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Zooplankton population in relation to physico-chemical factors of a sewage fed pond of Aligarh (UP), India

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Abstract
The present study conducted during the year 2008 deals with zooplankton population and chemical characteristics of a sewage fed pond of Aligarh. Sampling was done monthly between 8 am and 11 am from January to December 2008 to work out parameters such as air and water temperature, transparency, dissolved oxygen, total dissolved solids, pH, alkalinity, hardness, calcium, magnesium, hydroxide, carbonate, bicarbonate and conductivity. Air temperature ranged from minimum 17 °C in January to maximum 37 °C in June, and water temperature ranged from 15 °C in January to 35 °C in June. Minimum transparency was recorded 15.0 cm while maximum was 19.5 cm. Dissolved oxygen ranged from 1.6 mg/l to 9.2 mg/l. The pH ranged from 8.3 to 9.1. Carbon dioxide was never recorded throughout the study period. Phosphate ranged from 0.435 mg/l to 1.02 mg/l. Nitrate ranged from 0.106 mg/l to 0.198 mg/l. Total of 20 zooplankton species were found belonging to 4 groups i.e. Cladocera (4 species), Copepoda (3 species), Rotifera (11 species) and Ostracoda (2 species). Rotifers were found to be dominating other groups of zooplankton. The water body is receiving domestic discharge leading to large amount of nutrient inputs and high amount of phosphate and nitrate in the water body indicates that water is eutrophic in nature. Continuous presence of *Asplanchna*, *Brachionus*, *Keratella*, *Fillinia*, *Cyclops* and *Diaptomus* is an indicator of organic pollution.

Keywords: Sewage; zooplankton; eutrophic water bodies.

Introduction

Zooplanktons are microscopic organisms which do not have the power of locomotion and move at the mercy of the water movements. Rotifers, cladocerans, copepods and ostracods constitute the major groups of zooplankton. They occupy an intermediate position in the food web. Zooplankton mediate the transfer of energy from lower to higher trophic level (Waters, 1977), thus zooplankton represent an important link in aquatic food chain and contribute significantly to secondary production in fresh water ecosystem (Sharma, 1998). Zooplankton communities respond to a wide variety of disturbances including nutrient loading (Dodson, 1992), acidification and sediment input. It has immense significance in fisheries (Jhingran, 1991). Zooplanktons also play an important role as indicators of trophic condition in both cold temperate and tropical waters (Sharma, 1998). The most common and severe problem is the enrichment of water by a nutrient that increases the biological growth and renders the water bodies unfit for diverse uses. Nutrients that are present in fertilizers as well as in domestic and industrial wastewater have been identified as main cause for changing the trophic status of water bodies from oligotrophic to mesotrophic to eutrophic. Although zooplankton exists under a wide range of environmental condition, yet many species are limited by dissolved oxygen, pH, salinity and other physico-chemical factors. George (1962) and Hutchinson (1967) have reported several other factors like dissolved oxygen, pH, alkalinity, and temperature light and grazing affecting zooplankton population. Therefore, this work aimed to study the zooplankton population in relation to physico-chemical factors of sewage fed pond in Aligarh.

Materials and Methods

Present study was carried out on a fresh water body of Aligarh. The pond is a sewage fed used as drainage basins into which the surface runoff water and sewage from the surrounding catchments area enter. Different physico-chemical parameters were analyzed monthly from January 2008 to December 2008. Samples were collected from 8 am to 11 am. Air and water temperature were recorded by mercury thermometer graduated upon 100°C. pH of water was determined at the sites by using a portable electronic digital pH meter. Dissolved oxygen analysis was performed at the sites by Winkler's modified technique according to APHA (1998).

For zooplankton analysis, samples were collected from each water body on a monthly basis. About 100 liters of water is filtered by passing water through plankton net made up of bolting silk cloth having mesh size of 25 micrometer. Samples were then washed into wide mouth bottles and were preserved by adding 5% formaldehyde solution. Further analysis was done by putting 1 ml of the preserved sample on a Sedgwick-Rafter cell

and studying it under an inverted microscope. For qualitative analysis, the keys given in Edmondson (1959), Needham and Needham (1962), Pennak (1978), Tonapi (1980) and APHA (1998) were utilized and results were expressed in No./L.

