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Research Article

# Phytoplankton Diversity in The Two Ageing Ponds of L.N.M.U. Campus, Darbhanga, Bihar, India

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## ABSTRACT

The two ageing Ponds viz. Anandbag Pond (P1) and Manokamna Temple Pond (P2) of L.N.M.U campus has dense population of phytoplankton and it is one of the most important ecological parameters in water quality assessment. The study was carried in two ponds P1 And P2 on qualitative and quantitative diversity of phytoplankton from January 2012 to December 2012 and January 2013 to December 2013. The eighteen (18) different species were identified in present investigation belongs to three groups viz. *Chlorophyceae (7), Cyanophyceae (5) and Bacillariophyceae* (6). *Chlorophyceae* represented by *Euglena, Spirogyra, Volvox, Pediastrum, Cosmerium, Cladophora, Rhizoclonium. Cynophyceae* represented by *Nostoc, Spirulina, Oscillatoria, Anabaeana, Mycrocystic* whereas *Bacillariophyceae* represented by *Pinnularia, Cymbella, Synendra, Fragilaria, Navicula and Nitzhipalea*. Cynophyceae was dominant group among all three groups, *Chlorophyceae* was the second dominant group whereas *Bacillariophyceae* least abundant among all.

**Keywords:** Ponds; Phytoplanktons; Qualitative; Quantitative; *Chlorophyceae*; *Cynophyceae*; *Bacillariophyceae*

## INTRODUCTION

Phytoplankton is a prominent type of plant found in most pond water. The quality and quantity of phytoplankton is a good indicator of water quality. Phytoplankton forms the vital source of energy as primary producers and serves as a direct source of food to the other aquatic plants and animals [1]. According to the report of NASA (2009), phytoplankton accounts half of all photosynthetic activity on earth. Thus phytoplankton is responsible for much of the oxygen present in the atmosphere half of the total amount produced by all plant life [2].

The plankton study is very useful of water body and also contributes to understanding of the basic nature and general economy of pond. Phytoplanktons play an important role in the biosynthesis of organic matter in aquatic ecosystems, which directly or indirectly serve all the living organism of water body as food [3]. Phytoplankton is photosynthesizing microscopic organisms that inhabit the upper sunlight layer of all oceans and bodies of fresh water. They are agent for primary production the creation of organic compounds from carbon dioxide dissolved in the water a process that sustains the aquatic food web [4].

The clarity of a pond depends on the presence or absence of suspended materials such as microscopic day particles and phytoplankton. In the absence of suspended material and phytoplankton, a pond will appear almost crystal clear. When the algal species in the phytoplankton community reproduce, the phytoplankton reaches a density that can be characterized as a slight cloudiness or turbidity in the water. What are being observed is not the individual algal cells, but light reflecting off millions of microscopic, single and multicelled microscopic plants.

When the phytoplankton can be observed it is called an algal bloom. Often the phytoplankton population can become so dense that it will produce a deep, opaque colour at the pond's surface. The high relative abundance of *Chlorophyta* is indicator of productive water [5]. Phytoplankton is of great importance as the major source of organic carbon [6]. Phytoplankton is small organisms that play crucial role in food chain. While increased amount of phytoplankton provide more food for organisms at higher trophic levels, too much phytoplankton or toxin producing phytoplankton harm the over health of the Bay [7,8].

The effect of anthropogenic warming on the global population of phytoplankton is an area of active research. Changes in the vertical stratification the water column, the rate of temperature dependent biological reactions, and the atmospheric supply of nutrients are expected to have important effects on future phytoplankton productivity [2,9].

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Phytoplankton is also crucially dependent on minerals. These are primarily macronutrients such as nitrate, phosphate or silicic acid, whose availability is governed by the balance between the so-called biological pump and upwelling of deep, nutrient rich waters. Phytoplankton is also limited by the lack of the micronutrient rich iron. This has led to some scientists advocating iron fertilization as a means to counteract the accumulation of produced $CO_2$ in the atmosphere [10].

Phytoplankton forms the vital source of energy as primary producers and serves as a direct source of food to the other aquatic plants and animals [11]. Therefore phytoplankton population may be used as a reliable tool for biomonitoring studies to assess the pollution status of aquatic bodies [12].

However, no literature regarding the phytoplankton of Darbhanga district ponds specially those located in L.N.M.U. campus. The present investigation has been undertaken to assess the limnological knowledge of phytoplanktonic communities in two representative ponds located under different land use systems in Darbhanga district of Bihar viz. Aanandbag Pond (P1) and Manokamna temple pond (P2).

