

# A Limnological Profile of a Sewage Polluted Fresh Water Pond of District Mirzapur

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*The present article deals with the limnological profile of a man made fresh water pond situated in the village Manguri belonging to Chetganj town area of district Mirzapur. It was constructed in 1958 for the welfare of village people but now it has become a useless water body. As it receives domestic sewage from a residential police line colony established later on the eastside of the pond) without any pretreatment. Limnological investigations of pond water indicate towards high concentration of pH, TSS, hardness, turbidity, alkalinity, BOD, nitrates and phosphates alongwith excessive growth of members of Cyanophyceae.*

**Keywrds:** Total Suspended Solids (TSS), Biological Oxygen Demand(BOD), Cyanophyceae.

## 1. INTRODUCTION

Sewage effluents are the greatest source of organic material being discharged into fresh water bodies in India. The runoff from houses, factories and roads is causing severe pollution in rural as well as urban areas. The primary effect of sewage is to increase the number of bacteria, which use water as substrate. Various workers have assessed impact of sewage on hydrobiology of fresh water bodies in different topographical region in India [1,2,3,4,5,6,7,8,9,10,11,12].

## 2. MATERIALS AND METHODS

An intense and thorough survey of the selected pond was made which resulted that Chetganj pond is a perennial pond. The ultimate source of water for it is annual rains. It covers total area of 5 beegha and it is approximately 15 feet deep. It is square in shape and has 4,28,000 litres water holding capacity. There exist four staired ghats in the vicinity of the pond in all the four directions. It was constructed in 1958. Later, a residential police line colony was established on its eastern bank. At present, two direct drainpipes from this pretreatment. To analyse the physico-chemical parameters water samples were collected from aforesaid pond in 500 ml plastic bottles on monthly intervals for two year from January 2010 to December 2011.

## 3. RESULT AND DISCUSSION

The principal physico-chemical and biological parameters of the pond that influence the water quality were studied during 2010 & 2011 and are being expressed as under:

### 3.1. Physico-Chemical Parameters

- (i) **Colour:** A stratified green scum layer was observed on the upper surface of the pond during both the years in all the seasons (Tables 1 & 2), as it receives large amount of organic waste through sewage waste. Eutrophication has caused the increase in growth of algae & other aquatic plants, due to increase, in mineral nutrients like P, N, C, S, K and Ca in the pond[3].
- (ii) **Odour:** Pond water gave foul smell throughout the year while it was ammonical in summer month. The foul odour was due to the decomposition of organic matter in water.
- (iii) **Temperature:** The value of temperature fluctuated between 18.1°C to 37.2°C in the study period. The excessive solar radiation is responsible for the high water temperature during pre-monsoon while the low temperature during monsoon was due to heavy rains.
- (iv) **Turbidity:** The value of turbidity ranged between 820-1892 NTU during 2010 and from 845-1920 NTU during 2011. Turbidity was the maximum during rainy season during both the year (Tables 1-3). The allochthonous matter reaching the pond through runoff coupled with phytoplankton during rainy season increases turbidity and decreases transparency of water[13].
- (v) **pH:** pH values varied between 9.0-9.9 in summer, 7.9-8.8 in winter and 7.3-8.7 in rains. It was maximum in summer and minimum in rains (Tables 1-3). Higher values of pH in winter and summer can be attributed to high growth rate of algae population which utilizes CO<sub>2</sub> throughout photosynthetic activity[14]. Besides, presence of sewage together with low water level also causes increase in pH of water.
- (vi) **Dissolved Oxygen (DO):** Intensity of contamination can be assessed by the estimation of DO present in water i.e. lower the DO, higher the contamination. The annual and seasonal variation in DO showed variation between 2.1-3.7 mg/l in summer; 4.0-6.3 mg/l in winter and 7.8-8.8 ml/l in rains (Tables 1-3). The depletion of DO in various months can be ascribed to the combined effect of rising temperature, rapid decomposition of organic material and involvement of aquatic plants or excessive growth of phytoplanktons [8]. A comparison of DO content of water with temperature, revealed that period of high temperature coincide those of low oxygen content. The maximum DO content appears due to relatively low temperature and the maximum DO level is followed by a gradual rise in temperature[15] as shown in Fig. 1 and 2.
- (vii) **BOD & COD:** The measurement of BOD and Chemical Oxygen Demand (COD) is a vital index for the assessment of pollution load[8]. During the study period the BOD fluctuated between 405-580 mg/l in summer; 289-370 mg/l in winter and 225-290 mg/l in rains while COD ranged from 220-378 mg/l in summer; 81-168 mg/l in winter and 64-90 mg/l in rains (Tables 1-3). The higher BOD and COD values in summer months in the pond are associated with oxygen depletion on account of higher organic load, reduced rate of flow, increased biological activities at elevated temperature[13]. Presence of decomposing organic waste causes BOD rise in proportion to volume

