INTERNATIONAL JOURNAL OF APPLIED BIOLOGY AND PHARMACEUTICAL TECHNOLOGY

Volume: 2: Issue-3: July-Sept -2011 IJABPT *ISSN 0976-4550*

ZOOPLANKTON DIVERSITY AND PHYSICO-CHEMICAL CONDITIONS OF TWO WETLANDS OF JALPAIGURI DISTRICT, INDIA

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ABSTRACT: Zooplankton diversity and physico-chemical parameters of two wetlands were studied to adjudge the health and potential threats of those wetlands. Zoolankton species diversity in both the wetlands was found to be quite high. Rotifer was the richest group having 48 species and *Brachionus* species (11) enjoy numerical superiority followed by *Lecane* (9). Only during premonsoon period rotifer and cladoceran diversity was significantly different in these two wetlands. Presence of higher number of copepods in all seasons signifies oligotrophic condition of these wetlands. Physico-chemical parameters indicate prevalence of good quality of water in both the wetlands but the wetland (Domohani Beel) having lesser zooplankton diversity experienced deterioration in water quality during premonsoon season. During premonsoon period Domohani wetland experienced intense 'Boro' cultivation having little water covered area with full of water hyacinth; and this poor condition reflects on its poor zooplankton diversity. Zooplankton diversity was significantly positively correlated with TSS, vegetative heterogeneity, and submerged macrophytes and negatively correlated with BOD and free CO_2 of water. Loss of natural vegetation and eutrophic condition borne out of agricultural practices are thus hampering zooplankton life having an adverse effect on food chain.
Key words: wetland, zooplankton, habitat heterogeneity, submerged aquatic vegetation, Jalpaiguri

INTRODUCTION

Wetlands being one of the most productive ecosystems are crucial for biodiversity conservation. Richness of wetlands depends a lot on its plankton community because they are placed on the base of the food pyramid. Zooplankton are one of the most important biotic components influencing all the functional aspects of an aquatic ecosystem, such as food chains, food webs, energy flow and cycling of matter (Murugan et al., 1998; Dadhick and Sexena, 1999; Sinha and Islam, 2002; Park and Shin, 2007). The distribution of zooplankton community depends on a complex of factors such as, change of climatic conditions, physical and chemical parameters and vegetation cover (Rocha et al., 1999; Neves et al., 2003). Zooplanktons play an integral role and may serve as bio indicator and it is a well-suited tool for understanding water pollution status (Ahmad, 1996; Contreras et al., 2009).

Information on zooplankton diversity of floodplain wetlands of the country is scanty and scattered except some reports of Khan from Kashmir (1987), Rai and Datta Munshi from Bihar (1988), Sugunan (1995), Khan (2002, 2003), and Ganesan and Khan(2008) from southern Bengal; Sharma (2005, 2010), and Sharma and Sharma (2008) from Assam; Sharma (2009) from Manipur, and a few others. Study of this kind is almost lacking from this northern part of Bengal. Keeping in view the importance of such wetlands and general dearth of literature, the present work was undertaken to assess the physico-chemical quality of water and diversity, abundance and seasonal variation of zooplankton community of two wetlands of Jalpaiguri District of North Bengal.

STUDY SITES

Both the study sites (viz. Gajoldoba beel and Domohani beel) are basically perennial cutoff meander by the left side of river Teesta at the Jalpaiguri district of West Bengal, India. Gajoldoba beel (26.763897N, 88.597498E) is situated by the side of the Gajoldoba barrage and about 26km. upstream to Domohani beel (26.569688N, 88.765644E). The Gajoldoba beel is managed by the State owned Teesta Barrage Division, Odlabari, while the Domohani beel is privately owned. The average rainfall of this region is about 3160mm and the average temperature ranges from 32.8° C (max) to 6.9°C (min).

