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Community Structure of Zooplankton in Three Different Types of Water Bodies of West Midnapore District, India

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Abstract: *The aim of this study was to identify differences between different types of water bodies by comparing the composition of the zooplankton community. The study was conducted in three types of water bodies - a pisciculture pond (Eco-1), a macrophyte infested wetland (nayanjulli, Eco-2) and a flood-plain perennial impoundment (Eco-3). The spatio-temporal changes of these three types of aquatic habitats were investigated in terms of the zooplankton organisms by examining their species diversity. A total of seventy three species were identified among which twenty-four species were observed in all the water bodies. Forty-three species were observed in Eco-1 only whereas fifty six and forty-nine species were identified from Eco-2 and Eco-3 respectively.*

Key words: *Aquatic habitats, macrophyte, spatio-temporal changes, species diversity, zooplankton community.*

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I. Introduction

Wetlands are ecologically and economically important Ecosystems. Currently the value of many wetland functions is often underestimated even though economists continue to develop techniques to value the diverse array of wetland benefits (Barbier et al. 1997). All the benefits provided by wetlands must be incorporated in resource planning and decision making. The use of wetlands in a wise way can be defined as their sustainable utilization for the benefit of humankind in a way compatible with the maintenance of the natural properties of the ecosystem (Ramsar Convention Secretariat 2004). This concept acknowledges that human development necessitates adjustment of wetland ecosystems, and the sustainable utilization of wetlands requires a comprehensive understanding of developments at the interface between human societies and the natural world.

Various well known factors play a role in shaping the freshwater community structure. Among them abiotic parameters, nutrient limitation, predation and competition are the most important. Over the past several decades, many changes in land use patterns have increased water turbidity and nutrient concentrations. To track these changes in ecosystem quality and quantity, investigators require simple, robust indicators that can be applied uniformly by many environmental agencies. We have chosen zooplankton, and their association with macrophytes and relevant water quality variables, to indicate the quality of three wetlands of contrasting ecological characteristics. Our rationale for choosing zooplankton was – i) Zooplankton play a major role in the functioning and the productivity of aquatic ecosystems through its impact on the nutrient dynamics and its key position in the food webs [Etilé et al., (2009)].
ii) Zooplankton community is highly sensitive to environmental change (Joseph et al.,2011). A change in the physico-chemical conditions in aquatic systems brings a corresponding change in the relative composition and abundance of organisms thriving in the water, therefore they can be used as a tool in monitoring water systems (Smitha et al., 2013).
iii) Zooplankton also constitutes one of the main subsystems in water bodies, transferring energy from autotrophic organisms or microzooplankton to higher trophic levels and regulating sedimentation and cycling of nutrients (nitrogen, phosphorus, carbon) (Eyre [2000]; Eyre and McKee [2002]; Lassalle et al. [2013]).

Although zooplankton are well known for their quick response to environmental conditions, only a few attempts have been made to use the zooplankton community to indicate quality of aquatic ecosystems (Sla´decek 1983).

So the main focus of this investigation was to enhance the understanding of the distribution and the ecological requirements of zooplankton communities utilizing the littoral zone of the water bodies. Aquatic vegetation may offer both a nutritional source and protection against both invertebrate and vertebrate predation (Warfe & Barmuta 2004), as well as constitute a support for epiphytic and littoral-associated organisms. Furthermore, numerous studies have indicated the great importance of limnological parameters (e.g. conductivity, total dissolved solid, pH or dissolved oxygen) in modeling the zooplankton community structure

(Kuczyn´ska-Kippen & Nagengast, 2006). The present study was undertaken to assess the ecology and ecopotentiality of waterbody by studying zooplankton community and also to find out which of the environmental factors are most important in structuring zooplankton communities (eg. macrophyte substratum, physico–chemical parameters etc.).

