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Species Composition and Abundance of Zooplankton Population in Freshwater Pond of Noakhali District, Bangladesh

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Abstract: The present study was designed to estimate zooplankton abundance qualitatively and quantitatively in various types of earthen fish ponds of Noakhali region, Bangladesh. Experimental ponds were categorized as culture, household and unused and samples were drawn from 15 May to 15 November, 2012 during the entire study period using a plankton net (90 µm mesh size). Zooplankton enumeration was done on Sedgewick-Rafter counting chamber (S-R cell). Water quality parameters were measured and found within the optimal ranges for zooplankton growth. Temperature varied from 25-30 °C; transparency, 25-43 cm; pH, 6.0-9.0; Dissolved Oxygen (DO), 3.50-5.00 mg L^{-1}; conductivity, 338-573 ppm and salinity 0 ppt. Four groups of zooplankton viz.; Rotifera, Cladocera, Copepoda and Crustacean larvae consisting of 14 genera were identified. Total zooplankton density was found 5550, 2655 and 1670 units/l respectively in culture, household and unused pond. Rotifera was found most dominant group with the density of 2100 ind/l, 983 ind/l and 1370 ind/l respectively in culture, household and unused pond. Lowest density was found for Cladocera with 890 ind/l, 500 ind/l and 200 ind/l respectively in culture, household and unused pond. In culture pond, percentage of Rotifers, Copepod, Cladocerans and Crustacean larvae were 38%, 23%, 16% and 23% respectively. In household pond, percentage composition of zooplankton group was 37% (Rotifers), 37% (Copepod), 19% (Cladocerans) and 7% (Crustacean larvae). And in unused pond, Rotifers, Copepod, Cladocerans and Crustacean larvae were found 53%, 27%, 8% and 12% respectively. Rotifer was found more abundantly (54%) in unused pond whereas Copepoda was in household pond (37%). The results of the present study can be used to measure the seasonal changes of water quality parameters and its effects on zooplankton production in the fish ponds.

Key words: Zooplankton · Rotifera · Abundance · Freshwater ponds · Noakhali District

INTRODUCTION

Zooplankton is the assemblage of various microscopic or non-microscopic invisible aquatic animals which do not have locomotory power; depend on water current for their movement or those that have feeble locomotory power but not against the water current [1]. Most plankton is too small to see with the naked eye. Although they belong to different taxa, they have one thing in common, i.e. owing to the lack of strong locomotory organs (like fish fins), they are weak in locomotion and can only drift about in water at mercy of waves and currents, being incapable of mobbing anywhere as fish do [2]. Zooplankton formulates the base of food chains and food webs in all aquatic ecosystems. They also play a major role in recycling nutrients as well as cycling energy within their respective environments. The qualitative and quantitative abundance of plankton and its relation to environmental condition has become a prerequisite for fish production. Water quality determines the species optimal for culture under different environments [3]. The physicochemical attributes of a water body are principle determinants of fish growth rates and development [4]. The overall productivity of a water body can easily be deduced from its primary productivity, which forms the backbone of the aquatic food chains [5].

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The plankton community is comprised of the primary producers or phytoplankton and zooplankton; the secondary producers [6]. The zooplankton forms the principal source of food for fish within the water body.

Noakhali is one of the southern coastal districts of Bangladesh. In Noakhali region, there are thousands of small and large sized ponds where extensive fish culture is mainly practiced depending on natural food (zooplankton). In the fish farms, natural food concentrations are increased from different sources as artificial feeds and fertilizers (both organic and inorganic) etc., which lead to nutrient enrichment in fish ponds.

Although globally zooplanktons have been much studied but in Bangladesh the published information on zooplankton is scanty. There have been few studies on zooplankton abundance of different region of Bangladesh [7, 8]. Seasonal variation of the plankton populations with some water quality parameters of Borobila beel of Rangpur district [9]. However, no substantial works has yet been done for zooplankton at Noakhali region. Therefore, the study was aimed to document the composition and abundance of zooplankton in freshwater earthen fish ponds of Noakhali region.

