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Diversity and distribution of phytoplankton in an artificial pond

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Abstract

The present study was to understand the diversity and distribution pattern of microalgae in fresh water system represented by an open artificial pond. A total of 100 species of phytoplanktons were indentified from different groups during March 2014 to February 2015. Among the identified phytoplankton species Cyanophyceae (39%) formed the dominant group, followed by Chlorophyceae (34%) Bacillariophyceae (23%) and Euglenophyceae (4%). The fluctuations in the physico-chemical parameters like pH, temperature, EC, DO, BOD, COD, turbidity, alkalinity, hardness, nitrate, silicate, phosphate and were also been monitored. The result provides a primary documentation of the phytoplankton community and its diversity and basic understanding of hydrological variables in the pond ecosystem.

Keywords: phytoplankton diversity, artificial pond, physico-chemical parameter

Introduction

Ponds are generally small natural or artificial, shallow, confined bodies of standing water usually have a muddy or silty bottom that provides habitat and food for many species. It is too small for wave action and too shallow for major temperature differences from top to bottom. These freshwater communities are extremely sensitive to environmental variations. Phytoplanktons are the microscopic free floating algal communities of water bodies and productivity of an aquatic system is directly related to diversity of phytoplankton. The phytoplanktonic study is a very useful tool for the assessment of water quality and productivity of any type of water body and also contributes to understanding of lentic water bodies (Pawar *et al*., 2006). Phytoplankton includes several thousands of microalgae belonged to Chlorophyta (green algae), Cyanophyta (blue green algae), Bacillariophyta (diatoms), Euglenophyta (pigmented flagellate or phytoflagellated) etc. They respond quickly to environmental changes and are used to assess the ecological status of water body. They are used for assessing the degree of pollution or serve as bioindicators of water quality (Mondhare and Pangle, 1995). Phytoplankton has been used recently as an indicator to observe and understand changes in the ecosystem because it seems to be strongly influenced by climatic features (Li *et al*., 2000; Soni and Thomas, 2014.). Phytoplankton diversity and succession in small man-made ponds are largely ignored. In the present study an attempt has been made to assess the diversity of phytoplankton and their distribution and fluctuations in the hydrological variables in an artificial pond.

Materials and Methods

The study was carried out on the monthly basis from March 2014 to February 2015. The artificial pond selected for the present study is at Kattakada thaluk in Thiruvananthapuram district, Kerala. It is small, open, shallow, round shaped, cemented fresh water pond. All collections were made between 7.30 am to 9.30 am during the study period. Phytolankton samples were collected by filtering pond water through plankton net with 25 µm mesh size. The filtrate was immediately preserved in 4% formaldehyde. The phytoplankton samples were observed thoroughly under microscope and have been identified with the help of standard literature (Fritsch, 1935; Desikachary, 1959; Round 1971; Prescott, 1978 and Anand, 1998) and also analyzed few physico-chemical parameters as per standard procedures (APHA, 2005).

Results

Phytoplankton in the artificial cemented open fresh water pond was represented by four classes of algae viz. Chlorophyceae, Cyanophycae, Bacillariophyceae and Euglenophycae. In the selected pond 100 species of phytoplankton members were identified among these Cyanophyceae includes 39 species followed by Cholorophyceae 34 species, Bacillariophyceae recorded 23 species and Euglenophyceae reported 4 species. Monthly distribution of phytoplankton was shown in Fig.1 and percentage wise contribution of phytoplankton groups are shown in Fig 2. Diversity of phytoplankton during the study period has been given in Table 1.

