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Seasonal abundance of zooplankton and growth performance of prawn and fish in ponds of Rajshahi

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Abstract: The present study was conducted on seasonal abundance of phytoplankton of prawn based carp polyculture system fishponds for a period of six months from September 2006 to February in the village Meherchandi of Boalia thana under Rajshahi district of Bangladesh. During the study period, it was found that water temperature varied from 16.59°C (T_2) to 29.82 (T_1), transparency 26.72 (T_1) to 40.13cm (T_2), pH 7.21 (T_1) to 8.0 (T_2) DO 2.13 (T_2) to 3.6mg/l (T_2), CO_2 4.63 (T_1) to 10.63mg/l (T_2), NH_3N 0.001 (T_1) to 0.0197mg/l (T_2) and total alkalinity fluctuated from 85.38 (T_1) to 147.75mgl (T_2). A total four groups of zooplankton were identified where 5 rotifera (38.41%) was dominant followed by 3 cladocera (31.49%), 2 copepoda (21.84%) and crustacean larvae (8.26%). It was also found that zooplankton showed abundance in February. The highest total average zooplankton (18390.79±2144.63 cells/l) was recorded in T_1 than T_2 which might be due to the effective uses by high stocking density of fishes. Zooplankton showed positive correlation with pH, DO, CO_2 and alkalinity in T_1. In case of T_2, positive co-relationship was found with pH, DO, CO_2 and NH3-N. The mean values of highest final weight of *M. rosenbergii*, *H. molitrix* and *C. catla* were 89.20±8.62g (T_1), 682.70±44.20g (T_2) and 428.00±4.50g (T_1) respectively, highest survival rate was found 76.25±6.25% (T_1) of prawn and highest total average yield was obtained 940.65±259.43 kg/ha in T_2 due to high stocking densities of prawn.

Key words: Zooplankton abundance, physico-chemical parameters, carp polyculture, growth performance

Introduction

The role of plankton in a water body of the sources of foods for fishes has been well recognized. Because plankton is the natural food of many species of fishes, especially zooplankton constitute important food items of many omnivorous and carnivorous fishes. The larvae of carps feed mostly on zooplankton (Dewan *et al*., 1977). According to Prasad & Singh (2003), the zooplankton forms the principal sources of food for fish within the water body. Bhuiyan & Islam (1988) observed that zooplankton also plays a very important role in the food chain as they are in the second trophic level as primary consumer and also as contributors to the next trophic level. Seasonal abundance of plankton in a fish pond are of great importance for any type of aquaculture operation, as they vary from water quality of culture ponds, location to location and within similar ecological conditions (Boyd, 1982). Among the different types of culture systems, the semi-intensive aquaculture is common practice in Bangladesh. That's why a large number of research works has conducted on the ecology of zooplankton population from different waters body of carp polyculture fish ponds such Khan *et al*. (1978), Bhuiyan & Nesa (1998a & 1998b), Islam *et al*. (2000), Chowdhury & Mamun (2006), Rahman & Hossain (2008) and many researchers worked on the percentage composition, seasonal variation and occurrence of freshwater zooplankton. But, until now no systematic investigation was done on the zooplankton abundance of prawn based carp polyculture fish pond in Rajshahi region. Therefore, the present investigation has been undertaken on related to the title.

Materials and Methods

Location of study area and descriptions of ponds

The present study was conducted in the village Meherchandi of Boalia Thana under Rajshahi district for a period of 6 months from September 2006 to February 2007. For this study, four ponds were selected under two treatments with an average area of 0.34 ha and depth of 1m. The ponds were rectangular in shape, well exposed to sunlight, independent and completely free from aquatic vegetation.