**Table 1:** Physico-Chemical Characteristics of the Selected Pond Water during 2010

S.No.	Parameters	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
1	Colour	Green scum												
2	Odour	Foul												
3	Temp.(°C)	18.1	21.7	26.1	29	32.4	37	31.7	29.2	27	25.4	23.5	19.8	26.75
4	Turbidity <sup>#</sup>	820	685	708	743	781	853	1856	1892	1865	1273	943	868	1107.25
5	pH	8.2	8.3	9.0	9.1	9.4	9.5	8.4	7.3	7.7	7.8	7.9	8	8.38
6	DO*	5.2	4.5	3.7	3.2	3.1	2.7	8.3	8.6	8.8	8.3	6.3	5.6	5.69
7	BOD*	334	347	407	453	497	561	225	341	233	266	289	314	35.58
8	COD*	123	144	220	261	303	357	81	64	73	72	81	107	157.17
9	Alkalinity*	251	281	351	397	424	456	150	145	144	169	201	212	265.25
10	Hardness*	272	307	361	416	460	5.7	183	163	164	182	201	221	286.42
11	TSS*	181	151	239	273	330	387	325	330	337	344	229	213	278.25
12	TDS*	440	474	541	611	620	663	344	320	327	334	369	407	454.17
13	TS*	621	625	780	884	950	1050	669	650	664	678	598	620	732.42
14	Chlorides*	241	254	307	348	379	409	131	157	143	177	195	215	246.39
15	Phosphates*	24	27.7	23.8	22.2	19.3	16.8	17.5	15.5	17.5	16.5	17.6	20.1	19.88
16	Nitrates*	15.3	15.5	14.6	13.2	12	11.1	11.8	12.7	12.2	13.5	14.1	14.8	13.47
17	Chromium*	1.4	1.3	1.7	2	2.2	2.5	0.9	1	1	1	1.1	1.2	1.44

# Turbidity is in NTU.

\*All the values in mg/l.

**Table 2:** Physico-Chemical Characteristics of the Selected Pond Water during 2011

S.No.	Parameters	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
1	Colour	Green scum												
2	Odour	Foul												
3	Temp.(°C)	18.4	22	26.4	29.2	32.6	37.2	32	29.4	27.3	25.5	23.7	20	26.98
4	Turbidity <sup>#</sup>	845	702	730	775	810	878	1900	1920	1890	1300	1970	893	1134.42
5	pH	8.6	8.8	9.3	9.5	9.7	9.9	8.7	81	7.68	8.1	8.3	8.4	8.76
6	DO*	4.8	4	3.1	2.8	2.5	2.1	7.9	84	8.2	7.8	5.9	5	5.21
7	BOD*	352	370	425	478	511	580	241	255	261	290	311	335	367.42
8	COD*	146	168	235	287	321	378	90	83	70	87	95	122	173.5
9	Alkalinity*	278	302	370	412	445	478	172	178	167	190	212	238	286.08
10	Hardness*	301	335	380	442	492	528	201	197	184	210	235	256	313.42
11	TSS*	202	170	260	301	353	402	350	360	355	370	250	232	300.42
12	TDS*	465	502	570	632	655	690	370	353	349	365	398	432	481.75
13	TS*	667	672	830	933	1008	1092	720	713	704	735	648	664	782.17
14	Chlorides*	263	278	325	371	402	435	150	162	178	195	212	241	267.69
15	Phosphates*	24.6	28.2	24.4	22.7	19.9	17.2	17.9	18.1	16.1	16.9	18.2	20.8	20.42
16	Nitrates*	15.8	16.1	14.3	13.8	12.4	11.7	12.3	12.8	13.1	14	14.7	15.2	13.85
17	Chromium*	1.6	1.5	1.9	2.3	2.5	2.8	1	1.1	1.1	1.1	1.3	1.4	1.64

<sup>#</sup> Turbidity is in NTU.

