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RESEARCH ARTICLE

ALGAL BIODIVERSITY OF SOME SACRED PONDS OF KURUKSHETRA (INDIA)

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Abstract

Having known about the biodiversity conservation and the world wide applications of various algal species, a survey was conducted at some sacred ponds of Kurukshetra (India) to explore the algal wealth specially the cyanobacterial one, so as to further explore them for different biotechnological applications. From the observations, it may be summarized that a total number of 34 algal genera were recorded, out of which, 19 genera belonged to division Cyanophyta, 8 belonged to Chlorophyta, and 7 genera belonging to Bacillariophyta were found. Out of them, a few genera were common to all the selected ponds.

INTRODUCTION

As a basic research tool, the micro-organisms, mainly the algal and cyanobacterial flora are nature's unique gift to mankind, as they possess several innate properties that make them ideal organisms with potential for multifaceted biotechnological applications (Kashyap and Kumar 1994, Fatma 1999, Horikoshi 1999, Kasting 2001). They show wide ecological tolerance and they occur in almost every conceivable habitat on earth (Hof and Fremy 1933, Desikachary 1959, Fogg *et al.*, 1973, Carr and Whitton 1982, Pearl and Millie 1996). They are found as planktonic forms in both freshwater and marine ecosystems and also as gelatinous mat like growth on shaded soil, rocks, mud, wood and some living organisms (Kempe *et al.*, 1991). They produce the compounds responsible for 'earthy' odours we detect in soil and some bodies of water (Lund 1965). Active research in the field of algal biotechnology has opened up vast opportunities for eliminating human sufferings. In short, these organisms have gained significance as a source of wholesome food materials, fixed atmospheric nitrogen, natural sources of colourants, biolipstics, bioplastics, biofuels, and fine chemicals like proteins, lipids, pigments, enzymes, antioxidants, minerals and vitamins, polysaccharides, glycerol and many other novel biologically active compounds (Borowitzka 1988, Dubey 1993, Romay *et al.*, 2003, Biban 2015).

The basic and fundamental requirement for initiating algal and cyanobacterial biotechnology is to first enumerate the available natural wealth and to understand their ecobiological properties. This work is the first of its kind, surveying a continuous stretch of the cyanobacterial and algal flora of some sacred ponds of Kurukshetra (Biban and Singh 2011, 2012; Singh and Biban 2013).

MATERIALS AND METHODS

SELECTION OF STUDY SITES- Kurukshetra is probably the most famous religious site in India and one of the most ancient places of pilgrimage in the world. This ancient land of 'Mahabharata' is now no exception to globalization (Lal 1980, Trikha 2006, Dandekar 1990, Buck 2004, Chapple 2009). Geographically Kurukshetra district is a plain area which slopes from North East to South and South West. It is located at $29^0$57'53.54"N and $76^0$49'07.56"E. There are many ponds in Kurukshetra showing their spiritual value. Out of them, the three big ones- Brahma Sarowar, Sannihit Sarowar and the Jyotisar Sarowar were selected as Study Site-I, Study Site-

II and Study Site-III respectively for their exploration. Such freshwater habitats are the breeding grounds for various cyanobacterial blooms and diatoms. However, their population fluctuates according to the seasonal variations in summer, rainy, and winter seasons (Biban and Singh 2011, 2012).

SAMPLING PROCEDURE- In order to evaluate algal and cyanobacterial diversity, the planktonic samples were collected from the epilimnion at the selected fresh water ponds of Kurukshetra, using plastic plankton nets (0.1mm pore size), forceps and knifes. Water samples were collected using air tight bottles containers and transported to laboratory.