## MATERIALS AND METHODS

### Collection of sample

The samples of phytoplankton were collected from the water surface of both the investigation sites i.e. Aanandbag pond (P1) and Manokamna Temple pond (P2), in a 5 liter of plastic container, each marking as sample (P1) for Aanandbag pond and sample (P2) for Manokamna temple pond. Water sample for selected stations were collected monthly during, January 2012 to December, 2013. The sample were filtered through plankton net formed of standard bolting silk cloth no. 25 (mesh size 0.03 to 0.04 mm).

The plankton was collected from each sample in small bottle attached to the lower end of the bottle. The collected samples were again filtered through a sieve (mesh size 0.3 mm) in order to make them free from other materials. The filtrate containing plankton was transferred to specimen tube, each marked as TP1 and TP2. The filtrates along with plankton were preserved in Lugol's solution which stain the phytoplankton immediately and also cause their quick sedimentation.

### Concentration

Each filtrate containing planktons was further concentrated by centrifugation 2000 to 3000 r.p.m. for 10 minutes. By decanting the supernatant, the concentrated samples were obtained in desirable volume.

### Counting

The final concentrated samples were agitated to distribute the planktons evenly and using a micropipette, one ml the above marked sample was transferred properly to the sedgwick after cell separately. The cover slip was placed on the cell to avoid air bubbles. The planktons of each sample were counted under the microscope. Thus process of counting was repeated by taking another drop of each sample in order to find five replicates of the same and the density was calculated as,

No. of phytoplanktons/ml=No. of Phytoplank ton counted/No. of replicates taken

### Identification

Living specimens were identified immediately after collection of each sample. The length and breadth of phytoplankton's are determined with the help of an ocular micrometer, attached to the eye piece of the microscope. Lastly, with the help of monograph and available relevant literatures, the phytoplankton's were identified up to species.

### Long term preservation

Specimen were preserved by fixing the FAAG solution was prepared by mixing 100 ml absolute formaldehyde+30 ml glacial acetic acid+500 ml absolute alcohol+300 ml distilled water+50 ml Glycerin. Specimens were covered with two drops of Glycerin jelly on a slide. The margin of the cover glass was sealed by black paint before it was labeled.

### Calculation of species diversity

The indices of species diversity was calculated using following expression derived from Shannon-Weaver equation

– H=S/i=1 n:/N log2 ni/N (Shannon-weaver)[13]

Where N is the total number of individuals in species, in is the number individuals, species and the information content of diversity of expressed as number of b its/cell.

## RESULT

In the present investigations on the analysis of phytoplanktons of Aanandbag pond (P1) and Manokamna Temple pond (P2) water was taken in monthly pattern. They belonged to the family of *Chlorophyceae* (7 species), *Cyanophyceae* (5 species) and *Bacillariophyceae* (6 species). The phytoplankton analyzed from the pond water samples were identified and listed (Tables 1 and 2).

**Table 1:** Distribution and diversity of Phytoplankton in Andandbag pond (P1) and Manokamna Temple pond (P2) in L.N.M.U. campus of Darbhanga during January, 2012 to December, 2012.

| Phytoplankton | Species | Distribution(+/-) | |
|---|---|---|---|
| | | P1 | P2 |
| *Chlorophyceae* | *Euglena* | + | + |
| | *Spirogyra* | + | + |
| | *Volvox* | + | + |
| | *Pediastrum* | - | + |
| | *Cosmerium* | + | + |
| | *Cladophora* | - | + |
| | *Rhizoclonium* | + | + |
| *Cyanophyceae* | *Nostoc* | + | + |
| | *Spirulina* | + | + |
| | *Oscillatoria* | - | + |
| | *Anabeana* | + | + |
| | *Microcystic* | + | - |
| *Bacillariophyceae* | *Pinnularia* | + | + |
| | *Cymbella* | + | + |
| | *Synendra* | - | + |
| | *Fragilaria* | + | - |
| | *Navicula* | - | + |
| | *Nitzhiapalea* | + | + |

**Table 2:** Distribution and diversity of Phytoplankton in Andandbag pond (P1) and Manokamna Temple pond (P2) in L.N.M.U. campus of Darbhanga during January, 2013 to December, 2013.

