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Original Article

Diversity of Zooplanktonic Community of two wetlands of Kolkata

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Abstract

The diversity of zooplanktonic community of two fresh water wetlands designates as P-1(rain fed) and P-2 (sewage fed), in relation to influence of some abiotic factors (Water temperature, transparency, pH, DO, CO_2, DOM, SiO_2, PO_4-P, NO_3-N, Hardness, Alkalinity, COD and BOD) and their seasonal variations have been studied. P-2 has fairly high DO and pH is always alkaline and is also rich in nutrients. But in P-1 all the above parameters recorded low values.The zooplankton community comprised Rotifera, Copepoda, Cladocera and Ostracoda. A total of 76 species (57 of Rotifera, 13 of Cladocera, 5 of Copepoda and 1 of Ostracoda) in P-1 while in P-2, 66 species (47 of Rotifera, 10 of Cladocera, 7 of Copepoda and 2 of Ostracoda) are recorded. Among rotifers Asplanchna sp,, Brachionus spp., Keratella sp., Filinia sp., Lecane sp., Polyarthrasp., Testudinella sp. and Rotaria sp. are more abundant, among cladoceransDiaphnosomasp., Ceriodaphnia sp. and Moina sp., among copepodaHeliodiaptomus sp. ,Mesocyclops spp. and nauplius larvae are more abundant.

Keywords: *Diversity, zooplankton, abiotic factors, indicator species, wetlands.*

Introduction

One of the most important dimensions of the ecological community is that of diversity. Diversity of the community, both diversity of species with in it and of their interrelationship to one anotheris a crucial facet of the system having many implications for community function and stability.The zooplankton of the inland water bodies mainly comprises five groups: Pritozoa, Rotifera, Cladocera and Ostracoda. Except the above groups there are occasional minor elements like various coelentarets, larval trematodes, gastrotrichs, water mites, Mysis etc. However, in most cases the above mentioned five groups are overwhelmingly dominant. The population dynamics and productivity of the protozoa are little understood and this group generally formed a minor position of zooplanktonic population. The Rotifera is a large Phylum of which about 100 species are completely planktonic (Mulani *et.al*., 2009), Crustacean, the truly planktonic form of fresh water is dominated almost by the cladocerans and copepods.

Studies on the diversity of the zooplanktonic community deserve more attention in India. Sharma and Dudani(1992), Jana and Kundu (1993), Hazarika and Dutta, (1994), Ghosh and Banerjee (1996), Unniand Fole (1997), Thomas and Azis (1998), Sharma and Sharma (2000, 2012), Chakraborty*et.al*., (2001),Hulyal and Kaliwal (2008),Isshad *et. al.* (2012), Sukla *et.al*. (2013), Kar and Kar (2013), Jindal and Thakur (2014), Ramalingappa *et. al.,* (2015), Malik and Panwar (2016), Manickam *et.al*. (2017), Sharma and Hatimuria (2017), Jamila (2018), Khandayat and Singh (2019),Singh and Sharma (2020), Sharma and Noroh (2020), Shwetanshumala and Sharma (2020) and many others contributed in this field.

Material and Methods

Of the two wetlands P-1 is rainfed and situated at Golpark, Kolkata (Lat 22^{0}31' N and Long 88^{0}22' E) having surface area of about 0.4 ha with an average depth of 2.5 meter. Almost half of the wetland is covered by *Ipomia* sp., *Nelumbo* sp., *Azolla* sp., *Lemna* sp. *etc.* Neither fish culture nor any domestic use has been noticed in this wetland. The other wetland P-2 is 1.5 ha in area which forms a part of the East Calcutta Wetlands and is situated near E.M Bypass at Topsia, Kolkata (Lat 22^{0}33' N and Long 88^{0}25' E). Its average depth is 1.5 meter. Waste water released by Municipal Corporation of Kolkata gets its entry into the wetland and its supply is maintained round the year with increase quantum in summer through a sluice gate. No macro vegetation is kept in this wetland as it is profusely used for pisciculture round the year.

Water samples and the surface zooplankton were collected weekly from January, 2018 to December, 2019, between 9 to 10 am. For physic-chemical analysis of water Welch (1948), Michael (1990) and APHA (2005) were followed. The zooplankton were collected with a plankton-netmade up of bolting silk no. 25 and the identification of it was done with the help of Davis (1955), Edmondson (1959), Battish (1992) and Ward and Whipple (1959).

