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Algal Flora of Some Selected Water Bodies of Delhi

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ABSTRACT: The freshwater algae show an ability to tolerate a wide range of environmental conditions. Under natural condition, they usually grow in the mixed community which may include many species and genera. The identification of freshwater algae from Delhi mostly belonging to Chlorophycean members is totally dependent on the physico-chemical characteristics of the water bodies at different time intervals. This communication deals with the dynamics of the freshwater algae from river, ponds and wetlands of some parts of Delhi such as Wazirabad, India Gate, Old Fort, Shanti Van, Campus of Guru Gobind Singh Indraprastha University at Dwarka, Okhla Bird Sanctuary and Sanjay Jheel. A total of about 18 algal genera, 8 belonging to Chlorophyceae, 5 belonging to Bacilorophyceae, 5 belonging to Cynophyceae were recorded. In Okhla Bird Sanctuary, Shanti Van and Dwarka the algal genera with *Lyngyba sp., Anacystics sp., Tetraderon sp., Anabaena sp., Agmenellum sp., Navicula sp., and Nitzschia sp.* recorded and it was noticed that the presence of this algae in huge amount indicates that the water of all these sites is polluted, as they are good indicator of pollution whereas at other four sites it was found to be less polluted because of the presence of *Rhizoclonium sp., Oedogonium sp. and Pithophora sp.* which are indicators of clean water.

Key Words: Taxonomy, Chlorophycean, freshwater, algae.

INTRODUCTION

Algae, which are the diverse assemblages of chlorophyllous organisms, are found growing in a variety of aquatic and terrestrial ecosystems. The term algae has been derived from a Latin word *Algae* which means sea weeds. Algae are small autotrophic plants that fail to show any cellular differentiation and their sex –organs are unicellular and if multicellular all cells are fertile (Smith 1950). These lower plants are used as a feed, fodder, fertilizer and medicines. Their ecological status as primary producer in ecosystems has become a global interest in the contemporary world. Blue green algae one of the major group of algae, fix atmospheric nitrogen. The application of algal biofertilizers in various agricultural fields has been proved successful and eco-friendly. So the environmentally hazardous chemical fertilizer is now being gradually replaced by eco-friendly biofertilizers.

It is equally important to understand the harmful effects of algae which produce phycotoxins as secondary metabolites that are toxic not only to human beings but also to many animals, birds, insects etc. It has also been found that chemicals produced by algae cause destruction to many building and important historical monuments.

Algae are encountered in city's water supply that causes a lot of nuisance to drinking water. Many algae are troublesome for their ability to produce characteristic odour and taste. The algal blooms which form surface mats in the water bodies prevent penetration of oxygen thereby causes death of fishes. In contrast, algae that is dispersed and not in blooms or mats help in penetration of oxygen thereby helping bacterial decomposition of organic matter (Wetzel, 1975).

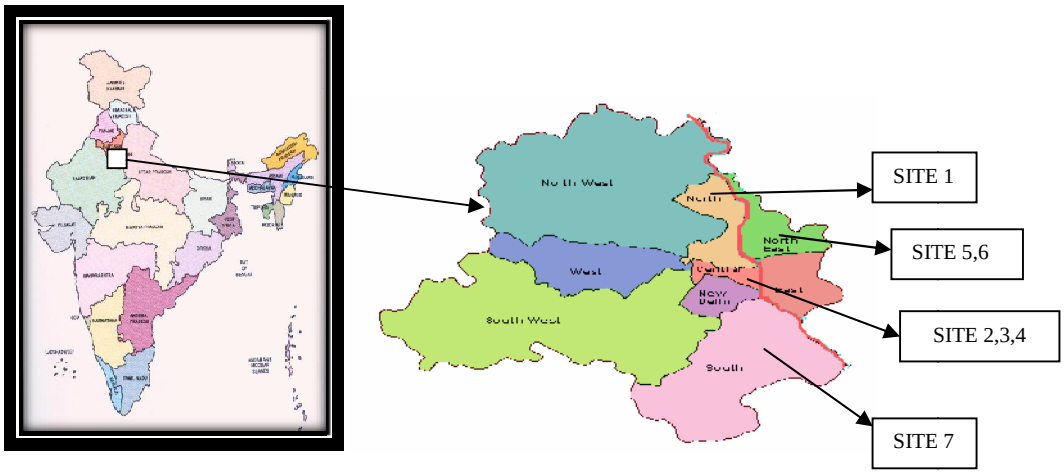
The growth of algae is affected by pollution in number of ways such as (i) poor availability of light (ii) substance may be toxic (iii) effluent may be modify physical and chemical environment (iv) sudden competition with additional organisms (v) depletion of oxygen etc. At the same time some algae may form blooms, produce obnoxious odour and increase toxicity in water.