| + | + | + | + |
|---|---|---|---|
| **Phytoplankton** | **Species** | **Distribution(+/-)** | |
| | | **P1** | **P2** |
| *Chlorophyceae* | *Euglena* | + | + |
| | *Spirogyra* | + | + |
| | *Volvox* | + | + |
| | *Pediastrum* | + | - |
| | *Cosmerium* | + | + |
| | *Cladophora* | - | + |
| | *Rhizoclonium* | + | + |
| *Cyanophyceae* | *Nostoc* | + | + |
| | *Spirulina* | - | + |
| | *Oscillatoria* | - | + |
| | *Anabeana* | + | + |
| | *Microcystic* | + | - |
| *Bacillariophyceae* | *Pinnularia* | + | - |
| | *Cymbella* | - | + |
| | *Synendra* | - | + |
| | *Fragilaria* | + | + |
| | *Navicula* | - | + |
| | *Nitzhiapalea* | + | + |

The monthly variation of phytoplanktons samples were listed (Tables 3 and 4) (Figures 1 and 2). Hence based on the diversity of plankton population highly abundance in month of December. The phytoplankton density was due to the presence of high photosynthetic activity in the pond water.

**Table 3:** Monthly variation of Phytoplankton (no/lit) in Anandbag pond (P1) and Manokamna Temple pond (P2) of Darbhanga during January, 2012 to December, 2012.

| **Month** | **Phytoplankton** | | | | | |
|---|---|---|---|---|---|---|
| | ***Chlorophyceae*** | | ***Cyanophyceae*** | | ***Bacillariophyceae*** | |
| | **P1** | **P2** | **P1** | **P2** | **P1** | **P2** |
| January | 150 | 160 | 300 | 320 | 180 | 170 |
| February | 360 | 400 | 360 | 390 | 150 | 150 |
| March | 280 | 320 | 280 | 310 | 260 | 250 |
| April | 200 | 250 | 320 | 350 | 110 | 120 |
| May | 160 | 210 | 260 | 280 | 150 | 160 |
| June | 160 | 200 | 340 | 350 | 260 | 250 |
| July | 210 | 280 | 250 | 260 | 160 | 140 |
| August | 260 | 330 | 200 | 220 | 210 | 200 |
| September | 320 | 360 | 250 | 270 | 290 | 280 |
| October | 180 | 240 | 350 | 370 | 250 | 240 |
| November | 150 | 190 | 360 | 370 | 200 | 180 |
| December | 120 | 150 | 380 | 420 | 310 | 300 |
| Total number of Phytoplankton (no/lit) | 2550 | 3090 | 3650 | 3910 | 2530 | 2440 |

**Table 4:** Monthly variation of Phytoplankton (no./lit) in Anandbag pond (P1) and Manokamna Temple pond (P2) of Darbhanga during January, 2013 to December, 2013.

| **S. No** | **Month** | **Phytoplankton** | | | | | |
|---|---|---|---|---|---|---|---|
| | | ***Chlorophyceae*** | | ***Cyanophyceae*** | | ***Bacillariophyceae*** | |
| | | **P1** | **P2** | **P1** | **P2** | **P1** | **P2** |
| 1. | January | 160 | 170 | 310 | 320 | 170 | 180 |
| 2. | February | 380 | 390 | 360 | 380 | 150 | 160 |
| 3. | March | 290 | 280 | 270 | 350 | 250 | 260 |
| 4. | April | 220 | 230 | 310 | 350 | 120 | 110 |
| 5. | May | 170 | 150 | 260 | 290 | 160 | 150 |
| 6. | June | 180 | 190 | 340 | 360 | 250 | 260 |
| 7. | July | 220 | 230 | 260 | 280 | 140 | 160 |
| 8. | August | 280 | 290 | 210 | 210 | 200 | 210 |
| 9. | September | 340 | 350 | 260 | 280 | 280 | 290 |
| 10. | October | 190 | 200 | 340 | 380 | 250 | 240 |
| 11. | November | 150 | 160 | 360 | 390 | 180 | 190 |
| 12. | December | 110 | 120 | 390 | 430 | 300 | 300 |
| 13. | Total number of Phytoplankton (no/lit) | 2690 | 2760 | 3670 | 4020 | 2450 | 2510 |

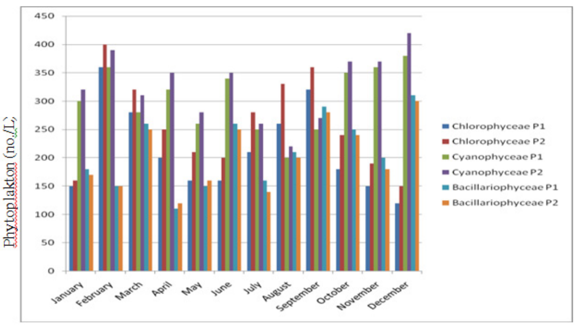


**Figure 1:** Monthly variation of Phytoplankton (no/lit) in Anandbag pond (P1) and Manokamna Temple pond (P2) of Darbhanga.