Results

The values of different physic-chemical factors are shown in table 1 &2 and briefly describe. In P-1 the water temperature varied from 19.75 to 34^{0}C while in P-2 it was from 15 to 34.5^{0}C. Transparency ranged from 21.15 to 88 cm in P-1 and 5.5 to 16 cm in P-2. pH of water showed its minimum and maximum values of 6.5 and 8.4 in P-1 and 7.85 to 9.3 in P-2. Dissolved oxygen ranged from 1.2 to 11.2 mg/lit in P-1 and 2.4 to 16 mg/lit in P-2. The total alkalinity varied from 60 to 82 mg/lit in P-1 and 148 to 251 mg/lit in P-2.CO_2 in P-1 varied from 2.4 to 30 mg/lit while in P-2 it was from 0 to 46 mg/lit.DOM ranged from 0.75 to 4.84 mg/lit and 0.38 to 5.7 mg/lit in P-2 and P-1 respectively. The nutrients like PO_4-P, NO_3-N and SiO_2ranged from 0.13 to 1.67 mg/lit, 0.03 to 0.08 mg/lit and 0.52 to 1.49 mg/lit in P-1 while 0.19 to 1.73 mg/lit, 0.03 to 0.34 mg/lit and 1.82 to 4.66 mg/lit in P-2 respectively. Hardness in P-1 ranged from 13 to 26.8 mg/lit and in P-2 it was from 49.45 to 164 mg/lit. COD and BOD ranged from 8 to 60.5 mg/lit and 1.13 to 10.2 mg/lit in P-1 and 16 to 94 mg/lit and 5.62 to 28.8 mg/lit in P-2 respectively.

Table 1. Monthly variations of physic-chemical characteristics of water in the rain fed wetland (P-1) during January 2018 to December 2019.

2018	WT	TRN	pH	DO	TA	CO2	DOM	PO4	NO3	SiO2	HAR	COD	BOD
January	20	88	6.9	10.4	82	8	4.13	1.67	0.03	0.93	19.6	14	8.6
February	22.5	80.3	7.55	11.2	66	8.1	2.55	0.77	0.03	0.73	18.6	8	3.9
March	29	77.7	7.85	10.4	68	10	0.61	0.21	0.05	1	20	56	5.6
April	28	68.8	8	7.6	70	2.4	2.44	0.29	0.04	0.82	20	40	1.2
May	30	50.2	7.1	2	66	10	0.98	0.25	0.08	1.02	18	16	5
June	30.25	45.6	7.18	2.7	63.5	13.5	0.87	0.52	0.04	1.18	19.3	28	1.3
July	29.63	40.78	6.88	2.1	62	15	2.38	0.47	0.06	1.28	20.7	48	3.6
August	29.3	31.83	6.8	2.1	61.5	15	2.23	0.28	0.04	1.46	20.65	26	1.13
September	29.75	21.15	6.77	4.3	63.5	11.25	2.63	0.23	0.05	1.49	20	28	10.2
October	27.5	28.95	6.67	1.5	65.5	14.5	2.57	0.47	0.06	1.37	15.6	32	3.47
November	26.38	38.5	7.02	1.8	66	12	1.79	0.62	0.05	1.27	13	16	8.17
December	20.38	46	6.74	1.2	68.5	17	0.8	1.36	0.04	1.27	17.1	24	6.34

2019	WT	TRN	pH	DO	TA	CO2	DOM	PO4	NO3	SiO2	HAR	COD	BOD
January	19.75	82.5	6.93	3.6	69	9	1.54	1.67	0.03	1	17.5	16	5.24
February	23.25	74	7.6	10.2	69	8	2.01	0.74	0.05	0.78	17.7	28	4.6
March	30.5	63.25	8.43	10.6	71	5	1.77	0.36	0.05	1	21.5	44	3.8
April	29	53.5	8.13	8.6	66	16.8	2.14	0.73	0.05	0.81	21.4	44	3.4
May	34	40.5	7.8	7.4	66	5.8	0.75	0.38	0.06	1.3	21.4	60.5	3.2
June	33	38.3	7.35	8.2	60	8	1.81	0.39	0.04	1.02	22.6	60	3.4
July	30.5	34	7.08	6.2	69	8.5	1.65	0.32	0.05	1.06	23.4	16	2.94
August	30	31.3	6.5	2.4	76	12	3.23	0.31	0.05	1	26.8	16	3.33
September	29.5	37	6.63	1.3	68	15	1.73	0.15	0.03	0.52	22.65	16	6.67
October	28	45.6	6.65	2	62	18	0.38	0.13	0.03	0.65	16.4	14	4.67
November	26	52.3	6.69	2.8	66	18	5.7	0.13	0.04	0.65	17.8	40	2
December	23	61.4	6.75	2.6	69	30	4.95	0.36	0.03	0.56	18.25	18	3

