyarthra, Pseudoploesoma*

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Among the zooplankton groups, Cladocera was the dominant group followed by Branchiopoda, Rotifera, Copepoda, and Isopoda (Fig. 5). The highest number of Cladocera and Copepoda was recorded in August and September, respectively. Branchiopoda and Rotifera were found higher in number in October and November, respectively (Fig.5).

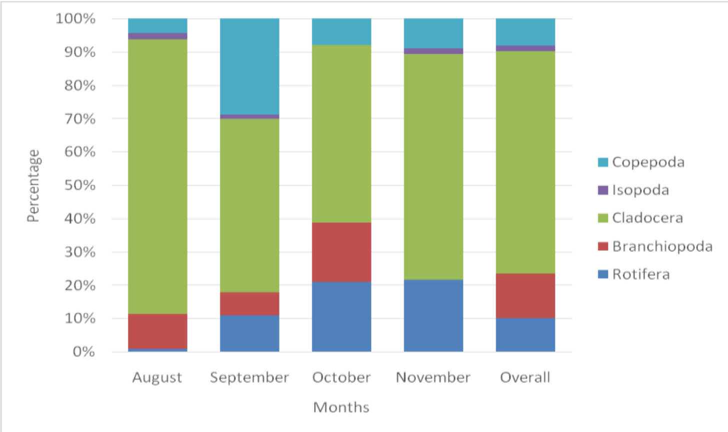

Figure 5. Monthly and overall variations (%) of different zooplankton groups in fish nursery ponds.

Water quality parameters

The variations in different water quality parameters are shown in Fig. 6. The surface water temperature of the selected ponds ranged from 24 to 33°C during the study period and monthly mean values of temperature varied from 25.7±1.16 to 30.7±1.20°C.The statistical analysis revealed that the water temperature in November was significantly lower ($p<0.05$) than the temperature of other months. The pH values fluctuated in a range from 6.8 to 9.7 and the mean values of pH were recorded from 7.68±0.26 to 9.03±0.44.Like temperature, pH in November was significantly lower ($p<0.05$) than the pH of other months. The average DO was varied from 4.2±1.55 mg/L to 6.3±1.81 mg/L and the lowest DO was recorded in August.

The values of alkalinity were varied from 150 mg/L to 450 mg/L and the mean values of alkalinity among ponds were recorded from 265±62.58 mg/L to 350±102.74 mg/L. The hardness fluctuated from 130 mg/L to 410 mg/L. The concentration of PO4 was found from 0.199 mg/L to 3.866 mg/L and the mean values of PO4 varied from 0.21±0.01 mg /L to 2.19±0.81 mg/L. The significantly lowest PO4 was recordedin August.The NO2 concentrations of the ponds varied from 0.004 mg/L to 1.029 mg/L. A significant variation in NO3 concentrations was observed as 0.40±0.32 mg/L to 1.85±1.19mg/L. Like PO4, a significantly lower NO3 concentration was recorded in August ($p < 0.05$). The NH3 ranged from 0.01 mg/L to 0.80 mg/L and the mean values of NH3 among the ponds varied from 0.21±0.15 mg/L to 0.28±0.24 mg/L.

Relationship between water quality parameters and plankton

Table 3 illustrates the correlation between water quality parameters and planktons. Phytoplankton showed inverse relationships with DO, alkalinity, hardness, NO3, PO4, and NH3 whereas temperature, pH, and NO2 had a positive relationship with phytoplankton. Like phytoplankton, zooplankton also exhibited a negative relationship with DO, alkalinity, hardness, NO3, and PO4. Temperature, pH, NO2, and NH3 were positively correlated with zooplankton.