Contour of these floodplain wetlands vary widely from season to season depending on the water incursion. The connection between Teesta and Gajoldoba beel is persistent for through out the year and as a result the water level in the 'beel' fluctuates in synchrony with the river. Most important thing of the Gajoldoba beel hydrology is that, it becomes regulated by the adjacent barrage authority not by the natural hydrological cycle of the region. For example, this region experiences about 78% rainfall during monsoon (June to September) and only 0.98% rainfall during winter (December to February); however, Gajoldoba beel experiences highest water level during winter season because during that period most of the gates of the barrage remains closed. Domohoni beel, on the other hand, get connected with the river Teesta only during the period of monsoon and water level in this wetland fluctuates with the normal hydrological cycle of the region.
Due to vigilance of Barrage authority, other than fishing, no human activities are permitted in the Gajoldoba beel. As a result the wetland maintains its structural heterogeneity with diverse macrophytes. On the other hand, Domohani Beel experience intensive 'Boro' cultivation during pre-monsoon period. From February to May most of the water filled area of Domohani Beel get covered with water-hyacinth and remaining parts look like a cultivated land having no structural and vegetative heterogeneity.

METHODS

Both the wetlands were surveyed at least twice in a month during the study period from March 2009 to August 2010. For the statistical analysis, data were pooled in three groups *viz.,* Premonsoon (March – May), Monsoon (July – September) and Postmonsoon (November – January). Also, for the convenience of study each wetland was divided into three zones considering its physical boundaries (mainly spurs of embankment), vegetation characteristics, and human activities.
Temperature (air and surface water) was recorded on the spot using Centigrade Thermometer. The pH, total dissolved solid (TDS), and conductivity of the water samples were measured on spot by using water analysis kit. All other physico-chemical analysis was done in the departmental laboratory on the same day preferably within one to two hours of collection. Turbidity was measured by Turbidity meter and results reported as Nephelometric Turbidity Units (NTU). Chemical analysis of the sample was done according to standard methods (APHA, 1995).
Water samples were collected periodically from the three selected zones of each wetland during morning session (7.00 to 9.00 am). Qualitative sampling of zooplankton was done with the aid of plankton net of mesh size 60 - 75µ by sweeping it through the weeds in the littoral zone and by towing it through the water in the limnetic zone from boat. Quantitative samples were collected by filtering 100 litre of water. Collected specimens were transferred carefully to a tube and narcotized with 5% formalin and preserved in 5% buffered formalin and added a few drops of Rose Bengal solution which colours the zooplanktons and make them conspicuous.
Detailed taxonomic identification was done with the help of a stereoscopic microscope having different magnifications following the literature of Sehgal 1983; Battish 1992; Sharma 1999; and Venkataraman 1999. The quantitative analysis of planktonic organisms was carried out using Sedgwick Rafter plankton counting cell.
Three indices were used to obtain the estimation of species diversity (Shannon and Weaver 1949), species richness (Margalef 1951; Menhinick 1964) and species evenness (Pielou 1966; Sheldon 1969). The Pearson's Correlation Coefficient (r) was used for the simple relationship analyses with the variables. When the data presented a non-normal distribution, these were logarithmically transformed. A forward stepwise multiple regression test was employed for each period, using Premonsoon, Monsoon and Postmonsoon number of species as dependent variables and the characteristics of the wetlands having simple significant relationship with the number of species on the wetlands as independent variables.

RESULTS AND DISCUSSION

Species diversity indices such as species richness and evenness were studied in order to measure the status of water quality in these two wetlands and relationship that exists between the physico-chemical characteristics. Data obtained from the study indicates that a total of 76 zooplankton species were recorded in two wetlands comprising of 48 species of rotifers, 9 copepods and 19 cladocerans. High number of zooplankton species was observed in the Gajoldoba beel (73 species) in comparison to Domohani beel (59 species) (Table 1).

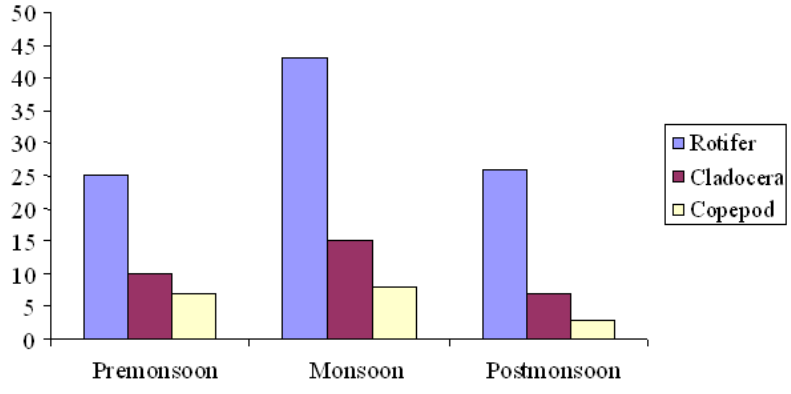
Table 1: List of Zooplankton species obtained during different seasons

