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Seasonal abundance and diversity of zooplankton in semi-intensive shrimp farm of Bangladesh

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ABSTRACT

The present study was carried out on the seasonal abundance and diversity of zooplankton in a semi-intensive shrimp farm of Bangladesh from June to December 2022. The abundance of zooplankton was affected by physico-chemical parameters, specifically temperature, salinity, pH, transparency, dissolved oxygen, free carbon dioxide, and alkalinity. The water quality was mainly influenced by temperature and salinity. The studied farm showed water temperature and salinity fluctuation ranging from 25 to 29°C and 6 to 15 ppt, respectively. Transparency varied from 20 to 24 cm. The maximum dissolved oxygen (5.83 mg/l) and free carbon dioxide (12 mg/l) was recorded in November and June while the minimum in June and September. The value of pH varied from 7.0 to 7.8 and alkalinity from 150 to 266.65 mg/l. In the present study, 5 groups (rotifer, copepod, Cladocera, ostracoda, and crustacean larvae) of zooplankton were observed. The culture system consisted of different kinds of zooplankton, with copepod, rotifer, Cladocera, Ostracoda, and crustacean larvae accounting for 52%, 39%, 7%, 1%, and 1%, correspondingly. Copepods accounted for the majority (52%) of the zooplankton population. There were two distinct maxima seen in August (833 individuals/l) and October (815 individuals/l). The presence of rotifer and copepod was seen throughout the year, however the ostracod genus Cypris was exclusively detected in the month of August. The study area revealed the presence of three copepod genera: Diaptomus, Cyclops, and Mesocyclops. Among these, Diaptomus and Mesocyclops were the more prevalent species. Additionally, four genera were identified within the rotifer and Cladocera groups: Brachionus and Filinia in the rotifer group, and Daphnia and Diaphanosoma in the Cladocera group.

Introduction

Bangladesh, the eighth most populous nation, suffers from protein deficiency. People must fight against malnutrition. Bangladeshis rely on fish for protein. Fish and fisheries are crucial to our economy. Many are actively or indirectly involved in prawn fishing. Shrimp production is declining due to diseases like white spot virus and poor management. We're in traditional culture but in some places semi-intensive culture system is practiced thus we can increase prawn production.

Semi-intensive culture involves external nutrition, increased stocking densities, fertilization, moderate water exchange, regular pond monitoring, and moderate fish biomass and yields (Pillay 1990). The growth of shrimp not only depends on the supplementary but also natural feed. Planktons play an important role in aquaculture. Planktons are tiny organisms that serve as the foundation of food chains and food webs in all aquatic habitats. It is a massive group of aquatic organisms that float on water due to the movement of water. The majority of these organisms are microscopic in size, requiring the use of a compound

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microscope to observe their intricate structure. However, there are a few exceptions to this, including certain larger creatures such as specific medusae (*Chynea, Physalia*, etc.), heteropods (*Pterotrachea*), and tunicates (*Pyrosoma*). Though they are from different taxa, they have one thing in common: they can't move quickly because they don't have strong locomotory organs like fish fins. Instead, they can only float on the water, letting waves and currents move them around and they can't mob anywhere like fish do (Zheng 1984).

Phytoplankton and Zooplankton are the primary categories of plankton. Zooplankton feed on Phytoplankton and exert a direct influence on the growth of carnivorous fish, namely prawns. Zooplankton is an essential food source for fish that eat both plants and animals, as well as fish that only eat other animals. Zooplankton contributes about 23% of the food item of *Penaeus monodon* (Alam et al. 1987). Fish larvae, particularly shrimp, mostly consume zooplankton as it provides the essential protein needed for their rapid growth (Bardach et al. 1972). Growth and variety of plankton also impact the viability and rate of development of cultivated fish. Their plentifulness and variety have a significant influence on the culture system by upholding the oxygen levels in the water, maintaining a balance between oxygen and carbon dioxide, promoting the breakdown of organic matter in the pond, preventing the growth of microalgae and pests at the bottom of the pond, stabilising the temperature of the water, regulating the pH levels, and reducing fluctuations in water quality (Das and Bhuiyan 1974).The correlation between the physico-chemical parameters and plankton production in water, as well as their monthly changes, is crucial for fish culture and fisheries management. The composition and quantity of plankton, as well as their fluctuations and seasonal abundance, are strongly influenced by water characteristics. The specific elements affecting water quality change depending on the season (Zafar 1964).

The growth, maturity, and development of shrimp are significantly influenced by several environmental conditions that define the characteristics of water. The relationships between the fishes and their biotic and abiotic (elements) environment is not as isolated phenomenon but changes in one may reflect on the other effectivity. Fish depends heavily on water temperature, pH, dissolved oxygen, free CO_2, alkalinity, and other salts for their growth and development (Nikolsky 1963). Any changes of these parameters may affect the abundance of plankton which indirectly affects the growth, development and maturity of shrimp (Nikolsky 1963; Jhingran 1985).

Bangladesh is lagging far behind in total fish production in comparison with other countries of the world. A satisfactory understanding of aquatic lives requires knowledge of the organisms and external influences which directly or indirectly affect them. The physico-chemical characteristics feature of the waterbodies is needed to be determined for better production of the biota there in. For the development of fisheries and to enhance current production levels, it is crucial to implement proper and scientific management practices that take into account water quality and natural productivity. The present study focused on a semi-intensive culture farm specifically dedicated to *Penaeus monodon*. The major objectives of the study were to be known the abundance and diversity of zooplankton in the culture system and find out the relationship between zooplankton community and different water quality parameters.

