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Water Quality Characteristics of Two Derelict Water bodies of Aligarh, Uttar Pradesh, India.

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Abstract

District Aligarh of Western U.P. in North India has diversified seasonal rain fed and sewage fed water bodies. Selected water bodies are ponds approximately 5 km away from university campus. These ponds seem to derelict as they are used just for collecting sewage water coming from the houses. Cattle use them for drinking water, bathing, and sometimes for grazing. The present study was carried out for 16 months from February 2001 to May 2002 and analysed various physicochemical parameters, namely temperature, dissolved oxygen, pH, transparency and nutrients. The study indicated that these water bodies are productive and they can be made useful for fish culture after adopting proper pond management strategies.

Introduction

India is rich in vivid types of lentic aqua-systems located in different geographical regions from the hot and dry arid zone to wet and humid zone of southern peninsula (Hosetti 2002). Aligarh, a district of Utter Pradesh in Northern India, is located in the central Ganga-Yamuna Doab at latitude 27^{o}54’N and longitude 78^{o}4’E. It experiences the tropical monsoon type of climate with marked North-East and South-West monsoon. Due to increasing population pressure in India it has become necessary to make use of more and more water bodies including derelict and waste water to fulfill the demand of protein requirements. The limnological characteristics of water of different regions are of immense practical value in fish culture programmes. Although lots of work has been done in the field of limnology in North India there is a lack of work done in these water bodies. Keeping in view the objective for use of such water bodies for fish culture it has become essential to analyze the water quality. Present study includes monitoring of various physicochemical and biological characteristics.

The selected water bodies are two ponds in Charrat village approximately 5 km away from university campus. At present these water bodies are used as drainage basin into which surface runoff water and sewage from surrounding catchment areas enters.

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Pond I is smaller approximately 0.26 ha in area than pond II which is approximately 1.03 ha. Depth varies from 0.52 to 0.96 m in pond I and 0.5 to 0.96 m in Pond II. The shoreline is irregular in both the ponds making the ponds very productive by increasing the opportunity of superimposition of photosynthetic zone upon decomposition zone.

Materials and Methods

For water quality analysis monthly sampling was done from these two water bodies for a period of 16 months from February 2001 to May 2002.Water sample was collected from surface and physicochemical and biological parameters were analyzed.

Transparency was recorded using standard Secchi disc method. Temperature of air and water was recorded with the help of mercury thermometer. Dissolved oxygen (D.O) was analysed by Winkler's modified technique (APHA 1992), carbon dioxide by titration method, and pH was determined with the help of Marconi's portable pen type digital pH meter. Alkalinity was determined by titration with a 100 mL water sample with 0.02 N sulphuric acid using phenolphthalein and methyl orange as indicators. Hardness was estimated by titration with 0.01 N EDTA solution using Muroxide as indicator (Trivedy and Goel 1984). The presence and amount of phosphates (PO_4-P) and nitrates (NO_3-N) were estimated following the method by Trivedy and Goel (1984) and Silica was determined by silicomolybdic acid (Ammonium Molybdate-yellow) method (Barnes 1959).

For phytoplankton analysis, monthly water samples (500 mL) were collected from each water body and fixed in 5 mL of Lugol's iodine solution (Edmondson 1959). After 24 hours the supernatant was discarded and concentrate was obtained. For zooplankton analysis every month 100 litres of water was filtered by passing it through plankton net made up of bolting silk cloth having mesh size of 30 µm, taking care that water was not disturbed much during the operation. Samples were then washed out into wide mouth bottles and were preserved by adding 5% formaldehyde solution to them. Further analysis was done by putting 1 mL of the fixed sample on a Sedgewick-Rafter cell, and studying it under an inverted microscope (Metzer). Counts were made as number of zooplankton per liter and number of phytoplankton of water sample. For qualitative analysis, the information given in Edmondson (1959), Needham and Needham (1962), Pennak (1978) and Tonapi (1980) were used. For most of the organisms encountered, the identification was made up to generic level.

Results and Discussions

Monthly variations in Secchi disc transparency, temperature, dissolved oxygen, and pH are given in Table 1.

Table 1. Monthly Variations in Air Temperature, Water Temperature, Transparency, pH and Dissolved Oxygen in Ponds I and II.