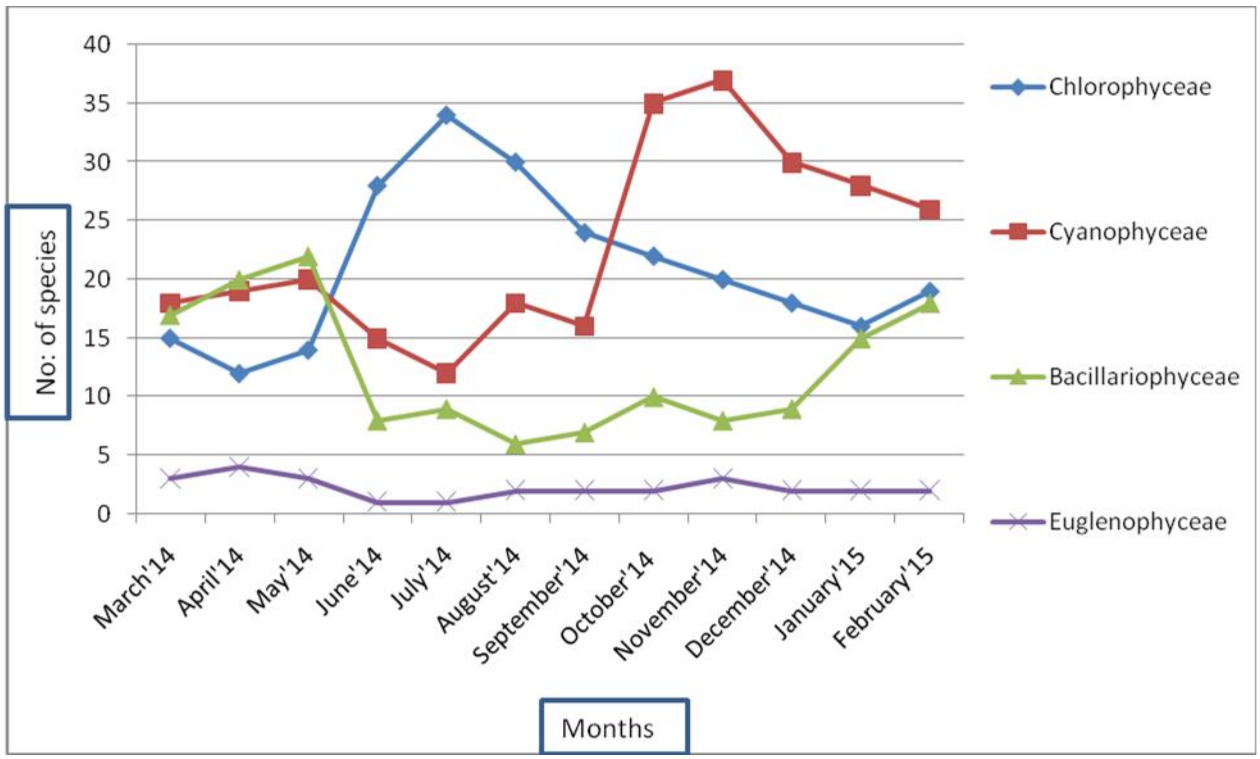

Fig.1: Monthly distribution of phytoplankton in artificial pond during the study period

Cyanophycean members contributed maximum diversity in the pond (Table 1) and were the most dominant class during the months of October to February (Fig.1), it contributed about 39% of the total phytoplankton population (Fig.2). Genus like *Chroococcus*, *Microcystis*, *Oscillatoria*, *Merismopedia*, *Anabaena*, *Nostoc*, *Aphanocapsa*, *Eucapsis*, *Arthrospira*, *Phormidium*, *Rivularia*, *Lyngbya*, *Anabaenopsis*, *Scytonema*, *Synechococcus*, *Gomphosphaeria*, *Aphanothece* and *Spirulina* were recorded. Chlorophyceae was the most significant group of phytoplankton contributing 34% from the total phytoplankton population. Cholorophyceaen diversity was highest during the months of rainy season ie., from June to September. This class was represented by *Ankistrodesmus*, *Characium*, *Chlorella*, *Chlorococcum*, *Cladophora*, *Closterium*, *Cosmarium*, *Crucigenia*, *Euastrum*, *Gleocystis*, *Hydrodictyon*, *Netrium*, *Oedogonium*, *Oocystis*, *Pediastrum* and *Scenedesmus*. In the case of Bacillariophyceae 23% of phtoplanktons were in this group. Among the diatoms *Achnanthes*, *Amphora*, *Cyclotella*, *Cymbella*, *Fragilaria*, *Gomphonema*, *Gyrosigma*, *Melosira*, *Navicula*, *Nitzschia*, *Pinnularia*, *Suriella*, *Synedra* and *Tabellaria* were found. Euglenophyceae contributed minimum of 4% phytoplankton. Throughout the study this group was mostly represented by *Euglena* and *Phacus*.