Experimental design and pond preparation

The present experiment was conducted with two treatments each with two replications and every treatment was designed with *M. rosenbergii*, *H. molitrix* and *C. catla*. The stocking density of carp in each treatment was fixed (*H. molitrix*-2968/ha *C. catla*-1976/ha) but the stocking density of prawn was at the rate of 40/40m^2 (9880/ha) in Treatment 1 (T_1) and at the rate of 60/40m^2 (14820/ha) in treatment 2 (T_2). During the study period, all the ponds were limed at the dose of 250kg/ha after removal of aquatic weeds and unwanted species and fertilized with cowdung-2470kg/ha, urea-50kg/ha and TSP-50kg/ha before stocking. Shelter or refuges was made for prawn by the uses of dried branches of bamboo which covered minimum 5% area of each pond. After seven days of fertilization all the ponds were stocked with specific species and initial average length, weights and sizes of each species of fishes and prawns were recorded before realizing. Post stocking fertilization was made (cow dung-50kg/ha, urea-1.25kg/ha and TSP-1.25kg/ha) as daily basis. The supplementary feeds were applied twice daily for fish species with same feeding formulation (rice bran 20% + mustard oil cake 50% + fish meal 30%) at the rate of 5% of fish. The daily ration was adjusted based on the determination of total biomass through monthly sampling.

Study of parameters

The physico-chemical parameters were done fortnightly (8:30-9:30am). A centigrade thermometer used to recorded water temperature (°C). Measurement of water transparency (cm) was done by a secchi disc of 15.5cm diameter. pH was measured by a pH indicator paper (LOGAK, Korea). DO was determined by the Winkler's titration method (APHA, 1989). Free CO_2, NH_3-N and total alkalinity was determined according to Welch (1948).

Study of zooplankton

For zooplankton study, 20 liters of water sample from each pond was collected (8:30-9:30am) in a plastic bucket fortnightly and passed through plankton net of 55µ mesh size. Then the concentrated plankton samples were preserved in plastic vials with 5% formalin for subsequent studies. For the qualitative and quantitative study of plankton, 1ml of the concentrated samples was taken by a dropper and then put on the S-R (Sedgwick-Rafter) counting chamber as described by Stirling (1985). Zooplankton were identified up to genus level following keys were given by Ward and Whipple (1954), & Needham & Needham (1962).

Study of growth performance

Final weight (g), survival rate (%) and yield (kg/ha) of prawn silver carp and catla was estimated. Survival rate and yield were estimated using the following formula

$$\text{Survival rate (\%)} = \frac{\text{No. of fish harvested}}{\text{No. of fish stocked}} \times 100$$

Yield/production = No. of fish harvested × final weight of fish.

Statistical analysis was done through SPSS programme and means were also compared to see the significant difference.

Results and Discussion

Water quality parameters: During the study period some selected physico-chemical parameters were studied which are shown in the Table 1. It was found that highest water temperature was found 29.82°C (September '06) in T_1 and lowest was 16.59°C (February '07) in T_2. Transparency was observed to be lowest (26.72cm) in February '07 in T_1 and highest (40.13cm) in December '06 in T_2. The pond water of both treatments showed alkaline condition. The highest pH was noted (8.0) in February '07 in T_2 and lowest was 7.21(October '06) in T_1. The lowest and highest dissolved oxygen content of water varied 2.13 (October' 06) to 3.6mg/l (September' 06) which was recorded in T_2. Free carbon dioxide showed maximum (10.63mg/l) in T_2 in February'07 and minimum (4.63mg/l) in September '06 in T_1. NH_3N varied from 0.001 (November' 06 and February '06) to 0.02mg/l (September '06) in T_1 and T_2 respectively. The total alkalinity fluctuated from 85.38 (September' 06) to 147.75mgl (September 06) where highest and lowest was recorded in T_1 and T_2 respectively. During the study period it was also found that the mean values of different water quality parameters were with the acceptable ranges (Table 1). Hoq *et al.* (1996) and Ling (1969) reported that the water temperature ranged from 27.5 to 30.5°C and 22 to 32°C was suitable for the growth of prawn and the present finding almost similar with findings of Hossain & Akhteruzzaman (2007). Secchi disc reading was lower in T_1 and high in T_2. However the ranges of secchi disc reading were found favorable for carp-prawn culture (Hossain *et al.,* 2002) who recommended 35 to 60cm water transparency for prawn farming. pH values 6.5 to 9.0 (Swingle, 1967) and 6.9 to 8.8 (Chiu, 1987) noted that optimum range for prawn culture. The best range of water pH for shrimp culture is 7-9 (Boyd & Faust, 1992). Therefore, the mean value of pH was found within

the suitable range according to the aforesaid scientists. Comparatively lower value of DO might be associated to the decomposition of unused feed and excreta of the fish (Boyd, 1998). The present findings more or less similar with the findings of Hoq *et al.* (1996) who reported DO ranged from 4.0 to 5.9 mg/l for prawn farming and CO_2 below 12 mg/l is suitable for fish culture (Boyd, 1998). The value of NH_3-N was in suitable range for fish culture and which is almost similar with findings of Boyd (1998) who suggested keeping the ammonia-nitrogen value lees than 0.1 mg/l. Singh & Singh (1975) concluded that alkalinity range from 30-125mg/l is favorable for fish growth and the present finding is strongly agreed with the findings of New and Singholka (1985).