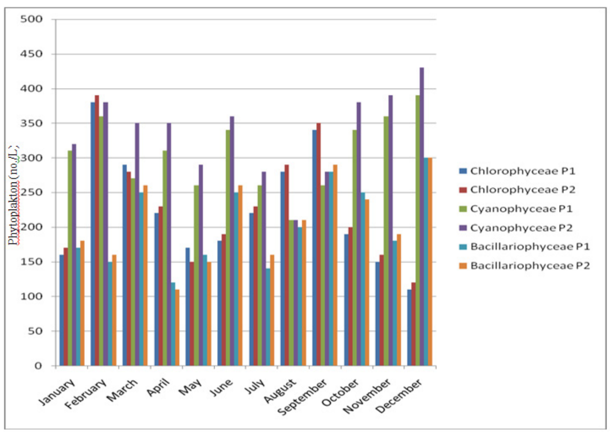


**Figure 2:** Monthly variation of phytoplankton (no/lit) in Anandbag pond (P1) and Manokamna Temple pond (P2) of Darbhanga during January, 2013 to December, 2013.

For any scientific utilization of water resources plankton study is of primary interest (Jhingran) [14]. Total eighteen phytoplankton species were encountered in both the ponds [Viz. *Euglena, Spirogyra, Volvox, Pediastrum, Cosmerium, Cladophora, Rhizoclonium, Nostoc, Spirulina, Oscillatoria, Anabeana, Microsystic, Pinnularia, Cymbella, Synendra, Fragilaria, Navicula, Nitzhiapalea]*. Of these, *Cyanophyceae* contributed the largest share 41.8% in P1 pond and 41.1% in P2 pond during year 2012 (Table 5) and 41.7% in P1 and 43.3% in P2 pond during year 2013 (Table 6) respectively of the total phytoplanktons. *Chlorophyceae* contributed to share 29.3% in P1 pond and 32.75% in P2 pond during 2012 and 30.6% in P1 pond and 29.7% in P2 pond during 2013 of the total phytoplankton respectively (Figures 3 and 4). *Bacillariophyceae* was found in very less number in comparison to other two phytoplanktons. It is contributed to share 28.9% in P1 pond and 26.6% in P2 pond during 2012 and 27.7% in P1 and 27.0% in P2 pond during 2013 of the total phytoplankton respectively. The P2 pond was richer phytoplankton in comparison to P1 pond. The total number of phytoplankton in P1 pond was 8730 and P2 pond was 9440 during 2012. In year, 2013, the total number of phytoplankton in P1 pond was 8810 and P2 pond was 9290. Among them eleven species were found to be common in P1 and P2 pond in year 2012 (Jan. to Dec.) where nine species were found to be common in both the pond in year 2013 (Jan. to Dec.).

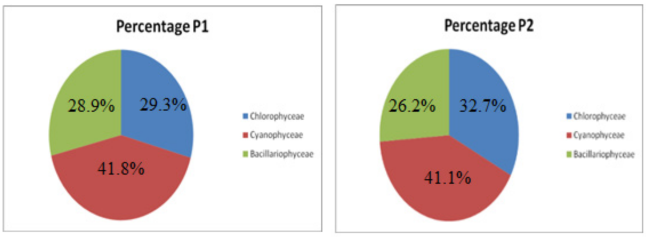


**Figure 1:** Percentage distribution of phytoplanktons in the Anandbag pond (P1) and Manokamna Temple pond (P2) of L.N.M.U. campus, Darbhanga during January, 2012 to December, 2012.