Materials and methods

Sampling station and period

The present study focused on a semi-intensive Shrimp farm located near Bagerhat town in Bagerhat district. The farm is located within the geographical coordinates of 22°36' to 22°46' north latitude and 89°40' to 89°50' east longitude (Fig. 1). The location of the farm is situated by the Bhairab river. The object has a roughly rectangular shape, with a surface area about 4100 square meters and a depth of 3 meters. A sluice gate connected the farm to the river, allowing coastal water to flow into the farm via a canal. The water and zooplankton samples were collected at 10.30 am at one month interval from June to December, 2022. The samples were collected from the surface region of the shrimp farm, as there was a high concentration of phytoplankton at the surface, which the zooplankton relied on.

Measurement of physicochemical parameters

During the study time, many physicochemical parameters were measured, including temperature, transparency, pH, free carbon dioxide (CO_2), dissolved oxygen (DO), alkalinity, hardness, and salinity. The water temperature was determined using a mercury thermometer with a range of 0 to 50° Celsius.

The thermometer was submerged in the surface water for a duration of one minute. Subsequently, the thermometer was elevated and the temperature was determined by viewing the centigrade scale. Salinity was quantified using a portable refractometer. In order to assess the water transparency, the Secchi disc was submerged into the water until the disc's color became distinctly visible. The lack of distinct color definition in the disc was due to the water's transparency. To quantify the amount of free carbon dioxide, we obtained a water sample from the surface and employed the titrimetric method. This involved using 0.1 N sodium hydroxide (NaOH) solutions and phenolphthalein as an indicator (Welch 1948). During this process, we measured the concentration of free carbon dioxide in the water. In order to measure additional parameters, we obtained an additional bottle of water. The sample was relocated to the chemical laboratory at Khulna University, where several parameters were examined using different methods. For instance, the pH was determined using a benchtop electrometric pH meter. The concentration of dissolved oxygen in the water was determined using the titrimetric method, employing a standard solution of 0.025 N sodium thiosulfate ($Na_2S_2O_3$). The alkalinity of the water sample was measured by titrating 10 ml of the sample with 0.1 N sulphuric acid (H_2SO_4), using methyl orange as an indicator. The water's total hardness was determined using the titrimetric method, employing standard EDTA.

Plankton collection, preservation and identification

The plankton collection was done using a conical-shaped monofilament nylon net, also known as a Plankton net. The plankton net had a mesh size of 90 µm and a mouth diameter of 30 cm. 60 liters of pelagic water from 6 distinct areas of the farm were filtered through a plankton net using a 5 liter plastic container. The water was filtered through the net, causing the plankton to gather at the bottom of the net. The concentrated plankton was then collected in a glass test tube and securely preserved (Welch 1948). The plankton materials were put into glass flasks and stored with Lugol's solution after being collected. Approximately 250 milliliters of plankton samples were treated with 1.5 milliliters of Lugol's solution for preservation. After preservation, the plankton samples were delivered to the biology laboratory of Fisheries & Marine Resource Technology Discipline, Khulna University for further analyses.

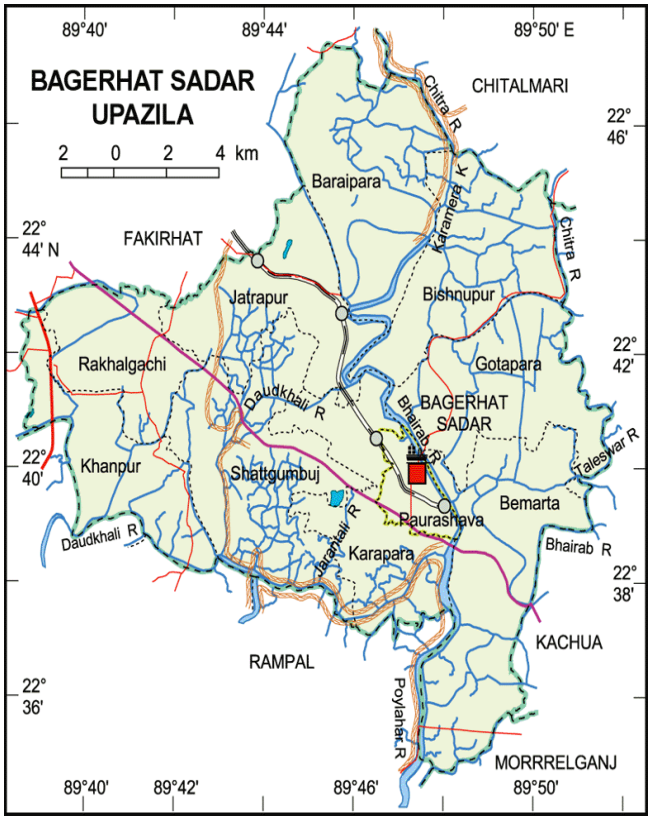


Fig. 1. Map of Bagerhat Sadar upazila and location of the study area. (Source: Banglapedia)

The measurement of plankton cells was conducted using a Sedgwick-Rafter cell under a light microscope. Identifying species requires expertise and practical knowledge. Consequently, a collection of pencil and ink drawings on postcards representing the identified species was created to facilitate the identification of the zooplankton. The identification process was conducted by using the methodologies outlined by Todd and Laverack (1991) and Charles (1955).