Results and Discussion

The air temperature ranged from 15C° to 37°C while water temperature from 15°C to 35ºC (Table 1), free CO_2 was never recorded throughout the study period. pH ranged from 8.3 during May to 9.1 during December 2008. Dissolved oxygen ranged from 1.6 mg/l to 9.2 mg/l. Higher values of dissolved oxygen during some months might be due to increased photosynthetic activity while lower values might be because of its utilization in decomposition of organic matter and respiration by micro and macro organisms. Total alkalinity ranged from 250 mg/l in June to 725 mg/l in September 2008. Varying alkalinity was found to be related with the fluctuations in the photosynthetic rate of phytoplankton. According to Alikunhi (1957), water with alkalinity greater than 100 mg/l is productive. Hardness ranged from 212 mg/l in June to 300 mg/l in September 2008. Higher values of hardness might be due to the evaporation of water at higher temperature during summer months while lower values during monsoon months might be attributed to dilution of water body by rainwater. Phosphate ranged from 0.435 mg/l in March to 1.02 mg/l in November 2008, nitrate value varied from 0.106 in March to 0.198 in June 2008. Higher values of phosphate and nitrate during the study period were due to the incoming sewage including household detergents, kitchen waste, human excreta etc. In the present study, Total Dissolved Solids (TDS) ranged from minimum 298 mg/l in June to maximum 662 mg/l in August 2008 (Table 1 a, b). TDS and phytoplankton showed positive but insignificant correlation (r = 0.125). TDS showed variations mainly caused by the addition of dissolved substances and utilization by organisms and other aquatic plants and animals during different months. Higher values of TDS during the monsoon period due to incoming surface runoff and drainage water containing large amount of silt, clay and other material, which increased turbidity of water inhibiting light penetration in the water body. Lower values might be due to loss of nutrients into sediments and their utilization by plankton and other aquatic plants. According to Trivedy and Goel (1984), an excess amount of TDS in water tends to disturb the ecological balance due to suffocation in aquatic fauna even in the presence of fair amount of dissolved oxygen.

The total zooplankton number fluctuated from 54 to 254 No./ml and zooplankton showed polymodal occurrence. Interspecific and intraspecific factors influence the distribution and abundance of zooplankton. The availability of phytoplankton affects the zooplankton by affecting female fertility. The fresh water zooplankton fauna of these water bodies comprised of four major groups i.e. the cladocerans, copepoda rotifera and ostracoda. Among zooplankton, rotifers formed the dominant group and cladocerans were the second dominant group during the study period.

A total of 11 genera were recorded belonging to Rotifers i.e. *Brachionus calciflourous, Brachionus bidentata*, *Brachionus angular, Brachionus plicatilis, Asplanchna peridontata, Keratella, Notholca, Monostyla*, *Rotaria* and *Fillinia longisita* (Table 2). They are valuable bioindicators (Sladecek, 1983; Berzins and Pejler, 1987). Rotifers are also essential food source for Indian major carps. Cladocerans formed the second most abundant group of zooplankton represented by *Daphnia, Moina, Bosmina* and *Cerodaphnia* while Copepoda was represented by three genera i.e. *Cyclops, Diaptonus* and *Mesocyclops* and Ostracoda was represented by two genera i.e. *Cypris* and *Cypriodopsis* (Table 2). Regression lines showing correlation between zooplankton with NO_3-N and PO_4-P in Medical and Lal Diggi pond have been given in Figure 1.

Conclusion

Findings of this study on physico-chemical relationship with zooplankton of a sewage fed pond are summarized below:

- In both the ponds, water temperature follows the trend of air temperature and is always found to be less than air temperature.
- Carbon dioxide never found during the study period.
- pH was always alkaline.
- Higher values of dissolved oxygen during some months might be due to increased photosynthetic activity while lower values may be because of its utilization during decomposition of organic matter and respiration by micro and macro organisms.
- Higher values of phosphate and nitrate during the study were due to the incoming sewage.
- Zooplankton showed polymodal occurrence.

- Interspecific and intraspecific factors influence the distribution and abundance of zooplankton.
- Rotifers, Cladocera, Copepoda and Ostracoda constitute the zooplankton population and contributed significantly to secondary production of the pond.
- Zooplanktons *Asplachna, Brachionus, Keratella*, *Fillina, Cyclops* and *Diaptomus* indicate organic pollution in the ponds studied.

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Tables and Figure follow……

Table 1a: Monthly variations in various physico-chemical parameters in Medical Pond.