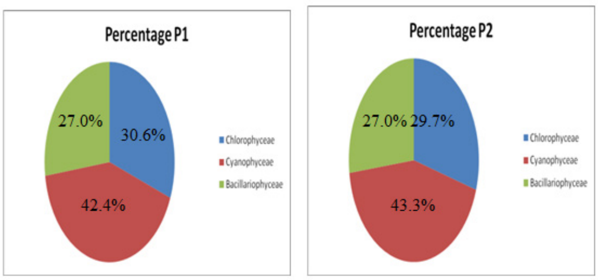


**Figure 2:** Percentage distribution of phytoplanktons in the Anandbag pond (P1) and Manokamna Temple pond (P2) of L.N.M.U. campus, Darbhanga during January, 2013 to December, 2013.

**Table 5:** Percentage distribution of Phytoplanktons in the Anandbag pond (P1) and Manokamna Temple pond (P2) of L.N.M.U. campus, Darbhanga during January, 2012 to December, 2012.

| S. No. | Phytoplanktons | Total numbers | | Percentage | |
|---|---|---|---|---|---|
| | | P1 | P2 | P1 | P2 |
| 1 | *Chlorophyceae* | 2550 | 3090 | 29.3% | 32.7% |
| 2 | *Cyanophyceae* | 3650 | 3910 | 41.8% | 41.1% |
| 3 | *Bacillariophyceae* | 2530 | 2440 | 28.9% | 26.2% |
| | Total | 8730 | 9440 | 100% | 100% |

**Table 6:** Percentage distribution of Phytoplanktons in the Anandbag pond (P1) and Manokamna Temple pond (P2) of L.N.M.U. campus, Darbhanga during January, 2013 to December, 2013.

| S. No. | Phytoplankton's | Total numbers | | Percentage | |
|---|---|---|---|---|---|
| | | P1 | P2 | P1 | P2 |
| 1 | *Chlorophyceae* | 2690 | 2760 | 30.6% | 29.7% |
| 2 | *Cyanophyceae* | 3670 | 4020 | 41.7% | 43.3% |
| 3 | *Bacillariophyceae* | 2450 | 2510 | 27.0% | 27.0% |
| | Total | 8810 | 9290 | 100% | 100% |

P2 was found to be richer in phytoplankton and showing eutrophic condition. The maximum number of *Chlorophyceae* was 360 no./lit in P1 and 400 no./lit in P2 was found in the month of February, 2012 and the minimum was found 120 no./lit in P1 and 150 no./lit in P2 was found in during the month of December, 2012. Similarly in year 2013, the maximum no. of *Chlorophyceae* was 380 no./lit in P1 and 390 no./lit in P2 was found in the month of February and the minimum number was found 110 no./lit in P1 and 120 no./lit in P2 was found during the month of December. The total no. of *Chlorophyceae* were observed in 2690 no./lit in P1 and 2760 no./lit in P2. The maximum number of *Cyanophyceae* was 380 and 390 no./lit in P1 and 420 and 430 no./lit in P2 found in month of December in 2012 and 2013 respectively and minimum number of *Cyanophyceae* 200 and 210 no./lit in P1 and 220 no./lit in P2 was found in month of August in 2012 and 2013 respectively. The total number of *Cyanophyceae* was 3630 and 3670 no./lit in P1 and 3910 and 4020 no./lit in P2 were found in the period of January 2012 to December 2012 (Table-3) and January 2013 to December 2013 respectively. The maximum number of *Bacillariophyceae* was 310 and 300 no./lit in P1 and 300 and 300 no./lit in P2 found in the month of December 2012 and 2013 respectively. The minimum 110 and 120 no./lit in P1 and 120 and 110 no./lit in P2 was found in month of April 2012 and April 2013 respectively. The total number of *Bacillariophyceae* 2530 and 2440 no./lit and 2450 and 2510 no./lit were analyzed from the pond water during the study period of January 2012 to December 2012 (Table-3) and January 2013 to December 2013 respectively.

## DISCUSSION

Phytoplankton is one of the major components in aquatic ecosystem because of its ability to carry out photosynthesis. Phytoplankton must live on pond surfaces to obtain sunlight for photosynthesis. Phytoplankton release $O_2$ and convert the sun's energy to chemical energy stored in food. Dissolved oxygen in the water increases due to photosynthesis. Phytoplankton is at the base of aquatic food webs, as a primary producer to feed Zooplankton and other microorganisms. When many algae are present, they give the water distinctive odor. Phytoplankton is necessary in aquatic ecosystems to carbon and nutrients cycles, such as sulphur nitrates and phosphates, throughout aquatic ecosystems. Phytoplankton's are numerically more abundant than Zooplankton in any pond, lake, rivers etc.

