A Critical Review of Studies Related to Diversity and Seasonal Variation of Phytoplanktons

Jyoti Sharma; Prahlad Dube*and V.D Karra

Department of Zoology, Government College, Kota, Rajasthan, India.

Abstract
The phytoplankton is defined as the microscopic plant life of the water, which functions as primary producers synthesizing the food. It belongs to the class Algae, which besides chlorophyll posses other characteristic pigments. The important components of phytoplankton are Diatoms (Bacillariphyceae), Dinoflagellates (Xanthophyceae, Chrysophyceae, Haptophyceae, Cryptophyceae) and Nanoplankters (Chlorella, Nannochlorpsis, etc.). In addition to these, two other classes namely Silicoflagellates and Coccolithophores also belong to the category of phytoplankton. The present paper discusses comprehensive review of phytoplankton diversity, seasonal variation and related aspects.

Keywords: *Phytoplankton, Diversity, Chlorophyta, Chromophyta, Rhodophyta, Ecological indicator.*

Introduction
Plankton are those organisms which spends either part or all of their life in a drifting state, with no ability to swim against a current. Phytoplanktons produce their own food and thus are very important part of food chain and food web. They act as very good indicators of health of water resource.
Plankton can be divided into two basic categories:
(a)Phytoplankton : organisms that are plant like.
(b)Zooplankton : organisms that are animal like.

Phytoplankton on the basis of cell structure may be divided into two categories:
1. *Prokaryotes : Prokaryotes have only one group - Cyanobacteria*
2. *Eukaryotes : Eukaryotes have 3 Divisions: Chlorophyta, Chromophyta and Rhodophyta.*

Chlorophyta has 3 classes, Choromophyta has 7 classes and Rhodoplyta has mostly macrophytes. In India, Plankton has been subject of study for nearly two centuries. A good amount of literature has been generated by several workers during this period. Many review papers appeared time to time, covering one or many aspects of plankton biology. During the survey of literature it has been observed that recently published research work should be reviewed in terms of diversity, seasonal variation and applied aspects.

Review
Amita-Arjaria (2003) studied physico-chemical profile and plankton diversity of Ranital Lake, Chhatarpur, M.P. According to the study, the phytoplankton is dominated mainly by the species of Cyanophyceae, Chlorophyceae and Diatoms, which belong to the tolerant species.

Kumar and Hosmani (2006) studied Algal Biodiversity in Freshwaters and related Physico-Chemical Factors in two Lakes of Mysore District. Euglinophyceae are poorly represented, Bacillariophyceae were the most dominant and occurred throughout the study period. Cyanophyceae dominated during winter season. Chlorococcales were less significant.

Mathivanan *et al*., (2007) studied plankton of River Cauvery water (Tamil Nadu), the qualitative and quantitative evaluation of the variation in river water showed high quantity of phytoplankton belonging to Chlorophyceae, Bacillariophyceae, Myxophyceae and Euglinae. This study revealed that the water of River Cauvery is highly polluted by direct contamination of sewage and other industrial effluents.

Desai *et al*., (2008) studied Phytoplankton diversity in Sharavati River basin, Central Western Ghats. During this study total of 216 species of 59 genera belonging to Bacillariophyceae, Desmidials, Chlorococcales, Cynophyceae, Dinophyceae, Euglenophyceae and Chrysophyceae were recorded. Various pollution indices showed the oligotrophic nature of the reservoir waters with slight organic pollution in stream waters. Ali *et al*., (2009) studied   an ecological study with special reference to

phytoplankton (algal) component River Gomti in Jaunpur City. The phytoplankton (algal) community of river was represented by four algal group viz., Cyanophyceae, Chlorophyceae, Euglenophyceae and Bacillariophyceae. Out of 44 algal species, 16 species of Cyanophyceae and Chlorophyceae, 1 species of Euglenophyceae and 11 species of Bacillariophyceae were recorded from different sites of the river. Phytoplankton population showed a positive correlation with pH, DO, alkalinity, phosphate and nitrate and negative correlation with temperature and chloride. Many of the algal species, of the total 44 reported from the river like *Aulosira, Microcystis, Oscillaloria, Chlamydomonas, Chlorella, Pediastrum, Euglena, Cyelotella, Nevicula, Nitzschia* were recognised as pollution indicators.

Dube *et al.*, (2010 a, b) have studied the occurrence and seasonal variation of the plankton in Kishore Sagar Tank, Kota, Rajasthan and twenty four species of phytoplankton were recorded. Sharma and Mankodi (2011) studied the diversity of various types of plankton like, phytoplankton and zooplankton in Narmada River. The phytoplanktons were represented by Bacillariophyceae, Chlorophyceae, Cynophyceae and Euglenophyceae, out of which generic diversity of Bacillariophyceae was more.