\*All the values in mg/l.

**Table 3:** Average Value of Physico-Chemical Characteristics of the Selected Pond Water

S. No.	Parameters	2010			2011		
		Winter	Summer	Rainy	Winter	Summer	Rainy
1	Temp.(°C)	20.78±2.34	31.13±4.69	28.33±2.74	21.03±2.31	31.35±4.65	28.55±2.80
2	Turbidity <sup>#</sup>	829±108.53	771.25±62.12	1721.5±299.39	852.5±112.77	798.25±62.44	1752.5±301.92
3	pH	8.1±0.18	9.25±0.23	7.8±0.46	8.53±0.22	9.6±0.26	8.15±0.42
4	DO*	5.4±0.75	3.18±0.41	8.5±0.25	4.93±0.78	2.63±0.43	8.08±0.27
5	BOD*	321±25.29	479.5±65.59	266.25±52.90	342±25.13	498.5±64.86	261.75±20.61
6	COD*	113.75±26.58	285.25±58.62	72.75±6.95	132.75±31.89	305.25±60.25	82.5±8.81
7	Alkalinity*	236.25±36.75	407±44.45	152.5±11.28	257.53±440.17	426.25±46.17	174.45±10.55
8	Hardness*	250.25±48.22	436±62.30	173±10.99	281.75±4.93	460.5±64.22	198±10.80
9	TSS*	193.5±34.66	307.25±64.88	334±8.28	213.5±35.11	329±61.78	358.75±8.54
10	TDS*	422.5±44.95	608.75±50.55	331.35±10.24	449.25±44.55	636.75±50.49	359.25±9.88
11	TS*	616±12.19	916±113.48	665.25±11.70	662.75±10.37	965.75±111.39	718±13.09
12	Chlorides*	226.25±64.66	360.75±43.64	152.18±19.83	248.5±28.69	383.25±46.81	171.33±19.58
13	Phosphates*	22.35±4.43	20.53±1.52	16.75±0.96	22.95±4.38	21.05±3.17	17.25±0.93
14	Nitrates*	14.93±0.63	12.73±3.07	12.75±0.77	15.45±0.62	13.05±1.21	13.05±0.71
15	Chromium*	1.25±0.12	2.1±0.34	0.98±0.06	1.45±0.12	2.38±0.88	1.08±0.06

<sup>#</sup> Turbidity is in NTU.

\*All the values in mg/l.