Researches were undertaken by various workers all over the world in different field of phycology. In India, studies in phycology were initiated mostly by Englishmen working either in Botanical Survey of India or in the University of England. Thresh *et al.,* (1944) suggested that high chloride concentrations indicates the presence of organic matter, presumably of animal origin. The constant addition of even low levels of nitrogen and phosphorus to an aquatic environment could greatly stimulate algal growth and high level of total nitrogen was followed with the growth of Chlorophycean, Eugleninean and Cyanophycean forms Hastler (1947). Prescott, (1948) discussed the importance of temperature in the growth and periodicity of blue green algae. Number of algae was found dominant in the surface layers of the water at the time of low water level Evans (1959).

Zafar (1964) reported that phosphates were observed in traces during winter season, and Cyanophyceae were in peak when the phosphate content is very low or even undetectable. Studies on diurnal variations in two shallow ponds in Delhi revealed some relationship between physico-chemical conditions of water and plankton. High temperature favored the growth of certain taxa of *Chlorococcales* Singh (1965). Philipose (1967) observed that *Chlorococcales* can grow in a wide range of temperature. Williamson (1998, 1999, 2002a, b) has studied the desmid flora of Malaysia, South Africa, Scotland, and Iceland-Orkney respectively. Similarly, Kanetsuna (2002) has described the desmids of Japan, Combodia, Malaysia and Thailand. Feher (2003), Kostkeviciene *et al*. (2003), and Novakova (2003) have also studied the desmids from Hungary, Lithuania and Czech Republic respectively. Our knowledge of Indian desmidiaceae is mainly through the works of Suxena and Venkataswarlu (1966a, b, c, 1968a, b, 1970), Vidyavati and Nizam (1970, 1974, 1975) from Andhra Pradesh; Sinha and Mishra (1967), Das and Purti (1990)from Bihar; Suxena and Venkataswarlu (1968c) from Kashmir; Kamat (1974), Ashtekar and Kamat (1979), Frietas and Kamat (1979) and Tarar *et al*. (1998) from Maharashtra; Iyengar and Vimala Bai (1941), Iyengar and Ramanathan (1942), Saraswati (1946), Iyengar (1958), Ramanathan (1962, 1964) from Tamilnadu; Bharti (1965a, b, c, 1966, 1971) from Maharashtra and Karnatka; Bharti and Pai (1972), Hegde and Bharti (1980) from Karnatka; Agarkar (1969, 1971, 1975), Agarkar and Agarkar (1973), Agarkar *et al*. (1979), Patel and Satyanarayan (1976) from Madhya Pradesh; Patel (1969, 1980), Patel and Asokakumar (1979, 1980, 1981) from Gujarat; Mukherjee and Srivastava (1993) from West Bengal; Suxena *et al*.(1973), Patel *et al*. (1977), Patel (1982) from Kerala; An attempt is made in the present communication to focus attention on the studies relating to the collection and identification of algal flora upto generic level.

MATERIALS AND METHODS

Study area: Delhi is a narrow strip of Indo-Gangetic plains. It is stretched between 28.61°N and 77.23°E, and lies in Northern India. It is bordered by the Indian states of Haryana on the north, west and south and Uttar Pradesh (UP) to the east. Two prominent features of the geography of Delhi are the Yamuna flood plains and the Delhi ridge. In the present study seven sites were selected in different ecological regions of Delhi. Site 1 is located in the north-eastern part, site 2, 3, 4 in central, site 5, 6 in eastern part and site 7 in south-west part of the Delhi (Fig.1).



INDEX: Site 1: Forest Garhi Mandu City, Wazirabad, Site 2,3,4: India Gate,Old Fort Lake, Shanti Van, SITE 5,6: Okhla Bird Sanctuary, Sanjay Jheel, SITE7-GGSIPU Campus.

Fig. 1.Sampling site of different water bodies.