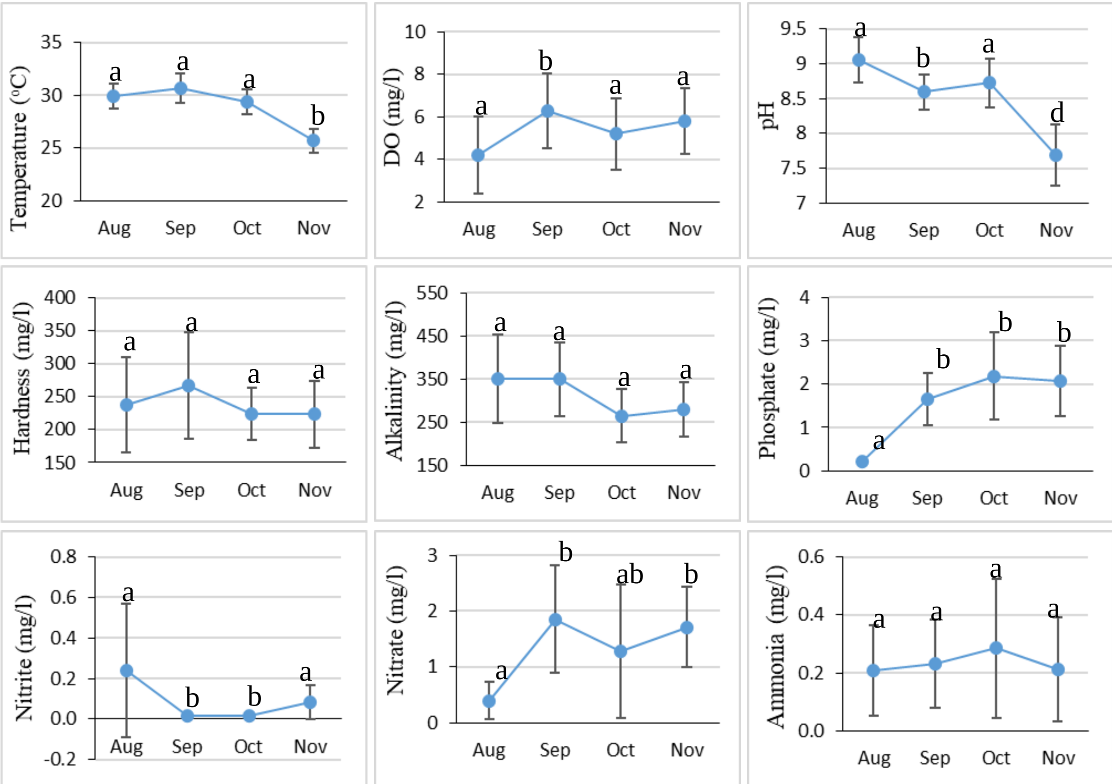

Figure 6. Monthly water quality variation in fish nursery ponds. Different superscripts in each graph represent significant differences at $p < 0.05$.

Table 3. Correlation between water quality parameters and plankton

Parameters	Temp	pH	DO	Alkalinity	Hardness	NO_2	NO_3	PO_4	NH_3	Phyto	Zoo
Temp	1										
pH	0.627**	1									
DO	-0.067	-0.013	1								
Alkalinity	0.245	0.058	-0.336*	1							
Hardness	0.118	-0.019	-0.250	0.748**	1						
NO_2	0.003	0.167	0.102	-0.230	-0.265	1					
NO_3	-0.147	-0.335*	0.275	-0.198	-0.194	-0.317*	1				
PO_4	-0.254	-0.421**	0.210	-0.087	0.176	-0.294	0.404**	1			
NH_3	-0.036	0.033	0.070	-0.141	-0.108	0.057	0.191	-0.014	1		
Phyto	0.224	0.454**	-0.138	-0.109	-0.091	0.155	-0.480**	-0.125	-0.153	1	
Zoo	0.033	0.111	-0.336*	-0.054	-0.107	0.284	-0.115	-0.241	0.046	0.066	1

*Temp: temperature, Phyto: Phytoplankton, Zoo: Zooplankton, DO: dissolved oxygen; **Correlation is significant at the 0.01 level (2-tailed).*Correlation is significant at the 0.05 level (2-tailed).*

Considering the multivariate associations among the physico-chemical parameters of water measured, we performed PCA for both phytoplankton and zooplankton (Fig. 7). The result of PCA analysis showed that 24.59% and 19.65% of the total variance was explained by the first two principal components (PC1 and PC2), respectively.

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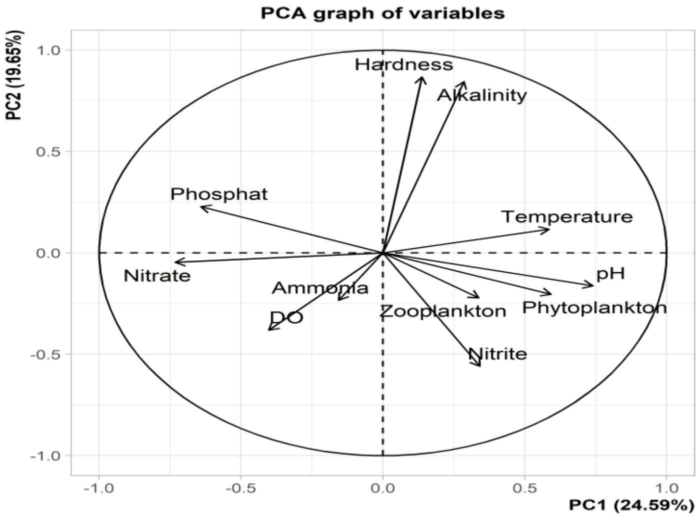

Figure 7. Ordination of planktons with respect to different physico-chemical parameters as tested with principal component analysis (PCA).

