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An annual algal diversity of Lakhna, Etawah, Uttar Pradesh, India

Omesh Bajpai*
Plant and Environmental Research Institute (PERI), Kanpur (Uttar Pradesh), India
Narendra Mohan
Pryavaran Shodh Ekai, Department of Botany, D. A-V. P.G. College, Kanpur (Uttar Pradesh), India
Jitendra Mohan
Pryavaran Shodh Ekai, Department of Botany, D. A-V. P.G. College, Kanpur (Uttar Pradesh), India
Rajan Kumar Gupta
Centre of Advanced Study in Botany, Banaras Hindu University, Varanasi (Uttar Pradesh), India

*Corresponding author. E-mail: omeshbajpai@gmail.com

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Abstract
The nature of an ecosystem can be easily assumed by the presence of planktonic diversity, as they have a major role in oxygen amelioration, binding and removal of toxic substances from water body. The present enumeration deals with the annual algal diversity from the Lakhna town of Etawah, Uttar Pradesh. During this one year period, total fifty-four species of Algae recorded *viz. Achnanthes minutissima*, *Amphora ovalis*, *Anabaena oscillarioides*, *A. oryzae*, *Ankistrodesmus falcatus*, *Aphanocapsa littoralis*, *Aphanothece microscopica*, *Arthrospira* sp., *Calothrix gloeocola*, *Chlorella vulgaris*, *Chlorococcum humicola*, *Chroococcus minor*, *C. minutes*, *Cladophora glomerata*, *Closterium venus*, *Coelosphaerium kuetzingianum*, *Cyclotella meneghiniana*, *Cylindrospermum minutissimum*, *Euglena minuta*, *Fragilaria crotonensis*, *Gloeocapsa magma*, *Gloeotrichia pisum*, *Gomphonema parvulum*, *Hydrodictyon reticulatum*, *Lyngbya contorta*, *L. epiphytica*, *L. majuscula*, *Merismopedia glauca*, *M. tenuissima*, *Microcystis aeruginosa*, *M. flos-aquae*, *M. robusta*, *Mougeotia calcarea*, *Navicula ambigua*, *N. brebissonii*, *N. lata*, *Nostoc commune*, *N. punctiforme*, *Oscillatoria formosa*, *O. subuliformis*, *O. princeps*, *Pediastrum boryanum*, *Phormidium ambiguum*, *P. fragile*, *P. lucidum*, *Rivularia aquatica*, *Scenedesmus bijuga*, *S. obliquus*, *Spirogyra affinis*, *S. submaxima*, *Spirulina gigantea*, *S. major*, *Ulothrix zonata*, *Zygnema collinsianum*. This information can be used as baseline data and may be further used to assess any change in algal diversity of Gangetic plain after a sufficient gap to understand the impact of changing climate on it.

Keywords: Algae, Freshwater bodies, Phycology, Diversity, Lakhna, Etawah, Uttar Pradesh

INTRODUCTION

The study on the ecology and behavior pattern of plankton in water bodies is a tool to know the ecology and the basic nature of that ecosystem (Singh *et al.,* 2013). Studies on the ecology of plankton of a water body are very helpful to know its general economy and to understand the basic nature of the lake or pond (Devi *et al.,* 2016). The qualitative and quantitative availability of plankton are the result of the interactions between the environmental factors and the organisms (Ramdani *et al.,* 2009). The primary productivity depends upon the photosynthetic trophic level (phytoplankton) and the rest of the biological community including zooplankton depends to a very large extent, on these phytoplanktons (Vallina *et al.,* 2014). The planktons are the direct food of different species of fishes and this relationship in the species composition and their seasonal variability is of great significance (Harris *et al.,* 2012; Hossain *et al.,* 2012; Vajravelu *et al.,* 2018).