Algal collections were undertaken in water-bodies in all these sites present in Delhi at an interval of one month for a period of six months i.e. from March to June 2014. The collected algal samples were preserved in Lugol solution. The preserved samples were then brought to the laboratory for qualitative analysis. Permanent slides were prepared and observed under microscope. Photography was done by an Olympus photomicroscope. The identification of phytoplankton was done with the help of standard books and monographs. (Sharma 1945; Pandey and Trivedi, 1983; Prescott, 1962).

Table 1: Diversity of Algal genera in fresh water bodies of Delhi.

Chlorophyceae	**Bacillariophyceae**	**Cynophyceae**
Cosmarium	*Agmenecenelum*	*Nostoc*
Oedogonium	*Stauroneis*	*Anabaena*
Rhizoclonium	*Pinnularia*	*Lyngyba*
Pithophora	*Nitzschia*	*Aphanocapsa*
Ulothrix	*Navicula*	*Anacytis*
Oocystis		
Tetraderon		
Sphaerocystis		

Table 2: Distribution of algae under different sites.

S.No.	**Sampling Site**	**Chlorophyceae**	**Bacillariophyceae**	**Cynophyceae**
1	Okhla Bird Sanctuary	*Tetraderon,ocystis ,*	*Navicula,Nitzschia, Pinnularia,Stauroneis, Agemencelum*	0
2	Sanjay Jheel	0	0	*Lyngyba sp*
3	Shantivan Lake	*Ulothrix., Sphaerocystis, Pithophora, Cosmarium*	*0*	*Anacystis*
4	Old Fort	0	0	0
5	India Gate	0	0	*Synechococcus, Nostoc*
6	Dwarka	0	0	*Aphanocapsa, Anaebaena*
7	Garhi Mandu Forest	*Rhizoclonium, Oedogonium*	0	0

Site 1: *Okhla Bird Sanctuary:* It is a bird sanctuary at the Okhla barrage over Yamuna River. It is situated in Noida, Gautam Budh Nagar district, on Delhi-Uttar Pradesh state border. In 1990, an area of 3.5 square kilometres (1.4 sq m.) on the river Yamuna was notified as a bird sanctuary by the Government of Uttar Pradesh under the Wildlife Protection Act, 1972. The site is located at the point where the river enters Uttar Pradesh.

Site 2: *Sanjay Lake:* It is an artificial lake developed by Delhi Development Authority (DDA) in Trilokpuri in East Delhi, adjoining Mayur Vihar II residential area.

It is an old depression in low lying area of the old floodplain in the East Delhi which was the receptacle of rainwater drainage

Site 3: *Water body at India Gate:* India Gate is one of the most important historical monuments in the city of Delhi. It is a tribute to the 90,000 Indian soldiers who sacrificed their life in World War I, the north-west frontier operations of the same time and the 1919 Afghan fiasco. It was designed by the famous British architect**,** Edward Lutyens and was originally called the All India War Memorial. The lawns of India Gate house a water body also known as boat club used by the visitors for boating and recreation.

Site 4: Old Fort Lake is located outside the old fort near Pragati Maidan, New Delhi. The fort is the oldest fort among all the forts in Delhi also known as Purana Quila and is the oldest known structure of any type in Delhi. It was rebuilt by the Afghan king Sher Shah Suri, on the same site, which was perhaps the site of Indraprastha, believed to be the capital of the Pandavas. The lake is used by the tourist for recreation purpose.

Site 5: The campus of Guru Gobind Singh Indraprastha University is situated in Sector 16 C, Dwarka. The campus is surrounded by compensatory forest plantation on its three sides and Najafgarh canal is running just back of the university campus. The campus is abode to various flora and fauna especially avifauna. Within the campus seasonal pools and ditches are filled with rain water, and algae are found in these pools besides providing water to various birds visiting the campus.

Site 6: *Waterbody at Shantivan:* Shantivan is the Samadhi, or cremation spot of India's first Prime Minister, Pt. Jawaharlal Nehru and is situated to the north of the Raj Ghat. Shantivan also means 'the forest of peace'. This area has a beautiful park adorned with trees planted by visiting dignitaries and heads of state. Shanti Van is beautifully landscaped with shady trees and immense greenery and probably for this very reason it was named as the peaceful forest. There are small to large water bodies within the Shanti Van which is home to various birds. Shanti Van is also lying on the banks of the River Yamuna.