Bhatnagar and Bhardwaj (2013) studied the seasonal algal diversity and the physico-chemical properties of water of Chambal River. This study shows the presence of a total of 65 algal species. Some algal forms are good indicators of water pollution and their presence show signs of water pollution. The algal forms consisted of a total of 65 taxa belonging to Chlorophyceae(32 species), Cyanophyceae(18 species), Bacillariophyceae (12 species), and Euglenophyceae (3 species).

Negi and Rajput (2013) studied Phytoplanktons Community Structure in Ganga River at Bijnor. They reported 43 genera of phytoplankton belonging to 5 groups viz. Chlorophyceae 16 genera, Bacillariophyceae 12 genera, Cyanophyceae 10 genera, Euglenophyceae 4 genera and Xanthophyceae 1genera. Chlorphyceae exhibited maximum abdundance and generic diversity and Xanthophyceae exhibited minimum abundance and generic diversity.

Subhashree and Patra (2013) studied phytoplankton of River Mahanadi of Odisha. This study revealed that diversity of species Chlorophyceae 53.45% whereas Cyanophyceae 20.78% and Bacillariophyceae 25.77% were composed. Mukati *et al.*, (2014) studied phytoplankton-ecology in Narmada River of West Nimar, M.P. India. Ten species of phytoplankton have been collected from various freshwater habitats in the West Nimar. This study revealed Cyanophyceae has a dominant class. Phytoplanktons belonging to Cyanophyceae (4 species), Charophyceae (3 species), Trebouxiophyceae (1), Ulvophyceae (1), Zygnematophyceae (1) were reported from River Narmada.

Singh (2015) deals seasonal study of phytoplankton diversity of Gomti River Lucknow, (U.P.) India. Various genera of algae belonging to chlorophyceae viz. *Chlamydomonas, Spirogyra, Oedogonium, Ulothrix, Hydrodictyon, Vaucheria, Scenedesmus, Desmidium, Zygnema, Mongeotia spp., Microspora spp., Gonium sociale, Pediastrum, Ranunculus aquatilis,* Seven genera of bacillariophyceae viz. *Stauroneis- pusilla , Cosmarium –formosuhum, Micrasterias desmids, Synedra- ulna, Navicula-sphaerophor, Nitzschia stagnorum, Synura*, Myxophyceae viz. *Volvox aureus ,Oscillatoria ,Stigonema* have been recorded. Phytoplankton are significant formal natural occupier of all water bodies. Monitoring programmes of phytoplankton are very important. They may provide information on possible new introductions and may serve as early warning system to detect the pollution level. *Chlamydomonas, Ranunculus aquatilis Microspora spp, Volvox aureus* were the most abundant followed by *Ulothrix, Hydrodictyon, Desmidium.* High concentration of diatoms at Daliganj bridge and Nishatganj bridge indicate polluted zone of the river. *Oscillatoria and Stigonema spp.* at polluted sites can be used as an indicator of organic pollution in the river. This study is very important from pollution indicator point of view.

Ansari *et al.*, (2015) studied phytoplankton diversity and water quality assessment of ONGC Pond, Hazira. Total seventy three genera of phytoplankton belonged to four classes viz., Euglenoplyceae, Chlorophyceae, Bacillariphyceae and Cyanophyceae were identified. Chlorophyceae group was dominated among the four Classes. Trivedi and Karode (2015) studied diversity of phytoplankton in Kshipra river at Triveni station, Ujjain (M.P.). They reported 21 genera belonging to Chlorophyceae, 14 belonging to Bacillariophyceae and 10 to Cynophyceae were recorded and *Rivularia sp.* is most dominant species among the Bacillariophyceae group.

Solanki and Shukla, (2016) studied preliminary study of phytoplankton diversity in River Naramada valley of Jabalpur region (M.P.). A total 30 algal taxa belonging to 16 genera have been collected and identified from different session. The number of various member of class Chlorophyceae with 12 taxa (40%), Euglinophyceae with 3 taxa (10 %), Bacillariophyceae with 7 taxa (23%), Trebouxiophyceae with 1 taxa (3%), Ulvophyceae with 1 taxa (4%), Zygematophyceae with 1 taxa (3%) and Cyanophyceae with 5 taxa (17%).

