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Phenological diversity of chlorophycean algae from river Ganges at Varanasi, Uttar Pradesh

Anand Prakash Singh and B. R. Chaudhary*

Centre of Advanced Study in Botany, Banaras Hindu University, Varanasi-221005, India

*E Mail: brchaudhary.bhu@gmail.com; anandbotany@gmail.com

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. Many algae can be tentatively identified by their appearance; shape and colour of thallus in a particular habitat. The phenology of freshwater algae from Uttar Pradesh mostly belonging to chlorophycean members is totally dependent on the physico-chemical characteristics of the water bodies at different time intervals. Maximum algal population during the year was noticed in early summer, while the lowest in august. The amount of water discharge velocity and transparency influence the occurrence and abundance of algal diversity. This communication deals with the dynamics of the freshwater algae from river Ganges, Uttar Pradesh which mostly belong to Chlorophyceae accumulating comprised of genera like *Spirogyra, Cladophora* and some times a single species of *Enteromorpha*, *E. intermedia.*

Key Words: Chlorophyceae, Phenology, River Ganges

INTRODUCTION

Algae constitute a large and diverse group of simple, typically autotrophic organisms, ranging from unicellular to multicellular forms. Algae represent a paraphyletic and polyphyletic group, as they do not include all the descendants of the last universal ancestor, nor do they all descend from a common algal ancestor although their chloroplasts seem to have a single origin. Algae are photosynthetic organisms that occur in most habitats, ranging from marine and freshwater to desert sands and from hot boiling springs to snow and ice. They vary from small, single-celled forms to complex multicellular forms, such as the giant kelps of the eastern Pacific that grow to more than 60 meters in length and form dense marine

forests. Chlorophycean members are important as primary producers of organic matter at the base of the food chain in most of the aquatic ecosystems and also provide oxygen for other aquatic life. It is a well established fact that more than 75% of freshwater fishes feed on plankton at one or the other stage of their life- cycle (Jafri *et al*., 1999). Phytoplanktons are the primary producers of water bodies; these are the main source of food directly or indirectly for various animal groups (Rao, 1975). The measurement of primary and secondary productivity gives indication regarding fish production (Panday, 1981). Physico-chemical parameters and quantity of nutrients in water play significant role in the distributional patterns and species composition of phytoplanktons mostly green algae in the aquatic habitats. The penetration of light, temperature, salinity, pH, hardness, phosphates, nitrates and water current velocity are the important factors for growth and density of phytoplanktonic species (Mahar *et al*., 2000).

Nutrients are the main limiting factor for algal growth. In freshwater habitats, like River Ganges, phosphorus is usually the principal and essential nutrient for all life forms. Nitrogen can also trigger algal blooms, but it is a more common factor in salt waters. There are two general sources of nutrients in our waters, natural and man made. Natural sources include nutrients that leach from soil and atmospheric deposition (Rai and Gaur, 2001), whereas man made sources account for much larger amounts and these include fertilizer, livestock manure, human sewage, industrial run-off etc.

Amongst autotrophic plants and possibly within the whole of the plant kingdom, algae are unexcelled for variation in structure, range of habitat and diversity of role. There are excellent texts dealing with their structure and reproduction, and much has been written about their ecology, but it is not easy to locate assembled information on their periodic distribution i.e. phenology. The Phycological researches and diversity of algae from the Indian sub-continent have been reviewed from time to time. Substantial contributions have been made by Indian and overseas workers to systematics and classification of algae on the basis of morphology, cytology, biochemistry, ecology and some recent aspects such as molecular biology. An attempt is made in the present communication to focus attention on the studies relating to the freshwater green algae and their phenology

in the river Ganges at Varanasi, Uttar Pradesh.

MATERIALS AND METHODS

Samples of freshwater algae were collected periodically over the year from different locations of the river Ganges, viz. Assi ghat, Samane ghat, Ramnagar pipapul and Ramna ghat at Varanasi (Fig. 1). The samples were brought to the laboratory, washed under running tap water and preserved in 4% formaldehyde solution. Mounts of these samples were prepared and Camera Lucida diagrams were made to effect identification of algae following the keys given by Prescott (1951), Tiffany and Britton (1952), Randhawa (1959), Prasad and Mishra (1992) and Kant and Gupta (1998). Microphotographs of dominant forms were taken by a digital camera (Cat Cam with 3 MPi) to assess algal diversity existent in the water body.