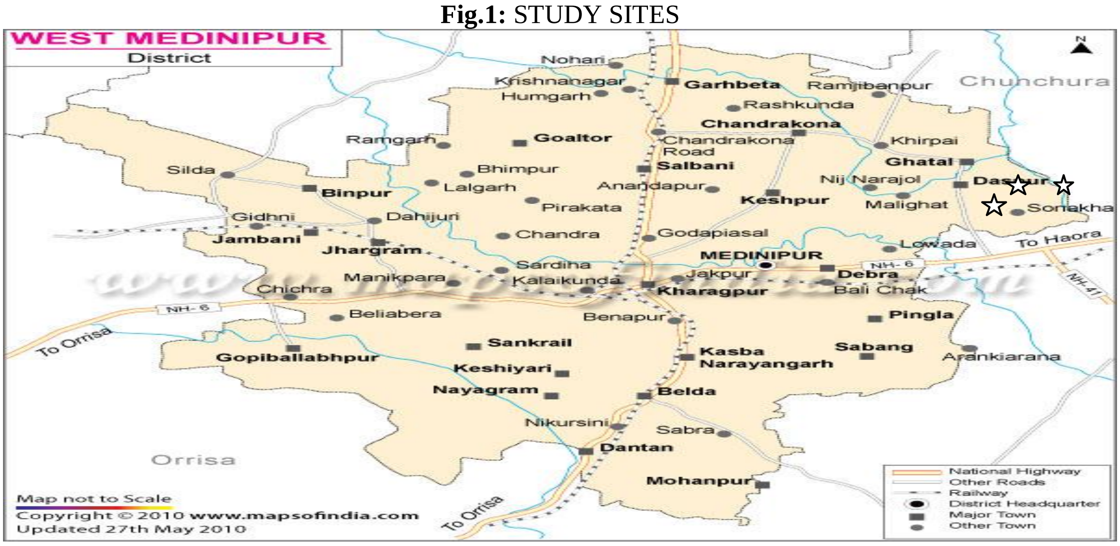
II. Materials and Methods

On the basis of topography, sources of run-off load and human impact following three types of waterbodies were selected. Total nine subsites belonging to three ecological patches- three sub-sites of a pisciculture impoundment (Eco-1), three from a macrophyte infested freshwater *nayanjulli* (Eco-2) and another three subsites of a perennial floodplain waterbody (Eco-3) having littoral and limnetic architecture along the riverine stretch of River Shilabati, West Midnapore (Fig.1) were being selected.

The present study was conducted during the period of November, 2012 to October, 2014. Monthly collections (last week of every month) of water samples were made from nine subsites between 7 am to 9 am. All these parameters were analyzed by a water analyzer.

One nylobolt plankton net (size 25) was swept through sub surface and collected organisms were transferred to 100 ml capacity plastic bottles. The samples were preserved in 4% formaldehyde solution and studied for diversity. The enumeration was done by using Sedgwick Rafter Counting Cell by taking 1 ml of subsample and expressed in number/liter.

Fig.1: STUDY SITES



III. Results

3.1 Environmental Variables:

Results of monthly physico-chemical analysis of water collected from nine sampling sub-sites with graphic representations were presented. Mean, range and standard deviation (SD) of different parameters during study period were recorded (Table1, 2 & 3). All the physicochemical parameters are computed by calculating the mean of sub-sites (three of each site).

Table- 1: Abiotic Factors of Eco-1

FACTORS	RANGE	MEAN ±SD
Water Temperature (°C)	17.07-38.17	27.54 ± 5.85
pH	6.3-8.8	7.46 ± 0.69
Dissolved Oxygen (mg/L)	5.87-10.23	7.67 ± 1.2
Conductivity (µs/cm)	278-958.73	600.97 ± 207.14
Total Dissolved solid (mg/L)	72.67-245.03	172.63 ± 43.11
Salinity (ppt)	0.04-0.43	0.19 ± 0.12

Table- 2: Abiotic Factors of Eco-2

FACTORS	RANGE	MEAN ±SD
Water Temperature (°C)	16.87-39.9	28.34 ± 6.12
pH	6.3-8.9	7.42 ± 0.79
Dissolved Oxygen (mg/L)	5.04-8.13	6.53 ± 0.86
Conductivity (µs/cm)	225.2-1122.3	675.43 ± 230.54

Total Dissolved solid (mg/L)	83.87-246.57	176.22 ± 45.5
Salinity (ppt)	0.04-0.527	0.2 ± 0.12