Kumar and Khare, (2015) studied the analysis of diversity of plankton (i.e., phytoplankton and zooplankton) and their seasonal variation of density in the Yamuna River at Kalpi, 3district Jalaun, U. P. Phytoplankton were belong to 35 species of 25 genera of different groups like as Chlorophyceae(12 species of 11genera),Euglenophyceae (3 species of 2 genera), Bacillariophyceae (5 species of 5 genera) and Cyanophyceae (15 species of 7 genera). Chlorophyceae was dominated over rest of the phytoplankton population. Kather Bee *et al.*, (2015) studied Plankton diversity and water quality of Ambattur Lake, Tamil Nadu. Water quality of the freshwater habitats provides substantial information about the existing resources which depends on the influences of physico-chemical parameter and biological features. According to the report, 22 species of plankton consisting phytoplankton and zooplankton were recorded and fluctuations among physico-chemical parameters. Shukla *et al.*, (2015) studied phytoplankton

diversity in River Ganga at Allahabad U.P. plankton identify in the river mainly composed of the members of Bacillariophyceae, Chlorophyceae and Cyanophyceae families. The abundance of phytoplanktons in April was greater than in march. Dhanam *et al*., (2016) studied physico-chemical parameters and phytoplankton diversity of Ousteri Lake in Puducherry. A total of 34 planktonic species belonging to 26 genuses under the 4 classes among these Cyanophyceae comprised of 15 species (belonging to 11 genera) followed by Chlorophyceae 9 species (belonging to 7 genera) Bacillariophyceae 7 species (belonging to 6 genera) and Euglenophyceae 3 species (belonging to 7 genera) were recorded. Cyanophyceae algal growth is dominated over Chlorophyceae, Bacillariophyceae and Euglenophyceae.

Gupta *et al*., (2016) studied the seasonal fluctuation of plankton and to examine the healthiness of water by analyzing the diversity and density of planktons in Keerat Sagar pond at Mahoba district. Phytoplanktonic population in various sites of Keerat Sagar pond indicated the order of dominancy among the group with regards to their density and diversity as chlorophyceae > baccillariophyceae > myxophyceae .. Maximum density of phytoplankton were found in the months of summer due to scarcity of water while minimum density was found in the months of winter and monsoon season due to low evaporation and inflow of water in the pond.

Saroja and Gopal (2017) studied Variations in the phytoplankton communities like Cyanophyceae, Chlorophyceae, Euglenophyceae, Bacillariophyceae, and Dinophyceae in two lakes of Udupi district, Karnataka have been discussed. This lake during a certain period supported as many as 26 species of Cyanophyceae, 30 species of Chlorophyceae, 7 species of Euglenophyceae, 8 species of Bacillariophyceae and 2 species of Dinophyceae. The growth of phytoplankton influenced by physicochemical parameters such as water temperature, dissolved oxygen, water pH, biological oxygen demand, chemical oxygen demand, nitrates, phosphates etc.

Goswami *et al*., (2017) studied the quantitative study of plankton diversity in three urban ponds (P-1, P-2 and P-3) of Kolkata in West Bengal. Three classes of phytoplankton (Chlorophyceae, Cyanophyceae and Euglenophyceae) were recorded from all three ponds during the study period. Chlorophyceae was encountered as the most significant group of phytoplankton with a contribution of 65% in P-1 followed by Cyanophyceae (20%) and Euglenophyceae (15%) of total population. Similarly it was also dominant in both P-2 and P-3 with a contribution of 68% followed by Cyanophyceae (19%) and Euglenophyceae (13%) respectively. Hossain *et al*., (2017) studied diversity of plankton communities in the River Meghna. He reported Chlorophyceae with 16 genera, Dinophyceae with 2 genera, Bacillariophyceae with 13 genera, Cyanophyceae with 2 genera, Myxophyceae with 5 genera, Englenophyceae with 1 genus and Xanthophyceae with 2 genera.

Karra *et al*., 2018 reviewed the studies of Phytoplankton in Lotic Water of India. Phytoplanktons are microscopic creatures mainly algae contain chlorophyll and live near the surface of water where there is sufficient light, producing their own food and thus providing meals for countless other aquatic dwellers. They play important role in maintaining the equilibrium between living organism and abiotic factors. The density and diversity of phytoplankton and their association as biological indicator is significant in the assessment of water quality. Phytoplanktons are good indicator of environmental changes and their variation provides a ground for monitoring and assessing the strategies of the river management.

Conclusion
The above account clearly suggests us to conclude that in spite of such a voluminous work done by a large number of scientists still, there are some gaps in terms of geographical or biological aspects. Considering Rajasthan, many river systems need extensive study and it may be safely expected to find out some new genera species and this information can be utilized to solve food scarcity problem in the world.