Table 1. Monthly variation of water quality parameters of pond-1 and pond-2 (September, 2006 to February, 2007)

Months	Temperature (°C)		Transparency (cm)		pH		DO (mg/l)		CO_2 (mg/l)		NH_3-N (mg/l)		Alkalinity (mg/l)	
	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2	T_1	T_2
Sep'06	29.82	29.59	32.63	38.94	7.41	7.38	3.10	3.6	4.63	6.00	0.004	0.019	85.38	147.75
Oct'06	28.16	29.07	31.5	32.55	7.21	7.53	2.79	2.13	8.38	6.63	0.012	0.018	94.13	104.25
Nov'06	24.21	24.10	34.69	38.32	7.57	7.59	3.38	2.96	6.38	7.13	0.001	0.019	97.38	102.75
Dec'06	18.23	18.59	35.63	40.13	7.49	7.64	3.26	2.99	7.63	7.64	0.04	0.019	93.25	113.88
Jan'07	18.88	19	27.82	33.32	7.67	7.63	2.56	2.93	9.38	9.50	0.011	0.019	92.75	110.75
Feb'08	16.75	16.59	26.72	27.68	7.89	8.00	2.98	2.84	9.63	10.63	0.001	0.015	122.38	123.13
Mean	22.68	22.82	31.50	35.16	7.54	7.63	3.04	2.91	7.75	7.92	0.012	0.018	97.55	117.09
± SD	±5.53	±5.61	±3.60	±4.80	±0.23	±0.21	±0.29	±0.47	±1.95	±178	±0.01	±0.00	±12.79	±16.72
*Acceptable range	25-31		25-40		6.5-9		5-7		Below 12		Below 0.025		40-200	

The occurrence (%) of different zooplankton groups: The occurrences (%) of different groups of zooplankton with genera under different treatments are shown in Table 2 and Fig 1. Dominance of different groups and genera were identified on the basis of presence in both treatments. During the present study, a total of 10 genera under 3 groups of zooplankton were identified where 5 rotifera (38.41%) was dominant group (*Brachionus>Keratella>Notholca>Asplanchna >Filinia*) followed by 3 cladocera (31.49%, *Daphnia >Moina> Diaphanosoma*), 2 copepoda (2184%, *Cyclops>Diaptomus*), and crustacean larvae constitutes 8.26% of total zooplankton groups. Rahman & Hossain (2008) study on four groups of zooplankton of culture and non culture fishponds and recorded that 2 copepods constituted 30.47 to 43.39%, 4 rotifers constituted 19.17 to 21.67%, 3 cladocera constituted 17.54 to 27.09% and crustacean larvae constituted 15.28 to 19.91% in total zooplankton population. These findings are in good agreement with Hossain & Akhterruzzaman (2007).

Table 2. The occurrence (%) of different groups of phytoplankton with genera under different treatments during the study period

Serial No.	Zooplankton groups	Genus	% of genus	
			T_1	T_2
1	Copepoda (21.84%)	*Cyclops*	55.35	59.92
		Diaptomus	44.65	40.08
2	Rotifera (38.41%)	*Notholca*	15.85	17.39
		Keratella	24.18	19.22
		Brachionus	40.28	37.4
		Filinia	10.28	9.12
		Asplanchna	9.41	16.87
3	Cladocera (31.49%)	*Moina*	34.77	38.46
		Daphnia	44.85	41.33
		Diaphanosoma	20.38	20.21
4	Nauplius (8.26%)		100.00	100.00

