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Full Length Article

Dynamics of plankton community in two adjacent unmanaged ponds of West Bengal, India

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ABSTRACT

Plankton occupies a significant position in the food web of lentic ecosystem. They play a central role in cycling organic matter in aquatic ecosystem. The abundance of plankton depends on the various hydrological variables. During our investigation on two adjacent ponds, 14 taxa of zooplankton, i.e. Copepoda 5, Cladocera 3 and Ostracoda 1 and 15 taxa of phytoplankton, i. e. Chlorophyceae 6, Cyanophyceae 5, Bacillariophyceae 3 and Euglenophyceae 1 were recorded. The zooplankton densities (4.90-266.0 individuals L^{-1}) and phytoplankton densities (56.0-336.0 individuals L^{-1}) were recorded in this investigation. Plankton densities were strongly influenced by different water parameters. Different taxonomic indices - Shannon's diversity index, Evenness index, Simpson's dominance index and Margalef's index were calculated. Our study revealed the presence of *Keratella* and *Brachionus* which may indicate eutrophic status of the ponds.

Key word: Hydrological variables, phytoplankton, taxonomic index.

INTRODUCTION

Wetlands are regarded as a sensitive ecosystem with immense importance. It is a confined ecosystem and comprises with water, bottom mud and surface film (Keddy, 2010). Whereas it's biological parts comprises plankton, fishes, aquatic plants and the birds (Clegg, 1986). In all kinds of aquatic system plankton has been regarded as a very good bio-indicator for the quality of water. Phytoplankton community serves as a bio-indicator for assessing the health of an aquatic ecosystem (Tiwari and Chauhan, 2006; Hoch *et al*., 2008). Anitha Devi *et al.,* 2013 also described that phytoplanktons are the primary producers of aquatic ecology and controls the dynamic of productivity. Zooplankton acts as bio-indicator of water quality as well as quantification of primary energy transfer from producer to primary consumer (Dulic *et al*., 2006). Kolhe *et al.,* 2013 also observed the zooplankton communities respond more quickly to environment variations. Diversity and population of phytoplankton are influenced by a number of factors like nutrients, physico-chemical parameters, carbon exchange and biological interactions (Bhuiyan and Gupta, 2007; Rajagopal *et al.*, 2010). Interactions between phyto and zooplankton maintain the hydrological regimes for aquatic biodiversity (Bunn and Arthington, 2002). The two ponds selected for the present study are the parts of wetlands of Santragachi, Dt.Howrah, West Bengal, India. In this study we investigated the month wise diversity pattern of plankton and their coherence in relation to hydrological parameters of these ponds, the results of which are presented herein.

MATERIALS AND METHODS

Two perennial ponds located near Santragachi hjheel (22 58′N and 88 27′E) in Howrah district of West Bengal, India were selected for investigations. Tese two ponds (Pond 1 and Pond 2) were situated about 600 m apart. The water of pond 1 was more or less clear and became the feeding ground of a number of migratory birds every winter. A factory situated near pond 2 which disposed the industrial effluents into this pond.

Our survey was carried out from October 2012 to March 2013. Water samples were collected twice in a month in 500 ml polyethene bottles and brought in the laboratory for further analysis. Plankton samples were collected by filtering 20 L of water through standard plankton net (77 mesh bolting silk) and concentrated to 35 ml. The plankton samples then preserved with 4 % formalin. One ml of this concentrated sample was then placed on a Sedgwick rafter cell and observed under Olympus MIPS microscope (Olympus India Pvt. Ltd., New Delhi,India).

Phytoplankton identified with the standard keys provided by Turner (1982); Anand (1998). Identification of zooplankton was carried out in accordance to the keys by Fernando (2002); Sharma and Sharma (2008). During water collections, water temperature was recorded by a thermometer (0 - 60° C), pH was measured using hand pH-meter (HANNA: HI 98107,USA).Other water quality variables like dissolved oxygen, free carbon dioxide, total alkalinity, nitrate and phosphate were estimated following the standard methods (APHA, 2005). By statistical analysis of mean, standard error and correlation were calculated. We also analyzed some taxonomic indices like Shannon's diversity index, Pielou's evenness index, Simpson's dominance index and Margalef's species richness index.

