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SOME PHYSICO-CHEMICAL CHARACTERISTICS ON ZOOPLANKTON COMMUNITY OF A FRESHWATER WETLAND OF WEST BENGAL, INDIA.

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ABSTRACT

Patashpur market pond, Purba Medinipur has to receive sewage water and sewage materials from adjoining shops, market and human habitation. It is hyper-eutrophic in nature with high contents of nitrates, NH_3-N, phosphates, chlorides, free Carbon-di-oxide, dissolved and suspended solids. The zooplankton community has comprised of three major groups – Rotifera, Cladocera and Copepoda. Rotifers showed numerical superiority over other groups of zooplankton. The zooplankton population was characterized by a few numerically abundant species that control the bulk of plankton density. The population of total zooplankton as well as rotifera possessed summer peak occurrence at various sewage sites of the wetland. It was well documented from the present study that zooplankton population was correlated significantly with the changing phenomena of physico-chemical characteristics of water. Eutrophication affected the species composition of zooplankton through chemical alternation of the environment. Several linear regression relationships were also established between zooplankton abundance and physico-chemical characteristics. Increment of population density of several zooplankton organisms (i.e., *Keratella tropica*, *Polyarthra vulgaris*) and low value of species diversity and species richness indicated the rise of pollutional stress on the market pond.

Key words: pond, sewage, physico-chemical characteristics, zooplankton.

INTRODUCTION

Zooplanktons are the major trophic link in food chain and being heterotrophic organisms it plays a key role in cycling of organic materials in aquatic ecosystem. The input of increasing load of pollutants and toxic substances into the water has been causing serious disturbances in the aquatic ecosystems. The physico-chemical methods are used to detect effects of pollution on the water quality but changes in the trophic conditions in water are reflected in the biotic community structure as shown by occurrence, diversity and abundance pattern of species (Cairns *et. al.*, 1972). The changes in community structures can be explained numerically with diversity index and are useful in assessing water quality based on the principle that clean water supports high community diversity while polluted waters have less diversified biota (Margalef, 1958). Monitoring the zooplankton as biological indicators could act as forewarning, when pollution affects food chain (Mahajan, 1981).

With the increment of human settlement polluted sewages were being dumped into the water body. Planktons are considered as indicator of the trophic status of a water body because of their specific qualitative features and their capacity to reproduce in large number under environmental conditions that are favourable to them (Vollenweider and Frei, 1953). Plankton has been used for pollution surveillance by many workers (Prescott, 1939; Mahajan, 1981). Similarly, changes in the water quality as well as zooplankton quality are indicators of rate and magnitude of cultural eutrophication (Vollenweider and Frei, 1953; Staub *et al*., 1970; Rao and Mohan, 1977;

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Kulshrestha *et al*., 1989; Chari and Abbasi, 2003). In the present communication I wish to analyse the impact of physico-chemical characteristics on zooplankton community structure of Patashpur market pond, Purba Medinipur both quantitatively and qualitatively in order to assess the water quality.

MATERIALS AND METHODS

Patashpur market wetland has to receive domestic sewage water, waste materials, materials from unauthorized cow sheds, fecal matters from the unwanted users of some parts of the wetland, sewage waters from shops and market.

To study the limnological changes, regular samplings of water were done fortnightly during February, 2014 - January, 2015 from three selected stations as follows:

Station B1: Located at the Western side of the wetland near the commercial cattle shed. Several sewage points are located on this side; Station B2: Located at the middle of Southern side and this station is devoid of sewage points; Station B3: Located at the Eastern side. Most of the major sewage points are located on this side.

Water samples were collected in three replicates from surface, column and bottom of each station and mean values of all three observations were taken into consideration. For BOD estimation, water samples were collected separately in dark bottles. A total of 17 limnological parameters of water viz., temperature, transparency, pH, dissolved oxygen, biological oxygen demand, chemical oxygen demand, free Carbon-di-oxide, total alkalinity, conductivity, $CaCO_3$ hardness, total suspended solid, total dissolved solid, chloride, ammonia, nitrite, nitrate and phosphate were determined. All the parameters were analyzed following the standard methods (Golterman, 1969; Michael, 1984; Trivedi and Goel, 1984 and APHA, 1989) and by spectrophotometer SQ 118.

