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Zooplankton population in relation to physico-chemical parameters of Lal Diggi pond in Aligarh, India

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Abstract

Physico-chemical parameters and zooplankton were assessed Lal Diggi pond from January to December, 2008. Four groups of zooplankton were recorded. Rotifera constituted the main dominant group in this pond contributing 44.89 % of the total zooplankton population followed by Cladocera (30.41 %), Copepoda (15.51 %) and Ostracoda (4.68 %). The highest density of zooplankton was recorded during January and February being 197 and 182 no l^{-1} respectively, while the lowest density was recorded during May and June being 64 no l^{-1} each could be due to the negative and significant value of correlation between zooplankton and water temperature (r = -0.700). These data is supported by similarity indices which recorded high values during January and February while the lowest values recorded during June and July.

Key words

Physico-chemical parameters, Zooplankton, Pond

Introduction

Ponds may have been natural water sources exploited by man at different time to meet different needs, or may have been created for a multitude of different purpose e.g. domestic or agricultural use, for transport, defense, ritual or industrial use, social aggrandizement, swimming, fish farming or the creation of the picturesque (Narayan *et al*., 2007; Bishnoi and Malik, 2008; Rajagopal *et al*., 2010). The major problems effecting standing water bodies have been recognized for at least two decades, but their quantification and classification of environmental managers has proved elusive. The Indian environment managers/researchers have recently described the condition of Indian freshwater resources and their management as a prominent environmental problem with nutrition enrichment, acidification and domestic waste, sewage, agricultural and industrial effluents contamination by toxic substances identified as major impacts (Senthilkumar and Sivakumar, 2008; Laskar and Gupta, 2009; Rajagopal *et al*., 2010).

Zooplankton constitute an important link in food chain as primary and secondary consumer and serve as food for fishes directly or indirectly; therefore any adverse effect on them will be reflected in the wealth of fish population. In the present time, the most common and severe problems is the enrichment of water by a nutrient that increases the biological growth and renders the water bodies unfit for diverse uses (Ahmed *et al.,* 2011). Nutrients which are present in fertilizers as well as in domestic and industrial waste water have been identified as main cause for changing the trophic

status of water bodies from oligotrophic to mesotrophic to eutrophic. Zooplankton is good indicators of particular environmental conditions as revealed by many studies. Some species flourish in highly eutrophic waters while others are very sensitive to organic or chemical wastes (El-Serafy *et al.*, 2009). Rotifers are considerably preferred food for many fish larvae (Pradhan *et al.*, 2007). Little information is available about zooplankton in eutrophic ponds. Hence, the aim of the present work was to study the distribution and abundance of zooplankton collected monthly from the selected pond along with analyses of certain physico-chemical parameters. Statistical analyses were also done to correlate these parameters with zooplankton in addition to similarity indices of zooplankton during study.

Materials and Methods

Present study was carried out on a fresh water pond Lal Diggi of Aligarh during January to December, 2008. This water body is used as drainage basin into which the surface runoff water and sewage from the surrounding catchments area enters. Samples were collected between 8 to 10 a.m. Air and water temperature was recorded by mercury thermometer graduated upon 100 °C. pH of water was determined by using a potable electronic digital pH meter. Dissolved oxygen (DO) analysis and other chemical parameters e.g. calcium, magnesium, carbon dioxide, alkalinity, nitrate and phosphate were performed following APHA (2005).

For zooplankton analysis, samples were collected from Lal Diggi pond and 100 l of water was filtered by passing water through plankton net made up of bolting silk cloth having mesh size of 25 µm and samples were preserved in 5% formaldehyde solution. Quantitative analysis was done by putting 1 ml of the preserved sample on a Sedgwick-Rafter cell and studying it under an inverted microscope and results were expressed in no l^{-1}. For qualitative analysis, the methods given by Edmondson (1966), Needham and Needham (1962), Pennak (1978) and Tonapi (1980) were followed.