Table- 3: Abiotic Factors of Eco-3

FACTORS	RANGE	MEAN ±SD
Water Temperature (°C)	15.73-36.97	26.3 ± 5.89
pH	6.3-9.27	7.64 ± 0.98
Dissolved Oxygen (mg/L)	6.03-11.23	8.45 ± 1.47
Conductivity (µs/cm)	211-965.9	578.38 ± 196.93
Total Dissolved solid (mg/L)	68.733-247.67	157.91 ± 63.29
Salinity (ppt)	0.58-2.52	1.31 ± 0.53

3.2. Species Composition:

Detailed microscopic examination has revealed total forty one genera of zooplankton in the sample scanned through 2 year study period. The group-wise break up was

1. Rotifera : 17 genera
2. Copepoda : 8 genera
3. Cladocera : 14 genera
4. Ostracoda : 2 genera.

During the period of investigation in all the study sites it was observed that zooplankton were represented by four group of species viz. Rotifera, Copepada, Cladocera and Ostracoda. The last group Ostracoda was very scanty in their occurrence (Table- 4).

Table-4: Species Composition of Three Sites:

	TAXA	ECO-1	ECO-2	ECO-3
Sl.no.	**Phylum : Rotifera**			
	Subclass : Monogononta			
	Order : Ploima			
	Family : Asplanchnidae			
1	*Asplanchna priodonta*	+	+	-
	Family : Brachionidae			
2	*Brachionus angularis*	+	+	+
3	*Brachionus bidentatus*	-	+	-
4	*Brachionus budapestinensis*	-	+	-
5	*Brachionus calyciflorus*	-	+	-
6	*Brachionus caudatus*	+	+	+
7	*Brachionus diversicornis*	-	+	+
8	*Brachionus falcatus*	+	+	+
9	*Brachionus forficula*	-	+	+
10	*Brachionus quadridentatus*	-	+	+
11	*Brachionus rubens*	+	+	-
12	*Brachionus urceolaris*	-	+	-
13	*Keratella cochlearis*	-	+	+
14	*Keratella tropica*	+	+	+
15	*Platyias quadricornis*	-	+	+
16	*Plationus patulus*	+	+	+
	Family : Euchlanidae			
17	*Beauchampiella eudactylota*	-	+	-
18	*Euchlanis dilatata*	+	+	+
	Family : Lecanidae			
19	*Lecane arcula*	+	+	-
20	*Lecane crepida*	-	-	+
21	*Lecane leontina*	-	-	+
22	*Lecane nana*	+	+	-
23	*Lecane papuana*	+	+	-
24	*Lecane ruttneri*	-	+	+
25	*Lecane ungulate*	-	+	+
26	*Lecane (Monostyla) bulla*	+	+	-
27	*Lecane (Monostyla) lunaris*	-	+	-
28	*Lecane (Monostyla) stenroosi*	-	+	-
	Family : Lepadellidae			