Zooplankton Species	Gajoldoba Beel			Domohani Beel		
	PRM	MON	POM	PRM	MON	POM
Rotifera :						
Brachionus angularis	+	+	-	-	-	-
Brachionus calyciflorus	+	+	+	+	+	+
Brachionus bidentatus	+	+	+	+	+	-
Brachionus quadridentatus	+	+	-	-	+	+
Brachionus forficula	+	+	-	-	-	-
Brachionus falcatus	+	+	-	-	+	-
Brachionus caudatus	+	+	+	+	+	+
Brachionus urceolaris	-	+	-	-	-	-
Brachionus patulus	+	+	+	-	+	+
Brachionus udapestinensis	-	+	-	-	-	-
Brachionus rubens	-	+	-	-	+	+
Asplanchna brightwelli	+	+	+	+	+	+
Asplanchna priodonta	+	+	-	+	+	-
Keratella tropica	-	+	+	+	+	+
Keratella cochlearis	-	+	+	-	-	-
Keratella quadrata	-	+	-	-	+	+
Keratella lenzi	-	+	+	-	-	-
Euchlanis dilatata	+	+	+	-	+	+
Dipleuchlanis propatula	+	+	-	-	-	-
Mytilina ventralis	+	+	+	+	+	+
Trichotria tetractis	+	+	+	-	+	+
Platyias quadricornis	+	+	+	-	+	+
Platyias trgonnellus	-	+	+	-	-	-
Lepadella ovalis	+	+	-	-	+	-
Lepadella patella	-	+	-	-	-	-
Lecane curvicornis	-	+	-	-	+	-
Lecane leontina	+	-	+	-	-	+
Lecane papuana	+	+	+	-	+	+
Lecane bulla	+	+	-	-	+	-
Lecane hamata	-	+	+	-	+	-
Lecane luna	-	+	+	-	+	-
Lecane quadridentata	-	-	+	-	-	-
Lecane ungulata	-	+	+	-	-	-
Lecane unguitata	+	+	-	-	-	+
Monommata sp.	-	-	-	-	+	-
Polyarthra vulgaris	+	+	+	+	+	+
Pleosoma lenticulare	+	+	-	-	+	-
Hexarthra mira	-	+	-	-	+	-
Filinia longiseta	-	+	+	-	+	+
Filinia terminalis	-	+	+	-	+	-
Ascomorpha ovalis	+	+	-	-	+	+
Testudinella patina	+	+	+	+	+	+
Testudinella parva	-	+	-	-	+	-
Trichotria tetractis	-	+	+	-	+	+
Trichocerca cylindrica	+	-	+	-	-	+
Trichocerca elonata	-	-	-	-	+	-
Trichocerca rattus	-	+	-	-	-	-
Trichocerca similis	-	+	+	-	+	+