Site 7: *Wetland in Forest Garhi Mandu:* Forest Garhi Mandu is situated in North-east Delhi that lies on the Yamuna Vihar-Wazirabad Road. The forest covers a total area of 894.73 acres of Delhi Development authority (DDA) land in the Sadatpur, Somali and Garhi Mandu Revenue Estates of North Forest division. Garhi Mandu Forest was named because of its location near the Garhi Mandu village and the rich biodiversity accommodated by the area. The forest is located on the eastern banks of River Yamuna and is accompanied by water body known as the Garhi Mandu Wetland which is home to many water birds.

Table 3: Indicator of pollution.

Clean Algal Species	Polluted Algal Species
Rhizoclonium sp.	N*itzschia sp.*
Navicula sp.	*Agemencellum* sp.
Ulothrix sp.	*Anaebaena sp.*
Pinnularia sp.	*Lyngyba sp.*
	Anacystis sp.
	Tetraderon sp.

RESULTS AND DISCUSSION

Algae are group of organisms which grow in different environments. There is hardly any habitat in which algae are not encountered. A great majority of them are truly aquatic and grows in ponds, lakes, puddles etc. Besides occurring in aquatic habitats, algae are found abundantly on tree, trunks rocks and in association with other plants and animals. Hence the ecological relationship of algae are complex and varied. Algae have long been used as indicator of water quality. Because of their short life spans, they respond quickly to environmental changes. They flourish both in highly eutrophic waters while a few others are very sensitive to organic and/or chemical wastes. Some species have also been associated with noxious blooms sometimes creating offensive tastes and odours or toxic conditions. Because of their short life cycles they respond quickly to environmental changes, and hence the standing crop and species composition indicate the quality of the water mass in which they are found. It also demonstrated that algal assemblages could be used as indicators of clean water or polluted water.

Clean water would support a great diversity of organisms, whereas polluted water would yield just a few organisms, with one or few dominant forms

The present work was aimed at studying the diversity and distribution of various species of algae in Delhi over a period of six months. During this period some interesting facts about the distribution were reported. In the present study, 9 genera of Chlorophyceae,4 genera of Bacillorophyceae and 6 species of Cynophyceae were recorded.

The chlorophyceae is a group of algae having their photosynthetic pigments localized in

chromatophores which are grass-green because of the predominance of chlorophyll – a and b over the carotene and xanthophylls. In the present study eight genera of chlorophyceae class were recorded. Chlorophyceae was widespread among the plankton. The dominance of chlorophyceae might be due to high dissolved contents. It had also observed that the green algae prefer water with higher concentration of dissolve oxygen.

The Bacillorophyceae group includes a large number of unicellular and colonial genera which differ from other algae in the shape of their cells. In the present study total five genera of bacillariophyceae class were recorded throughout the study . A number of factors influenced the distribution of diatoms in water body, such as change in water temperature light and irradiance of water and also suggested that high temperature favours the growth of diatoms, but observed an inverse relationship between diatoms and temperature

While Chlorophyceae members dominate most of the freshwater ecosystem, Cynophyceae are dominated in polluted water bodies. In river Yamuna, maximum diversity of algae was found in Wazirabad area whereas lowest species diversity were recorded in Sanjay Jheel. This species gradient in the river can be attributed to the pollution level found in different parts of Yamuna, where Wazirabad has clean water and the Sanjay Jheel has the most polluted water.

Some areas in Delhi like the Boat club at the India Gate, the small ponds in Dwarka and Okhla Bird Sanctuary have rich species diversity. The most dominant algae in these water bodies are *Oedogonium, Nostoc ,Scenedesmus* etc. In the order Ulotrichales *Ulothrix* was the most dominating with 2 species mostly occurring in the fresh water. They are found growing throughout the study.The order Cladophorales is well reprented by 1 species of *Pithopora* and one species of *Rhizoclonium.* They are found growing throughout the study in clean water bodies. *Ulothrix* mostly grows intermixed with other algae are attached to the aquatic plants.

The order Oedoginales is represented by one genus Oedogonium with 3 species. The reproductive structures of these species were clearly visible in the months of March and April. They are found growing on moist ground with their narrow hyaline rhizoidal submerged under the soil. Similar observations were reported by Chacko (1979) in Kerela.