Months	Air temperature (ºC)		Water temperature (ºC)		Transparency (cm)		pH		Dissolved Oxygen (mg. L^{-1})	
	I	**II**	**I**	**II**	**I**	**II**	**I**	**II**	**I**	**II**
February, 2001	18.3	18.3	15.5	16.5	38.5	38.0	9.0	8.7	6.2	4.2
March	25.5	25.5	23.5	24.0	37.0	34.0	9.1	9.0	8.0	6.8
April	25.5	25.5	24.0	23.5	34.0	30.5	8.4	8.4	7.6	6.2
May	36.0	36.0	34.0	34.0	36.5	36.0	8.6	8.3	6.0	3.6
June	39.0	39.0	35.0	35.0	32.0	32.0	8.3	8.6	7.2	5.0
July	38.0	38.0	35.0	36.0	28.5	18.0	8.3	8.6	5.6	4.6
August	36.0	36.0	32.0	32.0	18.0	16.5	8.3	8.5	6.0	3.4
September	30.0	30.0	28.0	27.0	22.0	26.5	8.4	8.7	8.0	4.4
October	30.0	30.0	28.0	28.0	28.0	28.0	8.3	8.5	6.0	4.0
November	29.0	29.0	25.5	25.5	38.5	38.5	8.4	8.6	4.6	2.6
December	22.0	22.0	18.5	18.5	32.5	36.0	8.6	8.4	5.0	3.8
January, 2002	17.0	17.0	16.0	16.0	30.7	27.0	9.1	9.1	8.4	7.2
February	15.0	15.0	14.0	14.5	36.5	38.0	8.6	8.3	4.8	5.2
March	23.0	23.0	21.5	21.0	38.5	34.0	8.7	8.8	4.0	3.8
April	25.0	25.0	23.0	22.5	26.5	23.5	8.8	8.7	6.4	6.6
May	32.0	32.0	28.5	28.5	28.0	24.5	8.5	8.8	5.2	6.2

It was found lowest in monsoon months, which might be due to entry of huge amount of suspended and colloidal matter, silt and clay into these water bodies along with the rain water from surrounding fields. Maximum transparency during winter might be due to settling of suspended materials. Water temperature in these shallow basins was closely related to ambient air temperature. The monthly water temperature changes follow the pattern in temperature change for Indian subcontinent. The fluctuations in D.O. content might be attributed to the fact that the concentrations and solubility of this gas in these waterbodies might be exposed to intense photosynthetic activity of phytoplankton. Statistically, these two parameters show direct and positive correlation with oxygen D.O. Higher values during monsoon months in both the ponds were found to be mainly due to agitation of water caused by falling rainwater over the surface of the water body. Carbon dioxide was never detected. High pH above 8.3 in both ponds might be the probable cause of complete absence of carbon dioxide. Absence of carbon dioxide was also noted by Jhingran (1991). There is always an optimum range of pH for growth and survival of any organisms. In the present study, pH range fluctuated between 8.3 and 9.1. High pH in these ponds during certain months might be due to high photosynthetic activity. Monthly variation in alkalinity, hardness, phosphate, nitrates, and silica are given in Table 2.

Table 2. Monthly Variations in Total Alkalinity, Hardness, Phosphates, Nitrates and Silica in Ponds I and II.

Months	Total Alkalinity (mg/L)		Hardness (mg/L)		PO_4-P (mg/L)		NO_3-N (mg/L)		Silica (mg/L)	
	I	II	I	II	I	II	I	II	I	II
February, 2001	360	384	290	230	0.36	0.27	0.12	0.07	0.240	0.133
March	400	389	270	170	1.65	1.14	0.13	0.08	0.223	0.195
April	380	350	290	200	1.74	1.74	0.11	0.10	0.351	0.326
May	285	204	500	500	1.14	0.91	0.18	0.15	0.638	0.726
June	350	280	380	360	1.60	0.93	0.21	0.20	1.310	0.285
July	320	298	280	260	0.98	0.98	0.16	0.12	1.162	1.100
August	300	128	142	140	1.10	0.91	0.18	0.10	1.096	1.196
September	340	190	160	141	0.97	1.14	0.19	0.09	0.564	0.651
October	300	185	164	234	0.85	1.16	0.15	0.09	0.832	0.928
November	261	167	232	240	0.62	0.53	0.11	0.18	0.675	0.077
December	370	180	290	270	0.67	0.57	0.13	0.05	0.787	0.833
January, 2002	380	380	380	220	1.53	0.58	0.21	0.06	0.916	0.326
February	300	213	276	234	0.73	0.98	0.10	0.07	0.216	0.252
March	170	225	320	312	1.05	0.80	0.11	0.11	0.833	0.598
April	250	295	350	360	1.06	1.01	0.13	0.13	0.429	0.326
May	220	295	326	312	1.01	1.18	0.16	0.16	0.351	0.226