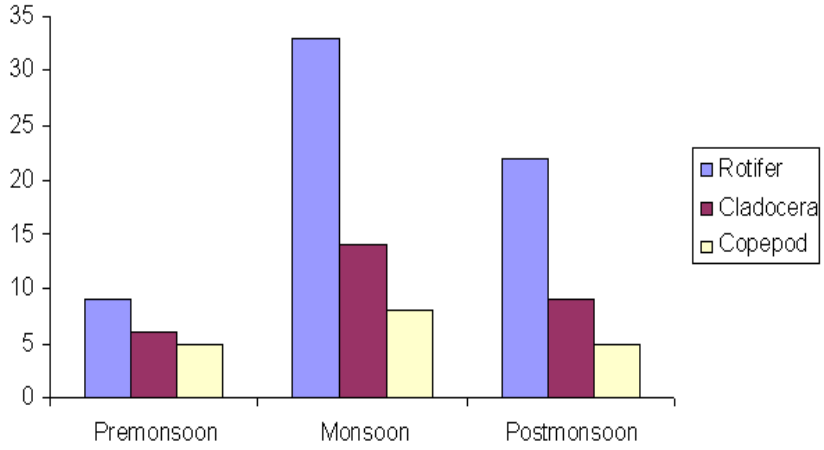
Cladocera :						
Bosmina longirostris	+	+	+	+	+	+
Alona pulchella	-	+	+	-	-	-
Alona rectangular	-	+	-	-	+	-
Alona verrucosa	+	+	-	-	+	-
Biapertura sp.	-	+	-	-	-	-
Kurzia longirostris	-	-	+	-	+	+
Chydorus parvus	-	+	-	-	+	+
Chydorus sphaericus	-	+	-	-	+	+
Chydorus ventricocus	+	+	-	+	+	-
Ceriodaphnia cornuta	+	+	+	+	+	+
Daphnia carinata	+	-	+	+	+	+
Daphnia lumholtzi	-	+	+	-	-	+
Daphnia pulex	-	+	-	-	-	-
Moina micrura	+	+	+	+	+	+
Diaphanosoma sarsi	-	+	-	-	+	+
Diaphanosoma excisum	+	+	-	-	+	-
Macrothrix goeldi	+	+	-	+	+	-
Macrothrix laticornis	+	-	-	-	-	-
Macrothrix spinosa	+	-	-	-	+	-
Copepoda :						
Cyclops vicinus	+	+	-	+	+	+
Mesocyclops leuckarti	+	+	-	+	+	-
Microcyclops varicans	+	+	-	+	+	+
Paracyclops fimbriatus	+	+	+	+	+	+
Trophocycops prascinus	+	+	-	-	+	-
Heliodiaptomus viduus	-	+	+	-	+	+
Heliodiaptomus cinctus	-	-	-	-	+	-
Neodiaptomus handelli	+	+	-	-	-	-
Nauplii Larvae	+	+	+	+	+	+
Total number of species :	42	66	36	20	55	63

PRM =Pre-monsoon; MON = Monsoon; POM = Post-monsoon

However, differences in species diversity and abundance of zooplanktons in these two wetlands were not significant for most of the season. Only during pre-monsoon period, rotifer ($t = 6.65$; $P = 0.001$) and cladoceran ($t = 4.1$; $P = 0.01$) diversity was significantly different (Figure 1(a) & (b). In both the wetlands higher number of zooplankton species was recorded during monsoon period (July to September). Lowest zooplankton diversity was observed during post-monsoon (winter) season at Gajoldoba beel but during pre-monsoon season (summer) at Domohani beel.



(a)



(b)

Figure 1: Seasonal variation in zooplankton species number at (a) Gajoldoba (b) Domohani

Rotifer is the richest group with 48 species, which accounts for 63% of total zooplankton population. About 1700 species of rotifers have been described from the different parts of the world and 500 species (only 330 species belonging to 63 genera and 25 families have so far been authenticated) was described from Indian water bodies (Arora and Mehra, 2003; Kiran et al., 2007). In this study, *Brachionus* species (11 specis) was found to attain numerical superiority in rotifer population followed by *Lecane* species (9 species). *Brachionus* species are considered typical for and most frequent in tropical environment (Nogueira, 2001; Mulani et al, 2009). Genus Brachionus is one of the most ancient genus of monogonont rotifers and is represented by 46 species in India (Sharma and Sharma, 2001). In overall count for all months copepods were present in fairly good numbers. Copepods are found to be dominant in oligotrophic lakes (Kurasawa, 1975).

Higher mean value of Shannon's index (H') was recorded in Gajoldoba (2.82±0.08) as compared to Domohani (2.39±0.21). However, other than pre-monsoon period this difference was not significant enough. Balloch et al. (1976) and Ismael and Dorgham (2003) advocated that the diversity index (Shannon's) was found to be a suitable indicator for water quality assessment. In that sense there does not exists any significant difference in the water quality of these two wetlands except pre-monsoon period.

Zooplankton species richness (R1 and R2) was also found to be high in Gajoldoba (R1: 4.52±0.17; R2: 2.36±0.08) as compared to Domohani (R1: 3.95±0.21; R2: 2.08±0.19). Higher species richness (R1and R2) is characterized by larger food chain (Dumont, 1999). The mean value of the evenness index ranges between E1=0.86 to 0.94 and E2= 0.73 to 0.87 at Gajoldoba and E1= 0.79 to 0.91 and E2= 0.54to 0.82 at Domohani. At Gajoldoba and Domohani evenness was relatively high during the postmonsoon and premonsoon period respectively, indicating a reduction in the plankton diversity at this period.