MATERIALS AND METHODS

Sampling Location: The study was conducted at various types of earthen fish pond of Noakhali region, Bangladesh to estimate the qualitative and quantitative abundance of zooplankton from 15 May to 15 November, 2012 (Fig. 1). Experimental ponds were categorized as culture, household and unused. Samples were drawn every week during the entire study period with three replicates.

Management Technique of the Studied Ponds: Survey was conducted to know the management technique of the studied ponds. Management technique was varied from pond to pond. Culture ponds were well managed whereas household or unused ponds were little or unmanaged. Lime was commonly used in culture ponds before the culture started. Fish farmers usually used cow manure, urea, MOP (Murate of Potash), geolite and triple super phosphate (TSP) fertilizers in culture pond to enhance the zooplankton growth (Table 1). They also used floated feed (Mega and ACI feed) in culture ponds 3-4 times at every day. Fertilizer not used in unused pond. Domestic wastage was used as supplementary feed for household pond while floated feed and mustard oil cake were used in culture pond. Supplementary feed not used in unused pond. Water quality parameters and sampling for zooplankton analysis was done once a week from specific points of the pond. A mercury thermometer was used to measure water temperature (°C), while transparency (cm) was measured with a secchi disc of 20 cm diameter. Digital electronic meters (Model YSI-58, USA and Jenway Model-3020) were used to measure dissolved oxygen (DO) (mg L^{-1}) and pH on site, respectively. Salinity and conductivity were measured by using a portable device (Model- EC 400).

Zooplankton Sampling and Analysis: Zooplankton samples were collected from a depth of 5-10 cm below the water surface in the morning hour (7-9 AM). Samples from different locations and depths may occasionally be combined in composite samples to reduce sampling effort [10]. Samples were collected using plankton net (90 µm mesh size) and preserved in dark sterile plastic bottles with 5% formalin on site. Identification of the zooplankton

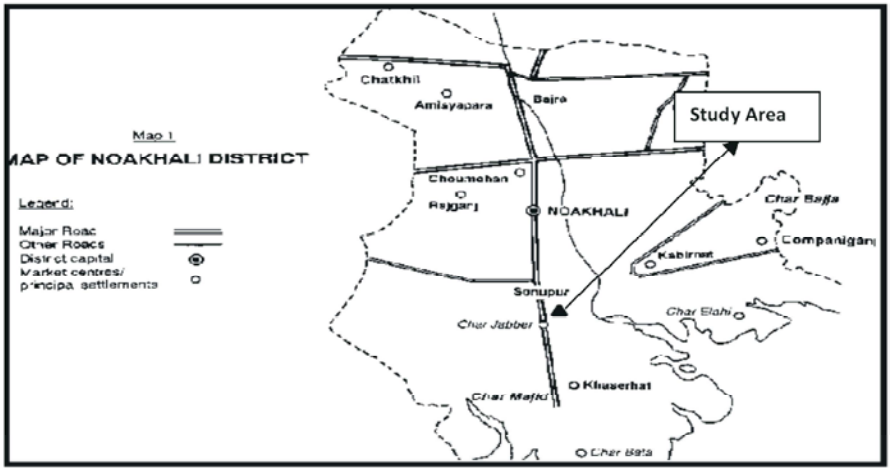

Fig. 1: Map showing the location of research station

Table 1: Management activities of the studied ponds

Management activities	Culture pond	Household pond	Unused pond
Predatory fish control	Sumithion (7500ml/ha)	-	-
Liming	Lime, Geolite (200gm/decimal)	Lime (Rare in case)	-
Fertilization	Cow dung (700kg/ha), TSP (Triple Super Phosphate), MOP(Murate of Potash)	Cow dung (daily supplement from cattle)	-
Supplementary feeding	Floated feed (3-4 times/day), ACI starter feed, MOC (Mustard oil cake)	Domestic wastage	-