Alkalinity ranges from 128 mg/L to 400 mg/L in both ponds. Jhingran (1991) has given the range 40 to 1000 mg/L for Indian waters. According to Alikunhi (1957) ponds with alkalinity greater than 100 mg/L can be categorized as highly productive. Statistically, a positive correlation between alkalinity and phytoplankton population was obtained (Table 3). Hardness showed wide fluctuations (140-500mg/L).

Table 3. Statistical brief of various water quality parameters in ponds I and II.

Parameters		Parameters	Pond I	Pond II
Water Temperature	vs	PO4-P	0.328	0.331
		NO3-N	0.532*	0.674*
		Silica	0.549*	0.462
Dissolved Oxygen	vs	Phytoplankton	0.738*	0.570*
Total Alkalinity	vs	Zooplankton	0.792*	0.900*
PO_4-P	vs	Phytoplankton	0.595*	0.298
NO_3-	vs	Phytoplankton	0.614*	0.335
Phytoplankton	vs	Phytoplankton	0.422	-0.422
	vs	Zooplankton	0.969*	0.554*
	vs	Carbonates	0.67*	0.67*
	vs	Chloride	0.256	0.476
		Water-Temperature	0.036	0.136

* = Significant at 5% level

Higher concentration during May might be due to excessive evaporation. Higher values of hardness are due to detergent containing domestic wastes. Moreover, high hardness is the general characteristic of water bodies situated in Indian plains. Phosphates (PO_4-P) showed generally higher values except during winters (Table 2). Various environmental factors such as temperature, pH, and redox conditions can influence phosphorus cycling (Forsberg 1989). Incoming sewage water is the major source of phosphate. Generally, higher concentration of Nitrates (NO_3-N) was noted during summer and monsoon months (Table 2) in both ponds. The higher values of nitrates and phosphates during summer might be attributed to increased rate of decomposition of organic matter at high temperature, as well as, high rate of evaporation in these shallow water bodies. Values of dissolved silica during summer might be associated with regeneration of silicates from diatom frustule at high temperature. The trend of silica content proved that concentration increases at high temperature within the range for freshwaters (Wetzel 1983). Statistically, a positive correlation between water temperature and these nutrients was obtained (Table 3). Phytoplankton mainly comprises algae as these have suitably adapted themselves to a planktonic mode of life. Five groups of planktonic algae are given in the order of abundance in Table 4 (a and b). Pond I showed minimum number (124 No./mL) in August 2001 and maximum number (217 No./mL) in January 2002, whereas pond II showed minimum number (83 No./mL) in November 2001 and maximum number (143 No./mL) in January 2002 (Table 4b). In the present study, it was noted that no single environmental factor was found responsible for the production of phytoplankton organisms but a number of factors acted together to bring forth the cumulative effect. Myxophyceae group is represented by following members: *Microcystis aeruginosa* contributed maximum (68 No./mL) during June 2001 in pond I and (56 No./mL) during February 2002 in pond II. This species showed its presence throughout the period of investigations. *Spirulina* was recorded in all the samples except during February 2001 and April-May, 2002 in pond I. In pond II, it was recorded only during July 2001 to February 2002. *Anabaena* showed its presence during February to July 2001, March 2002, May 2002 in pond I, during February to March 2001 and from August to December 2001 in pond II. *Agmenellum* also showed its presence throughout in all these ponds. Its maximum densities (17 No./mL and 12 No./mL) were recorded during April and February 2002 in ponds I and II. Chlorophyceae: In the present study, it is the second most abundant group of phytoplankton after myxophyceae (Tables 4 a,b). Members are *Crucigenia*, *Ankistrodesmus*, *Scenedesmus*, *Chlorella*, and *Protococcus* in pond I, *Ankistrodesmus*, *Protococcus*, and *Actinastrum* in pond II. The filamentous algae *Spirogyra* and *Ulothrix* show bimodal occurrence showing their presence during March to April 2001 and September to October 2001 in pond II and pond I showed the absence of *Spirogyra* during February to March 2001 and *Ulothrix* during May 2001, September to October 2001 and February to May 2002.