Table 2. Monthly variations of physic-chemical characteristics of water in the sewage fed wetland (P-2) during January 2018 to December 2019.

2018	WT	TRN	pH	DO	TA	CO2	DOM	PO4	NO3	SiO2	HAR	COD	BOD
January	15.5	10.65	8.25	7.6	227.5	20	4.73	0.82	0.03	3.37	71	94	10.05
February	21.25	14.75	7.98	4.3	251	25	3.04	1.02	0.05	4.4	157	32	13.8
March	27.5	18	8	8.3	240	19	1.13	0.36	0.06	3.81	164	16	18.4
April	28	6	8.15	16	164	46	1.13	0.22	0.04	2.47	102	32	28.8
May	32.75	8.5	8.75	9.2	166	26	1.73	0.23	0.06	3.21	49.45	32	17.2
June	31.75	10.25	8.5	6.4	191	0	4.05	0.25	0.06	4.55	93	16	13.8
July	30.63	14.5	8.07	4.7	194	11.5	1.6	0.32	0.06	3.25	85.2	44	10.2
August	30.55	14.34	8	6.77	184.84	14	2.07	0.24	0.34	2.53	108.17	32.67	5.62
September	31.6	15.25	8	6.1	195.5	12.5	2.29	0.24	0.33	2.28	120.5	40	7.9
October	28.33	16	7.99	5.2	207.5	23	2.33	0.38	0.2	3.32	94.4	34	9.8
November	25.22	13.25	8.14	7.3	205	23.16	1.41	0.8	0.1	3.6	64.75	36.47	6.45
December	21.85	11.5	8.23	8.8	219	21	2.48	1.35	0.04	3.62	69.1	44	8.6
2019													
January	23.85	8.6	8.15	12.8	224	20	3.38	1.73	0.03	4.4	84	28	10.4
February	23.5	7	8.78	10	238	18	4.47	0.46	0.04	4.66	78.8	32	16
March	28.5	5.75	8.8	10.6	187	0	2.67	0.39	0.05	2.18	57	60	10
April	27	5.5	9.3	13.2	148.4	0	1.13	0.78	0.05	1.82	63	40	10.4
May	29.74	10	9.3	8.4	168	0	3.19	0.33	0.07	4.33	65.5	44	8.4
June	31.5	6.5	9.05	9.8	207	0	0.87	0.27	0.09	4.66	84	36	11.2
July	34.5	8.4	8.75	14	168	0	3.58	0.19	0.05	3.68	66.2	44	12.6
August	31.75	10.5	8.05	6	180	7	2.71	0.36	0.07	3.85	83.2	36	10.4
September	32	10.5	8	7.6	28	16	0.83	0.42	0.06	4.16	100	24	27.2
October	30.15	9.5	7.88	2.4	224	24	0.75	0.39	0.04	2.32	51	20	24.8
November	28.5	10	7.85	3.2	244	18	6.38	0.31	0.04	2.85	80	40	14.4
December	21	5	8.6	9.6	218	17	4.84	0.32	0.05	3.16	71	36	21.6