Results and Disscusion

Water temperature varied in accordance with air temperature. Water temperature ranged from 15 to 37°C during the study period. Transparency ranged from 13.0 to 24.5 cm. Low values of transparency were recorded in monsoon season (July-Aug), which could be related to increased concentration of dissolved solids at high temperature and due to entry of huge amount of suspended and colloidal matter, silt and clay into the water body (Rajagopal *et al.*, 2010). This is supported by the negative correlation between TDS and transparency (- 0.159) and is in agreement with the observation of Ahmad (2011). In the present study, pH ranged from 7.7 in September to 9.0 in January. The wide range of pH is the result of disturbances caused by watermen activity, wind action and cattle's washing (Untoo *et al.,* 2001). Conductivity ranged from 1250 to 1879 µScm^{-1}. The high values during the study might be due to the fact that various dissolved substance are continuously released into the aquatic medium through death and decomposition of organisms (Raja *et al.*, 2008). Hence, the correlation coefficient showed a positive correlation (r=0.371) between TDS and conductivity. The lower values (1250 to 1269 µScm^{-1}) might be attributed to the consumption of TDS by the phytoplankton and aquatic organisms (Table 1, 2).

Dissolved oxygen varied from 2.1 mg l^{-1} in June to 10.2 mg l^{-1} February. Fluctuations in DO concentrations have been found to be affected by many factors like solubility of oxygen in water, intensity of light and photosynthesis (Ansari and Raja, 2007). Alkalinity ranged from 120 mg l^{-1} during June to 385 mg l^{-1} in December. Higher values during winter months might be due to input of detergents and lower values in monsoon months were found to be mainly due to higher turbidity and low transparency values (Rajagopal *et al.*, 2010). Calcium was recorded minimum 19.0 mg l^{-1} in September and maximum 65.0 mg l^{-1} in April.

Table- 1: Monthly variations in various physico-chemical parameters in Lal Diggi pond in Aligarh during 2008

Parameter / Months	Air temp. (°C)	Water temp. (°C)	Transparency (cm)	DO (mg l^{-1})	TDS (mg l^{-1})	pH	Conductivity (µS cm^{-1})	Carbondioxide (mg l^{-1})
January	18	17	21.0	5.8	715	9.0	1600	-
February	16	15	24.5	10.2	840	8.6	1462	-
March	24	23	17.0	2.8	550	8.7	1362	-
April	26	25	20.5	4.2	655	8.4	1250	-
May	35	32	21.2	3.5	818	8.5	1740	-
June	40	37	19.2	2.1	681	8.8	1775	-
July	39	36	16.0	4.4	980	8.0	1846	-
August	37	35	13.0	4.6	912	8.1	1879	-
September	31	28	15.5	7.5	995	7.7	1269	-
October	30	28	20.0	3.0	768	8.3	1836	-
November	27	25	23.0	4.2	960	8.5	1832	-
December	21	19	21.0	6.3	880	8.5	1842	-

Table- 2: Monthly variations in various chemical parameters in Lal Diggi pond in Aligarh during 2008

Parameter / Months	Ca (mg l^{-1})	Mg (mg l^{-1})	Total alkalinity (mg l^{-1})	CO_3^{2-} (mg l^{-1})	HCO_3^- (mg l^{-1})	PO_4-P (mg l^{-1})	NO_3-N (mg l^{-1})
January	41	4.7	258	174	84.0	0.801	0.083
February	30	10	172	140	32.0	0.580	0.101
March	50	17	168	56	112	0.610	0.165
April	65	21	180	144	36	0.715	0.182
May	45	18	125	80	45	0.509	0.467
June	33	12	120	60	60	0.670	0.583
July	27	7	230	30	200	0.685	0.247
August	31	13	290	60	230	0.727	0.211
September	19	26	267	130	137	0.785	0.102
October	27	22	330	175	155	0.806	0.090
November	30	15	360	225	135	0.742	0.108
December	45	18	385	262	93	0.707	0.101

Table- 3: Distribution and abundance of zooplankton population (No l^{-1}) in Lal Diggi Pond in Aligarh during 2008

