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ABUNDANCE OF ZOOPLANKTON AND PHYSICO-CHEMICAL PARAMETERS OF A POLYCULTURE FISH POND OF MANIKGANJ, BANGLADESH

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Abstract: Composition and abundance of zooplankton in a polyculture pond was studied during June 2003 to May 2004. A total of 33 major species of zooplankton including 11genera of Rotifera, 4 of Copepoda, 4 genera of Cladocera and 2 genera of Protozoa were identified. The monthly abundance of zooplankton varied form 4228 indiv/l in October 2003 to169 indiv/l in January 2004. Among the total zooplankton, Rotifera comprised of 71.07%, Copepoda comprised of 12.49% Nauplii comprised of 11.96%, Cladocera comprised of 1.49% and Protozoa comprised of 2.99%. Water temperature (r = 0.18), free CO_2 (r = 0.40), TDS (r = 0.14) and water depth (r = 0.55) showed positive correlation with zooplankton but air temperature, pH, dissolved O_2, total hardness and ammonia showed negative correlation (the coefficients being -0.18, -0.05, -0.25, -0.38 and -0.11 respectively) with the occurrence of zooplankton. The average growth of fishes and zooplankton showed positive correlation in all cases but the relations were insignificant when tested statistically.

Key words: Zooplankton, physico-chemical factors, polyculture, abundance.

INTRODUCTION

The plankton, which lives in all the aquatic habitats, play a significant role in the overall biological productivity of natural waters, as they serve food to most of the fishes. Zooplankton are important food item of omnivorous and carnivorous fishes (Alam *et al.* 1987). Bardach *et al.* (1972) stated that the larvae of carps feed mainly on zooplankton. Zooplankton are the major mode of energy transfer between phytoplankton and fish (Howick and Wilhm, 1984). The study of zooplanktonic composition, abundance and seasonal variations is helpful in planning and successful fishery management (Jhingran 1974). So the production of fish is dependent on the zooplankton community, and they are one of the most important factors in fish culture due to their higher caloric content. So, abundance of zooplankton in polyculture pond is necessary for more fish production. The physico-chemical factors and nutrient status of water play the important role in governing the production of planktonic biomass. A number of workers such as Alam and Choudhury (2000); Ali *et al.* (1980, 1982, 1985); Ali and Begum (1979); Ali and Islam (1981); Mohsin *et al.* (1985); Banu *et al.* (1987); Hafizuddin and Nazimuddin. (1984); Bijoya and Latifa. (2005) have

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reported on different aspects of zooplankton inhabiting Bangladesh freshwaters. Sehgal (1967) and Michael (1966) worked in detail on physico-chemical factors and zooplankton population from different water bodies of India. However little information is available on the monthly variation of zooplankton and their relationship with the physico-chemical factors of water and fish growth in polyculture ponds of Bangladesh. Therefore, the present investigation is an attempt to examine the influence of physico-chemical factors on abundance, monthly diversity and composition of zooplankton and their relation on fish growth in a semi-intensive polyculture fish pond of Manikgonj, Bangladesh.

MATERIAL AND METHODS

The present study was carried out on fresh water pond at a private fish hatchery and nursery complex called "Jahan-E-Nizam Bahumukhi Krishi Khamar"in Manikgonj district from June 2003 to May 2004.The area is rectangular in shape, water surface area is 66 decimal (2672 cubic meter) and average depth of the pond varied from 2.75 to 3.65 m. The pond bottom was muddy and no macro vegetation was evident. Water supply was dependent on rainfall and pumped water supply. During the study nursery pond was converted into rearing pond.

The monthly physico-chemical factors of the water were determined in the pond. The pH and dissolved oxygen (DO) were determined by digital pH meter (HANNA, China) and digital oxygen meter (HANNA, China) respectively. Free carbon dioxide (CO_2), hardness, ammonia, nitrite were determined by using HACH kit box (FF2, USA). A digital TDS (HANNA, China) was used to determine the transparency of water. At the time of sampling air and water temperature were recorded by a digital temperature meter (Fisher, U.S.A.).