The physico-chemical parameters of water of these two wetlands have been given in the Table 2. High value of pH, dissolved oxygen and total hardness and low value of nitrate and phosphate indicate the good quality of water at Gajoldoba beel. Also for Domohani it is partly true but distinct differences exist during premonsoon period. Lower pH and dissolved oxygen indicate the threat of eutrophication at Domohani beel. Out of 17 parameters only three (viz. Total Suspended Solid, free CO_2 and BOD) were found to be significantly correlated with zooplankton species number. Total suspended solid was positively correlated ($r = 0.704$; $P<0.05$) but free CO_2 ($r = -0.614$; $P<0.05$) and BOD ($r = -0.652$; $P <0.05$) were negatively correlated with species number. Zooplankton species diversity was also positively correlated with some habitat characteristics like submerged vegetation, habitat heterogeneity and depth of water and was negatively correlated with floating vegetation (mainly water hyacinth). Stepwise multiple regression analysis with all these significantly correlated data advocates the importance of submerged vegetation and negative impact of water hyacinth.

Table 2: Physico-chemical parameters of water of Gajoldoba and Domohani Beel at different season

Parameters	PRM		MON		POM	
	G	D	G	D	G	D
Air Temperature (°C)	28.4	28.8	28.8	29.3	13.6	14.1
Water Temperature(°C)	30.5	30.8	30.3	30.4	17.1	16.8
Salinity (ppt)	0.032	0.031	0.033	0.03	0.035	0.03
Conductivity (mS)	0.08	0.02	0.05	0.03	0.07	0.04
Turbidity (NTU)	10.6	8.8	74.4	15.6	9.6	10
Total Dissolved Solid	0.05	0.01	0.03	0.02	0.04	0.02
Total Suspended Solid	0.07	0.04	0.09	0.06	0.08	0.05
pH	7.62	6.28	7.71	6.65	7.58	6.93
Fluoride (ppm)	0.15	0.4	0.45	0.25	0.25	0.25
Chloride (ppm)	9.99	7.25	6.2	6.25	5.6	10.5
Total Alkalinity (mg/l)	50.65	23.8	24.26	20.36	72.18	31.44
Free CO_2 (mg/l)	2.82	18.6	3.52	13.8	2.2	15.4
Dissolve Oxygen (mg/l)	5.46	2.5	4.86	5.68	6.32	2.92
BOD (mg/l)	0.92	1.38	0.89	0.41	0.82	0.78
Nitrate (ppm)	0.48	0.66	0.46	0.32	0.3	0.35
Phosphate (mg/l)	1.55	1.73	1.05	0.76	0.8	0.75
Total Hardness (ppm)	15	25	25	25	21.67	25

Submerged and floating water plants serve a number of important functions. In wetlands, a well-developed macrophyte community provides shelter against predation for vulnerable prey species like small zooplankton (Batzer 1998). In addition, macrophytes are usually covered with epiphytes that are grazed upon by several invertebrates (van den Berg et al. 1997) that are themselves an important fraction of the diet of many fishes and birds (Batzer & Wissinger 1996). In general, lakes with a well-developed macrophyte community are characterised by a more diverse community of zooplankton (Timms & Moss 1984). Invasions of water hyacinth have become a nuisance worldwide. It is now considered as a threat to biological diversity, affecting fish faunas, plant diversity and other freshwater life and the food chains, which depend upon it (Luken & Thieret 1997). The absence of a well-developed macrophyte community and the decreased levels of oxygen under the canopy of water hyacinth (Rommens et al. 2003) may be adverse for zooplankton richness and abundance.

Acknowledgements

This study was financially supported by the University Grants Commission, India. I am thankful to the Department of Zoology, Ananda Chandra College, for providing all sorts of infrastructural support. I also thank Dr. Amal Kumar Patra, Mr. Santanu Ghosh Dastidar and Mr. Suman Senupta who helped me in various ways during field studies and laboratory works.

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