Classifications and identifying characters of observed zooplankton

Zooplanktons were identified by the characteristics given by different scientists. *Mesocyclops* and *Cyclops* were identified by using the characteristics given by Todd and Laverack (1991) while *Diaptomus, Daphnia, Diaphansoma, Filinia, Brachionus and Cypris were* identified according to Charles (1955). Characteristics of zooplankton according to different scientists are given below.

Phylum: Arthropoda

Class: Crustacea

Order: Cyclopoida

Family: Cyclopoidae

Genus: *Mesocyclops*

Key to the genera: The organism shows a distinct visual appearance, featuring a slender cephalosome that carries four unattached thoracic segments and short, densely covered antennae. The sixth thoracic segment, exhibits a somewhat rounded shape and bears two prominent lateral spines on either side (Todd and Laverack 1991).

Phylum: Arthropoda
Class: Crustacea
Order: Cyclopoida
Family: Cyclopoidae
Genus*: Cyclops*

Key to the genera*:* The articulation is present between the cephalosome and urosome, rather than between the sixth thoracic and first abdominal segments. Instead, it is located between the fifth and sixth thoracic segments. Cyclopoids exhibit a long and slender urosome, and their antennules are often shorter than those of calanoids (Todd and Laverack 1991).

Phylum: Arthropoda
Class: Crustacea
Order: Calanoida
Family:Diaptomidae
Genus: *Diaptomus*

Key to the genera: The genus *Diaptomus* is characterized by the beautifully streamlined torpedo-shaped cephalosome, five free thoracic segments and extremely long antennules, which bear three large setae two backward and one forward pointing at their tips (Charles 1955).

Phylum: Arthropoda
Class: Crustacea
Order: Cladocera
Family: Daphnidae
Genus: *Daphnia*

Key to the genera*:* The dimensions of the object are smaller than three millimeters. The head armour is extended dorsally and compressed laterally. The dorsal body wall consists of folds that envelop the body and limbs on each side, resembling a bivalve shell. Nevertheless, the head remains exposed and unrestricted. The valves of the shell are securely fused dorsally, and there is no hinge present (Charles 1955).

Phylum: Arthropoda
Class: Crustacea
Order: Cladocera
Family: Sididae
Genus: *Diaphanosoma*

Key to the genera*:* The body is elongated and has a transparent open valve. The eye pigment is black and fills the end of the head. The color appears to have a slight yellowish hue. There is no roster available. The reflexed antenna does not extend to the posterior edge of the valve. A claw located behind the abdomen, characterised by the presence of spines at its base. There are no anal spines (Charles 1955).

Phylum: Arthropoda
Order: Ostracoda
Family: Cypidae
Genus: *Cypris*

Key to the genera: They have a single eye and the two are most easily distinguish from each other by the structure (Charles 1955).

Phylum: Rotifera
Class: Monogononta
Order: Ploima
Family: Brachionidae
Genus*: Brachionus*

Key to the Species: The anteromedian spines possess a wide base, while posterior spines are frequently observed. The lorica is smooth and translucent, giving the appearance of a single unit (Charles 1955).

Phylum: Rotifera
Class: Monogononta
Order: Floscullariaceae
Family: Filinidae
Genus*: Filinia*

Key to the Species: Has spine lets on the bristles in the summer in the Great Lakes. (Charles 1955).

Counting

The zooplankton was quantitatively assessed with a Sedgwick-Rafter (S-R) counting cell measuring 50 mm in length, 20 mm in breadth, and 1 mm in depth. Before inserting the sample into the S-R cell, the cover glasses were placed diagonally on top of the cell. The samples were thereafter transferred using a wide bore pipette to prevent the formation of any air bubbles in the cell coverings. The S-R cell was left undisturbed for at least 15 minutes to allow the zooplankton to settle. The plankton situated at the base of the S-R cell was enumerated utilizing a compound microscope. The entire lower portion of the slide area was comprehensively examined by manipulating the mechanical stage. To get a random sample, three fields were examined for each sample, and the totals were

Table 1. Feeding rate with growth performance in semi-intensive shrimp farm of Bangladesh

Month	Age (Days)	Feed (Kg/ha)	Weight (g)			Growth rate (g/month)
			Minimum	Maximum	Average	
June	38	CP-3 (19)	5	8	7	-
July	53	CP-4 (12)	11	15	13	6
August	85	CP-4 (17)	16	22	19	6
September	117	CP-4 (29)	20	26	23	4
October	145	CPS (43)	23	29	26	3
November	178	CP-5 (49)	24	32	28	2

averaged and documented. The quantified organisms were expressed as the cell count per liter of the sample. In order to guarantee random counts, a total of 30 cell counts were performed on 3 slides for each sample, and the resulting average count was recorded. The abundance of zooplankton in the S-R cell was determined using the following equation-

$$\text{No/ml} = \frac{C \times 1000\ \text{mm3}}{L \times D \times W \times S}$$

where, C = number of organisms counted; L = length of each strip (S-R cell length) in mm; D = depth of a strip (Whipple grid image width) in mm; W = width in mm, S = number of strips counted. The number of cells per mm was multiplied by a correction factor to adjust the number of organisms per liter (APHA 1976).

Statistical analyses

Using the SPSS and Microsoft Excel program, correlation and regression analyses were performed between a variety of water quality parameters and abundance.