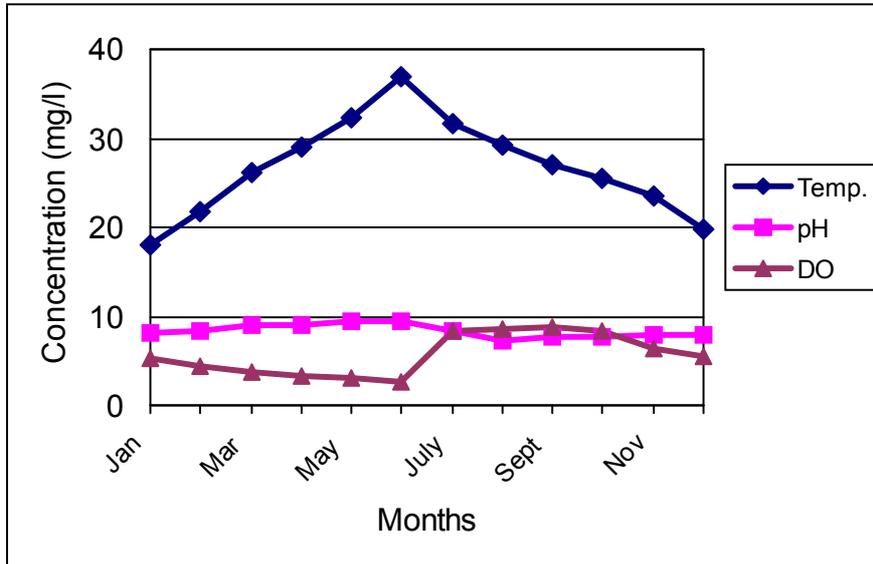


Fig. 1: Correlation between Temperature, pH & DO during 2011

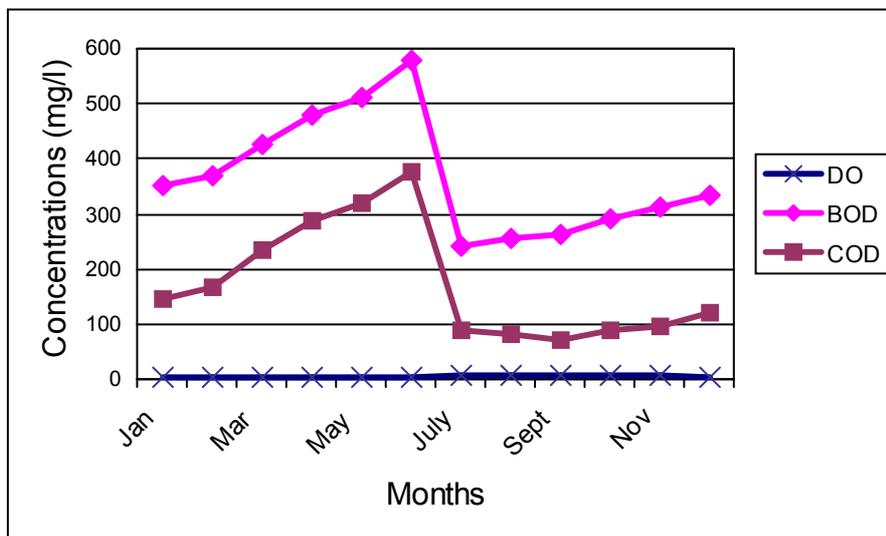


Fig. 2: Correlation between DO, BOD & COD during 2011

of organic materials and DO in waste water and natural waters. High values of BOD and COD are reducing DO and causing obnoxious condition in the pond water. BOD and COD are positively correlative parameters of pollution and causes anaerobic conditions, thus it shows a negative correlation with dissolved oxygen as shown in Fig. 2.

**(viii) Hardness:** In the present investigation values of hardness varied between 361-528 mg/l in summer; 201-335 mg/l in winter and 163-210 mg/l in rains (Tables 1-3). Values of hardness ( $> 300$  mg/l)[16] exhibit anthropogenic pressure on the water body. Addition of sewage, detergents and large scale human waste were the main causative factors for the elevation of hardness. Hardness has no adverse effect on health however, some evidences have been attributed to its role in heart disease[12].

**(ix) Alkalinity:** Alkalinity values varied between 351-478 mg/l in summer; 201-302 mg/l in winters and 144.7-190 mg/l in rains, (Tables 1-3). Highest values registered during summer were due to presence of excessive free  $\text{CO}_2$  produced as a result of decomposition process, while decline, during monsoon reflects the influx of fresh water from rains, causing dilution. Alkalinity is not harmful to human beings however, the water supply less than 100 mg/l of alkalinity is recommended for domestic use[8].

**(x) Total Suspended Solids (TSS):** TSS are considered to be pollution indicators as it deposit on the gills of fish and choke them even in the presence of high DO[17]. The values of TSS in the present study ranged between 239-402 mg/l in summer, 151-250 mg/l in winter and 325-375 mg/l in rains (Tables 1-3). The maximum values were observed during rains which reflects that runoff water is reaching into the pond. A sufficient amount of suspended solids have been recorded but the turbidity was less in comparison which can be correlated with the gradual sedimentation in the water [8]. Increased concentration of TSS (more than 100 mg/l)[16] adversely affecting the fish life in the pond as they cause:

- (1) Reduction in light penetration and of photosynthesis, resulting in reduced food availability and plant biomass.
- (2) Reduced visibility of pelagic food.
- (3) Reduced visibility of pelagic food.
- (4) Clogging of gill rakers and gill filaments of fishes.
- (5) Reduction in aerial predation risk[5].