Table1: List of phytoplankton identified from artificial pond (March 2014 - February 2015)

Phytoplankton

Euglenophyceae

Euglena gracilis Mallisch
Euglena sanguine Ehrenberg
Phacus curvicauda Swir. Skz.
Phacus oribicularis

Chlorophyceae

Ankistrodesmus falcatus (Corda.)
Characium sp.
Chlorella vulgaris Bayernick
Chlorococcum humicola (Nageli) Rabenhorst
Cladophora glomerata (L.) Kutzing
Closterium acerosum (Schrank.) Ehr.
Closterium ehrenbergii (Menegh.) ex Ralfs.
Closterium incurvum Brebisson
Coelastrum indicum Turner
Cosmarium auriculatum Reinsch
Cosmarium granatum Brebisson ex Ralfs
Cosmarium pyramidatum Brebisson ex Ralfs
Cosmarium turgidum Ralfs
Crucigenia quadrata Morren
Crucigenia tetrapedia Kirchner
Euastrum spinulosum Nordstedt
Gleocystis gigas (Kutzing) Lagerheim
Hydrodictyon reticulatum (L) Bory
Netrium digitus (Ehrenberg) Roth.
Oedogonium sp
Oocystis elliptica West
Pediastrum angulosum (Ehr.) Menegh
Pediastrum duplex Lagerheim
Pediastrum tetras (Ehr.) Ralfs.
Scenedesmus armatus (Chodat)
Scenedesmus bijugatus Kuetz.
Scenedesmus dimorphus
Scenedesmus quadricauda (Turpin) Brebisson
Selenastrum gracile Reinsch
Spirogyra longata (Vaucher) Kutzing
Spirogyra sp.
Staurastrum gracile Ralfs ex Ralfs
Ulothrix zonata (Kuetz)
Zygnema sp
Tabellaria flocculosa (Roth) Kuetz.

Bacillariophyceae

Achnanthes inflata (Kutzing) Grunow
Amphora ovalis Kuetz
Amphora veneta Kutzing
Cyclotella meneghiniana Kutzing
Cymbella lanceolata Breb
Fragilaria intermedia (Grun.)
Fragillaria sp.
Gomphonema gracile Ehrenberg
Gomphonema lanceolatum
Gomphonema parvulum (Kutzing) Kutzing
Gyrosigma acuminatum (Kutzing) Rabenhorst
Gyrosigma rautenbachiae Cholnoky
Melosira varians C.Agardh
Navicula cuspidate Kuetz
Navicula radiosa Kuetz.
Navicula viridula Kuetz
Nitzschia palea (Kutzing) W.Smith
Pinnularia simplex Ehr.
Pinnularia viridis (Nitzsch) Ehrenberg
Pinnularia sp.
Suriella elegans Ehr
Synedra ulna (Nitzsch.) Ehr.