species was conducted in laboratory of Fisheries and Marine Science department under a phase contrast light microscope at 16×40 and 16×10 magnification (Model No: XSZ21-05DN, Made in China) with bright field and phase contrast illumination. Quantitative analysis of zooplankton was done on Sedgewick-Rafter counting chamber (S-R cell). Analysis involved transfer of 1 mL sub-sample from each of the samples to the Sedgewick-Rafter counter and counting of cells within 10 squares of the cells, chosen randomly. The cell counts were used for computing the cell density using the formula where the zooplankton density was estimated by Stirling [11]: N= (A×1000×C)/ (V×F×L)

Where, N= no. of plankton cells or units per liter of original water; A=Total no of plankton counted; C= Volume of final concentrate of the sample in ml; V=volume of a field in cubic mm; F=No. Of fields counted; and L=Volume of original water in liter

The zooplankton were then identified up to the genus level and enumerated by the following [12, 13]. The mean number of zooplankton was recorded and expressed numerically per liter of water of the pond.

Statistical Analysis: The statistical analysis of different physicochemical and zooplankton parameters were carried out by using one-way ANOVA using the statistical package of Statgraphics Version 7, while the Microsoft Excel 2007 was used to plot graphs for dissemination of the results.

RESULTS AND DISCUSSION

Observation of Water Quality Parameters of the Studied Ponds: During this study period, physicochemical parameters of water such as temperature, transparency, salinity, conductivity, dissolved oxygen (DO) and pH were measured and found within the suitable range for zooplankton growth. Transparency, conductivity and pH of the studied pond water were found variable during the study period whereas DO and temperature were found nearly constant. Salinity was totally absent in the experimental site. Temperature varied from 25 to 30 °C; transparency, 25-43 cm; pH, 6.0-9.0; Dissolved Oxygen (DO), 3.50-5.00 mg L^{-1}; conductivity, 338-573 ppm and salinity 0 ppt (Table 2).

The variations observed in water temperature might be related to the weather conditions. However, temperatures are recorded within the optimal ranges (25-30 °C) for best possible zooplankton production in tropical ponds [4, 14]. The optimal temperatures for fish culture were 26.06-31.97°C [15]. Variation in transparency of water depends on several factors such as silting, phytoplankton density, suspended organic matter, latitude, season and the angle and intensity of incident light [16]. Moreover, it should also be noted that temperature alone may not account for variations in zooplankton densities as other factors such as high pH, conductivity and nutrients are also responsible for the organic production [17].

Qualitative Analysis of Zooplankton in Different Types of Ponds: Qualitative analysis of carried out in various types of pond like culture, household and unused pond over a specific period and found mainly 4 groups of zooplankton (Rotifers, Cladoceras, Copepods and Crustacean larvae) consisting of 14 genera. Among the identified genera, 2 Genera belonging to Copepoda, 3 to Cladocera, 3 to Crustacean larvae and 6 to Rotifera. In group Rotifer, *Brachionus* genus was found abundantly which is represented by 5 species viz., *Brachionus plicatilis, B. quadridentatus, B. falcatus, B. calyciflorus* and *B. diversicornis.* Others were *Tricocera*, *Lapadella*, *Keratella* and *Testudinella.* The observed 3 genus of cladoceran were *Diaphanosoma*, *Moina* and *Alona.* The group Copepoda was represented by 2 genus viz. *Cyclops* and *Diaptomus*. Group Crustacean larvae were represented by 3 genus viz. *Nauplius*, *Streptocephalus* and *Metanauplius* (Table 3).