**(xi) Total Dissolved Solids (TDS):** Dissolved solids are necessary for the productivity. In the present study annual and seasonal variation showed fluctuation between 541-690 mg/l in summer; 369-502 mg/l in winter and 320-370 mg/l in rains (Table 1-3). The result reflects the increase of TDS due to sewage mixing. Higher TDS may also produce distress in cattle and live-stock.

**(xii) Total Solids:** In the present study the total solids values of the pond varied between 620-1050 mg/l during 2010 and between 648-1092 mg/l during 2011 (Table 1-3).

Total solids showed similar increasing trend as observed in case of TSS and TDS and showed direct relationship with TSS & TDS as shown in Fig. 3.

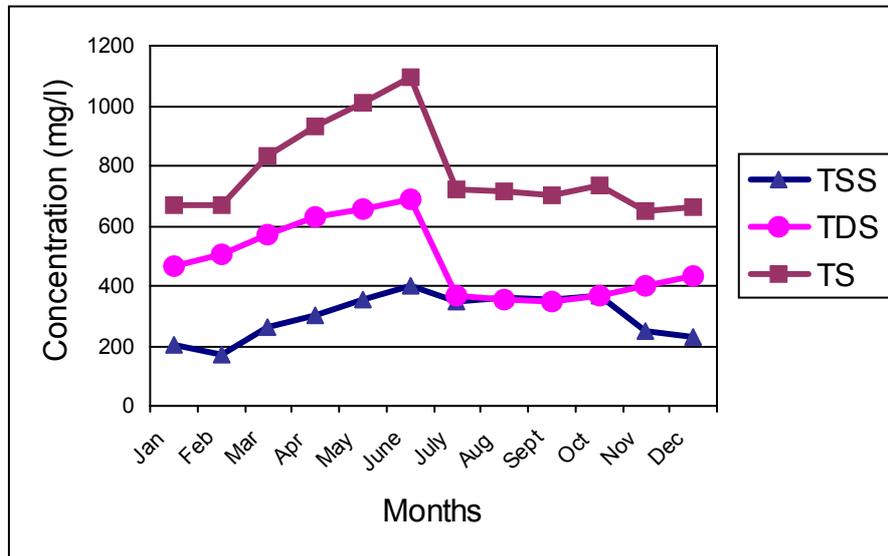


Fig. 3: Correlation between TSS, TDS & TS during 2011

**(xiii) Chlorides:** The amount of chlorides above permissible limits in a water resource is used as an indicator of pollution by domestic waste [18]. In the present investigation annual and seasonal variations in chloride content showed fluctuation between 307-435 mg/l in summer, 195-278 mg/l in winter and 131-195 mg/l in rains (Tables 1-3). High chloride content in summers indicates deterioration of water quality due to domestic sewage and household load and it crosses the acceptable limits (250 mg/l) [8].

**(xiv) Nitrates and Phosphates:** In natural water nitrates and phosphates are of terrigenous sources. Thus, enrichment of aquatic environment depends on precipitation and surface run-off. In the present investigation, the annual and seasonal data of nitrates varied between 11.1-14.6 mg/l in summer; 14.1-16.1 mg/l in winter and 11.8-14.0 mg/l in rains. Similarly, the value of phosphates varied between 16.8-24.4 mg/l in summer; 17.6-28.2 mg/l in winter and 15.5-18.1 mg/l in rains (Tables 1-3). The maximum values of nitrates and phosphates were recorded during winter seasons and minimum during rains. Domestic sewage, rich in nitrate and phosphates largely contributed to the increase in their concentration in pond water and resultant effect is, the excessive growth of cyanophyceae and also chlorophyceae, which formed a green scum layer over the water surface [19]. Nitrates and phosphates are responsible for eutrophic nature of water body. Some workers emphasized that besides absolute concentration, the ratio of phosphorous and nitrogen concentration likely to influence aquatic

productivity[20]. Shah *et al*[6] estimated that phosphorous and nitrogen was being utilized in plankton growth at the ratio of 6:1 to 3:1. However, excess of phosphorous in open water is a sign of heavy organic pollution.

**(xv)Chromium:** All heavy metals cause various chronic disorders in living world[21]. In the present study values of chromium varied between 1.7-2.8 mg/l in summer, 1.1-1.6 mg/l in winter and 0.9-1.1 mg/l in rains (Tables 1-3). Chromium concentration in pond water reflects higher value of chromium in comparison to acceptable limits (0.1 mg/l)[16]. The increase can be attributed to percolation from nearby small scale carpet making units as Mirzapur is a carpet manufacturing centre.