The algal diversity of lentic water bodies (ponds, lakes, and reservoir etc.) is very important because it is an important tool to understand its freshness (Patil and Tijara, 2001; Singh and Mathur, 2005; Devi *et al.,* 2016). They have a major role in oxygen enrichment of water, binding and removal of certain toxic substances (Gupta *et al.,* 2015). This type of study also provides a scientific way to manage such type of water bodies. Lentic water bodies (ponds, lakes, and reservoir) are of considerable significance as a source of drinking, domestic, industrial and irrigation waters (Bhateria and Jain, 2016). However, rapid industrialization and urbanization have induced enormous pollution

and caused severe imbalances in aquatic biology of these water bodies (Trivedy, 1990). These algal contributions are very crucial for water quality improvement (Sen *et al.,* 2013; Bhateria and Jain, 2016). There is an interesting side of lakes, reservoirs and ponds that, their characteristic changes due to seasonal variations which results in the change of water volume, salt concentration, dissolved substances, gases and organic matters and thus in the algal diversity (Bajpai *et al.,* 2013). Considerable amount of work has been done in India about systematic survey, distribution, periodicity and ecology of algae in different habitats from different areas (Misra *et al.,* 2002; Misra *et al.,* 2004; Dwivedi *et al.,* 2005; Tiwari and Chauhan, 2006; Mohan *et al.,* 2007; Misra *et al.,* 2008; Sultana and Gupta, 2009; Suseela and Toppo, 2010; Suresh *et al.,* 2012; Bajpai *et al.,* 2013; Srivastava *et al.,* 2014; Jitendra and Anand, 2016). But, still very little is known about the planktonic diversity of freshwater bodies in different ecological regions. On the bases of literature survey, it appears that no systematic survey has been done in this area of Gangetic plains and so the present work has been taken. Thus, the present study was made on the estimation of algal flora in the water bodies located in Gangetic plains at Lakhna, Etawah, Uttar Pradesh.

MATERIALS AND METHODS

The different water bodies of Lakhna town, Etawah, Uttar Pradesh were taken for the present study. Sampling was done from several fixed spots in each selected water body. The samples were collected at 30 days interval from the fixed spots. The samples were collected in a wide mouth glass bottle (500 ml) with 5% formaline and deposited at 'Pryavaran Shodh Ekai', Botany Department, D.A-V. P.G. College, Kanpur. For a detailed study, samples were stained with iodine, mounted in glycerin and examined under the microscope to identify the species. Species identification was done with the help of keys given by (Desikachary, 1959; Prescott, 1964; Prescott, 1976; Anand, 1998).

RESULTS AND DISCUSSION

The distribution of algae found in the aquatic system showed fifty-four species during our one year study (2008-09). Out of this 31 Cyanophyceae, 14 Chlorophyceae, 8 Bacillariophyceae and 1 Euglenophyceae forms were observed. Such a vast qualitative variance in algal profile is amazing. Detailed examination shows that algae exhibit a high degree of qualitative variance. The occurrence and periodicity of algal species reported are given in table 1.

Similar kind of phytoplanktonic assessment was conducted near Badrinath, Uttarakhand, which reported Chlorophyceae with maximum dominance, followed by Bacillariophyceae, Cyanophyceae, Euglenophyceae, Dinophyceae and Xanthophyceae (Kumar *et al.,* 2012). Generally, Bacillariophyceae are found as dominant group in temperate water bodies (Mir *et al.,* 2007), but the presence of Chlorophyceae here as dominant one clearly indicates the relatively high temperature and nutrient condition. Another study from the Sattur, Tamil Nadu, reported the dominance of Chlorophyceae (Rajagopal *et al.,* 2010). The presence of Chlorophyceae as a dominant group is more related with the water temperature and transparency than any other water property, as both the parameters supports growth of this group (Devika *et al.,* 2006). Findings of this study partially match with the annual planktonic peak concentration for Indian fresh waters bodies and shows maximum number of taxa (44) in the spring *i.e.* February (Ganpati and Chacko, 1951; Chacko and Krishnamurthy, 1954; Das and Srivastava, 1956; Das, 1959). Listing only one annual peak during the months of spring was also reported by Michael, (1968) and Mukherjee *et al.,* (1995, 2010) in their studies and supports the findings of present study. Tiwari and Chauhan, (2006), in his seasonal phytoplanktonic diversity assessment study, reported the dominance of Chlorophyceae, followed by Cyanophyceae from Agra and concluded the good water quality with limited organic matter. Similar kind of reports *i.e.* presence of higher number of green algae has also been recently reported from fresh water bodies of Central India (Srivastava *et al.,* 2018) and Peninsular India (Pandiammal *et al.,* 2017; Srinivas and Aruna, 2018; Rajyalaxmi and Aruna, 2019). On the other hand the present study shows the dominance of Cyanophyceae members, which may be due to the warmer condition and higher organic matter (Kruger and Elhoff, 1978; Mukherjee *et al.,* 2010). However, the gradual elimination of Chlorophyceae may be the result of an increase in other algae. The present study showed that the incidence of Cyanophyceae in large number indicated by blooms of *Microcystis* species and *Oscillatoria* species and also pointing the polluted condition of water bodies in the study area.