The genera noted to be absent during certain months appeared when conditions become favorable. In the present study, alkaline medium favors optimum growth of Chlorophyceae (Saha et al. 1985). The dominance of Chlorophyceae in pond I might also be due to comparatively high D.O. content than other ponds. Dhakar (1979) found that the green algae prefer waters with high D.O. content. Euglenophyceae: In the present study, euglenoids are represented by only two genera (*Euglena* sp. and *Phacus* sp.) throughout the study. The two species of *Euglena*, coexists without showing any competition and showed presence in good numbers throughout. During the period of investigations, *E. acus* and *E. deses* showed a range of 5 to 25 No./mL and 3 to 30.00 No./mL in pond I, 3 to 16 No./mL and 2 to 12 No./mL in pond II. *Phacus* sp. also showed continuous presence, fluctuating between 5 to 16 No./mL and 3 to 12 No./mL in ponds I and II, respectively. Less diversity and continuous presence of euglenoids in the present study might be due to richness of these waterbodies in terms of organic

Table-4a Distribution and Abundance of Phytoplankton population (No./ mL) in Pond I

Genera \ Months	Feb. 2001	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan. 2002	Feb.	March	April	May
MYXOPHYCEAE																
Microcystis	14	55	43	49	68	49	21	26	10	10	10	15	26	38	49	60
Spirulina	-	1	3	11	12	9	3	39	36	16	7	2	4	2	-	-
Anabaena	1	2	2	1	3	1	-	-	-	-	-	-	-	2	3	2
Agmenellum	5	9	7	17	7	4	2	4	5	4	3	3	10	15	16	14
Total	20	67	55	78	90	63	26	69	51	30	20	20	40	57	68	76
CHOLOROPHYCEAE																
Crucigenia	9	12	10	11	6	4	5	11	12	15	10	17	13	6	8	14
Pediastrum	1	2	3	-	1	2	2	1	-	1	2	3	1	2	1	2
Ankistrodesmus	12	18	11	4	13	11	4	7	14	9	12	18	18	10	9	4
Scenedesmus	4	6	5	7	7	6	5	4	5	4	6	10	8	5	6	8
Protococcus	12	18	9	10	12	16	10	16	18	18	19	24	17	10	9	10
Chlorella	5	3	2	1	2	3	2	2	3	8	6	8	4	2	2	3
Tetraspora	15	18	12	9	5	9	4	9	4	12	10	14	11	4	6	8
Actinastrum	6	3	3	2	2	5	3	7	8	7	3	9	7	4	6	9
Spirogyra	4	7	7	3	4	8	4	4	3	4	3	2	-	-	2	3
Ulothrix	2	4	5	-	2	3	1	-	-	2	1	1	-	-	-	-
Total	67	91	67	46	48	67	35	61	67	72	72	116	79	43	47	61
BACILLARIOPHYCEAE																
Navicula	2	3	6	14	18	16	18	11	12	11	10	10	8	8	6	6
Nitzschia	1	2	2	4	4	2	4	2	1	2	2	3	2	1	-	-
Synedra	-	-	1	3	2	4	1	3	2	2	2	3	2	4	3	2
Cyclotella	-	1	1	2	1	2	1	1	1	-	1	2	3	2	1	1
Amphora	2	3	2	2	3	3	2	1	1	-	1	2	2	3	3	2
Diatoma	1	2	1	1	2	1	2	1	-	-	-	1	1	-	1	1
Total	6	11	13	26	30	28	28	19	17	15	16	21	18	18	14	12
EUGLENOPHYCEAE																
Euglena acus	14	12	10	10	17	6	10	12	10	11	25	20	9	8	12	5
E.deses	12	6	7	6	5	10	11	10	12	10	10	30	6	7	10	3
Phacus sp.	16	5	10	8	7	8	9	16	8	10	10	13	6	6	14	6
Total	42	23	27	24	22	24	30	38	30	31	45	46	21	21	32	14
DESMIDIACEAE																
Closterium	5	6	5	6	4	6	4	3	5	3	12	10	5	2	13	6
Cosmarium	2	3	2	1	3	1	1	3	3	2	4	4	2	2	2	3
Total	7	9	7	7	7	7	5	6	8	5	16	14	7	4	15	9
Grant Total	142	201	199	181	197	189	124	193	173	153	169	217	165	143	176	172

Table - 4b Distribution and Abundance of Phytoplankton population (No./ mL) in Pond II.