### 3.2. Biological Parameters:

The changes in nutrient levels in the water body create a number of problems. The phytoplankton community is the most sensitive to eutrophication and their increase create severe problems in water purification. Plants in aquatic environment depend on the environmental variables, which regulate their presence, growth and development. In recent years, there is wide spread recognition that physico-chemical monitoring is not enough and pollution is essentially a biological phenomenon, because it has impact on living organisms. Hence, physico-chemical and biological approaches are complementary and it is appropriate to assess its impact through and examination of the biota. Waste water containing organic matter and chemical detergents increase the nutrient level of receiving freshwater body by several hundreds/thousands folds which in turn upset the natural ecosystem[18].

Biological communities of the fresh water body comprised of the *phytoplankton* and *zooplankton* chiefly from *plankton*. A list of *phytoplankton* and *zooplanktons* encountered during the present study is given in the (Table 4). The result of monthly analysis of phyto and *zooplanktons* in the pond is being present as under:

**Table 4:** List of Phytoplankton and Zooplanktons Encountered in the Pond

#### PHYTOPLANKTONS

##### A. CYANOPHYCEAE

- |                                       |                             |
|---------------------------------------|-----------------------------|
| 1. <i>Microcystic aeruginosa</i>      | 2. <i>M. Flos-aqua</i>      |
| 3. <i>Oscillatoria planktonia</i>     | 4. <i>O. splendida</i>      |
| 5. <i>Trechelomonas inconstans</i>    | 6. <i>T. hispica</i>        |
| 7. <i>Anabaena spiroids</i>           | 8. <i>A.cylindrical</i>     |
| 9. <i>Coalosphaerium kuetzinginum</i> | 10. <i>Anabaenopsis sp.</i> |
| 11. <i>Synechocystis sp.</i>          | 12. <i>Rivularia sp.</i>    |
| 13. <i>Nostoc sp.</i>                 |                             |

##### B. DINOPHYCEAE

1. *Ceratium hirundinella*

## C. BACILLARIOPHYCEAE

- |                          |                           |
|--------------------------|---------------------------|
| 1. <i>Pinnularia sp.</i> | 2. <i>Fragillaria sp.</i> |
| 3. <i>Synedra ulna</i>   | 4. <i>Synedra affinis</i> |
| 5. <i>Cymbella sp.</i>   | 6. <i>Tabellaria sp.</i>  |
| 7. <i>Diatoma sp.</i>    | 8. <i>Nitzschia sp.</i>   |
| 9. <i>Navicula sp.</i>   | 10. <i>Gomphonema sp.</i> |

## D. CHLOROPHYCEAE

- |                             |                               |
|-----------------------------|-------------------------------|
| 1. <i>Oedogonium calvum</i> | 2. <i>O. varians</i>          |
| 3. <i>O. acmadrium</i>      | 4. <i>Pleodorina sp.</i>      |
| 5. <i>Volvox sp.</i>        | 6. <i>Eudorina sp.</i>        |
| 7. <i>Cosmarium biretum</i> | 8. <i>C. Circulare</i>        |
| 9. <i>Spirogyra sp.</i>     | 10. <i>Closterium dianal</i>  |
| 11. <i>C. moniloformes</i>  | 12. <i>C. venus</i>           |
| 13. <i>Mougeottia sp.</i>   | 14. <i>Actinastrum sp.</i>    |
| 15. <i>Pediastrum</i>       | 16. <i>P. duplex</i>          |
| 17. <i>Pandorina sp.</i>    | 18. <i>Chlorella vulgaris</i> |
| 19. <i>C. busca</i>         | 20. <i>Ulothrix zonata</i>    |
| 21. <i>U. cylindricum</i>   |                               |