RESULTS AND DISCUSSION

Hydrological variables are summarized in the Table 1.During the study period, pH varied from 7.0 to 8.0 in pond 1 and from 6.5 to 7.5 in pond 2. The water temperature ranged between 19 ^{0}C-29 ^{0}C and 18 ^{0}C-30 ^{0}C in ponds 1 and 2 respectively.

In our investigations, free CO_2 value ranged from 6-16 ppm at pond 1 and 1.13-2.83 ppm at pond 2. In pond 1 alkalinity ranged from 32-65 ppm and from 32-72 ppm in pond 2. Nitrate and phosphate are the main nutrients which control the productivity of phytoplankton. During our investigation nitrate concentration fluctuated from 0.3-0.72 ppm in pond 1 and from 0.35-0.9 ppm in pond 2. Phosphate concentration varied from 0.1-0.8 ppm in pond 1 and from 0.35-0.8 ppm in pond 2. The dissolved oxygen contents were found to be below the safe limits for aquatic ecosystem in both ponds (Pond 1-2.66 ± 1.42 and Pond 2- 2.09± 0.24).

Table 2 and 3 represented the diversity and density of phytoplankton and zooplanktons in Pond 1 and Pond 2. Phytoplankton density was higher in pond 1 than pond 2. In this study, maximum phytoplankton density was observed in January and minimum density was recorded in March. In both the ponds, the phytoplankton community was dominated by Chlorophyceae and Bacillariophyceae.

The variations in zooplankton densities during the investigation were presented in Table 2. In pond 1 zooplankton density was maximum in November and minimum in January whereas zooplankton density was maximum in February and minimum in January in pond 2. Rotifera were the dominant species through out the season in both ponds followed by Copepoda and Cladocera (Table 2). The Pond 2 always showed lower amount of zooplankton in comparison to Pond 1. Table 4 and table 5 described the different diversity indices in Pond 1 and Pond 2 of zooplankton and phytoplankton respectively.

Shannon's index for both zooplankton and phytoplankton recorded, were lower in Pond 1 compared to Pond 2. Margalef's index for zooplankton was higher in Pond 2 than Pond 1 whereas it was lower in pond 2 for phytoplankton (Tables 4 and 5)**.** The mean value of Simpson index and Evenness index for both ponds indicated that the species diversities were distributed more or less evenly. Correlation value for both phytoplankton and zooplankton in pond 1 and pond 2 were recorded in relation to various water parameters (Tables 6 and 7). Correlation values between water temperature and zooplankton and phytoplankton density was found positive. Water pH was negatively correlated with the abundance of phytoplankton and zooplankton in both the ponds. The diversity of zooplankton in the two ponds under study was more or less similar. 15 species of zooplankton in Pond 1 and 16 species in Pond 2 were recorded but the density was higher in Pond 1. In both ponds, the zooplankton was dominated by rotifera followed by Copepoda and Cladocera.

Table 1 Limnological variable in the studied ponds.

Water Parameters	Pond 1	Pond 2
	Mean ± SE	Mean ± SE
pH	7.5±0.13 (7.0-8.0)	7.08±0.13 (6.5-7.5)
Dissolved oxygen (ppm)	2.66±1.42 (1.13-6.66)	2.09±0.24 (1.13-2.83)
Free CO_2 (ppm)	9.0±1.49 (6-16)	8.16±1.60 (4.0-15.0)
Temperature (^{0}C)	23.75±1.60 (19-29)	23.83±1.84 (18.0-30.0)
Alkalinity (ppm)	50.16±4.46 (32-65)	53.33±4.93 (32.0-72.0)
Nitrate(ppm)	0.51±0.056 (0.3-0.72)	0.59±0.069 (0.35-0.9)
Phosphate (ppm)	0.35±0.10 (0.1-0.8)	0.56±0.064 (0.35-0.8)