Results

Physical conditions of the farm

The shrimp farm was situated beside the Bagerhat town in Bagerhat district. Here semi- intensive culture was practiced during the study period. The shrimp farm was more or less rectangular in shape with a surface area of 4100 m^2 and a depth of 3 meter which varied slightly throughout the year due to rise and fall of the water level. It was joined with the river Bhairab by a sluice gate so that the coastal water could enter into the farm by a canal but occasionally. At first the river water entered into the reservoir tank then after treatment the water was allowed to enter into the cultured farm. There was an out late for passing out of excess water from the farm. High banks of the farm were covered with a carpet of grass. The farm received direct sunlight throughout the day. Zooplankton, fish and different water quality parameters were measured in the farm. The water of the pond was clear and no bloom sighted during the period of the study. As it was a semi-intensive culture system different physiological condition of the farm such as water temperature, transparency, pH, free CO_2, alkalinity, DO, salinity was measured. Liming was done when it was necessary. Artificial feed was also used. Generally, CP feed was used. It is mentioned that no chemical was used in the farm. The growth of the fish was checked regularly.

Feeding rate and growth

During study period the feeding rate and feeding frequency of the culture system was recorded. Mainly CP feed was used. This showed that maximum feeding frequency (4 times) was in August and minimum (1 time) in June. The range of the given total amount of feed per time was 19 kg/ha to 49 kg/ha. Growth of the individual was also measured during the study period at monthly interval. Maximum weight was found as 32 gm. The study showed that the maximum growth rate (6 gm/month) was in July and August while minimum growth rate (2 gm/month) was in November (Table 1, Fig. 2).

Physico-chemical parameters

The physico-chemical parameters such as temperature, transparency, pH, free carbon dioxide (CO_2), dissolve oxygen (DO), alkalinity and salinity were measured during the study period (Table 2).

Water temperature: Temperature of water of the farm showed considerable variations throughout the study period. The maximum water temperature was

recorded as 29°C in June and minimum was recorded as 25°C in December.

pH: The hydrogen ion concentration or pH of the farm was measured during study period. The pH value of water ranged from 7.0 to 7.8. The maximum pH value was 7.8 in the month of November and minimum in the month of June.

Free CO_2: Free CO_2 content was determined at monthly interval. Monthly variations were also noted. Free CO_2 of water ranged from 6 mg/l to 12 mg/l. The maximum free CO_2 value was in the month of June and minimum in the month of September.

Table 2. Minimum and maximum values of different water quality parameters in semi-intensive shrimp farm of Bangladesh

Parameter	Minimum	Maximum
Water temperature (°C)	25.0	29.0
pH	7.0	7.8
Free Carbon dioxide (mg/l)	6.0	12.0
Dissolve Oxygen (mg/l)	3.3	5.83
Alkalinity (mg $CaCO_3$/l)	150.0	266.65
Salinity (ppt)	6.0	15.0
Transparency (cm)	20.0	24.0

Dissolved Oxygen (DO): The dissolved oxygen (DO) concentration of the farm ranged from 3.3 mg/l to 5.83 mg/l. The maximum DO value was in the month of November and minimum in the month of June.

Alkalinity: It was calculated at monthly interval during study period. Monthly variations were also noticed. The alkalinity of water ranged from 150 to 266.65 $CaCO_3$ mg /l. The maximum alkalinity value was recorded in June while the minimum was in the month of August.

Salinity: Water salinity was found to be 6 to 15 ppt. The maximum salinity value was in the month of December and minimum in the month of August.

Transparency: Transparency of the farm was also observed during study period. It fluctuated from 20 to 24 cm. The maximum transparency was recorded in June and the minimum value was found in the month of August.

Zooplankton diversity and abundance

Both the diversity and abundance of zooplankton were identified through the present study. The number of copepods, rotifers, cladocera, ostracoda, and various crustacean larvae made up the zooplankton population. Eight genera in all were identified from the research farm. 3 of them were copepod larvae, 2 were *rotifer*, 2 were *cladocera*, 1 was *ostracoda*, and other larvae of crustaceans. *Filinia* and *Brachionus* were members of Rotifer. While the genus *Filinia* was only observed in November, *Brachionus* was discovered in the perineal. *Mesocyclops* dominated the group of copepods that included Diaptomus, *Cyclops*, and *Mesocyclops*. inside the *cladocera*, two genera—*Diaphanosoma* and *Daphnia*—were recognized, whereas only Cypris was discovered inside the ostracod group (Table 3).

Table 3. Genus composition of zooplankton in semi-intensive shrimp farm of Bangladesh

Month	Group (Genus)
June	Copepod (*Diaptomus*)
	Rotifera (*Brachionus*)
	Crustacean larvae (Shrimp larvae)
July	Copepod (*Cyclops, Mesocyclops*)
	Rotifera (*Brachionus*)
	Cladocera (*Diaphanosoma, Daphnia*)
	Crustacean larvae (Shrimp larvae)
August	Copepod (*Diaptomus, Cyclops, Mesocyclops*)
	Rotifera (*Brachionus*)
	Cladocera (*Diaphanosoma, Daphnia*)
	Ostracoda (*Cypris*)
	Crustacean larvae (Shrimp larvae)
September	Rotifera (*Brachionus*)
	Cladocera (*Diaphanosoma, Daphnia*)
	Crustacean larvae (Shrimp larvae)
October	Copepod (*Diaptomus*)
	Rotifera (*Brachionus*)
	Crustacean larvae (Shrimp larvae)
November	Copepod (*Diaptomus, Mesocyclops*)
	Rotifera (*Brachionus, Filinia*)
	Crustacean larvae (Shrimp larvae)
December	Rotifera (*Brachionus*)
	Crustacean larvae (Shrimp larvae)