The observed variability of zooplankton distribution in freshwater ponds mainly depends on ponds' environment, season, management activities and water quality parameters. Zooplankton population in nutrient rich waters is more diverse than those in nutrient deficient

Table 2: Physicochemical parameters of different types of ponds

Water quality parameters (Mean value)	Cultured pond	Household pond	Unused pond
Temperature (°C)	28-30	25-30	28-30
Transparency (cm)	25-38	38-40	40-43
Salinity (ppt)	0	0	0
Conductivity (ppm)	460-573	338-400	420-470
pH	7.5-8.9	7.8-9.0	6.0-9.0
DO mg/L	4.0-5.0	3.5-5.0	3.0-5.0

Table 3: Generic status of zooplankton with their different groups recorded from different types of pond during the study period in Noakhali region

Group	Genus	Species
Copepoda	*Cyclops*	*Cyclops vernalis*
	Diaptomus	
Cladocera	*Diaphanosoma*	
	Moina	
	Alona	
Crustacean larva	*Nauplius*	
	Streptocephalus	*Streptocephalus baird*
	Metanauplius larva	
Rotifera	*Brachionus*	*Brachionus diversicornis*
		Brachionus plicatilis
		Brachionus calyciflorus
		Brachionus quadridentatus
		Brachionus falcatus
	Rotifer	
	Keratella	*Keratella stipitata*
		Keratella Volga
	Tricocera	
	Lepadella	
	Testudinella	

waters [18]. Many researchers have studied about the diversity of zooplankton species in freshwater environment. Our findings are more or less comparable to the others. Similar finding was confirmed by other study [7, 19, 20]. It was 13 genera of zooplankton in earthen fish ponds within the Mymensingh region, Bangladesh of which Rotifera and Crustacea were found dominant [19]. It observed 11 genera of different group of zooplankton in Halda River, Bangladesh [7]. Higher number of zooplankton genera than our findings has also been confirmed by Rajashekhar *et al*. [21]. They found 24 species of which, 10 species belongs to Rotifera, 6 to Cladocera, 5 to Copepoda and 3 to Ostracoda. They recorded that Rotifera was the dominant group among the zooplankton species which is similar to our findings. However, lower number of zooplankton genera than the current study has also been recorded by Hossain *et al*. [19], Rahman and Hussain [22], Roy *et al.* [23] and Das *et al.* [24]. It was 9 genera of zooplankton in different water bodies of the Rajshahi University campus, Bangladesh of which Cyclops was found most abundant [22]. About 10 genera of zooplankton from earthen fish ponds within the Rajshahi region, Bangladesh of which 4 belonging to Rotifera (40.13%) and 6 to Crustacea (59.87%) [19]. It was also studied on carp brood pond and found six group of zooplankton of which Copepod and Cladoceron were most dominant species [23].

Quantitative Variation of Zooplankton Density in Different Types of Ponds: Quantitative analysis of zooplankton was observed among the identified groups (Rotifera, Crustacean larvae, Copepoda and cladocera). Zooplankton density was found 5550, 2655 and 1670 units/1 respectively in culture, household and unused pond (Fig. 2). Among the identified groups, Rotifera was found abundantly with a density of 2100 ind/l, 1370 ind/l and 983 ind/l respectively in culture, household and unused pond. The second dominant group Copepoda was found with the densities of 1260 ind/l, 983 ind/l and 700 ind/l respectively in culture, household and unused pond.

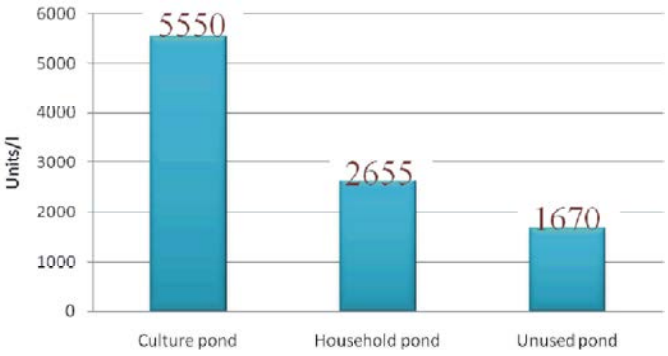

Fig. 2: Comparison of zooplankton density among various types of experimental ponds of Noakhali region

Table 4: Zooplankton abundance observed in various types of ponds during the study period in Noakhali region