Conclusion

The algal community of the study area is dominated by the Cyanophyceae members, at the same time, certain algae which contribute in degradation of water quality by showing toxic effect (species of *Anabaena, Lyngbya* and *Microcystis*), allergenic disease (species of *Chlorella*, *Scenedesmus*, *Anabaena*, *Microcystis* and *Oscillatoria*), colour (species of *Chlorella*, and *Microcystis*), taste and odor (species of *Chlorella*, *Cladophora*, *Hydrodictyon*, *Scenedesmus*, *Spirogyra*, *Fragilaria*, *Anabaena*, *Nostoc*, *Oscillatoria* and *Euglena)* are also

Table 1. Annual algal diversity in Lakhna town, Etawah, Uttar Pradesh.

Algal Species (2008-09)	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.
Achnanthes minutissima Kützing	+	+	+	-	-	-	-	-	-	-	-	-
Amphora ovalis (Kützing) Kützing	+	+	-	+	+	+	+	+	+	+	-	-
Anabaena oryzae F.E. Fritsch	-	-	-	+	+	+	+	+	+	+	-	-
Anabaena oscillarioides Bory ex Bornet and Flahault	+	+	-	-	-	-	+	+	+	+	+	-
Ankistrodesmus falcatus (Corda) Ralfs	-	-	+	+	-	-	+	+	+	-	-	-
Aphanocapsa littoralis Hansgirg	-	-	-	-	+	+	+	+	+	+	-	-
Aphanothece microscopica Nägeli	-	-	-	-	-	-	-	+	+	+	+	+
Arthrospira sp.	+	-	-	-	-	-	+	+	+	+	+	+
Calothrix gloeocola Skuja	-	-	-	+	+	+	+	+	+	+	+	-
Chlorella vulgaris Beyerinck	-	-	+	+	+	+	+	+	+	+	-	-
Chlorococcum humicola (Nägeli) Rabenhorst	+	-	-	+	+	+	+	+	+	+	+	-
Chroococcus minor (Kützing) Nägeli	+	+	+	-	-	-	-	+	+	+	+	+
Chroococcus minutes (Kützing) Nägeli	-	-	-	-	+	+	+	+	+	+	+	-
Cladophora glomerata (Linnaeus) Kützing	-	-	+	+	+	+	+	+	+	+	-	-
Closterium venus Kützing ex Ralfs	-	-	-	-	+	+	-	-	-	-	-	-
Coelosphaerium kuetzingianum Nägeli	-	-	-	-	-	-	+	+	+	+	-	-
Cyclotella meneghiniana Kützing	+	+	-	-	+	+	+	+	+	+	-	-
Cylindrospermum minutissimum Collins	-	-	-	-	+	+	+	+	+	+	+	-
Euglena minuta Prescott	-	-	-	-	-	+	+	+	+	+	+	-
Fragilaria crotonensis Kitton	+	+	+	-	-	-	-	-	-	+	+	+
Gloeocapsa magma (Brébisson) Kützing	-	-	-	-	-	+	+	+	+	-	-	-
Gloeotrichia pisum Thuret ex Bornet & Flahault	-	-	+	+	+	-	-	-	-	-	+	+
Gomphonema parvulum (Kützing) Kützing	-	-	-	+	+	+	+	+	+	+	+	-
Hydrodictyon reticulatum (L.) Bory	-	-	+	+	-	-	-	-	-	-	-	-
Lyngbya contorta Lemmermann	+	+	-	-	-	-	-	-	-	+	+	+
Lyngbya epiphytica Hieronymus	-	-	-	-	-	-	-	-	+	+	+	-