Months / Genera	Jan	Feb	March	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Cladocera (30.41)												
Daphnia sp	18	12	14	18	12	20	25	32	11	46	27	16
Moina sp	12	16	9	-	-	-	15	4	2	11	9	10
Bosmina sp	8	15	4	1	-	-	-	15	2	4	27	23
Cerodaphnia sp	4	9	2	5	2	-	-	11	6	2	8	11
Total	**42**	**52**	**29**	**23**	**14**	**20**	**40**	**62**	**21**	**63**	**71**	**63**
Copepoda (15.51)												
Cyclops sp	6	18	4	12	3	9	8	14	21	3	12	7
Diaptonus sp	11	2	6	3	2	2	-	2	29	15	1	5
Mesocyclops sp	4	7	3	7	-	-	2	11	9	2	13	12
Total	**21**	**27**	**13**	**22**	**5**	**11**	**1 0**	**27**	**59**	**20**	**26**	**24**
Rotifera (44.89)												
Brachionus bidentata	31	26	11	24	2	2	1	2	5	12	6	7
Brachionus plicatilis	21	17	43	2	-	-	6	11	2	9	5	2
Brachionus quadridentata	15	4	6	3	5	2	9	4	6	2	4	2
Brachionus angularis	13	2	2	2	9	3	9	3	5	9	6	6
Brachionus Calyciflorus	21	2	4	6	5	-	6	8	2	9	5	4
Monostyla sp	10	12	12	14	26	8	0	16	16	20	18	3
Keratella sp	6	8	5	3	2	3	-	1	6	7	7	8
Asplanchna	5	6	7	2	2	2	1	-	7	6	3	1
Filinia longisita	2	1	2	2	1	3	3	3	6	5	2	2
Notholca sp	2	1	2	1	3	-	-	1	2	2	1	-
Rotaria sp	6	9	4	2	2	-	-	2	2	1	-	2
Total	**121**	**87**	**98**	**61**	**31**	**23**	**35**	**51**	**60**	**83**	**57**	**31**
Ostracoda (4.68)												
Cypris sp	3	2	2	2	3	1	-	2	2	1	3	5
Cypriodopsis sp	4	9	6	13	2	1	2	5	2	6	-	2
Total	**7**	**11**	**8**	**15**	**4**	**2**	**2**	**7**	**4**	**7**	**3**	**7**
Others (4.50)												
Nauplii	3	3	3	4	6	5	2	3	3	3	3	5
Eggs	3	2	2	3	4	3	3	1	2	2	1	3
Grand total	**197**	**182**	**153**	**128**	**64**	**64**	**82**	**151**	**149**	**178**	**161**	**133**

Values in parenthesis show percent composition

Table- 4: Correlation coefficient between various water quality parameters and zooplankton in Lal Diggi Pond in Aligarh during 2008

Correlation between parameters		r value
Water temperature	Transparency	-0.619*
	Dissolved oxygen	-0.616*
	Total dissolved solids	0.202
	Conductivity	0.400
	NO_3-N	0.686*
	PO_4-P	-0.052
	Zooplankton	-0.700*
Transparency	Total dissolved solids	-0.159
	Zooplankton	0.168
Dissolved oxygen	Total dissolved solids	0.428
	Zooplankton	0.469
Total dissolved solids	Conductivity	0.371
	Hardness	-0.784*
	Calcium	-0.680*
	Magnesium	0.017
	Total alkalinity	0.513
	PO_4-P	0.202
Conductivity	Hardness	-0.752*
	Total alkalinity	-0.516
	Bicarbonate	0.523
NO_3-N	Zooplankton	-0.861*
PO_4-P	Zooplankton	0.529

* Significant at $p < 0.05$

Table- 5: Total zooplankton, richness and diversity indices in Lal Diggi Pond in Aligarh during 2008

Months	Species	Richness	Evenness	Shannon	Simpson
January	20	3.579	0.914	2.74	0.9265
February	20	3.667	0.9028	2.71	0.9268
March	20	3.802	0.8539	2.56	0.8843
April	19	3.747	0.8548	2.52	0.9018
May	16	3.413	0.828	2.22	0.8571
June	12	2.733	0.8168	2.03	0.8266
July	12	2.463	0.8497	2.11	0.8557
August	19	3.607	0.8634	2.54	0.9034
September	20	3.828	0.8725	2.61	0.9078
October	20	3.691	0.8455	2.53	0.889
November	18	3.362	0.8804	2.545	0.9063
December	19	3.71	0.8991	2.647	0.919

Magnesium showed lowest value of 4.7 mg l^{-1} in January and highest 26.0 mg l^{-1} in September. Dissolved nutrients mainly constituted of phosphate (PO_4-P) and nitrate (NO_3-N). Phosphate varied from 0.509 to 0.806 mg l^{-1}. Nitrate varied from 0.083 to 0.583 mg l^{-1} increase and decrease in the phosphate in the water bodies depend upon the adsorption and release of phosphorus by the pond bottom sediment (Abdel-Satar, 2001). Higher values of NO_3-N were found during summer and monsoon months and lowest during winter months (Ganai *et al.*, 2010).