Parameter Months	Air temperature °C	Water temperature °C	Transparency (cm)	Dissolved oxygen (mg/l)	TDS (mg/l)	pH	Conductivity (µS cm^{-1})	Carbon dioxide (mg/l)
Jan. 08	17	15	15.5	9.2	319	9.0	2698	-
Feb. 08	18	16	15.4	8.7	312	8.6	2525	-
Mar. 08	24	22	15.7	4.7	350	9.1	2528	-
Apr. 08	26	24	19.2	5.2	400	8.7	2168	-
May 08	35	32	18.0	2.0	330	8.3	2010	-
Jun. 08	37	35	17.5	1.6	298	8.7	2050	-
Jul. 08	35	33	18.1	3.3	490	8.8	2200	-
Aug. 08	33	30	19.0	4.2	662	8.7	2340	-
Sep. 08	31	28	19.5	4.6	595	8.5	2398	-
Oct. 08	28	26	16.0	5.0	386	8.6	2458	-
Nov. 08	25	23	15.0	5.4	560	8.7	2598	-
Dec. 08	22	19	16.0	7.3	580	9.1	2652	-

Table 1b: Monthly variations in various physico-chemical parameters in Medical Pond.

Parameter Months	Hardness (mg/l)	Calcium (mg/l)	Magnesium (mg/l)	Total Alkalinity (mg/l)	Carbonate (mg/l)	Bicarbonate (mg/l)	Po_4-P (mg/l)	No_3-N (mg/l)
Jan. 08	265	54.	31	480	210	270	0.720	0.132
Feb. 08	252	50	27	390	150	240	0.602	0.119
Mar. 08	240	67	25	550	180	370	0.435	0.106
Apr. 08	236	65	29	652	156	496	0.575	0.136
May 08	290	85	36	570	170	400	0.462	0.158
Jun. 08	300	95	26	725	20	525	0.470	0.198
Jul. 08	223	100	16	460	120	260	0.501	0.120
Aug. 08	250	97	20	320	100	220	0.703	0.132
Sep. 08	212	80	15	250	150	145	0.862	0.169
Oct. 08	230	72	12	298	188	110	0.921	0.145
Nov. 08	260	79	9	320	120	200	1.02	0.175
Dec. 08	267	81	25	315	110	205	0.968	0.144

Table 2: Distribution and abundance of zooplankton population (No/L) in Medical Pond during 2008.

Months Genera	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
CLADOCERA												
Daphnia sp	46	19	18	9	7	4	12	6	32	26	19	24
Moina sp	22	8	2	4	5	7	-	-	2	-	11	19
Bosmina sp	8	11	10	28	18	10	3	7	8	-	23	35
Cerodaphnia sp	4	12	11	5	9	-	1	-	2	5	8	16
Total	80	50	41	46	39	21	16	13	44	31	61	94
COPEPODA												
Cyclops sp	9	21	8	15	6	10	32	11	24	6	10	13
Diaptomus sp	11	2	1	1	4	-	-	-	9	5	2	-
Mesocyclops sp	2	15	7	3	1	3	2	15	19	10	7	10
Total	22	38	16	19	11	13	34	26	52	21	19	23
ROTIFERA												
Brachionus bidentata	23	31	12	19	8	4	1	1	7	2	2	3
Brachionus plicatilis	21	42	18	22	6	9	2	1	2	-	2	-
Brachionus calciflorus	9	18	12	10	5	-	-	-	1	3	5	10
Brachionus quadridentata	6	14	20	2	-	-	3	1	1	5	3	5
Brachionus angularis	26	15	11	18	12	-	2	-	1	13	9	9
Keratella sp	2	3	2	2	1	-	2	2	1	-	17	24
Asplanchna sp	6	6	2	2	1	1	1	-	2	10	3	5
Filinia longisita	19	11	9	2	-	4	1	2	-	-	2	4
Notholca sp	3	3	2	14	8	2	-	-	-	9	5	7
Rotataria sp	2	2	3	6	1	5	8	2	2	2	9	2
Total	117	139	91	97	42	25	19	9	17	44	57	69
OSTRACODA												
Cypris sp	6	4	2	9	2	1	1	-	2	3	7	2
Cypriodopsis sp	19	10	12	21	-	2	4	3	2	3	2	2
Total	25	14	14	30	2	3	5	3	4	6	9	4
NAUPLII	3	2	2	2	3	4	2	-	2	3	3	2
Eggs	7	2	4	3	5	7	5	3	3	5	-	-
Grand Total	254	235	168	197	98	67	77	54	115	80	149	192

Figure 1: Regression lines showing correlation between zooplankton (No./l) with NO_3-N (mg/l) and PO_4-P (mg/l) in Medical and Lal Diggi pond.