Asplancha sp. was the most dominant in pond 1 but in pond 2 it was *Keratella* sp. The relative abundance of species in Pond 1 and Pond 2 was influenced by the variation of tropic structure and seasonal changes of physicochemical variables of water body. Dominancy of rotifers such as *Asplancha, Brachionus and Keratella* was indicative of eutrophic condition of the pond (Dirican *et al.*, 2009; Dorak, 2013). Kolhe *et al.,* 2013 observed that zooplankton community of Godavari river was dominated by Rotifer and they concluded from their study that it may be due to the influence by the discharge of different industrial effluents, as rotifers are comparatively pollution tolerant forms. Karuphapandi *et al.,* 2013 investigated that density of zooplankton, specially rotifers increased significantly with increase in nutrient concentration. Data obtained (Tables 2 and 3) thus revealed that Pond 1 was more eutrophic nature than the pond 2. Presence of Copepods (pond 1 and pond 2) indicated that water quality was good (Basu *et al.*, 2013).

Phytoplankton in both ponds was dominated by Bacillariophyceae followed by Chlorophyceae and Cyanophyceae. Species diversities and densities of plankton were higher in pond 1 than pond 2. *Fragilaria* was the most dominant in both ponds. Chlorophyceae (green algae) was less abundant in both ponds probably due to low concentration of dissolved oxygen (2.66 ± 1.42 in pond 1 and 2.09 ± 0.24 in pond 2) (Rajagopal *et al.,* 2010). Dominance of *Fragilaria* sp. indicated that both the ponds were oligotrophic nature (Bajpai and Agarker, 1997). Presence of *Anabaena, Oscillatoria, Spirogyra, Navicula, Chlorella, and Microcystis,* though in low densities indicated the slightly organic and sewage pollution in both ponds (Gupta and Shukla, 1990; Shekhar *et al.,* 2008).

Low mean value of Shannon's index in both ponds indicated the poor diversity of species. Margalef's index, Pielou index and Simpson index showed low mean value indicating poor diversity and densities of both phytoplankton and zooplankton.

The present observed values for water parameters in both ponds indicated a low pH, alkalinity, dissolved oxygen and nutrients. All these parameters, especially the low dissolved oxygen level established the eutrophic nature of the ponds. The present findings showed that pond 1 is having a better aquatic ecosystem than pond 2. Both the water bodies are oligotrophic in nature, however, they tend to be eutrophic slowly. Low nutrient level of the ponds indicated the low productivity which was related to lower abundance of Chlorophyceae species.

In conclusion we suggest a sustainable and holistic management planning necessary for conservation of these ponds.

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Table 2 Density and diversity of Zooplankton and Phytoplankton (Individuals L^{-1}) in Pond 1

	Months							
A) Zooplankton	**October**	**November**	**December**	**January**	**February**	**March**	**Individ-ual Taxa**	**Group total**
a) Copepoda								
1. *Mesocyclops leuckarti*	7	9	2	0	0	2	**20**	**53**
2. *Cyclops abssorum*	0	5	0	2	0	3	**10**	
3. *Heliodiaptomus viddus*	0	10	0	0	3	0	**13**	
4. *Allodiaptomus* sp.	0	6	0	0	0	0	**6**	
5. Nauplius larva	0	1	0	0	2	1	**4**	
b) Cladocera								
1. *Daphnia laevis*	3	3	5	2	4	0	**17**	**26**
2. *Moina* sp.	0	5	0	1	0	0	**6**	
3. *Ceriodaphnia cornuta*	3	0	0	0	0	0	**3**	
c) Rotifera								
1.*Asplanchna brightwelli*	7	3	10	1	5	2	**28**	**90**
2. *Keratella tropica*	3	1	2	1	5	2	**14**	
3. *Horaella brehmi*	3	2	2	0	5	0	**12**	
4. *Brachionus rubens*	8	3	5	2	4	3	**25**	
5. *Brachionus typica*	4	0	2	0	4	0	**10**	
6. *Testudinella elliptica*	0	3	4	6	6	2	**21**	
d) Ostracoda								
1.*Cypris* sp.	0	3	0	3	4	10	**20**	**20**
	38	**54**	**32**	**18**	**42**	**25**		
B)Phytoplankton								
a) Cyanophyceaea								
1. *Anabaena affinis*	4	1	0	0	0	4	**9**	**42**
2. *Microcystis* sp.	0	0	0	0	5	0	**5**	
3.*Oscilllatoria formosa*	0	1	0	2	1	2	**6**	
4. *Nostoc azollae*	0	22	0	0	0	0	**22**	
b) Chlorophyceae								
1.*Chlamydomonous globosa*	0	2	7	0	1	3	**13**	**61**
2.*Volvox aureus*	5	1	3	0	0	0	**9**	
3. *Oedogonium* sp.	6	12	0	4	0	0	**22**	
4. *Ulothrix zonata*	0	0	2	3	2	5	**12**	
5. *Spirogyra maxima*	0	0	0	2	0	0	**2**	
6.*Chlorella* sp.	0	1	0	2	0	0	**3**	
c) Bacillariophyceae								
1.*Bacillaria* sp.	2	0	0	0	0	0	**2**	**94**
2. *Fragilaria* sp.**	17	7	17	28	14	4	**87**	
3. *Navicula trivialis*	2	0	0	1	1	1	**5**	
d) Euglenophyceae								
1. *Euglena* sp.	0	0	0	0	0	2	**2**	**2**
	36	**47**	**29**	**40**	**24**	**21**		