Zooplankton were collected by filtering 20 litres of water using plankton net of bolting silk No. 40 and preserved in 4% formaldehyde solution. Zooplankton density was estimated by counting them under microscope in Sedgwick rafter cell. Detailed taxonomic identification was carried out following Edmondson (1959), Battish (1992), Roy (1999) and Khan (2003).

Diversity index (H') and Species richness (d) were calculated using formula of Shannon and Wiener (1949) and Margalef (1958) respectively. Pearson's correlation coefficients and stepwise multiple regression analysis were carried out with the help of relevant software programme SPSS, version 6.0.

RESULTS

Zooplankton recorded in the present study was represented by three groups – Rotifera, Cladocera and Copepoda. Rotifera was represented by *Brachionus, Keratella, Lecane, Asplanchna, Polyarthra, Filina*; Cladocera by *Diaphanosoma, Ceriodaphnia, Daphnia, Moina, Bosmina, Acroperus* while Copepoda was represented by two genera i.e., *Heliodiaptomus* and *Mesocyclops*.

The population of total zooplankton showed pre-monsoon maxima and post-monsoon minima. The population of rotifera showed marked increase during summer which was declined considerably during monsoon months. In general, total rotifera population at B3 site was higher than other two sites. The density of *Keratella* was higher in sewage sites, i.e., B1 and B3 site. *Polyarthra* population showed marked increase at B3 site during summer, which was declined considerably during rainy season. The cladoceran population was generally higher in B2 site than B1 and B3 site. The abundance of copepoda was higher at B3 site than B1 and B2 site.

In the present study, Shannon -Wiener diversity index was found to be highest (0.918 - 2.041) at B2 site and lowest (0.502 - 1.224) at B3 site. The species richness value was comparatively lower (1.002 - 1.482) at B3 site of the pond.

Transparency exhibited highest negative correlation (r = -0.4989*) and PO_4

showed highest positive correlation with total zooplankton population (r = 0.7418**). Rotifera showed highest positive correlation (r = 0.7740**) with chloride and highest negative correlation (r = -0.6981**) with transparency. Chloride showed maximum positive correlation (r = 0.6748**) and pH showed negative correlation (r = - 0.6958**) with cladoceran population. Total copepoda density has expressed maximum positive r value (r = 0.5342**) with ammonia.

Zooplankton Parameters	Physico-chemical Parameters	$ß_j$	$ß_o$	R^2
Total Zooplankton	BOD	7.3123**	83.3212**	0.71587**
	PO_4	21.0435**		
Total Rotifera	FCO_2	94.5257**	42.6132**	0.9152**
	BOD	29.8567**		
	NO_3	-1156.8134**		
	Amn	-56.1806**		
Bra	Cl	0.7073**	-40.6628**	0.6809**
Ker	FCO_2	20.9652**	-10.0491*	0.7879**
	BOD	8.0046**		
	NO_2	-249.0792*		
	Amn	-19.371**		
Lec	TDS	-0.0339**	11.0093**	0.6637**
	Amn	1.9715**		
Asp	FCO_2	-1.9402*	5.9846**	0.6649**
	NO_3	3.5524**		
Pol	pH	18.7581**	69.7683**	0.9389**
	TA	-0.3431*		
	COD	0.1586*		
	Con	0.2297*		
	CaHa	-1.2090*		
	NO_3	-224.0917**		
	Amn	-12.0526**		
Total Cladocera	pH	-170.3850**	1502.2100**	0.7756**
	COD	-0.9406**		
	Cl	1.7013**		
Dia	pH	-26.0547**	206.4923**	0.7803**
	COD	-0.1675**		
	Cl	0.4019**		
Sim	FCO_2	-3.9353**	8.2781**	0.5890**
	Amn	1.8802**		
Cer	Tr	-2.3346**	143.5269**	0.6747**
	COD	-0.1494*		
Dap	PO_4	-8.0361*	24.4049**	0.1939*
Acr	Amn	0.8218**	-1.7856*	0.3297**
Total Copepoda	DO	-85.0739**	825.2446**	0.3885**
Hel	pH	-34.1488**	413.9455**	0.6057**
	DO	-7.5009**		
	CaHa	-0.3429*		
Mes	pH	-99.7536**	1197.6282**	0.6896**
	DO	-31.3972**		
	TDS	-0.4129**		

$ß_j$ = Partial regression coefficient
$ß_0$ = Constant
R^2 = Coefficient determination
* : $p < 0.05$, ** : $p < 0.01$

Table 1: Stepwise multiple regression analysis between physico-chemical characteristics of water and abundance(Ind/l) of total as well as dominant groups and genera of zooplankton in Block-market pond.