Cyanophyceae

Anabaena constricta (Szafer) Geitler
Anabaena fertilissima C.B.Rao
Anabaena orientalis S.C.Dixit
Anabaena variabilis Kuetz ex Bornet & Flahault
Anabaenopsis circularis (G.S.West)Wolosz.et Miller
Aphanocapsa biformis A.Br.
Aphanothece sp
Arthrospira platensis (Nordstedt) Gomont
Arthrospira sp.
Chroococcus minor (Kuetz) Nag
Chroococcus minutus (Kuetz)Nag.
Chroococcus tenax (Kirchn) Hieron
Chroococcus turgidus (Kuetz) Nag
Eucapsis minuta Fritsch
Gomphosphaeria aponina Kuetz.
Lyngbya spiralis Geitler
Merismopedia elegans Lemm
Merismopedia minima Beck.
Merismopedia punctata Meyen
Microcystis aeruginosa Kuetz.
Microcystis flos-aquae (Wilttra) Kirchner
Nostoc commume Vaucher ex Born. Et Flah.
Nostoc muscorum Ag.
Nostoc punctiforme Hariot
Oscillatoria curviceps C.Agardh ex Gomont
Oscillatoria formosa Bory ex Gomont
Oscillatoria limosa Ag. Ex Gomont
Oscillatoria princeps Vaucher ex Gomont

Phytoplankton	
.	*Oscillatoria sancta* (Kuetzing) Gomont *Oscillatoria subbrevis* Schmidle *Oscillatoria tenuis* Ag. ex Gomont *Phormidium fragile* (Meneghini) Gomont *Phormidium inundatum* Kutzing ex Gomont *Phormidium tenue* Gomont *Rivularia aquatica* De Wilde. *Scytonema myochrous* C.Agardh ex Bornet & Flahault *Spirulina* sp. *Synechococcus elongatus* Nag *Synechococcus sp*