**most dominant in pond 1.

Table 3 Density and diversity of Zooplankton and Phytoplankton (Individuals L^{-1}) in Pond 2.

	Months							
A) Zooplankton	**Oct.**	**November**	**December**	**January**	**February**	**March**	**Individu-al Taxa**	**Group total**
a) Copepoda								
1. *Mesocyclops leuckarti*	3	2	0	0	0	0	**5**	**29**
2. *Cyclops abssorum*	2	0	0	0	11	0	**13**	
3. *Heliodiaptomus viddus*	1	0	0	0	0	0	**1**	
4. *Allodiaptomus* sp.	0	0	3	0	2	0	**5**	
5. *Mysis* sp.	1	0	0	0	0	0	**1**	
6. Nauplius larva	0	0	0	0	4	0	**4**	
b) Cladocera								
1. *Daphnia laevis*	2	1	2	1	0	0	**6**	**17**
2. *Moina* sp.	2	0	0	2	3	0	**7**	
3. *Ceriodaphnia cornuta*	0	0	2	0	0	2	**4**	
c) Rotifera								
1.*Asplanchna brightwelli*	2	4	0	2	3	4	**15**	**62**
2. *Keratella tropica*	4	2	0	0	5	10	**21**	
3. *Horaella brehmi*	2	2	0	0	0	0	**4**	
4. *Brachionus rubens*	2	4	5	1	0	2	**14**	
5. *Brachionus typical*	0	0	0	0	2	0	**2**	
6. *Testudinella elliptica*	1	0	0	1	4	0	**6**	
d) Ostracoda								
1.*Cypris* sp.	3	0	5	0	1	0	**9**	**9**
	25	**15**	**17**	**7**	**34**	**18**		
B) Phytoplankton								
a) Cyanophyceaea								
1. *Anabaena affinis*	1	0	1	1	0	0	**3**	**31**
2. *Microcystis* sp.	8	2	3	0	4	0	**17**	
3. Pinocyano bacteria	2	0	0	0	0	0	**2**	
4.*Oscilllatoria Formosa*	4	0	0	1	2	2	**9**	
b) Chlorophyceae								
1.*Chlamydomonous globosa*	2	3	1	0	2	7	**15**	**36**
2.*Volvox aureus*	3	3	0	0	0	0	**6**	
3. *Oedogonium* sp.	0	0	3	0	0	0	**3**	
4. *Ulothrix zonata*	0	2	0	1	3	0	**6**	
5. *Spirogyra maxima*	0	2	1	2	1	0	**6**	
c) Bacillariophyceae								
1. *Fragilaria* sp.**	9	13	17	12	9	2	**62**	**63**
2. *Navicula trivialis*	0	1	0	0	0	0	**1**	
d) Euglenophyceae								
1. *Euglena* sp.	1	0	0	3	0	3	**7**	**7**
	30	**26**	**26**	**20**	**21**	**14**		