Highest R^2 value was related to *Polyarthra* (0.9389**) followed by total rotifera (0.9152**). FCO_2, BOD, NO_3 and Ammonia were found to be important factor affecting the total rotifera density and jointly explain 92% variation. R^2 value shown for *Keratella* by FCO_2, BOD, NO_2, Ammonia was 0.7879** which was followed by *Lecane* (0.6637**) and *Asplanchna* (0.6649**).

pH, COD and Cloride bear a relationship with total cladocera and 78% variation of density can be explained. *Diaphanosoma* was influenced by three independent variables, i.e., pH, COD, Cl (R^2 = 0.7803**). Abundance of *Simocephalus* was controlled simultaneously by two physico-chemical parameters and explained 59% variability and Transparency and COD jointly explained 67% variation of *Ceriodaphnia* abundance.

Heliodiaptomus abundance was controlled simultaneously by three physico-chemical parameters, i.e., pH, DO, CaHa and explained 61% variability whereas *Mesocyclops* were influenced by pH, DO, TDS (R^2 = 0.6896**). Linear regression relationship between *Brachionus* and Chloride was

$$Y = - 40.663 + 0.707 X \ (P < 0.01)$$

Where Y = Population of *Brachionus* (Ind/l)
X = Concentration of Chloride (mg/l)

The regression equation between *Asplanchna* population and NO_3 was

$$Y = 5.985 + 3.552 X \ (P < 0.01)$$

where Y = Population of *Asplanchna* (Ind / l)
X = Concentration of NO_3 (mg / l)

DISCUSSION

The zooplankton community was mainly comprised of three groups, viz., Rotifera, Cladocera and Copepoda. The density of zooplankton fluctuated widely and was related to the nature of wetlands as well as stations (Xiengfei, 1984). In the present study highest density was recorded in the site with very high organic load (B3 site). In the

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zooplankton community of an ecosystem, the main role is played by only a few commonly occurring species (Anderson, 1974; Patalas, 1972 and Das, *et. al.*, 2005). Anderson (1974) found that a few numerically abundant species contributed 27 % of the communities in 340 lakes and ponds of Canada. Yousuf and Quadri (1981) found that 35.5% of total community was contributed by only four species in some freshwater lakes and ponds of Kashmir, India. During the present study, only 4 genuses controlled the bulk of zooplankton density.

Rotifera showed a numerical superiority over the other groups of zooplankton and as noted by George (1966), indicated the eutrophic nature of Patashpur market pond, Purba Medinipur. The present observations point to the occurrence of a summer periodicity in rotifera. Moreover, the reproductive rate of rotifers is related strongly to the quality of food as well as temperature (Lampert, 1978; Lougheed and Chow-Fraser, 1998). In the present study *Brachionus* population was significantly correlated ($P < 0.05$) with temperature. Billings Reservoir - Sau Paulo, South America showed an environment in advanced stage of eutrophication (Branco, 1966; Sendacz, 1984). It showed high contents of nutrients as well as low transparency values (Sendacz, 1984 and Xavier, 1981) where within the zooplankton composition, rotifers were more significant than copepods as well as cladocerans. Similar results were also observed in the present study.

Diversity indices are used to measure the stress in the environment. Trivedi (1981) has emphasized the importance of species diversity in assessing the water quality and reported that polluted water supports low organism diversity while the clean water supports high diversity. Highly enriched condition obviously limited the species diversity at almost all groups of zooplankton (Lougheed and Chow-Fraser, 1998; Patil and Auti, 2005). In the present study Patashpur market pond, Purba Medinipur is enriched with organic matter (B2 < B1 < B3). The species diversity index value is lower in B1 and B3 site than B2 site. After application of the relationship put forward by Wilham and Dorris (1968) between the diversity values and pollutional status it can be concluded that B1 and B3 site is more polluted than B2 site. Larger the species richness index value denotes a more healthy body of water (Somasheker and Ramaswamy, 1984). The species richness value of zooplankton population is lower in market pond and comparatively higher value was observed in B2 site than B1 and B3 site.