A total of 76 species (57 of Rotifera, 13 of Cladocera, 5 of Copepoda and 1 of Ostracoda) in P-1 while 66 species (47 of Rotifera, 10 of Cladocera, 7 of Copepoda and 2 of Ostracoda) in P-2 were identified. Among the above species only 13 in P-1 and 16 in P-2 are more dominant than the others are considered here and are shown in table 3 & 4.Among Rotifers *Asplanchna brightwelli* was found only in P-1 during thirteen months with a maximum of 52 ind/lit and a minimum of 1 ind/lit.The other rotiferan species *Brachionus angularis* was found in less number with a maximum of 6 ind/lit in P-1 during 12 months and in P-2 minimum of 5 ind/lit and maximum 810 ind/lit was recorded during entire study. *B. caudatus,*the other brachionid was observed during ten months with a maximum of 10 ind/lit in P-1. While in P-2 it was noted during seventeen months with a maximum of 96 ind/lit. *B. calyciflorus* was noted only in P-2 and was noted during seventeen months with a maximum of 474 ind/lit. Other brachionoid *B. patulus* was recorded only in P-1 during eleven months with a maximum of 50 ind/lit. *B. quadridentatus* was observed during twelve months in P-1 being most abundant by 12 ind/lit, while in P-2 it was recorded during fourteen months with a maximum of 8 ind/lit. *B. rubens* occurred only in P-2 and was found almost throughout the study period except three months with a maximum of 29 ind/lit. *Keratella tropica,* the other brachionoid rotifer occurred during eighteen month throughout the study period in P-1 with a maximum of 660 ind/lit whereas in P-2 it was noted during eighteen months with a maximum of 583 ind /lit. *Lecane bulla*, the lecanidae rotifer was found during twenty months with a maximum of 20 ind/lit in P-1only. *Polyarthramulti appendiculata,* the synchaetid rotifer was found during sixteen months in P-1 with a maximum of 25 ind/lit, while in P-2 it was found during eleven months with a maximum of 130 ind/lit. The filinid rotifer, *Filinialongiseta* was noted during fifteen months with a highest abundance of 291 ind/lit in P-2. *Testudinella mucronata*, the testudinellid rotifer was found during thirteen months each in P-1 and P-2 with a maximum of 7 ind/lit in P-1 and 17 ind/lit in P-2.*Rotarianeptunia*was found in twelve months with a maximum of 5 ind/lit in P-1 and eighteen months with a maximum of 14 ind/lit in P-2. Among the cladocerans *Diaphanosoma brachyrum* was noted only in P-2 during thirteen months with a maximum of 68 ind/lit. Other cladoceran *Ceriodaphnia reticulata* was recorded during sixteen months with a maximum of 72 ind/lit in P-1 while in P-2 it was noted during nine months with a maximum of 86 ind/lit.*Moina brachiate* was observed during eighteen months in P-2 with a maximum of 135 ind/lit. Among calanoid copepod *Heliodiaptomus viduus* was noted during seventeen months in P-2 with a maximum of 130 ind/lit. In P-1 *Mesocyplops leukarti* was recorded during nineteen months with a maximum of 222ind/lit whereas in P-2 it was observed during twenty months with a maximum of 205 ind/lit. *M. hyalinus* was recorded only in P-2 during fourteen months with a maximum of 37 ind/lit. The developing stages of copepods *i.e*. nauplius larvae were noted throughout the study period both in P-1 and P-2 with a maximum of 708 ind/lit in P-1 and 610 ind/lit in P-2.

Discussion

Lake water containsmyriads of organisms, suspended passively or sometimes weakly swimming. Some are photosynthetic, some feed on organic matter live or dead, dissolved or particulate. The water contains their excretion and secretions, faeces and corpses, mixed with debris washed into suspension from the surrounding land. In this melange, chemical and biological changes of various kinds are taking place very rapidly (Chaudhuri, 1989).

Rotifers and Crustaceans are the major groups of zooplankton and are mostly suspension feeders. Among the crustaceans, the cladocerans are either herbivores or carnivores on small zooplankton. The other crustaceans, the copepods are small particle feeders or raptorial. The zooplankton community thus includes variety of forms having diverse feeding habits.

In the present investigation rotifers, cladocerans and copepods are the major groups. This observation agrees with those of Bandyopadhyay (1985), Chaudhuri, (1989), Arkawa*et.al.*(1998) and Mandal (2000).

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Table 3. Monthly numerical abundance of Zooplankton (ind/lit) in the rain fed wetland (P-1) during January 2018 to December 2019.