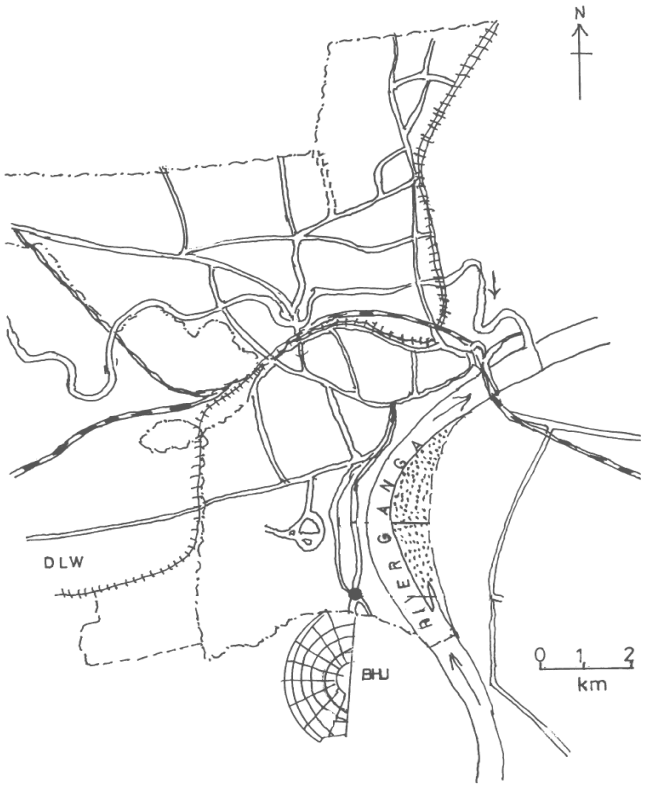

Fig. 1. Map of Varanasi showing sampling sites at river Ganges

RESULTS

The total chlorophycean algal flora (Plate 1: Figs 1-13) consisted of 13 genera drawn from different Orders, viz. Chlorococcales, Volvocales, Ulotrichales, Conjugales, Chaetophorales and Cladophorales as presented below.

Orders	**Genera**
1- Chlorococcales	*Pediastrum, Hydrodictyon, Chlorella* and *Scenedesmus*
2- Volvocales	*Pandorina* and *Eudorina*
3- Ulotrichales	*Enteromorpha*
4- Conjugales	*Spirogyra, Zygnema, Cosmarium* and *Closterium*
5- Chaetophorales	*Stigeoclonium*
6- Cladophorales	*Cladophora*

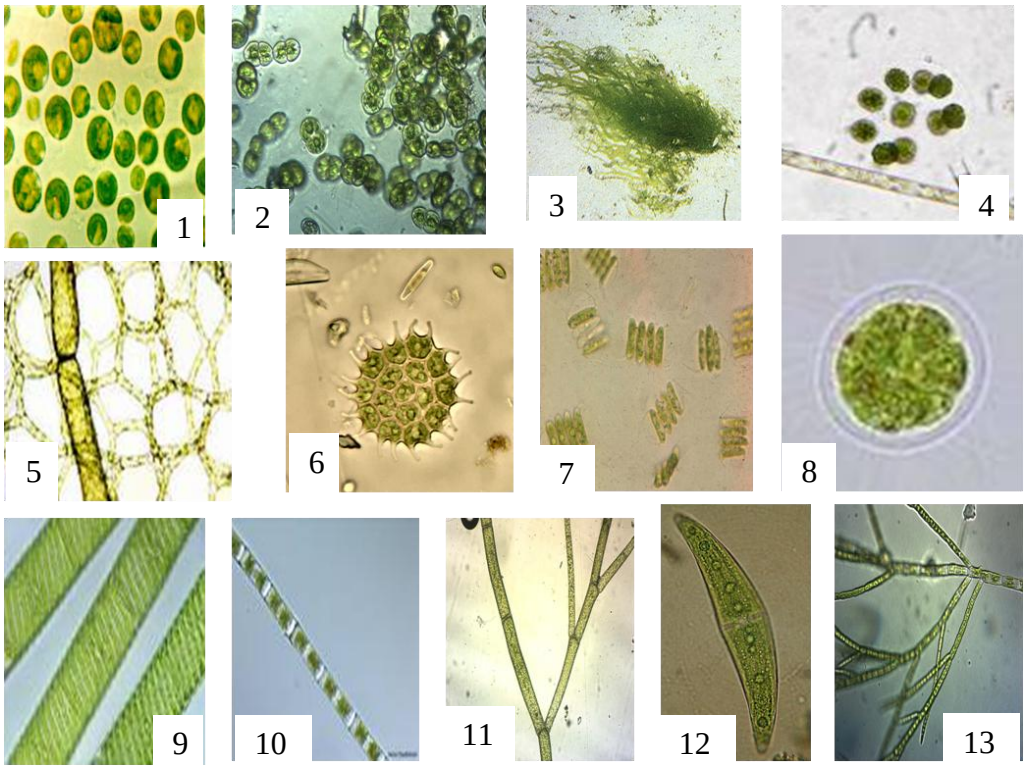

Plate 1:Fig. 1. *Chlorella* **2.** *Cosmarium* **3.** *Enteromorpha* **4.** *Eudorina* **5.** *Hydrodictyon* **6**. *Pediastrum* **7.** *Scenedesmus* **8.** *Pandorina* **9.** *Spirogyra* **10**. *Zygnema* **11.** *Cladophora* **12**. *Closterium* **13.** *Stigeoclonium*