In the present work, Rotifera constituted the most dominant group in the pond contributing 44.89 % of the total zooplankton population followed by Cladocera (30.41), Copepoda (15.51) and. Ostracoda (4.68 %). The highest density of zooplankton was recorded during January (197 no l^{-1}) and February (182 no l^{-1}) respectively, while the lowest density was recorded during May and June (64 no l^{-1}). Twenty genera of zooplankton were recorded belonging to Rotifera (11 species), Cladocera (4 species), Copepoda (3 species) and Ostracoda (2 species) (Table 3). Rotifera was represented by genera *Brachionus calciflorus, Brachionus bidentatus, Brachionus plicatilis, Brachionus quadridentata, Brachionus angularis, Asplanchna priodonta, Keratella cochaelaries, Notholca* sp., *Monostyla* sp., *Rotaria* sp. and *Filinia* longisita. Presence of *Brachionus* sp. indicates that the pond is approaching towards eutrophication and is organically polluted. This is in agreement with Mageed (2008), Ahmad (2011) and Mola (2011) they mentioned that Rotifers, especially, *Branchionus* sp. are the major component of zooplankton in eutrophic water bodies.

The most dominant species in terms of total population density was *Brachionus plicatilis*. Sharma (1998) while reviving the work on rotifers stated that *Keratella tropica, Brachionus angularis, Brachionus calciflorus, Brachionus falcatus* and *Brachionus forificula* are considered as eutrophic indicators of Indian fresh waters.

Cladocera formed the second most abundant group of zooplankton. The group was represented by *Daphnia* sp., *Moina* sp., *Cerodaphnia* sp. and *Bosmina* sp. It ranged from 14 no ml^{-1} in May to 71 no l^{-1} in November. Cladoceran comprised the food of fry, fingerlings and adults of many economically important and cultivable fish species. If food supply is enough Cladoceran usually level up high in number to dominate zooplankton population (Ahmed, 2011). Cladocerans have also been reported to be reliable indicators of eutrophic nature of water bodies (Sinha and Khan, 1998; Sharma, 2001).

Copepoda formed the third most abundant group of zooplankton. It was represented by *Cyclops*, *Mesocyclops* and *Diaptomus*. The population density ranged between 5 no l^{-1} in May and 59 no l^{-1} September. According to Reddy (2001), the copepods (either calanoid or cyclopoid) Cladocera ratio is used in limnological studies as a water quality indicators. El- Shabrawry and Khalifa (2002) mentioned that the presence of rotifers such as *B. calcifloris, Polyarthra vulgaris* and *K. cochlearis* are eutrophic indicators, revealed to effect of eutrophication. This eutrophication affect zooplankton composition, shifting the dominance from large species (Copepoda) to smaller species (Rotifera) (El- Shabrawry, 2000).

Ostracoda was represented by genera *Cypris* sp. and *Cypriodopsis* sp. It was found to be 2 no l^{-1} in June and July to 15 no l^{-1} in April during the study period. In the present study, they contributed least to total zooplankton. Though these are benthic in nature but become planktonic as disturbances in water which brings them to surface.

To study the relative effect of some environmental factors, correlation analyses were made between zooplankton and other

physico-chemical parameters (Table 4). Zooplankton showed negative and significant correlation with water temperature in Lal Diggi pond (r =-0.700). This indicated that the decrease in temperature leads to an increase in total zooplankton population. Also, zooplankton recorded positive correlation with transparency, dissolved oxygen and phosphorus (r = 0.168, 0.469 and 0.529 respectively) while it recorded a significant negative correlation with nitrate (r = -0.861). The highest similarity indices (Evenness, Shannon and Simpson) were recorded during January and February while the lowest values were recorded during June and July. Also, the highest species diversity, Shannon diversity and Simpson diversity was recorded during January and February when the richness values were 3.579 and 3.667, respectively (Table 5).

Although zooplankton exists under a wide range of environmental conditions, yet many species are limited by dissolved oxygen, temperature, salinity and other physical chemical factors. The presence of five species of *Brachionus* indicates that the pond is approaching towards eutrophic action and is organically polluted. Different species of zooplankton showed their abundance according to the favorable condition, so they disappear in unfavorable conditions and reappeared on return of favorable condition.

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