Weimin and Xiaoming (1987) showed positive correlation between zooplankton abundance and phosphate in Chenghu Lake, China. According to Evans (1983), the concentration of phosphate decides the abundance of zooplankton. Moitra and Bhattacharya (1965), Wynne and Gophen (1981), Banik *et al*. (1994) and Padmanabha and Belagali (2006) showed the positive regression between phosphate and zooplankton abundance. Total zooplankton abundance was positively correlated ($P < 0.01$) with phosphate contained in the present study.

Arora (1966) has emphasized the role of rotifers in assessing the water quality and stated the presence of *Keratella tropica*, *Filinia longiseta*, *Polyarthra vulgaris* and *Brachionus angularis* as indicators of pollution. Increment of population density of several zooplankton organisms (i.e., *Keratella tropica*, *Polyarthra vulgaris*) indicated the rise of pollutional stress on Block-market pond in the present findings. Low value of species richness and diversity indices revealed clearly the poor status of market pond (i.e. high organic load).

REFERENCES

Andersen, V.J.M. 1974. Nitrogen and phosphorus bedgets and the role of sediments in six shallow Danish Lakes. *Arch. Hydrobiol*. 74: 528 - 50.

APHA, 1989. *Standard Methods for the Examination of Water and Wastewater*. 17th edition American Public Health Association, Washigton, D. C.

Arora, H. C. 1966. Rotifera as indicators of trophic nature of environments. *Hydrobiologia.* 27: 146 - 149.

Banik, S., Debnath, R., Debbarman, S. and Kar, S. 1994. Occurrence of rotifers in a seasonal wetland in relation to some limnological conditions. *J. Freshwat. Biol*. 6(3): 221 - 224.

Battish, S. K. 1992. *Freshwater zooplankton of India*. Oxford and IBH Publishing Co., New Delhi. p.233.

Branco, S. M. 1966, Estudo das condicoes sanitarias da Represe Billings. *Arq*. *Fac. Hig*. *Univ. S. Paulo*. 20: 57 - 86.

Cairns, J. Jr., Lanza, G. R. and Parker, B. C. 1972. Pollution related structural changes in aquatic communities with emphasis on freshwater algae and protozoa. *Proc. Nat. Acad. Sci. Phila*. 134: 79 - 127.

Chari, K. B. and Abbasi, S. A. 2003. Assessment of impact of land use changes as on the plankton community of shallow freshwater lake in South India by GIS and remotesensing. Chemi. *Environ. Res*. 12 (1 - 2): 93 - 112.

Das, S.R., Patil, S.G. and Nandi, N.C. 2005. Zooplankton diversity of wetland ecosystems of Goa. *J. Env. Sociobio*.2(1-20): 15-23.

Edmondson, W. T. 1959. Rotifera. In *Freshwater Biology* (Eds. Ward, H.B. and Whipple, G. C.). John Wiley and Sons, New York. pp. 420 - 497.

Evans, M. S. 1983. Lake Huron: Crustacean and Rotifer Zooplankton, 1980. Factors affecting community structure with an evaluation of water quality status. *Special Publ. 98. The Great Lakes Research Division*. The University Michigan, Ann Arbor.

George, M.G. 1966. Comparative plankton ecology of five fish tanks in Delhi, India. *Hydrobiologia*. 27: 81 - 108.

Golterman, H.L. (Ed.) 1969. *Methods of chemical analysis of freshwaters*. IBP Handbook No. 8, Blackwells, Oxford.

Khan, R. A. 2003. Faunal Diversity of Zooplankton in Freshwater wetlands of Southern W.B. *Zool. Surv. India. Rec*. 204: 1 - 107.

Kulshrestha, S. K., Adholia, U. N., Bhatnagar, A., Khan, A. A., Saxena, M. and Baghail, M. 1989. Studies on pollution in River Kshipra: Zooplanktons in relation to water quality. *Int. J. Ecol. Env. Sci*. 15: 27 - 36.

Lampert, W. 1978. Climatic conditions and planktonic interactions as factors controlling the regular succession of spring algal bloom and extremely clear water in Lake Constance. *Int. ver. Theor. Angew. Limnol. Verh.* 21: 1436 - 1440.