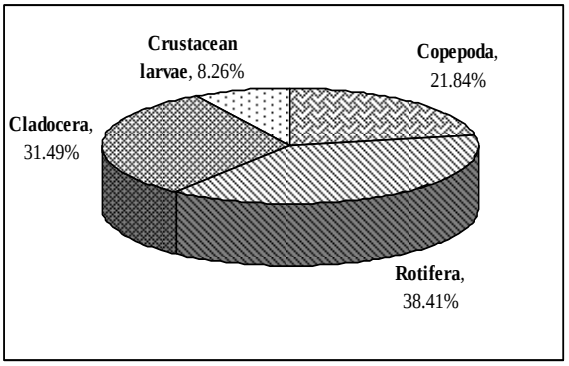

Fig 1. The occurrence (%) of different groups zooplankton

Seasonal abundance of zooplankton groups: Monthly abundance of different zooplankton groups under different treatments are shown in Table 3 and Fig 2 and 3. . It was found that the highest concentration of copepoda was found 6851.25 cells/l (February, 2007) and lowest value was recorded 2542.50 cells/l (September, 2006) in T_1. The concentration of rotifera varied from 4050.00 to 11812.50 cells/l where highest was recorded in T_1 (February'07) and lowest was recorded in T_2 (October, 2006). The highest concentration of cladocera (8268.75 cells/l) was recorded in T_1 (February, 2007) and lowest (2531.25 cells/l) was recorded in T_2 (October, 2006). The highest and lowest value of crustacean larvae varied from 3746.25 to 697.50 cells/l in T_1 and T_2 respectively where highest was recorded in February, 2007 and lowest was recorded in September, 2006. During the study period it was also found that highest total average zooplankton (18390.79±2144.63 cells/l) was recorded in T_1 than T_2 which might be due to the effective uses by high stocking density of fish (Table 3). Rahman & Hossain (2008) found peak season of copepods in September, rotifers cladocerans and crustacean larvae were dominant in January. Das & Srivastava (1956) divided their entire investigation year into various dominant periods such as September, October and November constituted the copepodan period, December and January were characterized by cladocerans and April, May and June were characterized by crustacean larvae. From the study, it was observed that zooplankton showed peak in January to February. Bhuiyan & Nessa (1998a,b) and Islam *et al.* (2000) recorded highest density of zooplankton in January (42213units/l and 1350units/l respectively). The present finding is almost similar with the findings of Hossain & Akhterruzzaman (2007).

Table 3. Monthly abundance of different zooplankton groups under different treatments

Zooplankton groups	Zooplankton concentration (cells/l)						Groups total (cells/l)
	Sep'06	Oct'06	Nov'06	Dec'06	Jan'07	Feb'07	
Treatment 1							
Copepoda	2542.50	3208.75	3307.50	3780.00	5298.75	6851.25	18390.79 ±2144.63
Rotifera	4736.25	4387.50	5332.50	7728.75	8845.00	11812.5	
Cladocera	2995.00	2767.50	4185.00	6378.75	7240.00	8268.75	
Crustacean larvae	832.50	971.00	1113.75	2362.50	1552.50	3746.25	
Total	11106.25	11334.75	13938.75	20250.00	22936.25	30678.75	
Treatment 2							
Copepoda	2812.50	3105.00	3780.00	4353.75	4387.50	5533.75	17195.04 ±1830.18
Rotifera	4183.75	4050.00	5737.50	8842.50	6506.25	9888.75	
Cladocera	2812.50	2531.25	3876.25	7089.00	6850.25	7188.75	
Crustacean larvae	697.50	945.00	843.75	3003.50	1856.25	2295.00	
Total	10508.25	10631.25	14237.50	23288.75	19600.25	24906.25	