## ZOOPLANKTONS

## A. ROTIFERA

- |                                |                             |
|--------------------------------|-----------------------------|
| 1. <i>Brachionus angularis</i> | 2. <i>B. forficula</i>      |
| 3. <i>B. caudatus</i>          | 4. <i>B. calcyflorus</i>    |
| 5. <i>Filinia longiseta</i>    | 6. <i>Keratella tropica</i> |
| 7. <i>K. procurva</i>          | 8. <i>Lecane stichaea</i>   |
| 9. <i>L. hamata</i>            | 10. <i>Monostyla sp.</i>    |
| 11. <i>Polyarthra vulgaris</i> | 12. <i>Asplanchna sp.</i>   |

## B. COPEPODA

- |                                |                               |
|--------------------------------|-------------------------------|
| 1. <i>Mesocyclops leukarte</i> | 2. <i>M. vidus</i>            |
| 3. <i>Heliodiaptomus sp.</i>   | 4. <i>Phyllodiaptomus sp.</i> |
| 5. <i>Larval stages</i>        |                               |

## C. CLADOCERA

- |                                |                         |
|--------------------------------|-------------------------|
| 1. <i>Daphnia sp.</i>          | 2. <i>Bosmina sp.</i>   |
| 3. <i>Ceriodaphnia cornuta</i> | 4. <i>Sida sp.</i>      |
| 5. <i>Chydorus sp.</i>         | 6. <i>Allonella sp.</i> |
| 7. <i>Simocephalus sp.</i>     |                         |

In the present investigation the total plankton density fluctuated between 2, 101 u/l (May 2011) to 42, 834 u/l (February) during 2011 (Table 5). Two peak periods were recorded during February and September during both the year. The two falls were in April and December (during 2010) while in the next year, minimum values were recorded during May and December (Table 5).

**Table 5:** Seasonal Fluctuation in the Density of the total Planktons  
(Period January 2010 to December 2011)

Year	Month	Phytoplanktons Density (u/l)	Zooplanktons Density (u/l)	Total Density (u/l)
2010	Jan.	27206	877	28083
	Feb.	40643	754	41397
	March	3099	774	3873
	April	899	846	1745
	May	8861	368	9229
	June	12245	298	12543
	July	14094	365	14459
	Aug.	15958	489	16447
	Sept.	21943	777	22720
	Oct.	43491	664	44155
	Nov.	18362	633	18995
	Dec.	3722	1189	4911
2011	Jan.	5528	1048	6576
	Feb.	20142	841	20983
	March	195	619	2604
	April	1132	837	1969
	May	1268	423	1691
	June	10503	294	10797
	July	21690	378	22068
	Aug.	26685	588	27273
	Sept.	46744	802	47546
	Oct.	31750	679	32429
	Nov.	19296	763	20059
	Dec.	2297	1395	3692

### 3.2.1. Phytoplankton

The most important planktonic group encountered in the present study was **Cyanophyceae**. It contributed 65.09% during 2010 while 82.69% of the total phytoplankton population during 2011 (Table 6). It was also noted that blue green algae increases in summer and attain their maximum during monsoon. Particularly *Microcystis*, *Coelosphaerium* and *Trachlomonas* increased considerably in number in monsoon months. Blooms of *Microcystis* were luxuriant during rainy season. Further a marked increase in their number as compared to first year has been observed which clearly indicate towards the increase in pollution status in the water body (Table 5).

The mass production of members of cyanophyceae has created a buoyant scum, which becomes concentrated toward the margins under the influence of wind[20]. The common cyanobacteria found in this water body were *Microcystis*, *Anabaena*, *Oscillatoria*, *Nostoc* etc. The blue green algae, (*cyanobacteria*) are known to produce neurotoxins, hepato-toxins, and neuromuscular blocking agents which cause respiratory failure in fishes[20]. *Anabaena* produces hepatotoxins which has to factors FDF (fast death factor) and SDF (slow death factor)[20]. Thus, it is obvious that total absence of fish diversity in the test pond can be attributed to excessive growth of cyanophyceae.