Lyngbya majuscula Harvey ex Gomont	+	+	-	-	-	-	-	-	+	+	-	+
Merismopedia tenuissima Lemmermann	+	+	-	-	+	-	+	+	+	+	-	-
Merismopedia glauca (Ehrenberg) Kützing	+	+	+	-	-	-	-	-	+	+	+	+
Microcystis aeruginosa (Kützing) Kützing	+	+	+	+	+	+	+	+	+	+	+	+
Microcystis flos-aquae (Wittrock) Kirchner	-	-	+	+	+	-	+	+	+	+	-	-
Microcystis robusta (H.W. Clark) Nygaard	-	-	-	-	-	-	+	+	+	-	-	-
Mougeotia calcarea (Cleve) Wittrock	-	-	-	-	-	-	-	+	+	+	+	-
Navicula ambigua Ehrenberg	+	+	-	-	-	-	-	-	-	+	+	-
Navicula brebissonii Kützing	-	-	-	-	-	-	-	+	+	+	+	-
Navicula lata (Brébisson) Kützing	+	-	-	-	-	-	+	+	+	+	-	-
Nostoc commune Vaucher ex Bornet & Flahault	-	-	-	+	+	+	+	+	+	-	-	-
Nostoc punctiforme Hariot	-	-	+	+	+	+	+	+	-	-	-	-
Oscillatoria formosa Bory ex Gomont	-	-	-	-	+	+	+	+	+	+	-	-
Oscillatoria princeps Vaucher ex Gomont	-	-	-	-	-	+	+	+	+	+	-	-
Oscillatoria subuliformis Kützing ex Gomont	-	-	-	+	+	+	+	+	+	+	+	+
Pediastrum boryanum (Turpin) Meneghini	-	+	+	+	-	+	+	-	+	+	+	-
Phormidium ambiguum Gomont	-	-	-	-	+	+	+	+	+	+	-	-
Phormidium fragile Gomont	+	+	-	-	-	-	+	+	-	-	-	+
Phormidium lucidum Kützing ex Gomont	-	-	-	-	-	-	-	+	+	-	-	-
Rivularia aquatica De Wildeman	-	-	+	+	-	-	-	-	-	-	+	+
Scenedesmus bijuga (Turpin) Lagerheim	+	+	+	+	+	+	+	+	+	+	+	+
Scenedesmus obliquus (Turpin) Kützing	+	+	-	-	+	+	-	+	+	+	-	+
Spirogyra affinis (Hassall) Petit	+	+	+	+	+	+	+	+	+	+	+	+
Spirogyra submaxima Transeau	+	+	+	+	+	+	+	+	+	+	+	+
Spirulina gigantea Schmidle	-	-	-	-	-	+	+	+	+	+	+	-
Spirulina major Kützing ex Gomont	-	-	+	+	+	+	+	+	+	+	+	-
Ulothrix zonata (F. Weber & Mohr) Kützing	-	+	+	+	+	+	+	+	+	+	-	-
Zygnema collinsianum Transeau	+	+	+	-	+	+	+	+	+	+	-	-

Note: (+) = Presence and (-) = Absent.

reported from the study site. Thus, the study site can be considered to be eutrophic with the mesosaprobic conditions and requires management strategies to improve its water quality. As the study is very first report of algal diversity from the study site, the extracted information from this study can be used as baseline data for climate change and global worming studies. Further, after a sufficient interval of time, one can assess the impact of changing environment on the algal diversity from the same study area.

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