The phenologies of thirteen dominant genera (Plate 1: Figs. 1- 13) have been studied. Higher populations of Spirogyra and Cladophora were recorded in most of the seasons in river Ganges, but their population were drastically reduced during monsoon months i.e. from June to September due to the occurrence of flood with suspended soil and sand particles. Three peaks of Pedistrum growth occurred during January, March and December. Cosmarim showed its occurrence during summer months with a peak in april and may. The population, however, was recorded from all the sampling stations of the river Ganges. The peak of Pediastrum appears during December and January and slowly declined till March.

Table1. Monthly variation of phytoplankton community in river Ganges at Varanasi

S.N.	Algae	Jan.	Feb.	Mar.	April	May	Jun	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	*Chlorella*	-	-	-	+	++	++	-	-	-	-	-	-
2	*Cosmarium*	-	-	-	++	++	+	-	-	-	-	-	-
3	*Enteromorpha*	-	++	++	+++	+	-	-	-	-	-	-	-
4	*Eudorina*	+	-	-	-	-	-	-	-	-	-	-	++
5	*Hydrodictyon*	-	-	-	++	++	+	-	-	-	-	-	-
6	*Pediastrum*	+++	++	+	-	-	-	-	-	-	-	-	++
7	*Scenedesmus*	-	-	-	++	++	+	-	-	-	-	-	-
8	*Pandorina*	-	+	-	-	++	-	-	-	-	+	-	-
9	*Spirogyra*	+++	+++	+++	+++	+++	++	-	-	-	+	++	+++
10	*Zygnema*		+++	++									
11	*Cladophora*	+++	+++	+++	+++	++	+	-	-	-	-	+	+++
12	*Closterium*				+++	++							
13	*Stigeoclonium*	++	-	-	-	-	-	-	-	-	-	-	+

(+)= Present, (++) = Common, (+++) = Abundant, (-) = Absent

The seasonal fluctuations of Enteromorpha intermedia, the only freshwater form of Enteromorpha showed two peaks, one observed in February and the other in april. This taxon was rarely found during rest of the year. Higher population of Pandorina was observed during summer months, especially in May. The population of this genus was lower in October and February and was absent during September, December, January, March and April months. Higher population of Scendesmus species was observed during the period of april to May, during which the water level

declined gradually. As a consequence of the entry of freshwater and rainwater into the river Ganges after summer months, the population of Scendesmus was comparatively reduced from July to November. The seasonal fluctuation in Stigeoclonium showed distinct change; while population was observed in winter months, it was much less during summer months. Peak of this genus occurred during the month of January. The population of the genus Chlorella was very low throughout the year. A single moderate peak, however, occurred during May. Genus Hydrodictyon was present in month of April at almost all the stations studied. Population was low during cold season while from April onward their number gradually increased to result into a prominent peak, and further decreased gradually till October. The seasonal variations in these phytoplanktonic communities (Table. 1) indicate the natural management of primary production throughout the year. Most of the chlorophycean members flourished well from December onword till April/ may; forming prominent peak in the month of March. With respect to relative abundance of different genera of Chlorophyceae, most of the member of Conjugales and Cladophorales flourished well. The occurance of one freshwater species of E. intermedia was also reported in the month of March and April. In general, moderate temperature, low current velocity and high transparency of water appears to be better conditions for algal growth in the river Ganges.

DISCUSSION

Banaras (also known as Kashi) is one of the most ancient, religious and visited cities in Utter Pradesh. The river Ganges is a major river of Utter Pradesh catering to the needs of agriculture and human consumption. Ongoing climatic changes coupled with unwarranted human activities have significantly disturbed the ambient water quality. Xenobiotic compounds together with various types of biological particles are continuously added to the river Ganges. Physico-chemical characteristics of the river water determine the presence or absence the algal groups. The water temperature of river Ganges ranges from 10-30ºC and pH varied between 7.4 and 8.17 in different months of the year. The seasonal succession of phytoplanktonic community at the four Ghats of river Ganges exhibits the typical pattern. While Summer season is dominated by Spirogyra, Cladophora, Closterium ,