	2018												2019											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Rotifera																								
Asplanchna brightwelli	-	1	3	-	1	12	5	9	52	-	-	-	-	3	-	-	-	-	1	9	2	-	-	1
Brachionus angularis	-	-	-	-	1	-	6	1	1	1	-	1	-	-	-	5	2	-	2	-	1	-	1	1
B.caudatus	-	1	2	1	-	-	-	2	2	2	-	-	-	1	-	10	-	-	-	-	1	-	1	-
B. patulus	45	20	1	-	1	9	5	2	-	1	-	2	50	-	-	-	-	-	-	-	-	-	1	1
B. quadridentatus	6	12	4	-	4	6	-	-	1	-	-	-	10	3	-	5	-	-	2	1	-	-	-	1
Keratella tropica	-	1	14	22	-	6	1	4	6	2	-	1	1	10	402	660	37	3	6	1	-	-	2	-
Lecane bulla	10	3	1	3	8	12	15	10	4	3	-	2	20	-	4	5	13	2	2	1	1	-	-	1
Polyarthra multiappendiculata	-	1	23	1	-	25	7	2	4	-	-	-	-	1	2	25	7	-	1	9	4	2	2	-
Testudinella mucornata	1	-	4	1	2	7	7	4	4	1	-	-	1	-	-	-	6	-	-	1	2	-	-	-
Rotaria neptunia	3	-	-	-	1	1	-	1	2	3	5	1	2	-	-	-	1	-	-	-	1	1	-	-
Cladocera																								
Ceriodaphnia reticulate	1	72	9	-	1	3	1	4	1	-	-	-	1	18	-	10	-	1	4	1	1	-	-	2
Copepoda																								
Mesocyclops leuckarti	4	79	38	1	3	222	21	5	42	2	-	-	3	170	-	5	6	7	3	-	8	-	41	10
Nauplius	27	521	136	50	137	335	281	19	34	1	1	4	74	102	708	160	97	21	90	52	26	1	215	170

Table-4:- Monthly numerical abundance of Zooplankton (ind/lit) in the sewage fed wetland (P-2) during January 2018 to December 2019.

	2018												2019											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Rotifera																								
Brachionus angularis	7	32	10	170	78	125	122	5	137	59	63	8	38	20	244	810	747	28	56	17	263	16	33	26
B.caudatus	1	4	-	-	6	99	6	29	9	6	1	2	2	-	62	69	2	36	8	-	-	-	3	-
B. calyciflorus	-	4	-	-	34	235	61	17	10	15	4	2	2	35	474	116	28	4	-	1	-	-	-	7
B. quadridentatus	1	2	5	-	-	-	-	-	1	-	1	2	-	2	8	-	7	-	1	1	1	-	1	-
B. rubens	11	7	16	-	9	1	4	1	3	29	3	10	15	13	5	9	3	2	17	1	-	1	1	-
Keratella tropica	1	1	13	20	24	6	39	17	5	9	1	2	1	-	32	583	10	4	-	1	-	-	-	-
Filinia longiseta	-	-	-	-	45	21	14	1	-	-	-	-	1	2	20	291	55	118	8	2	1	1	1	-
Polyarthra multiappendiculata	-	-	-	25	-	1	9	2	10	5	1	1	-	-	130	5	-	70	-	-	-	-	-	-
Testudinella mucornata	-	-	17	-	-	2	8	1	1	1	1	1	1	1	3	-	-	3	-	1	-	-	-	-
Rotaria neptunia	10	8	14	-	7	8	2	1	1	1	5	14	3	1	1	9	3	4	3	-	-	-	-	-
Cladocera																								
Diaphanosoma brachyurum	-	-	-	-	68	24	8	9	7	9	7	-	-	5	5	9	-	-	-	1	1	1	-	-
Ceriodaphnia reticulate	-	-	-	25	28	86	1	4	-	-	-	-	1	-	3	-	-	-	-	1	-	-	-	1
Moina brachiate	-	9	13	135	3	13	1	2	1	1	3	-	-	9	13	13	-	2	1	2	-	1	-	2
Copepoda																								
Heliodiaptomus viduus	10	2	33	130	11	4	6	4	10	3	6	2	6	4	14	39	-	-	-	1	-	-	-	-
Mesocyclops hyalinus	-	6	5	10	4	5	2	4	1	3	-	-	2	37	4	2	-	-	4	-	-	-	-	-
M. leuckarti	6	25	50	80	80	90	28	58	112	14	7	6	4	205	26	11	3	10	6	3	-	-	-	-
Nauplius	48	610	122	465	269	76	103	400	185	172	79	67	80	88	77	253	193	30	39	5	5	12	7	9