** most dominant in pond 2.

Table 4 Diversity Indices of zooplankton species in the studied ponds

Diversity index	Months													
	October		November		December		January		February		March		Mean ± SE.	
	Pond 1	Pond 2	Pond 1	Pond 2	Pond 1	Pond 2	Pond 1	Pond 2	Pond 1	Pond 2	Pond 1	Pond 2	Pond 1	Pond 2
1.Shannon's diversity index	0.64	0.72	0.75	0.75	0.46	0.49	1.30	0.55	0.58	0.67	0.79	0.53	0.75 ± 0.12	0.62 ± 0.04
2.Evenness index(Pielou index	0.82	0.80	0.83	0.83	0.51	0.63	1.54	0.65	0.69	0.86	0.93	0.88	0.89 ± 0.14	0.78 ± 0.04
3.Simpson index	0.28	0.19	0.13	0.23	0.41	0.45	0.94	0.39	0.36	0.25	0.16	0.33	0.39 ± 0.12	0.31 ± 0.04
4.Species richness index(Margalef's index)	1.39	2.05	1.81	2.05	0.89	1.53	1.60	1.66	1.86	1.64	1.97	1.13	1.59 ± 0.16	1.68 ± 0.14

Table 5 Diversity Indices of phytoplankton species in the studied ponds.

Diversity index	Months													
	October		November		December		January		February		March		Mean ± SE.	
	Pond 1	Pond 2	Pond 1	Pond 2	Pond 1	Pond 2	Pond 1	Pond 2	Pond 1	Pond 2	Pond 1	Pond 2	Pond 1	Pond 2
1.Shannon's diversity index	0.86	1.03	0.93	0.72	0.87	0.66	0.56	0.67	0.77	0.84	0.81	0.49	0.80 ± 0.05	0.74 ± 0.07
2.Evenness index (Pielou index)	0.95	0.92	0.81	0.93	0.76	0.94	0.62	0.95	0.74	0.84	0.85	0.82	0.79 ± 0.04	0.90 ± 0.02
3.Simpson index	0.14	0.07	0.10	0.18	0.10	0.22	0.18	0.22	0.08	0.13	0.21	0.38	0.14 ± 0.02	0.21 ± 0.04
4.Species richness index (Margalef's index)	1.88	3.72	3.00	1.84	2.01	1.41	2.81	2.05	2.67	2.45	2.48	1.03	2.48 ± 0.18	2.08 ± 0.38

Table 6 Correlation between zooplankton and water parameters of Pond 1 and Pond 2.

	pH	**Water Temp.**	**Dissolved Oxygen**	**Free CO_2**	**Alkalinity**	**NO_3^-**	**PO_4^{3-}**
Zooplankton (Pond 1)	-0.30[a]	0.69[b]	0.082	-0.387	0.53[a]	0.33[a]	0.61[a]
Zooplankton (Pond 2)	-0.54[a]	-0.021	0.050	-0.373	0.62[b]	0.24[a]	0.53[a]

a= 5% level of significance, b= 1% level of significance

Table 7 Correlation between phytoplankton and water parameters of Pond 1 and Pond 2.

	pH	Water Temp.	Dissolved Oxygen	Free CO_2	Alkalinity	NO_3^-	PO_4^{3-}
Phytoplankton (Pond 1)	-0.14 [a]	0.50 [a]	0.30 [a]	0.798	-0.42[a]	-0.59 [a]	-0.74[c]
Phytoplankton (Pond 2)	-0.48 [a]	-0.38 [a]	0.55 [a]	0.618	-0.73[b]	-0.67	-0.15[a]

a= 5% level of significance, b= 1% level of significance, c= 0.1% level of significance.

REFERENCES

Abdar MR, 2013. Physico-chemical characteristics and phytoplankton of Morna lake, Shirala (M.S.), India. *Biolife*. **1**(2):1-7.

Anand N, 1998. *Indian Freshwater Microalgae*. Bishen Singh Mahendrapal Singh Publishers. Dehra Dun.

Anitha Devi U, Ugandhar T and Masingara Sharya, 2013. Dynamic of productivity in Lower Manaie dam (Lmd) and Kakatiya canal (KC) Karimnagar, Andhra Pradesh, India. *Bioscience Discovery,* **4**(1): 111-116.

APHA 2005.*American Public Health Association standard methods for examination of water and waste water.* 21st edition. Washington D.C.

Bajpai AK and Agarker MS, 1997. Lower plants at high Altitutes, I. Some plankton from Auli Skiing field. *Ecol Environ Conser*, **3**: 97-100.