Scenedesmus and Enteromorpha and the winter period by Stigeoclonium, Zygnema and Pediastrum, comparatively smaller population of some members is present in the month of monsoon. The most frequent of phytoplankton species found are Cladophora and Spirogyra found at all the station studied throughout the year except during floods. Most of the earlier studies on the river Ganges were mainly concerned with the physico-chemical and bacteriological properties of the river water. Even Ganga Action Plan launched by the Government emphasized only the physico-chemical and bacteriological characteristics of the river to assess its pollution status. Algal dynamics of river was rather neglected, although Jha (1982) and Patric (1993) gave some attention to this aspect. Algal diversities are natural occurrences, and may occur with regularity depending on weather and water conditions of the river. The likelihood of the algal bloom depends on local conditions and characteristics of the particular body of water. The occurrence of rich algal flora results generally at the place where there are high levels of nutrients present, together with the occurrence of warm and sunny conditions. However, human activity can often trigger and accelerate the pace of algal growth. Natural sources of nutrients such as phosphorus and nitrogen in the river Ganges can be supplemented by a variety of human activities. For example, in rural areas, agricultural run-off from the fields can wash fertilizers into the water. In urban areas, on the other hand, nutrient sources can include treated wastewaters from septic systems and sewage treatment plants, and urban stormwater run-off that carries nonpoint-source pollutants such as lawn fertilizers that support the growth of many green algae. River water is quite rich in nitrogen and phosphorus, which supported luxuriant algal growth. Algae prefer ammonia to nitrate; when different nitrogen forms are supplied simultaneousaly they exhaust ammonia then nitrate and further nitrite (Chick, 1902). Seasonal phytoplankton abundance and variation is the reflection of collective response of several physico-chemical characteristics of the river water. It is expected that more than 90% variation in phytoplankton density is influenced by physico-chemical factors and only 10% by other factors.

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REFERENCES

Chick, H. 1902. A study of unicellular green algae occurring in polluted water with special reference to its nitrogen metabolism. Proc. Roy. Soc. London. 71: 458-470.

Crayton, W. M. and Sommerfeld, M. R. 1979. Composition and abundance of phytoplankton in tributaries of the lower Colorado river; Grand Canyon region. Hydrobiologia. 66: 224-257.

Hyness, H. B. N. 1966. The biology of polluted water. Liverpool University Press, Liverpool, England

Jafri, S. I. H., Mahar, M. A. and Leghari, S. M. 1999. Diversity of fish and plankton in Manchhar lake (Distt. Dadu) Sindh, Pakistan. Proc. Semi. Aq. Biodiv. Pakistan. 63-70.

Jha, D. N. 1982. Influence of water pollution on the distribution of algae in the river Ganga at Kanpur. Ph.D. thesis. Kanpur University, Kanpur.

Mishra, P. K., Srivastva, A. K. and Prakash, J. 2002. Morphotaxonomic survey on Ulotrichales and Cladophorales of Narth-Eastern Uttar Pradesh, India. J. Ind. Bot. Soc. 81(3-4): 345-350.

Mahar, M. A., Jafri, S. I. H. and. Leghari. S. M. 2000. Studies on water chemistry and fish production of Manchar lake, Dadu, Sindh, Pakistan. Pakistan J. Biol. Sci. 3(12): 2151-2153.

Panday, S. N. 1981. Studies on the effect of selenium on *Chlorella vulgaris* Berji. Environment India. 4: 77-79.

Prasad, B. N. and Mishra, P. K. 1992. Fresh water algal flora of Andaman and Nicobar Islands, Vol. II. B. Singh and M.P. Singh, Deharadun, India, 248.

Rai, L. C. and Guar, J. P. 2001. Algal Adaptation to Environmental Stresses. Springer-Verlag; Berlin Heidelberg, New York.

Randhawa, M. S. 1959. Zygnemacea*e* . Indian council of Agriculture Research, New Delhi, 471.

Rao, V. S. 1975. An ecological study of three ponds of Hyderabad, India III. The phytoplankton, Volvocales, Chroococcales and Desmids. Hydrobiologia, 47(2): 319-337.

Reddy, M. P. and Venkateswarlu, V. 1987. Assessement of water quality and pollution in the river Tungabhadra near Kurnool, Andhra Pradesh. J. Enviroment. Biol. 8: 109-119.

Smith, G. M. 1950. The Fresh Water Algae of United States. McGraw- Hill Book Company, INC, New York.

Sarma, Y. S. R. K. and Khan, M. 1991. Fresh water algae **.** Ind. phyco. Rev. 1: 1-56.

Senger, R. M. S. and Sharma, K. D. 1982. Algal flora of Yamuna river at Agra. Chlorococcales. Phykos, 21: 164-165.

Tiffany, L. H. and Britton, M. E. 1952. The algae of Illians. Hafner publishing. The university of Chicago press. 407

Tiwari, D. 1983. Pollution phycology of the varanasi frontage of river Ganga. Ph.D. thesis, B.H.U..