The rotifers are almost universally present in freshwater habitat and constitute an important component of zoobiota. It has been observed that genus *Brachionus* is the predominant form of rotifers in P-2 but in P-1 *Lecane*contributes more individuals. In P-2 rotifers are the most dominant group but in P-1 it is second largest group. This finding is in agreement with George (1966), Chaudhuri, (1989), Unni (1993), Chakraborti*et. al*. (1995), Unni and Fole (1997) and Lougheed and Chow-Fraser (1998).

The seasonal occurrence and abundance of different taxa of rotifers showed that genus *Brachionus*is numerically superior over other rotifers. *B. angularis* in P-2 is exceptionally abundant throughout the study period and clearly dominant over other species. O' Brien and Noyelles (1972) and Sharma (1992, 1996) reported*Brachionus*spp are Characteristics of alkaline and hard water. Moreover, a number of workers like Green, 1972, Shiel and Koste, 1983 and Dussart*et.al*, 1984 have registered distinct abundance of *Brachionus* species in alkaline waters of different parts of the world. A similar observation is also noted in P-2 but not in P-1 as P-2 is an alkaline and hard water wetland. In P-1 the occurrence of this species is very scarce and obviously the abundance is very low. Perhaps this is because *Brachionus* is less abundant in acidic water(pH of P-1 is mostly < 7). In P-2 *B. angularis* alone influences the total fluctuation of the rotifer of the wetland. Williams (1966) is of the opinion that more than one genus of rotifer often dominates in a sample but each dominant genus show only one dominant species. The present finding is also in agreement with the above statement.

B. caudatus is very scarce in P-1 and never showed distinct seasonal variations. However, in P-2 the abundance of this species is very high and mainly noted in monsoon, post monsoon and summer.The poor availability of this species in P-1 is probably due to its oligotrophic condition (Deb *et. al.*, 1987; Chaudhuri, 1989). *B. calyciflorus* is recorded in P-2 and the abundance of this species is very high.*B. caudatus* are observed more in P-1 than P-2. Other species *B. rubens*was noted throughout the study in P-2except few months. The remaining species of *Brachionus*showed higher abundance in P-2. Sharma (1983) opined that *B. angularis*, *B. rubens* and *B. calyciflorus* are the indicator species of eutrophic water, but *B.caudatus* and *B. patulus* are indicator of oligotrophic water which was also observed during present study.

Keratellatropica is also the most abundant species in both the wetlands though numerically it was highest in P-1. Studies showed that*Filinia*spwas observed only in P-2 with a maximum number.According to Saz (1971) and Ruttner- Kolisko (1980) this species can tolerate low level of O_2 and can thrive and reproduce in completely anaerobic waters which can support the occurrence of this species in P-2. According to Ruttner-Kolisko (*op.cit*), the variation of this species is to be explained not only by the physic-chemical parameters of water but also their physiological requirements.

Lecane bulla was recorded almost throughout the study period except few months in P-1 only. Pennak (1978) opined that *Lecane* is registered as acid water species. This is clearly evident in the present observation also as*Lecane* sp.Are found only in P-1 where the wetland water is mostly acidic in nature.*Polyarthramultiappendiculata*and *Testudinellamucornata*are more profuse in P-1 without showing any specific trend. This observation is in corroboration with Mandal (1985),Chaudhuri (1989) and Lougheed and Chow-Fraser (1998).

Ceriodaphnia reticulate is the dominant species among cladocerans in P-1 and in P-2 *Moina brachiate* and *Diaphanosoma brachyurum* are the dominant species which influence the fluctuation pattern of cladocera. Lougheed and Chow-Fraser (1998) observed *Moina*sp in hypereutropic wetland. Michael (1968) reported that *Ceriodaphnia* sp, *Diaphanosoma* sp are monocyclic and *Moina* sp occurred throughout the year. Chaudhuri (1989) suggested that both *Diaphanosoma*sp and *Moina* sp is indicator of eutrophication. In the present observation P-2 being eutrophic these species are more profuse than P-1.