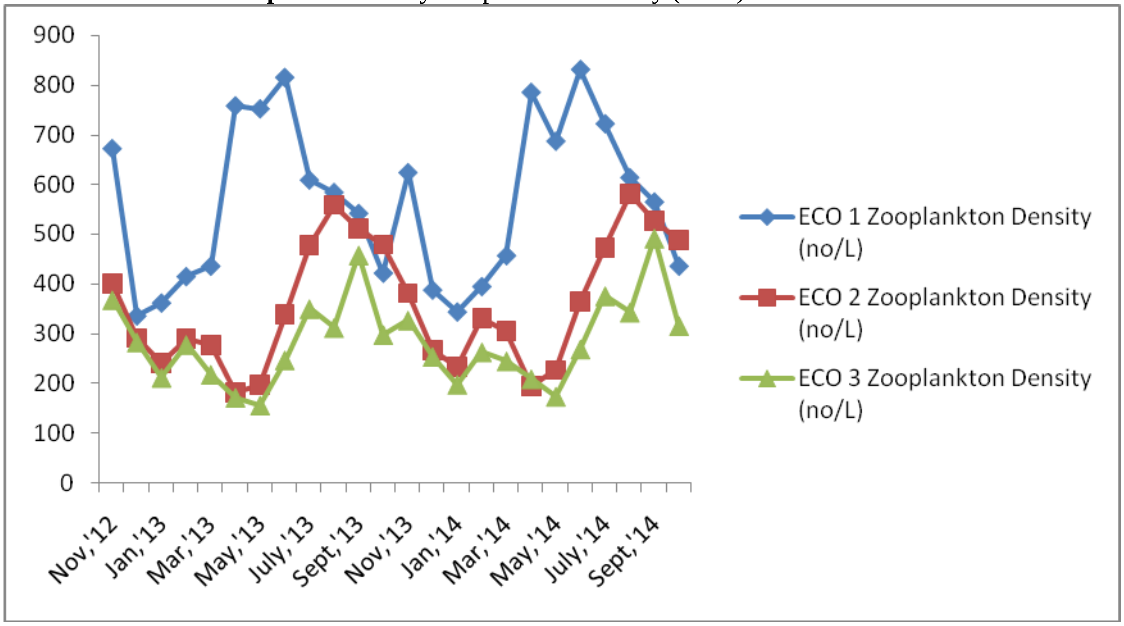
29	*Colurella uncinata*	-	+	+
30	*Lepadella ovalis*	-	+	+
	Family : Mytilinidae			
31	*Mytilina ventralis*	-	+	+
	Family : Scaridiidae			
32	*Scaridium longicaudum*	-	+	-
	Order : Flosculariaceae			
	Family : Conochilidae			
33	*Conochilus unicornis*	-	+	+
	Family : Testudinellidae			
34	*Testudinella emarginula*	-	+	+
	Family : Trichocercidae			
35	*Trichocerca rattus*	+	+	+
36	*Trichocerca spp.*	-	+	+
37	*Trichocerca similis*	+	+	+
	Family : Trochosphaeridae			
38	*Filinia longiseta*	-	+	+
39	*Filinia opoliensis*	-	+	+
40	*Filinia terminalis*	+	+	+
	Subclass : Digononta			
	Order : Bdelloidea			
	Family : Philodinidae			
41	*Rotaria rotatoria*	-	+	-
	Super-order : Cladocera			
	Family : Chydoridae			
	Subfamily : Aloninae			
1	*Alona rectangular*	+	-	+
2	*Alona affinis*	+	-	+
3	*Alonella sp*	-	-	+
4	*Camptocercus australis*	+	-	-
5	*Leydigia acanthocercoides*	-	+	+
6	*Oxyurella singalensis*	+	-	-
	Subfamily : Chydorinae			
7	*Chydorus barroisi*	+	+	+
8	*Picripleuroxus denticulatus*	+	-	-
9	*Picripleuroxus similis*	+	+	+
	Family : Daphniidae			
10	*Ceriodaphnia cornuta*	+	+	+
11	*Ceriodaphnia reticulate*	+	+	+
12	*Daphnia carinata*	+	+	+
13	*Daphnia lumholtzi*	+	+	+
14	*Daphnia similis*	+	+	-
15	*Scapholeberis kingi*	+	-	-
	Family : Macrothricidae			
16	*Eschinisca triserialis*	+	+	+
17	*Macrothrix spinosa*	+	+	+
	Family : Moinidae			
18	*Moina micrura*	+	+	+
	Order : Ctenopoda			
	Family : Sididae			
19	*Diaphanosoma excisum*	+	-	-
20	*Diaphanosoma sarsi*	+	-	-
	Class : Copepoda			
	Order : Cyclopoida			
	Family : Cyclopidae			
1	Cyclopoid nauplius	+	+	+
2	*Ectocyclops phaleratus*	+	-	+
3	*Eucyclops* sp.	+	-	+
4	*Mesocyclops leuckarti*	+	+	+
5	*Microcyclops varicans*	+	+	-
6	*Paracyclops fimbriatus*	+	-	-
7	*Tropocyclops prascinus*	-	-	+
	Order : Calanoida			
	Family : Diaptomidae			
8	Calanoid nauplius	+	+	+
9	*Heliodioptomus viduus*	+	+	+
10	*Neodiaptomus*	-	-	+

	Class : Ostracoda			
	Family : Cyprididae			
1	*Cypris sp.*	+	+	+
2	*Cyprinotus sp.*	+	-	+
	Miscellaneus	+	+	+