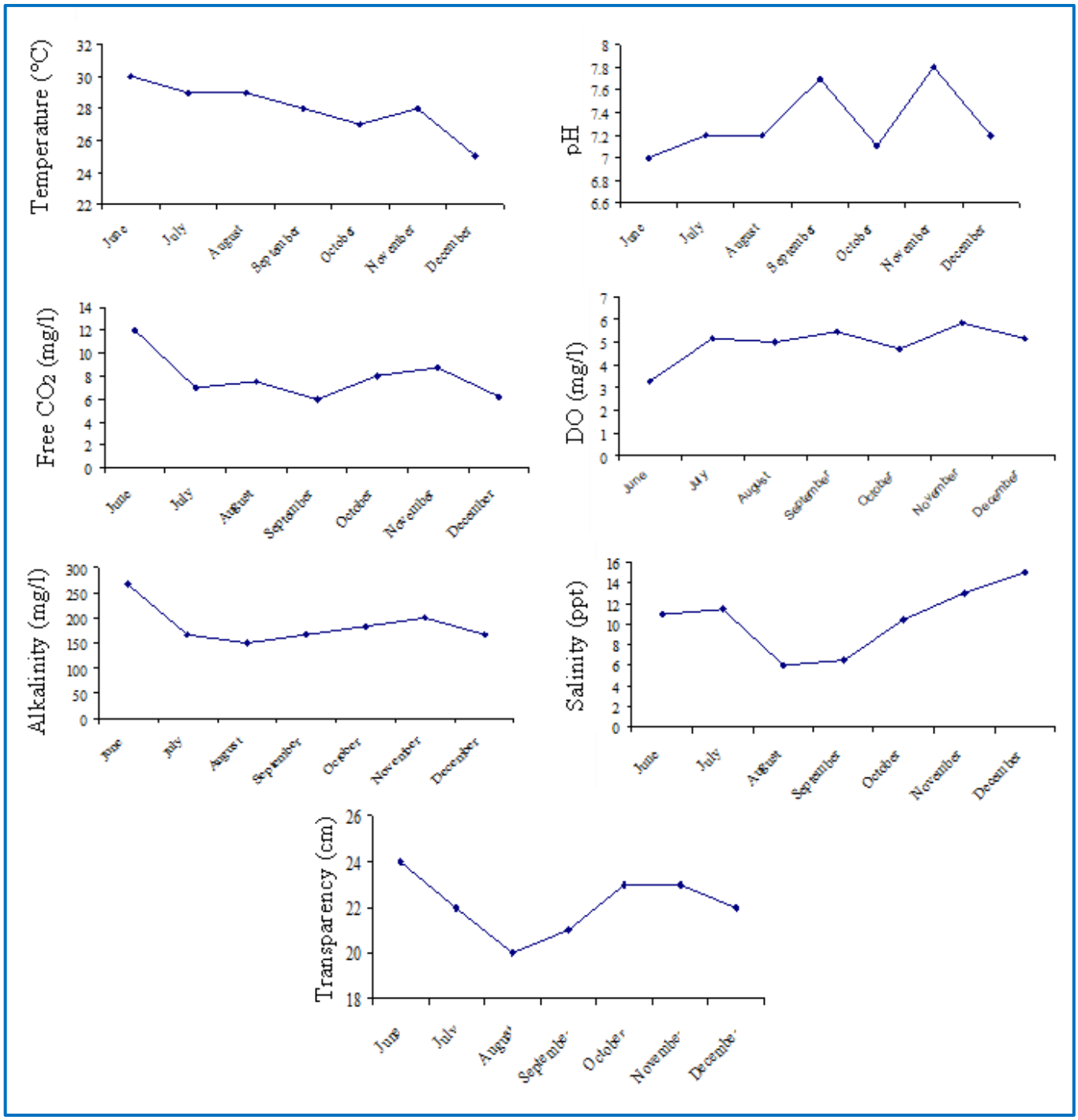


Fig. 2. Monthly variation of physico-chemical parameters in semi-intensive shrimp farm of Bangladesh

The study assessed the frequency and seasonal abundance of various categories of zooplankton populations. The zooplankton exhibited both qualitative and quantitative variations, both seasonally and monthly. The current study involved the observation of 5 distinct kinds of zooplankton, including rotifer, copepod, cladocera, ostracod, and crab larvae. Throughout the study period, copepod was the most prevalent species in the months of June, July, August, and October, accounting for 77%, 72%, 80%, and 90% respectively. On the other hand, rotifer was the dominating species in the months of September, November, and December, representing 62%, 84%, and 54% correspondingly of the total zooplankton population. The presence of ostracods was exclusively seen throughout the month of August. The highest overall abundance of zooplankton (18%) was seen in November, while the lowest (10%) was recorded in June. These findings indicate that there is no substantial fluctuation in the total zooplankton over different months (Fig. 3 and 4).