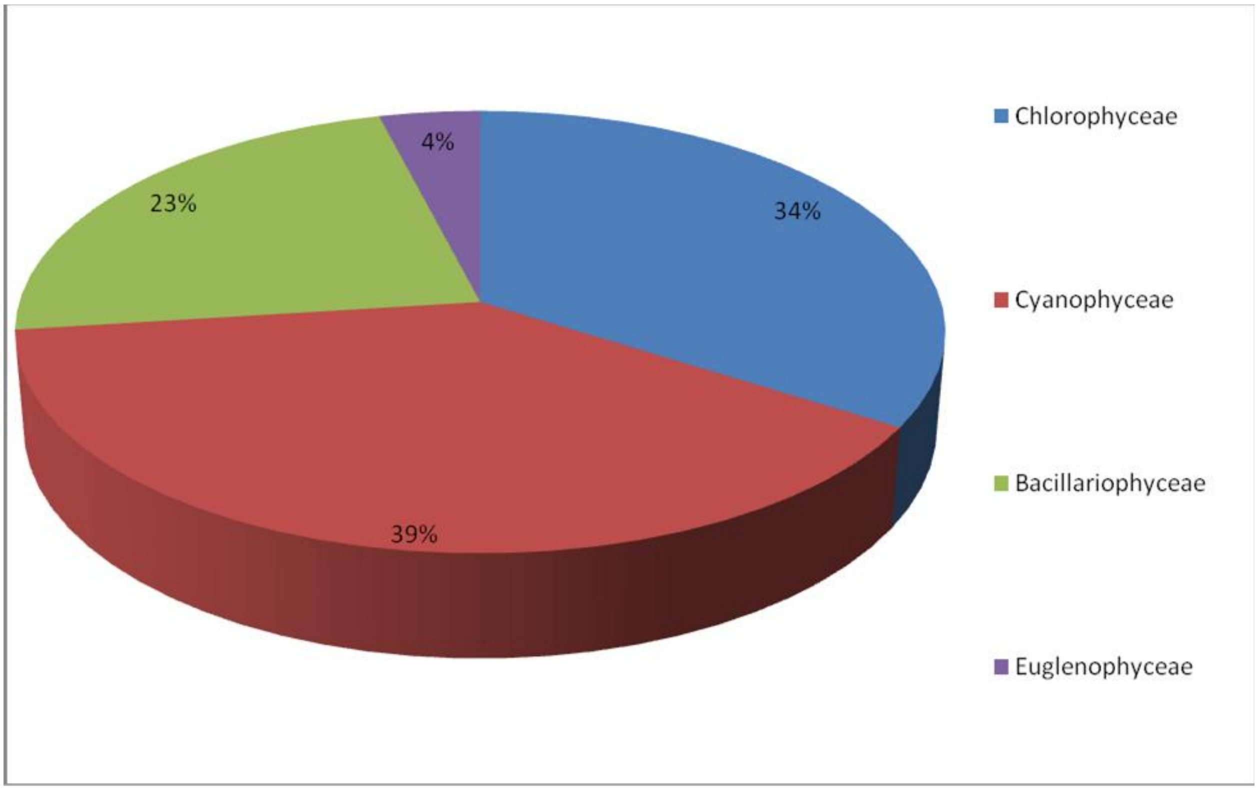

Fig.2: Percentage contribution of phytoplankton divisions in artificial pond during the study period

The annual mean value and standard deviation of the physico-chemical parameters of water recorded from artificial pond is presented in Table 2 and the monthly variations were shown in Fig.3. The water was found light green in colour to dark green in colour during the course of study.

Temperature recorded in the artificial pond water was 28.81±1.03°C, where as the pH of water was found almost neutral during the study period (7.47± 0.61). Electric conductivity recorded from the cemented pond was 57.36±4.02 µm hos/cm. Total hardness and total alkalinity recorded was 9.83±3.45 mg/l and 48.36±9.43mg/l. In present study DO, BOD and COD values were recorded as 6.63±1.44mg/l, 3.78±1.48mg/l and 4.38±1.56mg/l respectively. Nutrients like phosphate, silicate and nitrate were found correspondingly in 4.87±1.59mg/l, 2.94±1.68mg/l and 5.25±1.97mg/l.

Table 2: Physico-chemical parameters (Mean ±SD) of artificial pond during the study period

Sl.No	Parameters	Artificial pond water
1	pH	7.47± 0.61
2	Temp (°C)	28.81±1.03
3	EC (µm hos/cm)	57.36±4.02
4	DO (mg/l)	6.63±1.44
5	BOD (mg/l)	3.78±1.48
6	COD (mg/l)	4.38±1.56
7	Turbidity (NTU)	5.28±1.35
8	Total Alkalinity (mg/l)	48.36±9.43
9	Total Hardness (mg/l)	9.83±3.45
10	Nitrate (mg/l)	5.25±1.97
11	Silicate (mg/l)	2.94±1.68
12	Phosphate (mg/l)	4.87±1.59