RESULTS

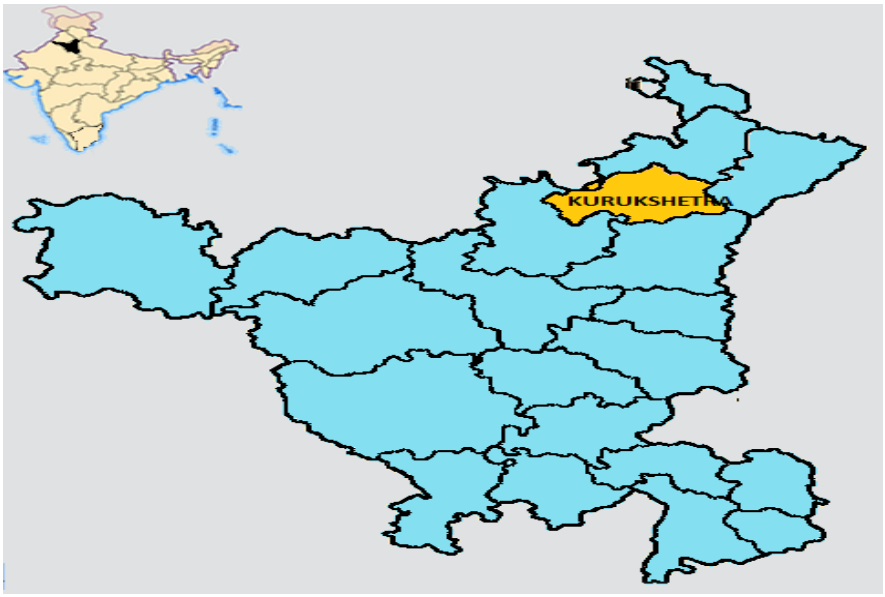

Fig.1.1 Map of Haryana (India) showing location of district Kurukshetra.

In the present study, a total number of 34 algal genera were recorded, out of which, 19 genera belonged to division Cyanophyta, 8 belonged to Chlorophyta, and 7 genera belonging to Bacillariophyta were found. The field photographs showing the algal populations and sampling sites have been shown in Fig. no. 2. The distribution of different algae so found, has been presented in Table no. 1 respectively. Among the cyanobacterial genera, 8 were unicellular colonial forms and 11 were the filamentous blue green algae.

Table No. 1: Distribution of Algal species recorded to different study sites

SR. NO.	ALGAE DESCRIPTION	SITE-I (*BRAHMA SAROWAR*)	SITE-II (*SANNIHIT SAROWAR*)	SITE-III (*JYOTISAR SAROWAR*)
Division: Cyanophyta				
1	*Aphanothece sp.*	+	+	+
2	*Aphanocapsa sp.*	+	+	+
3	*Chroococcus sp.*	+	+	+
4	*Gloeothece sp.*	-	+	+
5	*Gloeocapsa sp.*	+	+	+
6	*Merismopedia sp.*	-	+	+
7	*Microcystis sp.*	-	+	+
8	*Synechocystis sp.*	+	+	+
9	*Oscillatoria sp.*	+	+	+
10	*Phormidium sp.*	+	+	+
11	*Lyngbya sp.*	+	+	+
12	*Anabaena sp.*	+	-	+
13	*Nostoc sp.*	+	-	+

14	*Aulosira sp.*	-	+	+
15	*Nodularia sp.*	-	+	+
16	*Cylindrospermum sp.*	-	+	+
17	*Rivularia sp.*	+	+	+
18	*Gloeotrichia sp.*	+	-	+
19	*Microcoleus sp.*	+	+	+
Division: Chlorophyta				
20	*Eudorina sp.*	+	+	+
21	*Chlorella sp.*	+	-	+
22	*Cladophora sp.*	+	+	+
23	*Closterium sp.*	+	+	+
24	*Cosmarium sp.*	+	+	+
25	*Spirogyra sp.*	+	-	+
26	*Scenedesmus sp.*	-	+	+
27	*Ulothrix sp.*	+	+	+
Division: Bacillariophyta				
28	*Navicula sp.*	-	+	+
29	*Pinnularia sp.*	+	+	+
30	*Synedra sp.*	-	+	+
31	*Fragillaria sp.*	+	+	+
32	*Melosira sp.*	-	-	+
33	*Nitzschia sp.*	+	+	+
34	*Amphora sp.*	-	+	+

Note: (+) shows the presence and (-) shows the absence of the organism in collected sample.

The cyanobacteria from the selected ponds of Kurukshetra belonged to the following genera: *Aphanothece, Aphanocapsa, Chroococcus, Gloeocapsa, Gloeothece, Microcystis, Merismopedia, Synechocystis, Anabaena, Aulosira, Oscillatoria, Nostoc, Lyngbya, Nodularia, Rivularia, Gloeotrichia, Cylindrospermum, Microcoleus* and *Phormidium*. The *Microcystis* formed bloom at *Sannihit Sarowar* as well as at *Jyotisar Sarowar*. The *Microcystis* bloom at *Sannihit Sarowar* was accompanied by S*ynechocystis* and *Merismopedia*. The filamentous blue green algae like *Oscillatoria, Rivularia, Lyngbya, Phormidium* and *Microcoleus* were found attached to the stairs and in the soils of the ponds. The following green algae were recorded from different study sites: *Eudorina, Chlorella, Cladophora, Closterium, Cosmarium, Spirogyra, Scenedesmus* and *Ulothrix*. The planktonic green algae like *Eudorina* and *Scenedesmus* formed bloom along with other planktonic algae at their sites. The diatoms of following genera were also found during the study period: *Navicula, Pinnularia, Synedra, Fragillaria, Melosira, Nitzschia* and *Amphora*. The diatoms were found free floating and near the region where a scum was formed.