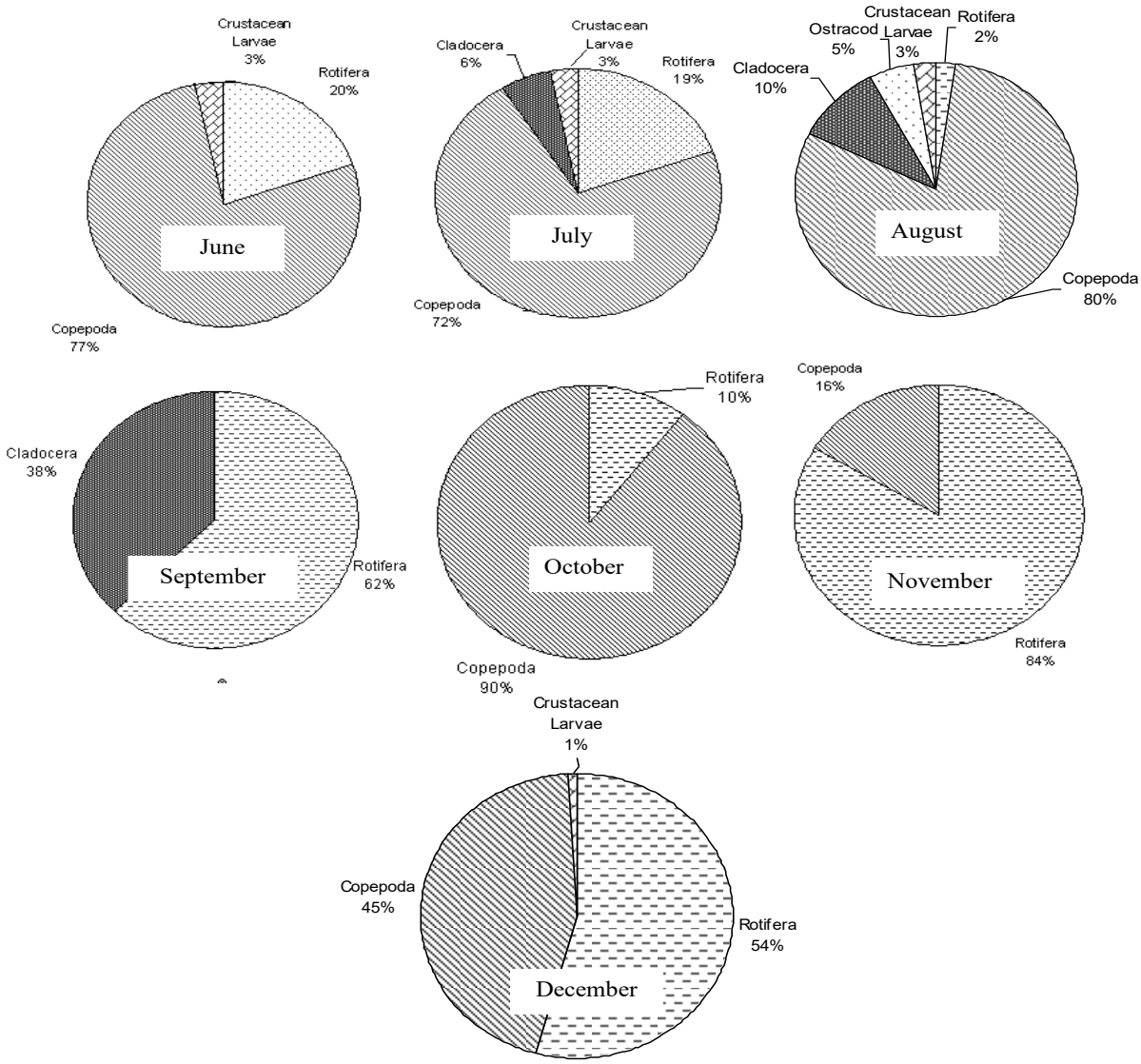
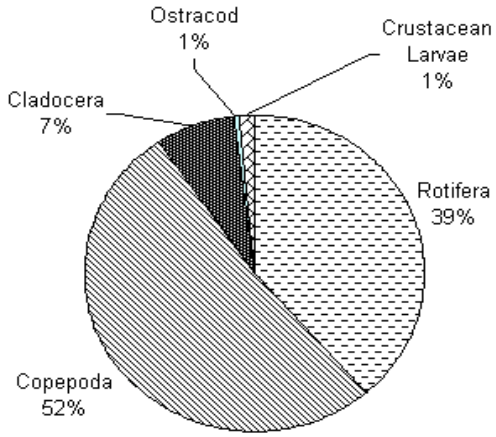
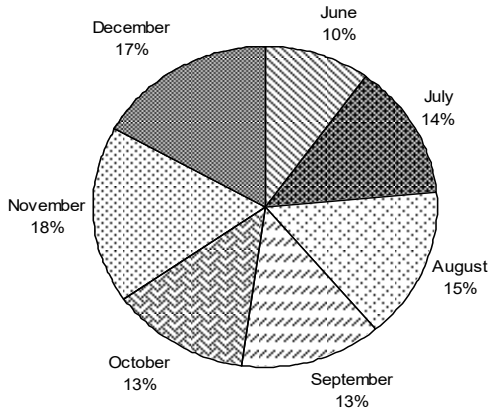


Fig. 3. Percentage distribution for different groups of zooplankton in semi-intensive shrimp farm of Bangladesh



(a) Percentages of different groups of total zooplankton



(b) Percentages of total zooplankton in different months

Fig. 4. (a) Percentages of different groups of total zooplankton, and (b) Percentages of total zooplankton in different months in semi-intensive shrimp farm of Bangladesh

Relationship of zooplankton abundance with different water quality parameters

Rotifer was the second dominant among the total zooplankton group. From the present study we found that it has a great relationship with different water quality parameters. Rotifer showed positively correlation with transparency, pH, DO and salinity while negative correlations were noticed with temperature, free CO_2 and hardness. Rotifer had no significant relationship with alkalinity (Table 4).