3.3 Variation of Total Zooplankton:

In Eco-1, the maximum numerical abundance (815 no/L) was recorded in June, 2013 and minimum abundance (336 no/L) was recorded in December, 2012 during the first annual cycle. During the second cycle, the minimum Zooplankton (344 no/L) was recorded in January, 2014 and the maximum (831 no/L) was noticed in June, 2014 During this study period Zooplankton showed two major picks in June in every consecutive year. Another two small peaks were also noticed in November (Graph-1). In Eco-2, during the first cycle, the highest value was (560 no/L) in August, 2013 and lowest value (182 no/L) noticed during April, 2013. In this site, the maximum numerical abundance (582 no/L) was recorded in August, 2014 and minimum abundance (196 no/L) was recorded in April, 2014 during the second annual cycle. In the first year of study only a single major peak was recorded in August (560 no/L) followed by February (290no/L) and November (402no/L) and in the second year however, the peaks were noticed. The first one was in August (582 no/L) and also a minor peak in February (332 no/L).(Graph-1). Eco-3 showed the total number of zooplankton was much less in this site than another two sites. During the first year of study the maximum zooplankton (458 no/L) was observed in September, 2013 and the minimum (156 no/L) was in May, 2013. In the second year the highest (492 no/L) was in September, 2014 and the lowest (174 no/L) was found in May, 2014. During the first cycle one sharp peak was noted in September. In the second cycle only one peak was observed in September (Graph-1).

Graph- 1: Monthly Zooplankton Density (No/L) of Three Sites



3.4. Relationship between total Zooplankton & physico-chemical factors:

Simple Correlation between physico-chemical parameters of water and total zooplankton of two years were analyzed. Besides, trophic interactions among macrophytes, phytoplankton, zooplankton and fishes had shown interesting differences among three different study sites. In Eco-1, out of the six physico-chemical parameters considered in the present study, the total zooplankton was found to have significant negative correlation with dissolved oxygen (DO) (r= -0.55; P<0.01). Significant positive correlation had been observed between total zooplankton and temperature (r=0.76; P<0.01), pH (r=0.54; P<0.01), conductivity (r=0.73; P<0.01) and salinity (r=0.55; P<0.01) (Table-5). In Eco-2, total zooplankton was positively significant with total dissolved solid (r=0.6; P<0.01) (Table-6) and in Eco-3, significant positive correlation had been recorded between total zooplankton and dissolved oxygen (r=0.66; P<0.01). Another significant positive correlation between total zooplankton and total dissolved solid was also noticed (r=0.64; P<0.01) (Table-7).

Table-5: Correlation of Zooplankton density with water quality parameters on monthly basis

Eco- 1	Temperature	pH	DO	Conductivity	TDS	Salinity	Zoo
Temperature	1.000						
pH	0.768	1.000					
Dissolved Oxygen (DO)	-0.820	-0.619	1.000				
Conductivity	0.784	0.621	-0.705	1.000			
Total Dissolved Solid (TDS)	0.524	0.266	-0.505	0.300	1.000		
Salinity	0.433	0.122	-0.244	0.302	0.237	1.000	
ZooPlankton Density (Zoo)	0.759	0.538	-0.553	0.733	0.363	0.549	1.000

Table-6: Correlation of Zooplankton density with water quality parameters on monthly basis in ECO-2

Eco- 2	Temperature	pH	DO	Conductivity	TDS	Salinity	Zoo
Temperature	1.000						
pH	0.648	1.000					
Dissolved Oxygen (DO)	-0.207	-0.382	1.000				
Conductivity	0.846	0.615	-0.221	1.000			
Total Dissolved Solid S)	0.582	0.181	0.028	0.690	1.000		
Salinity	0.604	0.314	-0.171	0.749	0.587	1.000	
ZooPlankton Density (Zoo)	-0.092	-0.211	0.385	0.143	0.668	0.216	1.000

Table-7: Correlation, Regression & ANOVA of Zooplankton density with water quality parameters on monthly basis in ECO-3