Genera \ Months	Feb. 2001	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan. 2002	Feb.	March	April	May
MYXOPHYCEAE																
Microcystis	16	35	32	34	37	31	29	10	8	6	11	12	56	24	23	31
Spirulina	-	-	-	-	-	2	4	14	19	18	9	3	4	-	-	-
Anabaena	1	1	-	-	-	-	2	3	3	2	2	-	-	-	-	-
Agmenellum	3	4	3	4	7	5	6	7	6	6	7	5	12	2	5	5
Total	20	40	35	46	44	38	42	34	36	32	29	20	72	26	28	36
CHOLOROPHYCEAE																
Crucigenia	2	4	2	3	3	2	2	3	4	-	4	7	6	3	5	3
Pediastrum	1	1	-	-	-	1	-	2	1	-	-	2	1	-	-	-
Ankistrodesmus	5	7	4	3	4	3	3	5	4	3	5	10	6	4	5	3
Scenedesmus	2	3	3	2	2	1	1	2	1	1	-	3	2	3	4	5
Protococcus	4	7	5	5	4	5	4	9	7	4	2	19	10	7	6	4
Chlorella	1	2	2	1	1	2	1	2	3	1	-	4	1	2	2	1
Tetraspora	3	5	3	2	2	3	2	4	3	2	-	10	2	2	3	2
Actinastrum	4	12	4	4	3	2	3	5	5	3	2	14	3	6	6	3
Spirogyra	-	6	3	-	-	-	-	6	4	-	-	-	-	-	-	-
Ulothrix	-	2	2	-	-	-	-	2	3	-	-	-	-	-	-	-
Total	22	49	28	20	19	19	16	40	35	15	13	58	31	27	31	21
BACILLARIOPHYCEAE																
Navicula	3	2	5	16	4	15	10	10	12	12	18	6	5	7	6	3
Nitzschia	1	2	2	5	5	7	4	2	4	4	5	-	1	3	2	2
Synedra	-	1	1	4	-	8	5	2	2	2	3	2	1	3	2	-
Cyclotella	1	1	1	4	-	6	3	3	3	3	2	1	1	2	1	-
Amphora	-	-	1	1	-	2	-	1	2	2	1	-	-	-	-	-
Diatoma	-	-	-	1	-	-	-	1	-	-	-	-	-	1	-	-
Total	5	6	10	31	9	37	38	19	27	23	29	9	8	16	11	5
EUGLENOPHYCEAE																
Euglena acus	14	16	13	9	11	5	8	6	7	3	5	14	7	11	10	8
E.deses	7	11	6	4	10	3	5	3	4	2	2	12	3	10	10	6
Phacus sp.	7	10	5	4	7	4	3	6	4	3	6	12	3	7	9	6
Total	28	37	24	17	28	12	16	15	15	8	13	38	13	28	29	20
DESMIDIACEAE																
Closterium	9	8	8	6	4	4	5	7	12	3	4	14	6	6	16	15
Cosmarium	5	2	3	1	1	2	1	3	2	2	2	4	4	3	2	1
Total	14	10	11	7	5	6	6	10	14	5	6	18	10	9	18	16
Grant Total	89	142	108	121	105	113	102	118	127	83	90	143	134	106	117	98

matter and nutrients. Bacillariophyceae*:* This group is represented by *Navicula*, *Nitzschia*, *Amphora*, *Synedra*, *Diatoma*, and *Cyclotella*. All these have their own distribution pattern. Among these, *Navicula* was most dominant in pond I and II and showed its presence continuously. It was noticed that this group showed increase in abundance during summer at high temperature. Pearsall (1932) observed that diatoms occurred when the water was rich in nitrates, phosphate, and silicates. Desmidiaceae*: Closterium* sp. and *Cosmarium* sp., which are known to exhibit tolerance with the higher concentration of organic matter, were the only genera noted throughout the period of investigations. *Cosmarium* sp., was found to be less abundant in these ponds as compared to *Closterium* sp. Singh and Pandey (1991) recorded only two genera of desmids in polluted waterbody. Zooplankton: Reice and Wohlenberg (1993) have pointed out that the state of an aquatic system can not be truly understood without the knowledge of zooplankton due to its important role in food chain. Monthly abundance and distribution of different zooplankton species are given in Tables 5 (a & b).