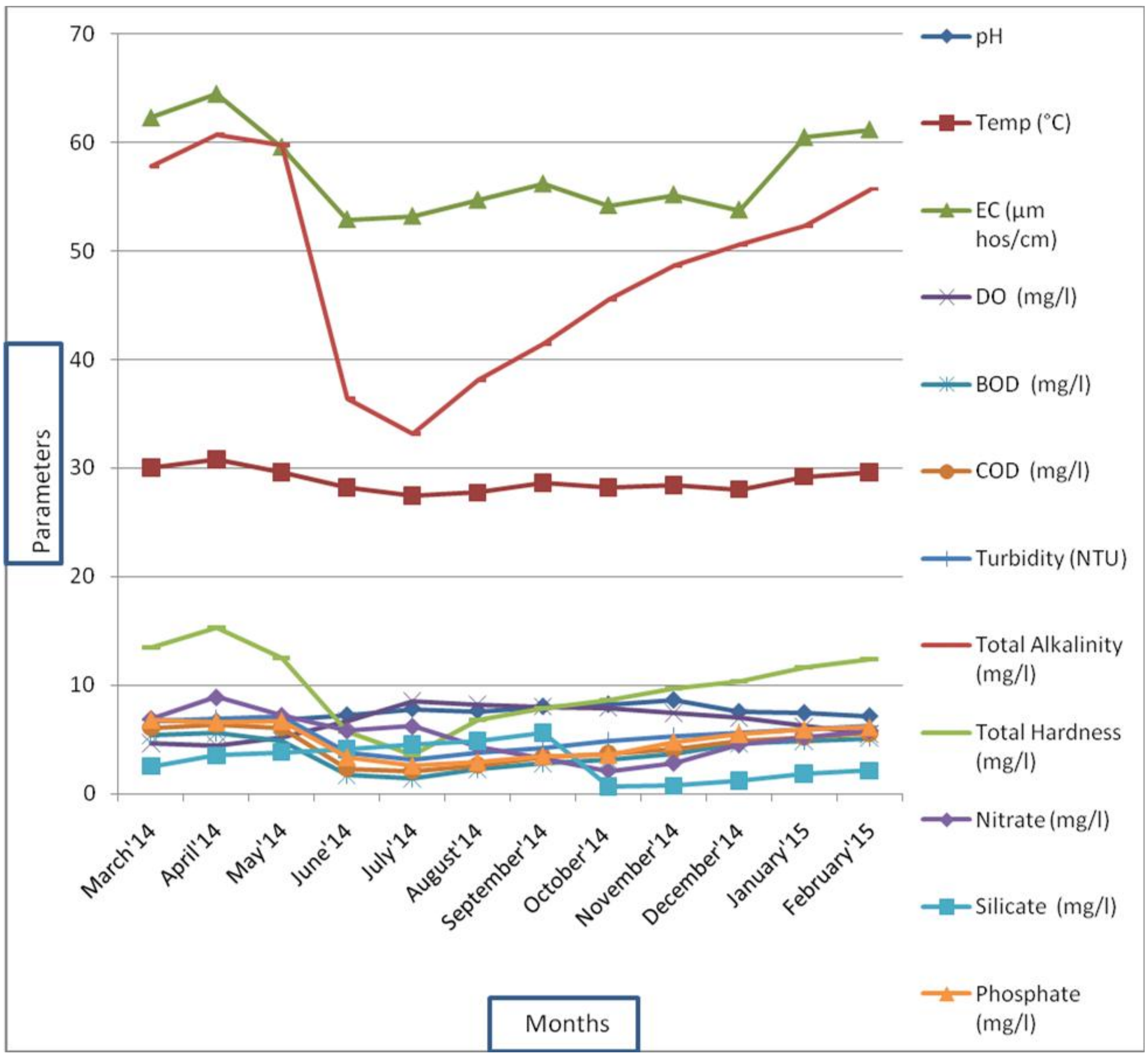

Fig.3: Monthly variations in physico-chemical parameters of artificial pond during the study period

Discussion

Phytoplankton are sensitive to the environmental changes and their distribution varies considerably with respect to seasons, water quality and nutrient concentrations (Thirugnamoorthy and Selvaraju, 2009; Ganai *et al*., 2010; Manickam *et al*., 2012). Planktonic communities are influenced by the prevailing physico-chemical parameters and these determine their abundance, occurrence and seasonal variations (Rothhaupt, 2000).

In the present investigation, 4 group of algae viz. Chlorophyta, Cyanophyta, Bacillariophyta and Euglenophyta were identified. Similar to the present investigation Devi and Singara (2007), Rout and Borah (2009), Mahor and Singh (2010), Gopinath and Ajit (2014) and Ansari *et al*. (2015) have reported four algal groups in their studies. In present study algal taxa Cyanophyceae and Chlorophyceae dominated as compared to other groups of algae. The seasonally distribution of algal diversity shows dominance nature as Cyanophyceae > Chlorophyceae > Bacillariophyceae > Euglenophyceae. Among the four groups, Cyanophyceae members dominated and earlier observation of Hudder (1995), Hujare (2008), Joseph (2012) and Singh (2015) also pointed out the same in their studies.