The results of PCA also suggest that phytoplankton abundance is positively associated with PC1, whereas the temperature (0.59) and pH (0.74) are positively associated with PC1 and nitrate (-0.73) and phosphate (-0.64) are negatively associated with PC1. Some parameters, such as Alkalinity (0.84) and Hardness (0.87) are positively, and Nitrite (-0.56) is negatively associated to PC2. The zooplankton abundance is associated with neither PC1 nor PC2 rather it is associated with PC3, where DO (0.56) is positively associated.

Discussion

Plankton diversity and abundance are considered as pointers to ecological changes in an aquatic ecosystem. Physico-chemical parameters of water changing over time influence the fluctuations in phytoplankton abundance (Islam et al., 2008). According to Ghosh et al. (2012), the species composition of phytoplankton is influenced by numerous factors, including temperature, light, nutrients, and other limnological factors present in pond water. Moreover, lacking inorganic micronutrients can limit phytoplankton production in a water body (El Gammal et al., 2017). The present study demonstrated both qualitative and quantitative variations in plankton populations during the period of collecting samples. In October, the highest number of phytoplankton was recorded which was significantly higher ($p<0.05$) than the abundance found in both November and September, and no significant difference in abundance was observed between October and August. Therefore, it is anticipated that more favorable conditions for phytoplankton abundance were found in October attaining the highest phytoplankton. This finding was confirmed by the fact that the higher phytoplankton abundance in October was due to recent inorganic fertilization in some nursery ponds before sampling. In accordance with our findings, Mischke and Zimba (2004) and Miah et al. (1999) reported rapid growth of phytoplankton in ponds receiving inorganic fertilizers. The second favorable condition for phytoplankton abundance was found in August. This may occur due to the heavy rainfall during June to July of rainy season which may lead to the accumulation of nutrients from surface runoff, streets, and ground seepage (Affan et al., 2005). The phytoplankton also showed a significant variation in diversity. The variation in the phytoplankton population might be associated with the species compositions in the study period. Total 12 genera belonging to 5 major groups were recorded from August to November. The month-wise distribution of phytoplankton showed that Cyanophyceae was the most dominant group and the highest number was estimated in November. The highest number of Bacillariophyceae and Euglenophyceae was estimated in September and August, respectively. These findings revealed the presence of some stressors resulted in the reduction in the abundance of certain phytoplankton groups.

During the study period, there was also a significant variation in the composition and abundance of zooplankton species. Fish rely heavily on those zooplankton species as food sources, and understanding its abundance and variation is crucial for studying the pond ecosystem. Like phytoplankton, the higher number of zooplankton was recorded in August and October. It was supported by the statement that zooplankton's abundance and diversity are contingent upon the availability of phytoplankton (Aziz et al., 2006) and can be varied with the proper nutrient accumulation during the rainy season. In addition, due to the different feeding habits, the distribution of zooplankton may also be varied with the abundance of different phytoplankton groups. Cladocera had the largest population among the zooplankton groups, with the highest number being recorded in August. This may be occurred because of nutrient accumulation inthe rainy season. Cladocera is nutritionally high valued live food for hatchery and nursery (Anton-Pardo & Adámek, 2015; Singh, 2015).

The physico-chemical parameters of any aquatic system may fluctuate depending on the season, month, or even hourly basis. Temperature is a significant factor that impacts the primary production of a pond. The highest temperature was recorded in September, while the lowest temperature was recorded in November during the study period. The monthly variation of air temperature affects the pond water temperature resulting in a change in temperature value. pH is also a crucial parameter in water quality assessment as it has an impact on many biological and chemical processes in the water body(George et al., 2012).A little alkaline pH was recorded in November (7.68), while a moderately high alkaline condition was found in August (9.05). It was reported that pH 8-8.5 is suitable for maximum phytoplankton growth (El Gammal et al., 2017). In general, during this study period, the ponds had shown a normal range of pH values from 6.8 to 9.7. The variations of pH were occurred due to the fluctuations of photosynthesis activity that depend on the availability of light (Bhatnagar & Devi, 2013). The mean values of DO among the selected ponds ranged from 4.2 mg/L to 6.3 mg/L. During the study period, the lowest DO was recorded in August while the highest was found in September. Lower oxygen concentrations were also observed in a few ponds during the study period because water samples were collected between 8.00 and 9.00 am in the morning. Generally, due to respiration lower oxygen concentrations are estimated in the early morning and higher concentration is found in the afternoon due to photosynthesis (Yao, 1988).