Following group comprised zooplankton in these two ponds. Regarding seasonal fluctuations, zooplankton showed polymodal occurrence (several peaks of maxima) during early summer (March-April), monsoon and post monsoon (June-September) in the year 2001 and January, and April-May in the year 2002 in pond I. Pond II zooplankton showed maxima during summer (March) in the year 2001 and during winter (January) and again during summer (April) in the year 2002. Statistical analysis showed positive and significant correlation between zooplankton and phytoplankton density (Table 3). Rotifera*: Keratella tropica*, one of the most important rotifer species, occurred throughout the study in pond I. Pond II showed its absence during March, 2001, September to January 2002 and March 2002. *Testudinella* sp. was found throughout the study in Pond I. In pond II, it was recorded in the collections of May to October 2001 and January to April 2002. *Brachionus calyciflorus* was recorded throughout the study except in the month of January 2002 in pond I. In pond II, its absence was recorded from May to August 2001 and May 2002. *B. angularis* was recorded from Feb to June 2001 and from Sepember to January 2002 in pond I; from February to April 2001 and from September to April 2002 in pond II. Pennak (1978) remarked that *B. angularis* is often considered bicyclic or perennial. *Filinia longiseta* was observed throughout the year in both these ponds. Maximum density was recorded during July 2001 in pond I, during June 2001 in pond II. *Filinia longiseta* has also been reported by Pejler (1957) as a representative of eutrophic waters. *Notholca sp.* was recorded more frequently in pond I than in ponds II. *Lecane sp.* was encountered during February to July 2001, September to October 2001 and April to May 2002 in pond I, during February to March 2001, May to June 2001, Table - 5a. Distribution and Abundance of Zooplankton population (No./ L) in Pond I.

Months / Genera	Feb. 2001	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan. 2002	Feb.	March	April	May
CLADOCERA																
Daphnia carinata	16	32	31	22	5	16	10	28	23	22	30	52	26	15	12	10
Moina micrura	5	7	4	2	-	-	-	-	5	7	8	18	3	5	7	3
Ceriodaphnia cornuta	2	6	6	4	3	6	3	6	2	3	5	3	2	4	4	3
Leptodora sp.	1	-	-	-	2	2	1	1	-	-	-	1	-	1	-	2
Total	24	45	41	28	10	24	14	35	30	32	43	74	31	25	23	18
COPEPODA																
Cyclops sp.	6	15	10	6	13	10	4	9	3	4	5	4	6	5	8	10
Diaptomus sp.	4	1	8	7	7	6	5	7	2	2	2	3	5	4	7	6
Mesocyclops leuckarti	8	15	12	9	9	8	3	9	6	3	3	6	5	7	14	8
Total	18	40	30	22	29	24	12	25	11	9	10	13	16	16	29	24
ROTIFERA																
Brachionus angularis	2	12	13	18	3	-	-	1	12	10	6	9	-	-	-	-
B.calyciflorus	1	4	7	2	9	3	4	2	4	4	2	-	7	2	6	14
Testudinella sp.	2	2	1	2	3	1	1	3	2	2	2	2	3	1	2	2
Notholca sp.	1	2	2	3	2	1	-	2	1	1	2	1	2	1	2	1
Filinia longiseta	4	5	6	6	14	18	2	3	6	2	3	4	3	2	5	5
Keratella sp.	1	3	2	5	4	5	1	6	4	1	1	2	1	1	3	3
Lecane sp.	1	1	2	2	3	1	-	2	1	-	-	-	-	-	1	2
Total	12	30	33	36	38	29	8	28	29	20	16	18	16	7	19	27
OSTRACODA																
Cypris sp.	3	2	2	2	4	3	5	2	7	4	2	2	4	5	2	1
EGGS	6	2	3	2	8	9	3	7	8	2	5	10	3	2	10	10
NAUPLII	2	2	2	1	6	4	6	4	2	1	2	5	2	-	6	7
Grant Total	64	121	111	91	95	93	48	101	87	68	78	122	72	55	89	87

Table - 5b. Distribution and Abundance of Zooplankton population (No./ L) in Pond II.