The water samples for biological studies were taken from four different places of the pond from the surface and middle level of water in a plastic bucket on monthly basis. Water was collected with a 10 liter plastic bucket. First the water (30 liters) was sieved through plankton net (64 mesh/m^{-2}). The concentrated plankton was adjusted to 18 ml and preserved immediately in 4% buffered formalin solution.

For qualitative and quantitative study, zooplankton samples were examined under a compound microscope in a S-R (Sedgeweak-Rafter) cell using 100x magnification. The identification of zooplankton up to generic /species level were done with the help of Ward and Whipple(1959), Tonapi (1960), Mellanby (1975), Ali and Chakrabarty (1992) and Bhouyain and Asmat (1992). Quantitative analysis was followed by the total count method of Welch (1948).

Statistical analysis: The relationships between zooplankton and physico-chemical factors and average fish growth were established by correlations using Excel software of Microsoft office 2003.

RESULTS AND DISCUSSION

Zooplankton abundance: In the present study, five groups of zooplankton were recorded. Data obtained from the study indicates that a total of 33 zooplankton species were present in the pond comprising of 22 species of rotifers, 5 copepods, 4 cladocerans and 2 species of protozoans along with nauplius and metanauplius larvae. Highest number of zooplankton species (18) was observed in the month of August 2003 and lowest number of zooplankton species (7) was observed in the month of April 2004 (Table 1).

The rotifer was the most dominant group in the pond throughout the year. Kaliamurthy (1974) noted rotifers as the most dominant group followed by copepods, cladocerns, and ostracods. The dominance of Rotifera indicates the eutrophic nature of the water body. According to Brooks and Dodson (1965) selective predation by planktivorous fish results in the shifting of zooplankton communities with the dominance of rotifers (Table 2). Singh *et al.* (2002) reported that higher rotifer populations occurs during summer and winter due to hypertrophical conditions of the pond at high temperature and low level of water respectively. Monthly variation of zooplankton species in pond has shown in Table 1.

Monthly percentage distribution of zooplankton groups are showing in Table 2. Protozoa comprised 2.99 % of the total zooplankton. The highest percentage of protozoan (13.64%) was recorded in April 2004 and the lowest (0.13%) in October 2003 (Table 2). Rotifera comprised 71.07% of the total zooplankton. The maximum percentage of rotifera (98.81%) was recorded in October 2003 and the minimum (1.85%) in June 2003 (Table 2). Copepoda and cladocera comprised 12.49% and 1.49% of the total zooplankton respectively. The highest percentage of copepoda (48.48%) and cladocera (4.55%) were recorded in April 2004. The lowest percentage of copepoda (0.02%) was observed in August 2003 and that of cladocera (0.04%) was recorded in October 2003 (Table 2). Nauplii comprised 11.96% of the total zooplankton. The highest percentage of nauplii (45.37%) was recorded in June 2004 and the lowest (0.28%) in July 2003 (Table 2).

The numerical variation in peak periods of different groups of zooplankton might be due to their biological parameters. During study, zooplankton density increased sharply through October'03 to December'03 (Fig. 1). This may be the result of less or inactive feeding of fish in winter months. Similar results were also observed by Ali *et al.* (1982).