Lougheed, V. L. and Chow-Fraser, P. 1998. Factors that regulate the zooplankton community structure of turbid, hypereutrophic Great Lakes wetland. *Can. J.Fish. Aquat. Sci.* 55(1): 150 - 161.

Mahajan, C. L. 1981. Zooplankton as indicators for assessment of water pollution. In *WHO sponsored workshop on Biological Indicators and Indices of Environmental Pollution. Cent. Bd. Prev. cont. Poll./* Osmania University, Hyderabad, India. pp. 138 - 148.

Margalef, R. 1958. Information theory in Ecology. *Gen. Syst*. 3: 36 - 71.

Michael, P. 1984. *Ecological methods for field and laboratory investigations*. Tata - McGraw Hill Pub. Com. Ltd., New Delhi . pp. 1 - 404.

Moitra, S. K. and Bhattacharya, B. K. 1965. Some hydrological factors affecting plankton production in a fish pond in Kalyani, West Bengal. *Ichthyologica*. 4: 8 - 12.

Padmanabha, B. and Belagali, S.L. 2006.Comparative study on population dynamics of rotifers and water quality index in the lakes of Mysore. *Nat. Env. Polln. Techno*.5(1): 107-109

Patalas, K. 1972. Crustacean plankton and the eutrophication of St. Lawrence great

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Lakes. *J. Fish Res. Bd. Can*. 29: 1451 - 1462.

Patil, S.S. and Auti, R.G. 2005. Seasonal variations of zooplankton from Salim Ali Lake of Aurangabad. *Bioinfonet.*2(2): 81-85

Prescott, G. W. 1939. Some relationships of phytoplankton to limnology and aquatic biology. *Publ. Amer. Assoc. Adv. Sci.* 10: 65 - 78.

Rao, R. K. and Mohan, P. C. 1977. Rotifers as indicators of pollution. *Curr. Sci*. 46: 190 - 192.

Roy, T. 1999. Copepoda: Calanoida and Cyclopoida. *Zool. Surv. India, State Fauna Series* 3: Fauna of West Bengal. 10: 287 - 313.

Sendacz, S. 1984. A study of the zooplankton community of Billings Reservoir - Sao Paulo. *Hydrobiologia*. 113: 121 - 127.

Shannon, C. E. and Wiener, W. 1949. The mathematical theory of communication. University of Illinois Press, Urbana. p.117.

Somashekar, R. K. and Ramaswamy, S. N. 1984. Biological assessment of water pollution- A study of river Kapila. *Int. J. Environ. Stud*. 23: 261 - 267.

Staub, R., Appling, J. W., Hofstciler, A. M. and Hans, I. J. 1970. The effects of industrial water of Memphis and Shelby country on primary planktons producers. *Bioscience*. 20: 905 - 912.

Trivedy, R. K. and Goel, P. K. 1984. *Chemical and Biological Methods for Water Pollution Studies*. Environmental Publishers, Karad, India. pp. 304.

Vollenweider, R. A. and Frei, M. 1953. Vertikale and Zeitliche Verteilung der Leitfahigkeit in einem eutrophen Gewasser wahrend der sommerstagnation. *Schweiz. Z. Hydrol*. 15: 58 - 167.

Weimin, C and Xiaoming, G. 1987. Annual changes in Zooplanktonic Curstacea and their relationship with physicochemical factors in Chenghu Lake. *Int. J. Ecol. Environ*. *Sci*. 13: 95 - 103.

Wilham, J. L. and Dorris, T. C. 1968. Biological Parameters for water quality criteria. *Bioscience*. 18: 477 - 481.

Wynne, D. and Gophen, M. 1981. Phosphate activity in freshwater zooplankton. *Oikos.* 37: 369 - 376.

Xavier, M. B. 1981. Represa Billings Sao Paulo 1. Fitoplancton e caracteristicas fisicas da agua. *B. Inst. Pesca*. 8: 23 - 46.

Xiengfei, H. 1984. Studies on the variations of abundance and biomass of zooplankton in Donghu Lake. *Acta Hydrobiologia*. 8: 345 - 357.

Yousuf, A. R. and Quadri, M. Y. 1981. Seasonal abundance of rotifera in a monomictic lake. *J. Ind. Ins. Sci*. 63(C): 23 - 24.