DISCUSSION:

In any ecosystem, not a single species grows independently and indefinitely (Casamayor *et al*., 2000, Ernst *et al*., 2005). The physicochemical changes in the environment may affect particular species and induce the growth and abundance of other species, which leads to the succession of several species in a course of time (Jensen *et al*., 1994, Huisman and Hulot 2005). As reported, cyanobacteria particularly forms their extreme blooms throughout the main part of the summer in fresh water ecosystems (Duncan and Blinn 1999, Scarsbrook 2002, Soininen and Eloranta 2004). We have also observed various algal bloom formations at different study sites i.e. Study Site-I (*Synechocystis* and *Chroococcus* bloom), Study Site-II (*Merismopedia* and *Scenedesmus* bloom) and Study Site-III (*Microcystis* bloom) respectively (Arjariya 2003, Pingale and Deshmukh 2005, Subha and Chandra 2005).

Fig. No. 2: Field Photographs showing algal growth at Study Site-I (Column-1), Study Site-II (Column-2) and Study Site-III (Column-3)

The interest towards the study of the cyanobacterial communities present in various water reservoirs of Kurukshetra fuelled with the richness in cyanobacterial biodiversity (Table no.1), because a lot of work has been already done at many places in the world (McDaniel *et al*., 1962, Margalef 1972, Tilman *et al*., 1986, Thajuddin and Subramanian 2005, Otsuka *et al*., 2001, Taton *et al*., 2003, Oren 2004, Tringe *et al*., 2005, Addico *et al*., 2009, Yamamoto *et al*., 2010) yet, a place like Kurukshetra is still untouched and needs to be explored (Biban and Singh 2011). Such freshwater habitats are the breeding grounds for numerous algal and cyanobacterial blooms. The climatic conditions have affected the biodiversity of phytoplanktonic community (Panigrahi *et al*., 2009). During summer season, low diversity of cyanobacteria was attributed to a massive bloom of *Microcystis* at Jyotisar sarowar, *Merismopedia* and *Scenedesmus* bloom at Sannihit sarowar and *Synechocystis* and *Chroococcus* bloom at Brahma sarowar respectively (Rani *et al*., 2005)**.** *Microcystis* is one of the dominant organisms that are associated with almost permanent blooms in tropical freshwaters that are exposed to constant sunshine, warmth, and nutrients. Formation of cyanobacterial blooms in freshwater bodies is essentially due to buoyant nature of these organisms (Jeyaraman 1972, Jones *et al*., 1998). Chaudhary and Meena (2007) enlisted various phytoplanktons from Udaipur Lakes. Mohan *et al*., (2006) identified thirty eight species of blue green algae from *Hadeera Tal (Kannuji)* U.P. Their distribution was markedly influenced by the physicochemical nature of the aquatic system. Pandey and Dungarwal (2004) gave the taxonomic account of the freshwater algae collected from the tank of Ekling Ji temple in Udaipur. Suseela and Kumar (2004) described freshwater algal variation at three sites of river Gomti in India during winter. A phytoplankton and water quality survey was conducted by Zhao *et al*., 2004 during flood and dry seasons in 2000 in 19 typical reservoirs in Guangdong Province, China, in order to evaluate the trophic state and cyanobacterial pollution.

The ponds were also covered by some higher plants like *Eichhornia, Hydrilla and Nelumbo* etc. with very high population. The *Diatoms* like *Navicula, Nitzschia, Pinnularia, Fragillaria* were also in abundance in all the

ponds throughout the observations. During the sampling time of rainy season, the dominant cyanobacterial genera were the filamentous forms like *Oscillatoria, Anabaena, Lyngbya* etc. Totally 19 genera of cyanobacteria (Frankelin 1972), 8 genera of green algae and 7 genera of diatoms were recorded in the ponds (Krammer and Lang-Bertalot 1986, 1988).

CONCLUSION:

The micro-organisms show specific growth pattern in a specific environment and therefore their distribution, ecology, periodicity, qualitative and quantitative occurrence differ widely. Cyanobacterial and other algal blooms may have far-reaching ecological effects on aquatic ecosystems.

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