Phosphate (PO4) is an essential plant nutrient that stimulates algal growth (Kaur et al., 2015). In the present study, the lowest PO4 concentration was found in August (0.21mg/L) while the highest was in October (2.18 mg/L). The lowest PO4 concentration in August was supported by the highest phytoplankton production that indicates the increased rate of PO4 uptake. El Gammal et al. (2017) also reported similar findings that observed in the present study. However, this statement was not in accordance with the findings in October, because due to inorganic fertilization in some ponds PO4 was comparatively higher in October. This study revealed that the lowest NO2 concentration was found in October (0.02 mg/L) and the highest was in August (0.24 mg/L). Nitrite (NO2) is present in natural waters only in smaller quantities and it was reported that NO2 concentration in the freshwater pond should not exceed 0.2 mg/L (Bhatnagar & Devi, 2013).Nitrate (NO3) is the major form of nitrogen used by phytoplankton. The higher NO3 concentration favors faster mineralization of organic matter and thereby enhances phytoplankton production (El Gammal et al., 2017; Hepher & Pruginin, 1981). The lowest concentration of NO3 was found in August (0.40 mg/L) and the highest was in September (1.85 mg/L).These findings are also supported by the higher phytoplankton abundance in August and lower abundance in September. Our results indicate that the highest NH3 concentration was found in October. Several factors are responsible to increase the NH3 concentration in pond water such as application of nitrogen fertilizer, organic matter decomposition, use of artificial feed and excretion of waste by fish, etc. (Boyd, 1982).

Increasing water temperature results in a reduction in oxygen solubility (Calliari et al., 2005). In the present study, temperature and DO were negatively correlated (-0.067). El Gammal et al. (2017) observed a negative correlation between temperature and DO in accordance with this study. Increasing temperature coincides with the decomposition of organic matter and detritus resulted in higher oxygen consumption (El Gammal et al., 2017). In this study, the Pearson correlations illustrated a positive relationship between temperature and pH, while a negative relationship was observed between phytoplankton and DO. This correlation attributed to the fact that Cyanophyceae was found to be the most abundant group among other phytoplankton in this study, which might reduce oxygen availability through photosynthesis as reported byEl Gammal et al. (2017). The relationship between phytoplankton with both PO4 and NO3 pointed out the important role of these nutrients for increasing phytoplankton, with a negative correlation being identified between the consumption of these nutrients and phytoplankton growth. A similar relationship between phytoplankton with both NO3 and PO4 was estimated by El Gammal et al. (2017). They also observed a positive relationship between phytoplankton and temperature that is similar to the finding of our study. Likewise, Morais et al. (2003) reported that increasing water temperature may enhance phytoplankton growth and productivity. However, Kebede and Ahlgren (1996) reported that 30oC is the optimal temperature for phytoplankton growth. However, zooplankton had a positive relationship with NH3 concentration while phytoplankton showed an inverse relationship (Table 3). Different planktons may exhibit a diverse relationship with physico-chemical parameters of ponds. These results are similar to principal component analysis (PCA), which clearly separated the parameters in relationship to plankton abundance as presented in two-dimensional plots. The Principal Component 1 (PC1) seems to capture the overall nutrient availability and environmental conditions in the fish nursery ponds. The positive association of PC1 with phytoplankton abundance indicates that higher nutrient levels and favorable environmental conditions promote phytoplankton growth. Conversely, the negative associations of PC1 with nitrate and phosphate suggest that phytoplankton abundance decreases as these nutrients are depleted. The principal component 2 (PC2) appears to represent variations in water quality parameters such as alkalinity, hardness, and nitrite. These parameters may reflect the overall stability and mineral composition of the water, influencing the composition and abundance of plankton indirectly. The positive association of PC2 with alkalinity and hardness suggests that water stability and mineral content positively influence plankton dynamics. The principal component 3 (PC3) showed no direct association with plankton abundance, reflects variations in dissolved oxygen (DO) levels. DO is crucial for the survival of aquatic organisms, including plankton. The positive association of PC3 with DO indicates that higher DO levels are associated with certain conditions that may favor zooplankton abundance (Karpowicz et al., 2020).

Conclusions

Both phytoplankton and zooplankton play an important role in rearing fish in a nursery. The present study revealed that the plankton abundance could vary with months. Both phytoplankton and zooplankton showed a significant variation during the study period. Water temperature, DO, NO3 and PO4 played a significant role in altering the plankton abundance. The variations of plankton might be an indicator of nutrient availability in the fish nursery ponds. The findings of this study could serve as a baseline for the development of better fish nursery management practices. Further research would be conducted to explore the effects of specific nutrient concentrations on plankton communities or assessing long-term trends in plankton dynamics by sampling several times in a month for better understanding of water chemistry in nursery ponds.

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Conflict of interest

The authors declare that they have no conflict of interest.

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