Among cyclopoid copepod, in P-1 only *Mesocyclops leuckerte* is dominant but in P-2 both *M. leuckerte* and *M. hyalinus* are dominant. *Heliodiaptomus viduus* among calanoid copepods was recorded more than half of the entire study period in P-2.The seasonal abundance of nauplius larva also exhibits interesting variation pattern in both the wetlands. Numerically it is high in P-1. The instability of the environment in P-1 and P-2 seems to be responsible for this difference because nauplius larvae being a developing stage are likely to be more sensitive to pollution, toxicity and environment instability (Chaudhuri, 1989).

Davis (1955) stated that undoubtedly a number of independent physical, chemical and biological factors which operate in an ecosystem have influences on seasonal variation and succession of planktonic organism. In the present study too, the influence of several physic-chemical factors on the occurrence and abundance of total population was noticed. It is generally believed that temperature is one of the most important factors in ecosystem in controlling both the quantity and composition of zooplanktonic organism but it cannot be only important variable (Hutchinson, 1967).The effect of transparency on the zooplankton has already been examined by Patalas and Salki (1984) and Zettler and Carter (1986).In the present investigation also zooplankton is found to be influenced by transparency. Though in the present investigation no influence is noted between zooplankton and dissolved oxygen but negative influence is observed with CO_2.

Zooplankton has been a subject in assessing water quality and pollution level (Juneja, 1979). In the present investigation emphasis has been laid on rotifers and microcrustaceans.

Rotifers exhibits high population turnover rates in nature and therefore, respond more quickly to environmental changes than microcrustaceans and appear to be more sensitive indices of changes in water quality (Khan and Rao, 1981). An increase in abundance of total rotifers may indicate advancing eutrophication and it can occur without a major change in composition (Gannon and Stemberger, 1978). According to various workers (Datta and Bandyopadhyay, 1985; Sharma, 1992; Sharma and Dudani, 1992) certain species like *B. angularis, B. caudatua, B. calyciflorus, F. longiseta*are bioindicators of alkaline eutrophic water. Others like *B.patulus, B. forficula, K. tropica* are also bioindicator species.

In the present observation among rotifers genus *Brachionus* is more abundant in P-2 than in P-1. Among Brachionus, *B. angularis* was recorded throughout the entire study period with numerically higher abundance in each month and *B.rubens was noted* in P-2 only. So from the above observation it may be contended that *B. angularis* and *B. rubens*are pollution indicator species as their occurrence was maximum in P-2 which is a sewage enriched wetland. Among the other rotifer species of brachionidae family *Keratellatropica* and *Filinialongiseta* are found in both wetlands, while B. patulus was recorded only in P-1, so it can be treated as sensitive species. On the other hand, the members of Lecanidae family can be considered as the most sensitive species as these never occurred in waste water wetland P-2.

Among copepods *Mesocyclops leuckarti* and *Heliodiaptomus viduus* are found in plenty in P-2 than P-1. Among cladocerans *Moina brachiate* is also found in plenty in P-2. According to Chaudhury (1989), *Cyclops* sp and *Moina* sp is the indicator of eutrophication. The present finding too, extends further support to the above contention.

Conclusion

From the present investigation it may be emphasized that the kinds and classes of biota can hardly be separated from habitat, the physical space and the factors of the environment with which these form an integrative unit *i.e.* ecosystem. The rapid pace of industrialization, modern agriculture with the use of chemical fertilizers and pesticides and increase human population, have posted a serious threat to the aquatic biota as the water quality is getting rapidly degraded due to massive discharge of waste of diverge origin.

Therefore, as far as the physicochemical characteristics of water as well as the biotic community (Zooplankton) are concerned, it can be said that the combined effect of the physicochemical factors of the respective wetlands might have promoted the luxurious growth of the biotic community of each wetlands.

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Abbreviation used

WT - Water temperature
TRN - Transparency
DO - Dissolved oxygen
CO_2 - Carbon di oxide
TA - Total alkalinity
DOM - Dissolved organic matter
PO_4-P - Phosphate phosphorous
NO_3-N - Nitrate nitrogen
SiO_2 - Silicate
HAR - Hardness
COD - Chemical oxygen demand
BOD- Biological Oxygen demand