Phytoplankton was represented by eighteen species in Aanandbag pond and Manokamna Temple pond. They belonged to three classes *Chlorophyceae, Cyanophyceae and Bacillariophyceae*. The genera recorded in two ponds are summarized in Tables 1 and 2. The P1 and P2 pond was dominated by blue green algae (*Cyanophyceae*). The monthly numerical abundance of different phytoplankton was studied and the dominant genera during the culture period are given in Table-3 and 4.

In the ponds (P1 and P2) under study, the temperature was ranged from 26$^0$C-35$^0$C and dense algal blooms occurred (October, May, July in pond P1 and P2) respectively. When the temperature was at its maximum. According to various previous research it had been reported that 26$^0$C-35$^0$C is the temperature for optimal growth of *Anabaena, Aphanizomenon, Oscillatoria* and *Mycrocystic* [15,16]. Thus high temperature forms an important factor conditioning the formation of blooms.

Phytoplankton is more abundant in areas with higher light intensities and its concentration varied depending on nutrient content. Green algae are found more in ponds and lakes than other groups of algae. Desmids, a type of green algae, are a common Phytoplankton type [17]. Blue-green algae were abundant in ponds with organic matter and may be an indication of polluted water. Blue- green algae may give water stinky odor and taste. Diatoms are yellow-green algae that have walls made of silica [18]. Diatoms are brownish- green algae that inhabit open lake water shore water [19].

phytoplankton's are free floating microscopic plants that are mostly unicellular and produce chemical energy from light. This process is called primary production. phytoplankton's have a critical role in primary production, nutrient cycling and food webs and makeup a significant proportion of the primary production in aquatic systems [20]. In many coastal systems, primary production in almost entirely a function of the phytoplankton's. Phytoplankton can contribute substantially to overall primary production [21].

Primary productivity is "the rate at which solar energy is converted into chemical energy by photosynthetic and chemosynthetic organisms and is usually expressed as grams of carbon fixed per unit area per unit of time [20]. It had been reported that annual Phytoplankton primary production is southeastern estuaries ranges from 67-375 grams of carbon per square meter per year (gc/m$^2$/year) while other reported values of 600-700 gc/m$^2$/year for wassaw sound in Georgia.

The population density trend showed gradual increase during post monsoon period and monsoon season, *Chlorophyceae*, *Cyanophyceae* and *Bacillariophyceae* was recorded in large numbers during the study period and the *Cyanophyceae* was dominant. There are several reports available on the distribution, density, species diversity and ecology of plankton in different water bodies. Hence based on the diversity of phytoplankton population highly abundance in the month of December (monsoon). The phytoplankton's density due to the presence of high photosynthetic activity in the lake or ponds waters. Many reports are available on the plankton diversity of Indian lakes [22-26]. It had been previously reported that systematic and ecological studies on *chlorophyceae* of north India and their relationship with water quality were made [27]. It had been reported phytoplanktonic study of Shershah Suri pond, Sasaram, Bihar, were found 89 species of phytoplankton, among them *Cyanophyceae* was most dominant during their study period [28]. Previous study reveals the eutrophic nature of pond [28]. Seasonal abundance and diversity of phytoplankton in Goverdhan Das pond, Chapra, Bihar [29].

It had been stated that *Cyanobacteria* predominant in waters poor in nutrients. The reason for this may be that they store previously available nitrogen which they use under nitrogen limiting conditions. It had been stated that accumulations of orthophosphates by blue-green algae helped their bloom formation and in the liberation of phosphates into water during their decomposition [30]. According to previous report blue green-algae can have inhabiting effects on other species (hetro-antagonism) [31]. A blue green algae species finds optional conditions in a pond and increases until it becomes dominant, climinating most of the other species through its excretions, until they are found only sporadically (hetero-antagonism), so that the phytoplankton present in very abundant but not very diversified. The effect of the active substances released by blue-green algae is not only limited to other phytoplanktonic organism but also to the Zoplankton, e.g. inhibiting nutrition and production among some *Rotifers* and certain Cladocerans [32-34].

In the fish pond the diversity and density of plankton was also affected by the fish predation as feeders. Among phytoplankton, green algae are preferably fed by the cultured carps, especially by *Labeo rohita* [34].

## CONCLUSION

Hence the low diversity and density of phytoplankton in the ponds can be attributed to the cumulative effect of blue-green algae and the grazing effect of cultured carps. Thus the formation of such blooms in commercial fish ponds threatens severe economic losses

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