Zooplankton		Culture pond		Household		Unused pond	
Group	Genus	(Units/l)	Percentage (%)	pond (Units/l)	Percentage (%)	(Units/l)	Percentage (%)
Copepoda	*Cyclops*	860	23	586	37	400	27
	Diaptomus	400		386		300	
	Total	1260		973		700	
Cladocera	*Alona*	250	16	0	19	0	8
	Moina	390		250		0	
	Diaphanosoma	300		250		200	
	Total	890		500		200	
Rotifera	*Brachionus*	1850	38	583	37	450	53
	Rotifer	250		200		0	
	Keratella	0		200		270	
	Lepadella	0		0		200	
	Tricocera	0				200	
	Testudinella	0		0		250	
	Total	2100		983		1370	
Crustacean larvae	Nauplis	1250	23	200	7	300	12
Grand Total	5550	100	2655	100	1670	100	

The observed density of Cladocera was 890 ind/l, 500 ind/l and 200 ind/l respectively in culture, household and unused pond. Density of Crustacean larvae was also found 1250 ind/l, 200 ind/l and 300 ind/l respectively in culture pond, household and unused pond. In culture pond, percentage of Rotifers, Copepod, Cladocerans and Crustacean larvae were 38%, 23%, 16% and 23% respectively. In household pond, percentage composition of zooplankton group was 37% (Rotifers), 37% (Copepod), 19% (Cladocerans) and 7% (Crustacean larvae). And in unused pond, Rotifers, Copepod, Cladocerans and Crustacean larvae were found 53%, 27%, 8% and 12% respectively. Among the identified four groups of zooplankton, Rotifer was observed more abundant (54%) in unused pond whereas Copepoda was found more abundantly in household pond (37%). Highest level of Cladocera was observed both in household (19%) and culture pond (16%). Crustacean larvae were found abundant in culture pond (23%) than in unused pond (11%) and lowest in household pond (7%) (Table 4).

The observed variation in zooplankton density among the ponds could be related to strategy of pond management. Fertilization is a common practice in culturable pond to increase natural food productivity whereas it is little or not practiced in household and unused pond. Moreover, water quality parameters of pond water also might be related to variation in zooplankton abundance. Our observed zooplankton density in freshwater ponds is much or less similar to the findings of other researchers. It was reported about zooplankton abundance in different water bodies of the Rajshahi University campus [22]. They recorded that Copepods were the most dominant group which contributed an average density of 1260 units/l and 973.33

units/l in water body-1 and water body-2 respectively. Rotifers were second dominant, next was Cladocerans and lastly Crustacean larvae. It was reported various percentages of Copepod (55%), Rotifer (8%), Cladocera (25%), Ostracoda (9%) and Crustacean larvae Brysozoa (2%) in carp brood fish pond [23]. It was observed zooplankton abundance of an earthen fish pond varied from 7620 to12160 units/1 [19]. It was observed the zooplankton abundance in a shrimp culture pond of Orissa and found dominant group Crustacean (1.78×10^3 L^{-1}) than Rotifera (1.34×10^3 L^{-1}) [24]. It was studied on quantitative status of zooplankton of a large man-made reservoir in the Gulbarga district, India and found the composition as Rotifera (41%), Cladocera (28%), Copepoda (23%) and Ostracoda (8%) [21].

CONCLUSION

The results of the study show that zooplankton species composition and their abundance in freshwater fish ponds are variable. No single factor is responsible for this variability. However, temperature, sunlight exposure period, sunlight penetration, water pH, wind, transparency, seasonal variations, water characteristics, nutrient enrichment and prey-predator might be related with variable changes. Hence, there is a need to carry out successive studies to look at the dynamics of the plankton groups within the culture ponds sampled over several years in order to characterize fully the variations both due to water quality and variability in climatic conditions. This information is useful for the future research as a foundation study towards characterization of these dynamics within the culture ponds of the Noakhali, Bangladesh.

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