Copepod was the most dominant among the total zooplankton group. It did not show any significant relationship with physico-chemical parameters like rotifer. It was positively correlated with water temperature, free CO_2 while negative correlations were noticed with transparency, pH, DO and alkalinity. Abundance of rotifer did not show any relationship with salinity and hardness (Table 4).

Cladocera showed significant relationship with different physico-chemical parameters like rotifer. It had a positive correlation with water temperature, pH and DO and negative correlation with transparency, free CO_2, alkalinity and salinity. Cladocera did not have any relationship with hardness. Cladocera had negative relationship with salinity that means the number of Cladocera may undergo a rapid change with the fluctuation of salinity (Table 4).

Crustacean larvae were positively correlated with water temperature, free CO_2 and hardness while negative correlations were found with transparency, pH, DO, salinity. Crustacean larvae did not indicate any relationship with alkalinity and salinity (Table 4).

The abundance of zooplankton exhibited a positive correlation with pH, DO, and salinity, while negative correlations were observed with temperature, transparency, free CO_2, and alkalinity. The study found a strong positive correlation between pH and salinity with the total zooplankton population. This indicates that pH and salinity have a significant impact on the total zooplankton. However, the study also revealed that the number of total zooplankton per liter may decrease as the temperature, transparency, free CO_2, and alkalinity of the water increase.

Discussion

During the study period the total number of zooplankton was dominated by copepod (52%) which supports Islam et al. (2007). They also observed copepod as a dominant group in two shrimp ghers at Khulna, Bangladesh though Ali and Islam (1983), Alam et al. (1987), Ali et al. (1989) found rotifer as a dominant group in different conditions. During the present study a distinct fluctuation of zooplankton population in different months as well as seasons was observed. Similar observations were noted by George (1961), Krishnamoorthi and Visweswara (1966), Michael (1970), Islam and Aziz (1975), Naser (1978), Ali et al. (1980), Ali et al. (1985), Banu et al. (1987), Chowdhury et al. (1989), and Jana and Sengupta (1989) in various habitats. The bulk of the zooplankton consisted of rotifer, cladocera, copepod and crustacean larvae. During the present study a total of 8 genera of different groups of zooplankton were identified from the study farm. The zooplankton showed its peak (November and December) in winter. Such peak was recorded by Menon et al. (1981) from a fish pond at Mymensingh. George (1964) observed maximum population of zooplankton in November, January and April to September and the major pulse was in June with 1399 units/l was observed in different habitats. Patra and Azadi (1987) also found the peak in winter from the Halda river in Bangladesh. The peak of zooplankton population in winter may be due to the less rainfall, comparatively high DO content (5.83 mg/l in November and 5.83 mg/l in December), low free CO_2 (6.25 mg/l in December) and high pH (7.8 in November and 7.2 in December). The lowest density of zooplankton during June may be due to the high rainfall, comparatively low DO content (3.3 mg/l), high free CO_2 (12 mg/L) and low pH (7.0). During the present study, relevant Co-efficient of correlation showed total zooplankton had a highly significant relationship with pH (r =0.820) and DO (r =.630). A significant relationship has also been observed with salinity (r = 0.447). An inverse relationship was seen in case of water temperature (r = -0.71), alkalinity (r = -0.022) and free CO_2 (r = -0.217).

During the present study the rotifer was second dominant (39% of total zooplankton) group among the zooplankton. The highest population (1028 units/l) was found in November and lowest (23 units/l) in August. Resemble finding was made by Krishnamoorthi and Visweswara (1966) in Gandisagar tank in India. Islam et al. (2007) found the highest abundance of rotifer was in the month of December and the lowest in September. He worked on zooplankton of two shrimp

Table 4. The correlation of zooplankton with physico-chemical parameters in semi-intensive shrimp farm of Bangladesh

Particulars	Rotifers		Copepod		Cladocera		Crustacean larvae		Total Zooplankton	
	r	Comment	*r*	Comment	*r*	Comment	*r*	Comment	*r*	Comment
Water Temp.	-0.71	IR	0.262	*	0.304	*	0.673	**	-0.705	IR
Transparency	0.130	*	-0.038	IS	-0.610	IR	-0.192	IR	-0.327	IR
pH	0.820	**	-0.829	IR	0.490	*	-0.600	IR	0.548	**
Free CO_2	-0.217	IR	0.144	*	-0.489	IR	0.240	*	-0.543	IR
DO	0.630	**	-0.387	IR	0.314	*	-0.438	IR	0.830	**
Alkalinity	-0.022	NS	-0.117	IR	-0.381	IR	0.050	NS	-0.564	IR
Salinity	0.447	*	0.009	NS	-0.721	IR	-0.138	NS	0.349	*
Hardness	-0.363	IR	0.013	NS	-0.019	NS	0.307	*	-0.733	IR

r, Co-efficient of correlation; IR, inversely related; *, Significant; **, Highly significant; NS, not significant; IS, inversely significant.