Table 1 Monthly variation of zooplankton species in polyculture fish pond

Major Zooplank-tonic group	Genus/species	Year -2003								Year - 2004			
		Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
PROTOZOA	*Arcella* sp.		+		+		+	+	+	+	+	+	+
	Difflugia sp.			+		+		+					
ROTIFERA	*Asplanchna* sp.				+	+							
	Brachionus sp.			+	+	+	+	+	+		+		+
	Brachionus angularis	+	+	+		+	+	+	+				
	Brachionus bidentata						+			+			
	Brachionus falcatus					+						+	
	Brachionus forficula			+	+	+		+					
	Brachionus calyciflorus		+		+	+	+	+	+	+	+		+
	Brachionus diversicornis		+	+	+	+		+	+	+	+		+
	Brachionus nilsoni	+	+			+	+	+	+	+	+		+
	Brachionus plicatilis		+	+					+				
	Brachionus quadridentatus		+						+				
	Brachionus urceolaris		+				+						
	Dipleuehlanis sp.		+	+						+			
	Filinia opolinesis			+	+	+							
	Filinia terminalis	+	+			+	+	+	+	+			+
	Filinia longiseta			+	+	+	+	+	+				
	Hexarthra sp.			+	+	+				+			
	Horaella sp.		+			+			+		+		
	Keratella sp.			+	+	+		+					
	Lepadella ovalis			+						+	+		
	Monostyla sp.	+	+	+				+				+	
	Polyarthra sp.	+	+		+	+	+	+	+	+	+		+
	Unidentified	+	+	+		+	+	+	+	+	+	+	+
COPEPODA	*Cyclops*			+				+	+			+	+
	Cyclops nanus	+									+		
	Diaptomus sp.								+			+	
	Diaptomus gracilis	+		+				+					+
	Heliodiaptomus sp.	+			+				+	+	+	+	+
	Mesocyclops dybowskii	+											
	Mesocyclops inversus			+	+			+		+			
NAUPLII	Nauplius	+	+	+	+	+	+	+	+	+	+	+	+
	Metanauplius			+	+	+	+	+	+	+	+	+	+
CLADOCERA	*Bosmina* sp.								+				+
	Daphnia sp.				+				+	+			
	Diaphanosoma sp.	+	+	+			+			+		+	+
	Moina sp.		+	+		+							
TOTAL SPECIES		**10**	**15**	**18**	**14**	**17**	**11**	**16**	**17**	**14**	**10**	**07**	**12**

(+) Present

Table 2. Monthly percentage distribution of the major groups of zooplankton

Major zooplankton	Year 2003								Year 2004			
groups	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Protozoa	0	1.63	4.92	0.19	0.13	2.11	0.55	7.45	2.06	0.68	13.64	2.56
Rotifera	1.85	97	90.56	95.56	98.81	93.67	97.91	76.6	80.25	94.41	3.03	23.16
Copepoda	50.93	0	0.02	1.2	0	0	0.33	5.32	4.32	1.23	48.48	38.04
Copepode nauplii	45.37	0.28	1.25	2.02	1.02	3.38	1.21	8.50	10.25	3.68	30.3	36.24
Cladocera	1.85	1.09	3.25	1.03	0.04	0.84	0	2.13	3.12	0	4.55	0
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 3. Monthly physico-chemical factors of polyculture pond

Physico-chemical	Year 2003								Year 2004			
factors	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Air temp. (^{0} C)	27	28	28.5	30	29	27.4	22.7	22.3	25	28.3	34.8	25.1
Water temp. (^{0} C)	28	30.3	30.8	32	30.7	29.9	23	21	23	26.1	33.4	29
pH	8	8.4	8.5	7.4	7.3	9.2	8.6	8.5	8.6	8.1	8	8.4
Dissolved O_2 (mg/ l)	3.2	3.8	3.93	3.5	3.7	6.5	8.2	4.5	6.2	7	6.8	4.1
Free CO_2 (mg/ l)	32.3	15.2	30.4	31.8	30.6	18.8	16	19	18	26.8	25.1	27.1
TDS (µS)	27	25	25	26	29	18	16	18	24	30	30	30
Total hardness (mg/ l)	107	110	111	144	139	86	86	80	83	93	86	167
Ammonia (mg/ l)	0.5	0.3	0.4	0.5	0.6	0.6	0.5	0.4	0.3	0.5	0.6	0.6
Nitrite (mg/ l)	0	0	0	0	0	0	0	0	0	0	0	0
Water depth (cm)	105	135	145	230	230	220	217	201	198	198	210	100

The monthly variation in zooplankton population (Fig. 1) showed that they varied from 169 indiv/l to 4228 indiv/l of pond water. The zooplankton showed its peak (4228 indiv/l) in October'2003, the minimum (169 indiv/l) zooplankton was observed on the January'2004 (Fig. 1). Das and Bhuiyan (1974) observed the greatest abundance of plankton in Dhaka city during the months of April – May and October, and the greatest depletion was observed in the months of August and January – February.