Basu A, Mondal D, Roy D, Choudhury S, Datta S and Roy S, 2013. The composition, diversity and population dynamics of zooplankton in river Ichamati,W.B.(India). *IJALS*, **6**(4):349-372.

Bhuiyan JR and Gupta S, 2007. A comparative hydrobiological study of a few ponds of Baral valley, Assam and their role as sustainable water resources. *J.Environ. boil.*, **28**:799-802.

Bunn S and Arthington AH, 2002. Basic Principles and Ecological Consequences of Altered Flow Regimes for Aquatic Biodiversity. *Environ. Management*, **30**(4):429-507.

Clegg J, 1986. In: Observer's Book of Pond Life. Frederick Warne and Co. Ltd. London. p 460.

Dirican S, Haldun M and Suleyman C, 2009. Some physicochemical characteristics and Rotifers of Camligoze Dam lake, Susehri, Sivas, Turkey. *J Anim. Vet. Adv.,* **8**(4):715-719.

Dorak Z, 2013. Zooplankton abundance in the lower Sakarya river basin (Turkey): Impact of environmental variables.*J.Black Sea/Meditearnean Environment*, **19**(1):1-22.

Dulic Z, Veramitrovic-Tutundzic V, Markovic Z and Zivic I, 2006. Monitoring water quality using zooplankton organisms as bioindicators at the Dubica fish farm, Serbia. *Arch. Biol.Sci., Belgrade*, **58**(4):245-248.

Fernando CH, 2002. A guide to Tropical Freshwater Zooplankton, identification, ecology and impact on fisheries. Backhuys Publishers, Leiden, Netherlands. pp 291.

Hoch MP, Dilon KS, Coffin RB and Cifuentes LA, 2008. Sensitivity of bacterioplankton nitrogen metabolism to eutrophication in sub-tropical coastal water of Key West. Florida. *Mar.Pollut Bull*., **56**:913-926.

Karuphapandi M, Rao DV, Xavier Innocamp B, Deepa J, 2013. Zooplankton diversity and trophic status of Saphilguda tank, Hyderabad.*IJALS.*,**6**(1): 44-50.

Keddy Paul A, 2010. In: Wetland Ecology (2nd Edition). Principles and Conservation. Cambridge University Press. Cambridge, p 497.

Kolhe BG, Zambare SP, Andhale SB, Rane MS, 2013. An estimation of plankton population of Godavari river with reference to polluotion. *Bioscience Discovery*, **4**(1): 117-120.

Margalef R, 1968. Perspectives in ecological theory.University of Chicago Press. Chicago, USA.

Pielou EC, 1966. The measurement of diversity in different types of biological collections. *J. Theor. Biol*, **13**:131-144.

Rajgopal TA, Thangamani A and Archuran G, 2010. Comparison of physico-chemical parameters and phytoplankton species diversity of two perennial ponds in Sattur area, Tamil Nadu. *J. Environ. Biol.*, **31**: 787-794.

Rajagopal T, Thangamani A, Sevarkodiyone SP, Sekar M & Archunan G, 2010. Zooplankton diversity and physico-chemical conditions in three perennial ponds of Virudhnagar dist. Tamil Nadu. *J. Env. Biol.*, **31**: 265 -272**.**

Shannon F and Weiner W, 1964. The mathematical theory of comm. Univ. Illinois Press, Urbana, USA.

Sharma S and Sharma BK, 2008. Zooplankton diversity flood plain lakes of Assam. Records of the Zoological survey of India, Occasional paper No. **290**:1-307.

Shekhar RT, Kiran BR, Puttaiah ET, Shibraj X and Mahadevan KM, 2008. Phytoplankton as index of water quality with reference to industrial Pollution. *J Environ Biol.*, **29**:233-236.

Simpson E H, 1949. Mesurement of diversity. *Nature*,**16**: 688.

Tiwari, A and SV Chauhan, 2006. Seasonal phytoplanktonic diversiy of lake, Agra. *J. Environ. Biol.*, **27**:35-38,

Turner WB, 1982. The Freshwater algae of East India.
K. Svenska Akad. Handl,25(5):1-187