**Table 6:** Contribution of Various Groups of Phytoplankton

Year	Cyanophyceae	Dinophyceae	Chlorophyceae	Bacillario- -phyceae	Total Phytoplankton
2010	65.09%	32.50%	0.99%	1.41%	2,10,519
2011	82.69%	13.78%	1.26%	2.17%	1,87,230

**Dinophyceae** group was not well represented. It contributed 32.50% during 2010 and 13.78% during 2011 (Table 6). It is represented by the only genus *Ceratium* which thrives during colder part of the year and disappears at or more than 30°C. **Diatoms (Bacillariophyceae)** as a whole were fairly abundant throughout the study except winter months. They showed periodic fluctuations. The peak period was monsoon. They prefer to colonize during warmer part of the year and have lean population during winter months. They contributed 1.41% during 2010 and 2.17% during 2011 (Table 6). The dominating genera were *Synedra*, *Tabellaria*, *Fragilaria* and *Navicula*. Members of **Chlorophyceae** appeared increasing in summer and showed peak in rainy season. All members showed discontinuous periodicity. The dominant members were *Actinastrum*, *Consarium*, *Pediastrum* and *Spirogyra*. Chlorophyceae contributed only 0.99% during 2010 and 1.26% during 2011 (Table 6). Comparatively higher concentrations of objectionable chlorophytes were observed.

### 3.2.2. Zooplanktons

The zooplanktons which play a role of converting phytoplankton into food suitable for fish and aquatic animals also play an important role as an indicator for the presence or absence of certain fish species or in determining their population densities. The knowledge of the abundance, species diversity and their special distribution is important in understanding the photodynamic and trophic progression of water body[22].

In the present investigation zooplanktons population formed 3.73% during 2010 and 7.19% during 2011 of the total plankton population (Table 5). The data reveals that zooplankton mainly comprised of 3 main taxonomic groups namely Rotifers, Copepods and Cladocerans. Among them rotifer dominates the others. **Rotifers** contributed 45.71% during 2010 and 45.08% during 2011 of the total zooplankton in the present study (Table 7). They showed maximum growth during December and minimum growth during May/June. Seven genera

represented this group but *Brachionus* and *Keratella* were dominant. The physico-chemical factors such temperature, turbidity, transparency and DO play an important role in controlling the diversity and density of Rotifers[8]. **Copepods** contributed 38.55% during 2010 and 39.43% during 2011 of the total zooplankton population in present study (Table 7). They showed three pulses during each year of study viz. December, April and September. Copepods were represented by *Mesocyclops*, *Heleodiptomus* and *Phyllodiptomus*. *Cyclops* which is very sensitive to pollution stress was not observed. Water temperature and availability of food organisms affect the copepod population. The member of **Cladocera** contributed 15.74% during 2010 and 15.49% during 2011 of the total zooplankton population (Table 7). Seven genera were noticed under cladocera but none of them was significant. The maximum population of cladocera in winter can be attributed to favourable temperature and availability of abundant food in the form of bacteria, nanoplankton and suspended detritus.

**Table 7:** Contribution of Various Groups of Zooplankton

Year	Rotifera	Copepoda	Cladocera	Total Zooplankton
2010	45.71%	38.55%	15.74%	8034
2011	45.08%	39.43%	15.49%	8667

Thus, limnological profile of the pond selected for present investigation clearly indicates that sewage contamination in this stagnant fresh water body has altered its ecosystem deleteriously. The heavy load of organic matter (from sewage) has hampered its self purification process due to aerobic and anaerobic oxidation of both soluble and deposited organic matter, which has resulted in reduction in DO in the water. High concentration of pH (9.9), TSS (402 mg/l), hardness (528mg/l), alkalinity (478 mg/l), turbidity (1920 NTU), BOD (580mg/l), COD (378mg/l), nitrate (16.1 mg/l) and phosphates (28.2 mg/l) along with excessive growth of members of cyanophyceae have created obnoxious condition in the water for fish culture. The pond has already lost its aesthetic value. It is high time to monitor such water bodies otherwise they will become cancer to the society.

#### 4. REMEDIAL SUGGESTIONS

- (i) Community drain-pipes from police line colony which brings domestic sewage, household waste and soap & detergents should be abandoned with immediate effect. They should be diverted or septic tanks inside the colony should be constructed.
- (ii) To check the eutrophication, nutrient inactivation should be done by adding phosphorous precipitating chemicals into the ponds.
- (iii) Hypolimnetic aeration should be increased through mechanical aeration technique (jet fountain).
- (iv) Botton sediments can be replaced by periodical dredging.
- (v) Harvesting of macrophytes can be promoted.
- (vi) Algaecide (e.g. copper sulphate) or herbicides can be used to reduce excessive planktonic growth.

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