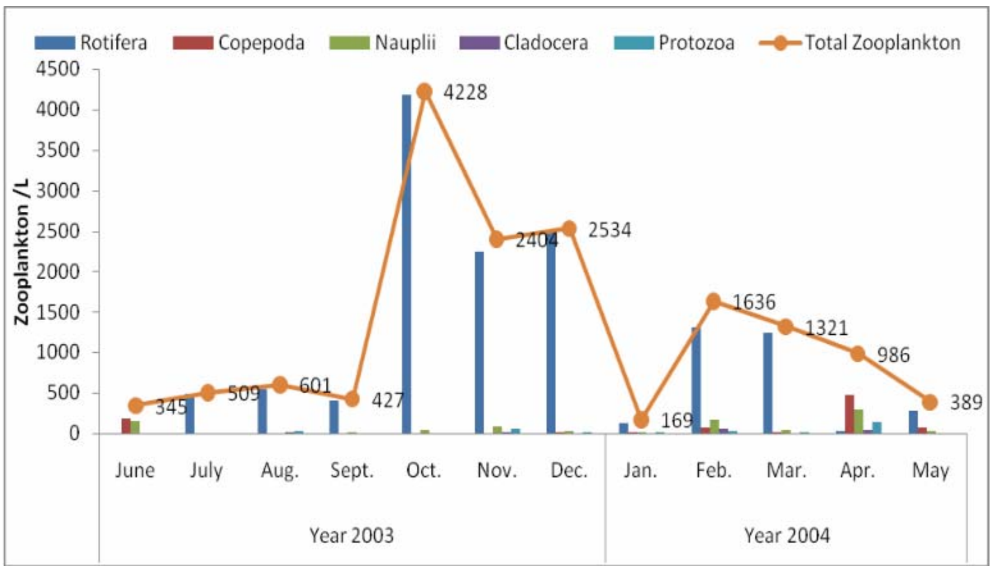

Fig. 1. Monthly variation of zooplankton population in pond

Physico-chemical factors: Monthly records of different physico-chemical factors showed fluctuations in different months, which are showing in Table 3.

The maximum water temperature (33.4^{0}C) and air temperature (34.8^{0}C) recorded in April'2004 (Table 3) and the minimum water temperature (21^{0}C) and air temperature (22.3^{0}C) recorded in January '2004. Similar result was observed by Miah *et al.* (1981) from Bangladesh pond. Similar trend had also been observed by Rao (1955). The water depth of the ponds was recorded. In polyculture pond it was found to be the lowest 198 cm. in February 2004 and the highest 230cm. in September 2003 (Table 3) .The trend of increasing in depth towards the peak is related to the monsoon. Similar observation was observed by Michael (1969) from tropical water bodies.

During the study the lowest pH was in 7.3 (October 2003) and the highest was in 9.2 (November 2003) (Table 3). Such observation was supported by Michael (1969). The maximum concentration of dissolved O_2 was 8.2 mg/l

(December 2003) and the minimum 3.2 mg/l (June 2003) was recorded in pond (Table 3). Higher values of dissolve oxygen were observed at the surface water might be due to the wind action and also due to the active photosynthesis process. Similar trend had also been put forward by Ali *et al.* (1989). The maximum concentration of CO_2 was 32.3 mg/l (June 2003) and the minimum 16 mg/l (December 2003) was recorded in pond (Table 3). Similar trend had also been put forward by Ali *et al.* (1989). The ammonia content in pond water was varied from 0.3mg/l to 0.6 mg/l (Table 3). The value of total hardness varied from 80mg/l to 144 mg/l during study period (Table 3). Ferdousi (1986) reported that low and high values of nitrite in the pond water might be associated with the phytoplankton populations, i.e. food availability in the pond. In the present experiment the nitrite was totally absent (Table 3). During study period the value of TDS varied from 16 µS to 30µS, which corresponds to the transparency (Table 3).