ghers in Khulna, Bangladesh. The peak in winter might be due to the favorable conditions of physico-chemical parameters and the availability of nutrients in the pond. Rotifers feed on phytoplankton to a great extent (Krishnamoorthi and Visweswara 1966). During the winter season due to higher degree of photosynthesis, number of phytoplankton increased and in turn resulted in the higher production of nutrients of rotifers which might result in flourish of rotifers during winter season. Though the photoperiod was shorter in winter yet photosynthesis increased due to clear sky. Winter was supposed to be positive for plankton growth (Edmonson 1965; Huet 1972). But Roy et al. (2008) reported that the rotifera population prolonged in summer and decrease in the monsoon, probably due to water movement and increased in the post monsoon. The abundance of rotifers was comparatively lower in winter. During study period the genus *Branchionus* was observed perennial which support the report of George (1964), Das and Bhuiyan (1974), Islam et al. (1974), Islam and Saha (1975), Habib et al. (1984), Patra and Azadi (1987), Chowdhury et al. (1989) from different habitats in different condition.

The abundance of zooplankton not only depends on season but also different water quality parameters. Nayar (1965) pointed out that pH and dissolve organic content of water influences the abundance of rotifera population, where water temperature played a positive role. In the present investigation water was always alkaline. Islam et al. (1974) reported the absence of *Brachionus* from acidic waters, while George (1964) reported the absence of *Brachionus* from water above pH 8.5. Lower pH value below 5 is regardless as adversive to the aquatic organisms (Nikolsky 1963; Michael 1970). *Brachionus* is characteristic of higher alkalinity reported by Michael (1970). During the present study relevant Coefficient of correlation showed rotifers had a highly significant relationship with pH (r = 0.820) and DO (r = 0.630). A significant relationship has also been observed with salinity (r = 0.447). An inverse relationship was seen in case of water temperature (r = -0.71), alkalinity (r = -0.022) and free CO_2 (r = -0.217).

Copepod was the dominant group (52%) among the zooplankton during study period. The highest density 833 (units/l) was found in August and lowest 202 (units/l) in November when pH values were found 7.2 and 7.8 and DO values were recorded 5.0 mg/l, 5.83 mg/l respectively. Copepod was totally absent in September. More or less two peaks were evident in August and October. Resemble finding was made by Krishnamoorthi and Visweswara (1966) in Gandisagar tank in India in different condition. Roy et al. (2008) was observed a peak in the copepod populations in

October and other peaks in December and July when pH values were found 8.4, 8.5 and 7.6 and DO values were recorded 5.52 mg/l, 5.61 mg/l and 5.75 mg/l. Islam (2007) observed copepod were highly abundant in monsoon and post monsoon. During the present study, relevant Co-efficient of correlation showed copepod had a significant relationship with water temperature (r = 0.262), free CO_2 (r = 0.144) and inversely related with pH (r = -0.829), DO (r = -0.387) and alkalinity (r = -0.117). Noticed that copepod had no relationship with salinity (r = -0.009) and hardness (r = -0.013).

Cladocera contributes 7% of the total zooplankton. The highest density 348 (units/l) was found in September and lowest 55 (units/l) in July. The members of Cladocera were very poor in number. This group showed irregular pulses during the study period. Irregular pulses of cladocerans were also reported by Smyle (1957), Straskrba (1965), and Islam et al. (2007) in different conditions. Islam et al. (2007) reported that the irregular pulses of cladocerans might have been caused by different duration of life span of different genus. Life span of various genera depends upon various physico-chemical factors. During the study period cladocerans were only found in the month of July, August and September. Among them highest peak was observed in September. Roy et al. (2008) reported that the cladocerans had their peak in monsoon and summer. The winter population was very poor. During the present study relevant Co-efficient of correlation showed cladocerans had a significant relationship with water temperature (r = 0.304), pH (r = 0.490) and DO (r = 0.314). An inverse relationship was seen in case of transparency (r = 0.630), free CO_2 (r = 0.630), alkalinity (r = 0.630) and salinity (r = 0.630). It is found that cladocerans had no relationship with hardness. During field observation, the abundance of crustacean larvae was higher in the months of June, July and August while it was totally absent during the rest of the study period. Crustacean larvae showed positive correlation with temperature and free CO_2.

Conclusion

Plankton is widely regarded as the most reliable indicator of biological productivity and the characteristics of aquatic environments. In a semi-intensive shrimp culture farm, the growth of the shrimp is influenced by both the supplemental feed and the production of plankton. The presence of a particular species of plankton is essential for the optimal development of shrimp and other aquatic organisms. This study involved a thorough examination of the physico-chemical characteristics, as well as the number and variety of zooplankton, in a semi-intensive shrimp farm. There were certain connections observed between the physico-chemical parameters and the abundance of zooplankton. To understand the seasonal and geographical fluctuations in the zooplankton population, these correlations are useful. The results of this study would serve as fundamental data for future research on plankton. The current investigation reveals that the abundance of zooplankton fluctuates over the seasons and exhibits either direct or indirect correlations with the physico-chemical parameters. Within the study area, a total of 8 zooplankton genera were identified. These eight genera are classified into five distinct groups. The copepod population was the most prevalent and influential among the identified zooplankton in the shrimp semi-intensive farm. The present study aimed to investigate the taxonomy, quantity, and periodicity of zooplankton. Additional research is necessary to compile an extensive list of the zooplankton species present in the semi-intensive shrimp farms of the southwest coastal region of Bangladesh, as well as to determine their influence on water quality.

Conflict of interest

There is no competing interest that might influence the research work.

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