Months / Genera	Feb. 2001	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan. 2002	Feb.	March	April	May
CLADOCERA																
Daphnia carinata	22	24	13	8	7	5	9	10	16	14	16	28	19	17	18	6
Moina micrura	5	8	4	4	-	1	3	5	6	2	3	6	6	3	3	3
Ceriodaphnia cornuta	3	4	6	4	2	1	3	2	8	3	1	8	3	5	6	3
Leptodora sp.	1	1	3	1	2	1	3	5	2	1	-	2	3	3	1	1
Total	31	37	26	17	11	8	18	21	32	20	20	44	31	28	28	13
COPEPODA																
Cyclops sp.	4	6	9	8	7	8	6	3	5	2	3	5	4	2	7	8
Diaptomus sp.	3	4	7	2	4	3	4	2	2	1	2	2	3	1	5	2
Mesocyclops leuckarti	4	8	7	7	8	6	9	10	3	2	3	4	3	3	7	10
Total	11	18	23	17	19	17	19	15	10	5	7	11	10	6	19	20
ROTIFERA																
Brachionus angularis	8	4	3	-	-	-	-	3	4	6	5	9	8	3	6	-
B.calyciflorus	-	-	4	5	7	3	5	-	-	-	-	-	11	11	3	7
Testudinella sp.	-	-	-	2	3	3	2	1	1	-	-	1	2	1	2	-
Notholca sp.	-	-	-	1	1	-	-	-	-	-	-	-	-	-	1	1
Filinia longiseta	2	2	3	4	7	6	4	2	1	1	2	1	2	1	2	4
Keratella sp.	2	-	2	3	1	1	4	-	-	-	-	-	1	-	2	2
Lecane sp.	1	1	-	1	2	-	1	-	-	-	-	1	-	-	1	2
Total	13	7	12	16	21	13	16	6	6	7	7	12	14	6	17	17
OSTRACODA																
Cypris sp.	2	2	1	1	4	2	2	2	1	2	2	1	1	4	2	4
EGGS	8	6	4	6	7	2	2	3	4	5	7	8	6	4	3	4
NAUPLII	2	6	2	4	3	1	2	1	2	2	4	2	4	1	3	4
Grant Total	67	76	68	61	65	43	59	48	55	41	47	78	66	49	72	62

August 2001, January 2002, and April to May 2002, in pond II. Cladocera*: Daphnia carinata* is abundantly found throughout the study period contributing maximum (52 No./L) in pond I, (28 No./ L) in pond II during January, 2002. *Moina micrura* was recorded in all these ponds, but found to be absent from June to September 2001 in pond I and during June 2001 in pond II. These species have been reported to be widespread in the plankton samples of ponds, lakes, and reservoirs of Northern India. *Ceriodaphnia cornuta* was noted throughout the study period in all these ponds. However, its density was always found to be lower than *Daphnia* spp. *Leptodora* sp. is a transparent crustacean and the largest of the cladocera (Cole 1983). It showed its occasional presence with one or two numbers per litre in both ponds. It's occasional presence and least density might be due to the fact that it rises at night and preys on other zooplankton, including *Daphnia*, but during the day it migrates toward deep waters and is not readily found (Cole 1983). It is also reported from freshwaters of Kashmir region (Sharma 2001). Copepoda: *Mesocyclops leuckarti* was found to be the most dominant in both ponds. It was recorded maximum (15 No./L) during March 2001 in pond I, (10No./L) during September, 2001 and May 2002 in pond II. *Cyclops* sp. formed the second most abundant copepod genera and recorded in maximum numbers (15 No./L and 9 No./L during March, April 2001 in ponds I and II, respectively). *Diaptomus* sp. was recorded maximum (10 No./L and 7 No./L) during March and April and August 2001 in ponds I and II, respectively. This species always encountered in small numbers than other two species. Ostracoda*:* It is represented by *Cypris sp.* only in both ponds. Year round occurrence of eggs of rotifers and crustaceans and nauplii (Table 5 (a & b)) also indicate that these zooplankton (rotifers and crustaceans) are prolific and continuous breeders. The commonly occurring fish species in these ponds are *Channa punctatus*, *Wallago attu*, *Clarias batrachus*, *Heteropneustes fossilis*, *Puntius sophore*, and *Gambusia affinis*.

Conclusions

From the present study it has been concluded that these water bodies are productive. Presence of sufficient nutrients, suitable pH, phytoplankton, zooplankton, plants, and fishes is an indication of healthy and balanced ecosystem. Therefore, we can say that though these water bodies seem derelict they can be made useful for fish culture after adopting proper pond management strategies.

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