From the above observation it is found that, the physico-chemical conditions of the ponds were favourable for normal growth and life in the pond.

Coefficient of correlation among bio-physicochemical factors: Coefficient of correlation among bio-physicochemical factors are shown in Table 4. In the present study the coefficient of correlation between water temperatures and occurrence of zooplankton showed positive (0.18) correlation, whereas it showed negative (-0.18) correlation between air temperatures and occurrence of zooplankton. Ali *et al.* (1980) found that most of the zooplankton had positive correlation coefficient with temperature with the exception of the protozoans.

Table 4. Correlation co-efficient between physico-chemical parameters of water and density of total zooplankton of the polyculture pond.

Sl.	Relationship	Correlation co-efficient 'r'
1.	Air temp. Vs Total Zooplankton	-0.178
2.	Water temp. Vs Total Zooplankton	0.182
3.	pH Vs Total Zooplankton	-0.051
4.	Dissolved O_2 Vs Total Zooplankton	-0.248
5.	Free CO_2 Vs Total Zooplankton	0.399
6.	TDS Vs Total Zooplankton	0.139
7.	Total hardness Vs Total Zooplankton	-0.380
8.	Ammonia Vs Total Zooplankton	-0.113
9.	Water depth Vs Total Zooplankton	0.546

During the study, zooplankton showed inverse relationship with pH (the coefficient being -0.05), which support the works of Patra and Azadi (1987) in Halda river of Bangladesh. The coefficient of correlation between CO_2 and occurrence of zooplankton showed positive (0.40) correlation. Total hardness

(HCO_3) showed negative correlation, and TDS showed positive correlation with the occurrence of zooplankton (the coefficients being -0.38 and 0.14 respectively). The dissolved oxygen showed negative correlation with zooplankton (i.e. coefficient being -0.25) and Singh and Singh (1993) drew similar conclusion. The coefficient of correlation between water depth of pond and occurrence of zooplankton was found positive (0.55).

Table 5. Relationships between water temperatures, DO, and pH, with average growth (by weight) of fishes in pond (r = correlation; t = t test value).

Fishes	Water temperature and avg. growth		pH and avg. growth of fishes		DO and avg. growth of fishes		CO_2 and avg. growth of fishes		Zooplankton and avg. growth of fishes	
	r	t	r	t	r	t	r	t	r	t
Catla rohita hybrid	-0.235	-0.94	-0.069	- 0.27	0.751	4.41	-0.097	- 0.38	0.210	0.83
Catla catla	-0.178	- 0.70	-0.104	- 0.40	0.708	3.91	-0.072	- 0.28	0.235	0.94
Labeo rohita	-0.287	- 1.16	-0.083	- 0.32	0.739	4.27	-0.086	- 0.33	0.238	0.95

Correlation between the average growth of fishes and bio-physico-chemical parameters: The correlation between the average growth of fishes and water temperature, pH and CO_2 in pond although showed negatively correlation but the relations were insignificant when tested statistically. The correlation between DO and average growth of fishes showed positive correlation and the relationship was significant at 5% level of significance (Table 5). The average growth of fishes and zooplankton showed positive correlation in all cases but the relations were insignificant when tested statistically (Table 5).

The results revealed that the zooplankton abundance in fish culture pond varied from month to month. Among zooplankton groups, Rotifera appeared to be most dominating community throughout the study period.

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