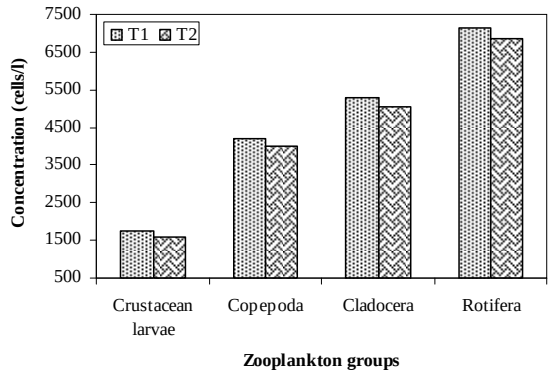

Fig 2. Mean concentration of different groups of zooplankton of T_1 and T_2

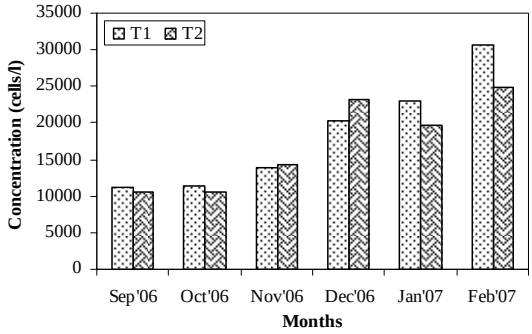

Fig 3. Monthly abundance of zooplankton of T_1 and T_2

Correlation between water quality parameters and zoooplankton

It was found that zooplankton showed positive correlation with pH (r=0.859), DO (r= 0.352), CO_2 (r=0.838) and alkalinity (r=0.656) where negative co-relationship was found with water temperature and transparency in T_1 (Table 4). In case of T_2, positive co-relationship was found with pH (r=0.686) DO (r=0.045), CO_2 (r=0.787) and NH3-N (r=0.248) where negative co-relationship was found with other observed parameters. Rahman & Hossain (2008) found that zooplankton showed significant positive correlation with pH, DO and CO_2. Miah *et al.* (1981) and Alam *et al.* (1987), zooplankton showed positive correlation with CO_3^- and HCO_3^- alkalinity. Patra & Azadi (1987) reported that inverse relationship existed between zooplankton and water temperature which is strongly support the present study.

Growth performance of prawn and fish

Final weight, survival rate and yield of different fish species under different treatments are shown in Table 5. During the study period maximum final weight (g) of *M. rosenbergii*, *H. molirix*, and *C. catla* was recorded as 89.20 (T_1), 672.70 (T_2) and 428.00 (T_1) respectively. The present result is more or less similar with the findings of Sadek and

Table 4. Relationship between water quality parameters and zooplankton under different treatments during the study period

Water quality parameters	Zooplankton	
	T_1	T_2
Temperature (ºC)	-0.905	-0.865
Transparency (cm)	-0.536	-0.071
pH	0.859	0.686
DO (mg/l)-morning	0.352	0.045
Free CO_2 (mg/l)	0.838	0.787
NH_3-N (mg/l)	-0.312	0.248
Alkalinity (mg/l)	0.656	-0.120

El-Gayar (1993), Islam *et al.* (1999) and Chand *et al.* (2002). The highest value of survival rate (%) was recorded as 76.25 (T_1), 74.99 (T_1) and 68.75 (T_2) for these species respectively, which was higher than the findings of Alam *et al.* (2001) who recorded 62.50% survival rate of *M. rosenbergii* and 96.42% of *H. molitrix*. Chand *et al*. (2002) recorded 65-66% survival rate of *C. catla*. and the maximum yield (kg/ha) was recorded as 851.53 (T_2), 1496.60 (T_1) and 542.53 (T_2) where total highest average yield (kg/ha) was recorded for these species as 940.65 in T_2 due to high stocking density of prawn. Chand *et al.* (2002) recorded the yield 229 and 622 kg/ha for the *M. rosenbergii* and *C. catla*, respectively. In case of *H. molitrix*, Islam *et al.* (1999) recorded yield 927.15 kg/ha.

Table 5. Variation in the mean values of final weight, survival rate and yield of different fish species under different treatments

Species	Final weight (g)		Survival rate (%)		Yield (kg/ha)		Level of significance
	T_1	T_2	T_1	T_2	T_1	T_2	
M. rosenbergii	89.20 ±8.62	80.03 ±6.38	76.25 ±6.25	71.65 ±1.65	677.27 ±119.98	851.53 ±87.48	NS
H. molitrix	675.50 ±21.75	682.70 ±44.20	74.99 ±8.33	70.83 ±4.17	1496.60 ±118.54	1427.87 ±8.47	NS
C. catla	428.00 ±4.50	398.60 ±8.40	62.50 ±12.50	68.75 ±6.25	529.99 ±111.57	542.53 ±60.64	NS
Total average yield					901.29 ±300.68	940.65 ±259.43	NS

NS=Non significant

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