Cyanophyceae group contributed 39% of total phytoplankton (Fig. 2). Prescotte (1984) and Zafar (1964) suggested that higher value of nutrients favored the growth of Cyanophyceae. Cyanophyceaen members were recorded higher during the months of October to May. Many workers have reported blue green algae as a dominant group during these periods (Santhosh *et al*., 2007; Zacharias and Roy 2007; Khanna and Indu, 2009 and Jeyabaye, 2010). The dominant nature of Cyanophycean members are the characteristic feature of eutrophic environment which have high concentrations of nutrient especially phosphate and nitrate (Neelam *et al*., 2009). In the present study maximum population of blue green algae was observed during the months when the temperature was recorded higher.

The occurrence of rich algal flora results generally at the place where there are high levels of nutrients, together with favorable environmental conditions (Kumar and Radha, 2012). According to Philipose (1967) Chlorophyceae group dominate the water that is rich in nutrients such as nitrate and phosphate. In the present study class Chlorophyceae were abundantly found in rainy season while minimum count was recorded in summer season. Korgaonkar and Bharamal (2016) also noticed comparatively higher values of class Chlorophyceae in monsoon season than in summer season.

In present work there were good supplies of nitrate during the month of February to May (Fig. 3) and have higher growth of diatoms (Fig.1). Jyotsna *et al*. (2014) also observed maximum members of Bacillariophyceae in the month of April. According to Munawar (1970) regular supply of nitrate encouraged the growth of diatoms. Ansari *et al*. (2015) reported presence of phosphate, nitrate, silicate and total hardness promoted the growth of diatoms.

Euglenophyceae was reported maximum during the months were temperature and nitrate values were noted higher. Previous studies on freshwater environment showed that higher temperature and nitrate concentration favours the growth of euglenoids (Jasprica *et al*., 2006). Seeneyya (1971) reported that temperature above 25°C was good for the growth of Euglenophyceae. The high temperature, chloride, TDS, and BOD might have played an important role in growth and development of Euglenophyceae (Ansari *et al*., 2015).

In the present study the values of physico-chemical parameters fluctuates greatly during different months. This may be due to various physico-chemical factors which are modifying the diversity of phytoplankton. Devika *et al.* (2006) suggests that physico-chemical conditions had a direct relationship on phytoplankton diversity in aquatic ecosystem. The pH, dissolved oxygen, alkalinity and dissolved nutrients are important for phytoplankton production (Bais and Agarwal, 1990). Ashok *et al.* (2015) observed that DO possess an indirect relation with temperature. The solubility of oxygen, or its ability to dissolve in water, decreases as the water's temperature increase. EC is a numerical expression of the ability of an aqueous solution to carry electric current. EC is an indication of extent of salinity in the pond water samples. The phosphate showed lower values during July to December but there was an increase in phosphate concentratrion during January to May. Nitrate content also showed increased values from January to May. Chaudhary and Rachana (2009) also made similar observations in their study.

The phytoplankton diversity is largely influenced by interaction of a number of physico-chemical and biological factors acting simultaneously. According to Harikrishnan *et al.* (1999), the maintenance of a healthy aquatic ecosystem depends on physico-chemical and biological diversity of the ecosystem. From the present observation it is difficult to point out any single factor which is responsible for the fluctuations and abundance in plankton community. In India, diversity of phytoplankton in different freshwater water bodies along with their physico-chemical characteristics were studied by various scholars (Veereshakumar and Hosmani 2006; Ravikumar *et al*. 2006; Tiwari and Shukla 2007; Senthilkumar and Das 2008). The present study reveals that variation in the abundance of plankton is explained with abiotic factors. Thus it may be noted that the density of phytoplankton is dependent on different abiotic factors either directly or indirectly.

Conclusion

The present study provides an insight into the distribution, abundance, diversity and ecology of phytoplankton in an artificial pond. From the results, it is evident that the ecological conditions of pond support a rich diversity of algal flora. The experimental pond had a diversified group of phytoplankton dominated by Cyanophyceae members followed by Chlorophyceae, Bacillariophyceae, and Eugleanophyceae. Results indicated that the values of physico-chemical parameters were responsible for the diverse group of phytoplankton in cemented pond.

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