The desmids are represented by only one genera *Cosmarium.* The class Bacillariophyceae is reprensted by 4 genera *Navicula and Nitzschia* are the most common diatoms in Delhi Order Nostacles is represented by a number of important species.Amongst them 1 genera of Lyngbya,1 genera of anabaena and 1 genera of Nostoc were reported in the present study which is considered as a indicator of polluted water.

Class –Bacillariophyceae (Plate 1)

ORDER: GENERA

1. Pennales- *Navicula, Nitzschia, Pinnularia, Stauroneis, Agmenecenelum*

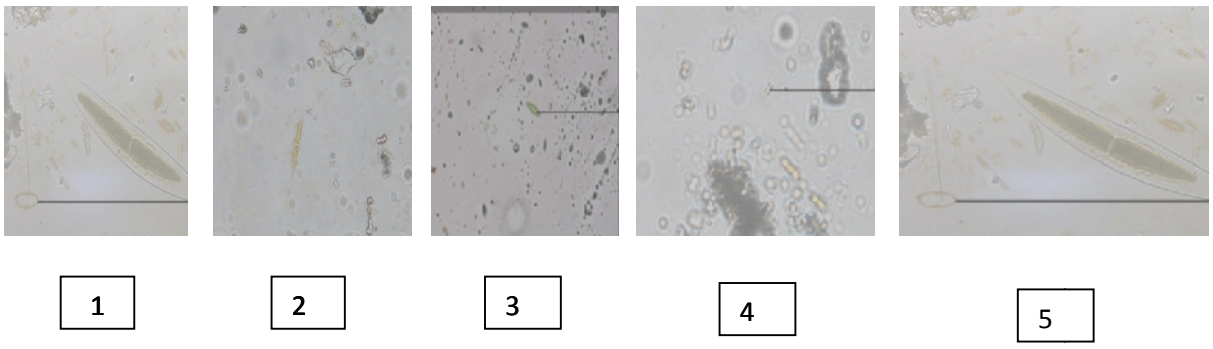


Plate 1 – (**Class-Baccilorophyceae) 1.** *Pinnularia* **2.** *Nitzschia* **3**. *Stauroneis* **4.** *Agmenecenelum* **5.** *Navicula*

Class –Chlorophyceae (Plate2)
ORDER: GENERA
1. Volvocales-*Sphaerocystis ,Tetraderon, Oocystis*
2. Ulotrichales-*Ulothrix*
3. Cladophorales-*Pithophora, Rhizoclonium*
4. Oedogoniales-*Oedogonium*

Class –Cynophyceae (Plate 3)
ORDER: GENERA
1.Chroococcales-*Aphanocapsa, Anacytis, Synechococcus*
2. Nostocales-*Anabaena, Nostoc, Lyngyba*