Eco-3	Temperature	pH	DO	Conductivity	TDS	Salinity	Zoo
Temperature	1.000						
pH	0.480	1.000					
Dissolved Oxygen (DO)	-0.443	0.203	1.000				
Conductivity	0.912	0.236	-0.546	1.000			
Total Dissolved Solid (TDS)	0.353	0.478	0.168	0.259	1.000		
Salinity	0.313	0.329	-0.184	0.337	0.457	1.000	
ZooPlankton Density (Zoo)	-0.147	0.310	0.660	-0.357	0.641	-0.044	1.000

IV. Discussion

In our study, rotifera species form the main qualitative component of zooplankton at all the study sites and additionally, cladocera contributes significantly to the zooplankton richness. The qualitative importance of rotifera in my study sites agrees with that reported by other researchers (Khan 2002, Sharma 2011, Sharma 2017). The higher zooplankton diversity in the macrophyte infested waterbody (Eco 2) is influenced by the higher rotifera diversity that increased in high water temperature and presence of aquatic vegetation, which is also observed in other studies in temperate and warm vegetated lakes. The probable explanation is that the macrophyte infestation promotes a high concentration of detritus that enhances bacterial production, which may be an important source of food for rotifers. In contrast, lower abundance of zooplankton in Eco-2 and Eco-3 (macrophyte infested fully or partially) than the Eco-1 was also supported by Rocha et al. (1997). In Eco 2 of my study, Zooplankton density oscillates (minor peaks) with annual frequency with winter peaks in February and November and minima in summer (April) which simulates the observation of Sharma 2011. While the peaks concur with luxuriant winter growth of aquatic macrophytes, the latter coincides with the lowest water level.

In aquatic ecosystem, zooplankton play an important role as they serve as a source of food for higher organisms. The composition and abundance of zooplankton are affected by the properties of water masses (Boucher,1987)like temperature and salinity. In our study forty one genera of zooplankton were observed and recorded in the study sites during the study period. The higher densities of zooplankton were recorded in the months of April, May, June, July, November (Eco-1) and August, September, November (Eco-2,3) and the higher peaks of TDS were also recorded in the months of July to September (in all the sites). The results showed to be similar with Etilé et al. (2009). This could be accounted to temperature and nutrients, because according to a study done by Wang et al in 2011, these two parameters play an important role in determining the biomass of zooplankton. Increase in TDS would likely increase in the abundance of zooplankton in the study sites. Temperature, one of the most important environmental factors greatly affects the biota of an ecosystem (Basu, 2010). Water temperature ranging between 13.5 to 32°C is reported to be conducive for the growth of the planktonic organisms. . (Kamat, 2000) Results of my study showed that the temperature in the study sites is favorable for the survival of zooplankton. Dissolved oxygen plays an important role in life processes in aquatic environment. Dissolved oxygen concentrations in Eco-1 ranged from 5.87-10.23 mg/L (Table-1), 5.04-8.13mg/L in Eco-2 (Table-2), 6.03-11.23 mg/L (Table-3) in Eco-3 during the investigation. The lowest concentration of dissolved oxygen in Eco-2 was recorded in March,'13 that reached 5.04 mg/L. Result showed that dissolved oxygen concentration in Eco-2 is one of the deciding factors of the variation in the abundance of zooplankton. Low dissolved oxygen concentration would bring about a decrease in the number of species thriving in the environment.

The significant positive correlation between zooplankton density and salinity in Eco-1 suggests that salinity in this site would result to greater abundance of zooplankton. High values of salinity were recorded in the month of October'14 wherein Eco-3 it reached 2.515 ppt. At the same stations zooplankton density was also recorded higher as compared to the other stations of the same time (September). Our current study showed that the zooplankton abundance varied seasonally in all the three types of waterbody. Zooplankton diversity was higher in vegetated waterbody than others. Higher amount of input of run-off in the Eco-2 might be the reason behind this observation (Saha et al 2016). The regular input of this provides a certain high level of nutrient to the fisheries which might be the reason that the zooplankton diversity and their abundance remain consistent throughout different seasons whereas in rest zooplankton diversity was observed to fluctuate showing the lowest values in monsoon. Domination of Brachionids among rotifers, *Ceriodaphnia*, *Moina* and *Diaphanosoma* among cladocera species and *Cypris* among Ostracods further reflect on trophic status of water body. The ecology and ecopotentiality of study sites are also determined by the zooplankton community.

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