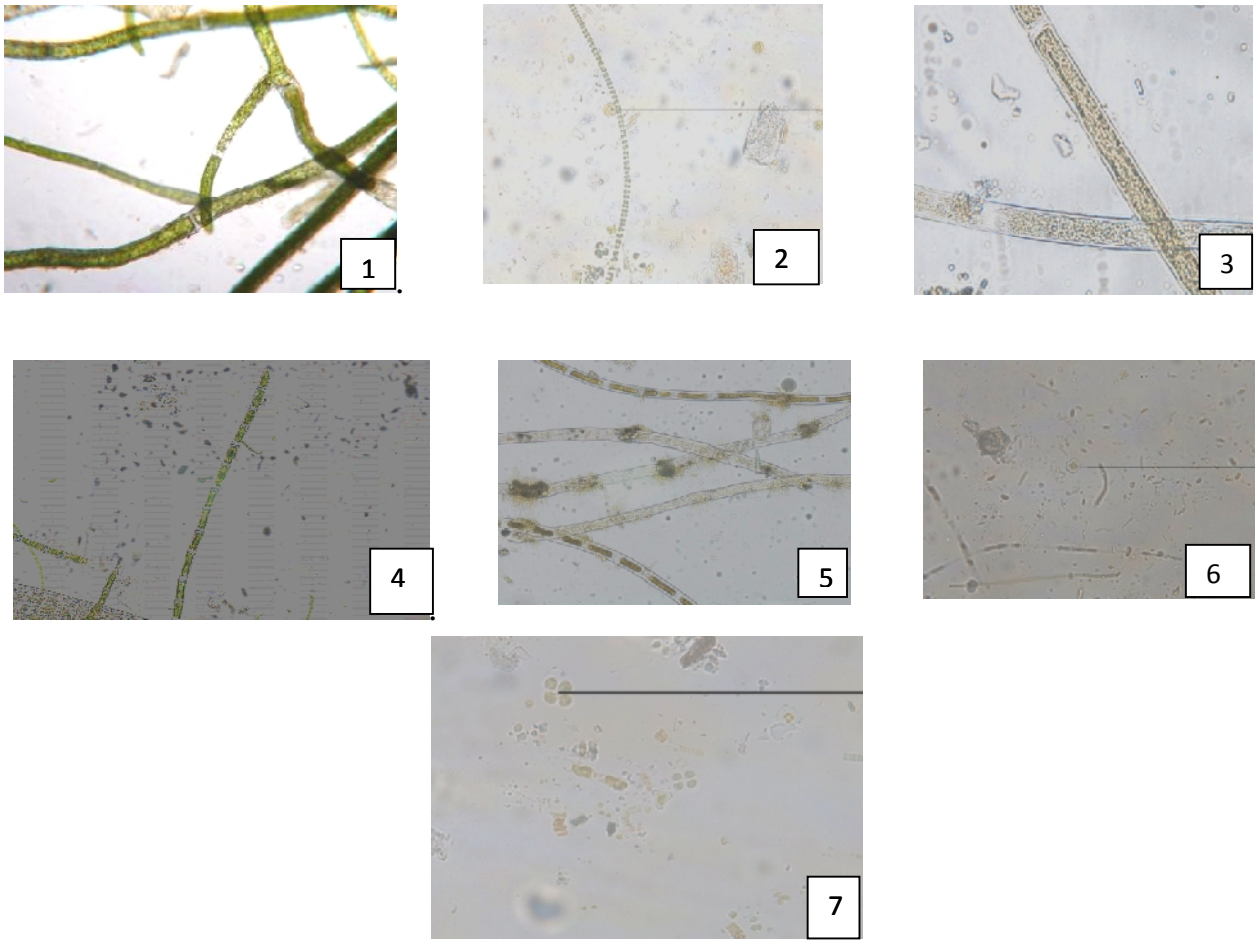


Plate 2 – **(Class-Chlorophyceae) 1**. *Pithophora* **2.** *Sphaerocystis* **3.** *Rhizoclonium* **4.** *Ulothrix* **5.** *Oedogonium* **6.** *Oocystis* **7.** *Tetraderon.*

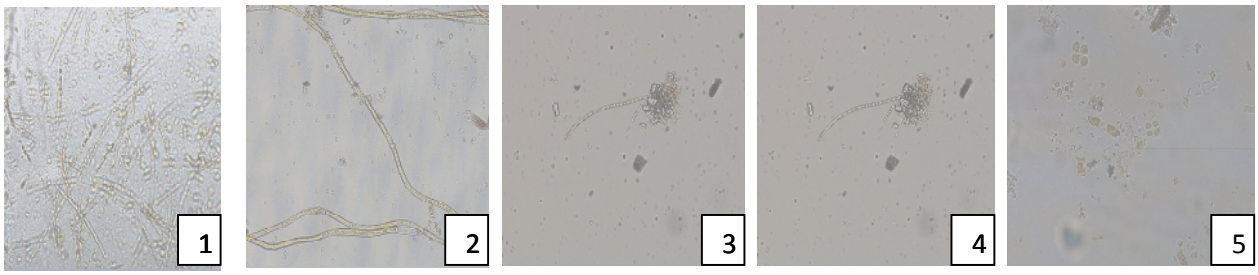


Plate 3 – **(Class –Cynophyceae)** 1. *Nostoc* **2.** *Lyngyba* **3.** *Anabaena* **4.** *Anacytis* **5.** *Aphanocapsa.*

CONCLUSION

Therefore from the above study it is concluded that the total phytoplankton is more in Okhla Bird Sanctuary and Chlorophyceae is dominant. It has been concluded that the water of Okhla Bird Sanctuary and Sanjay Jheel shows high dominance of *Lyngbya sp. Chlorella sp.*, *Navicula sp.,Nitzchilla and Agemencellum* which indicates that this lakes posses high amount of organic waste and therefore the water of the lake is organically polluted. Whereas India gate and Old Fort show high dominance of Rhizoclonium, Pithophora, Ulothrix indicated that water is less polluted.

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