Bibliography
A.K .Negi and A. Rajput 2013: Impact of pulp and paper mill effluents on phytoplankton community structure in Ganga River at Bijnor (U.P.), India. *Journal of entomology and zoology studies*, Vol. 1(5): 70-73.
Ali, S. N., Akhtar, M. and A.K. Pandey 2009: Studies on phytoplankton diversity in the River Gomti at Jaunpur (U.P.). *Asian Journal of Environmental Science,* Vol. 4 (1): 78-80.
Amita-Arjaria 2003: Physico-Chemical Profile and Plankton Diversity of Ranital Lake, Chhatarpur, M. P.. *Nature Environment and Pollution Technology,* Vol.2 (3): 327-328.
Ansari, E., Gadhia, M. and N. C. Ujjania 2015: Phytoplankton diversity and water quality assessment of ONGC Pond Hazira. *International Journal of Research in Environmental Science,* Vol. 1(1): 1-5.
Bhatnagar, M and N. Bhardwaj 2013: Algal biodiversity status in Chambal River at Kota *Barrage, Rajasthan. Journal of experimental biology and agricultural sciences,* Vol. 1(2s): 132-138.
Desai, S. R., Chandran, M. D. S. and V. Ramchandra 2008: Phytoplankton diversity in Sharavati River basin, Central Western Ghats. *Icfsai university journal of soil and water sciences,* Vol. 1(i): 7-28.
Dhanam, S., Sathya, A. and B. Elayaraj 2016: Study of phycico-chemical parameters and phytoplankton divercity of Ousteri Lake in Puducherry. *World Scientific News* 54, 153-164.
Dube, P., Garg, V. and S. Sharma 2010b: The occurrence and seasonal variation of the plankton in Kishore Sagar Tank, Kota, Rajasthan. *Life science bull.,* Vol. 6 (3): 327-330.
Goswami, S. N., R. K. Trivedi, S. Saha, A. Mandal and S. Jana 2017: A study on plankton diversity of three urban ponds in Kolkata of west Bengal state, India. *IJABR*, VOL. 7 (4): 687-691.

Gupta, M., Kumar, P., Mishra, U. K. and D. Kumar 2016: Planktonic Diversity and Density in Keerat Sagar Pond at Mahoba District of Uttar Pradesh, India. *ss*5 (7): 181-186.

Hossain, Md. R.A., Pramanik, Md. M. H. and Md. M. Hasan 2017: Diversity indices of plankton communities in the River Meghna of Bangladesh. *International journal of fisheries and aquatic studies,* Vol. 5(3): 330-334.

K. N. Sharma and P. C. Mankodi 2011: Study on plankton diversity of Narmada River, Gujrat. Journal of current sciences, Vol. 16 (1): 111-116.

Karra, V. D., Dube, P., Sharma, J., Sood, Y. and Manju Sharma (2018): A critical review on the studies of phytoplankton in lotic water of India. *International Journal of Life Science,* Vol.7 (2): 71-74.

Kather Bee, S., Chitra, J. and E. Malini 2015: Plankton diversity and water quality of Ambattur Lake, Tamil Nadu. *Int. J. Pure Appl. Zool.*, Vol. 3(1): 31-36.

Kumar M, and P. K. Khare 2015: Diversity of plankton and their seasonal variation of density in the Yamuna River at Kalpi, district Jalaun, U.P. India. *Journal of Global Biosciences,* Vol. 4 (7): 2720-2729.

Kumar, N. S. V. and Shankar P. Hosmani 2006: Algal Biodiversity in Freshwaters and related Physico-Chemical Factors. *Nature Environment and Pollution Technology,* Vol. 5(1): 37-40.

Mathivanan, V., Vijayan, V., Sabhanayakam S., and O. Jeyahitra 2007: An Assessment of plankton population of Cauvery River with reference to pollution. *Journal of Environmental Biology*, Vol. 28(2): 523-526.

 Mukati, P., Naqvi, S. M. A., Aske, D. K., Sainkhediya, J. and A. Thakur 2014: Studies of Phytoplankton Ecology in Narmada River of West Nimar, M.P., India. *Research Journal of Animal, Veternary and Fishery Sciences*, Vol. 2(4): 13-16.

Saroja, N. M. and Gopal, G.V. 2017: Seasonal Variations in Phytoplankton Populations in Two Freshwater Lakes at Udupi District, Karnataka, India. *International Journal of Development Research* Vol.7 (12): 18105-18108.

Shukla, N., Gupta, M. K., Chaurasia, G. L., Singh, S., Singh, S. B., Shukla, D. N., Srivastava, V. and   P.K. Tandon 2015: A study on phytoplankton diversity in River Ganga at Allahabad U.P. .*Green Chemistry and Technology Letters*, Vol. 1(1): 92-95.

Singh, P. 2015: A seasonal study of phytoplankton diversity of Gomti River Lucknow, (U.P.) India: A pollution indicator. *International Journal of Research in Engineering and Applied Sciences* Vol. 5 (4): 43-48.

Solanki, R. and Shukla, A. 2016: Preliminary study of phytoplankton diversity in river Naramada valley of Jabalpur region (M.P.). *International Journal of Information Research and Review* Vol. 3 (3): 2057-2059.

Subhashree, P. and A. K. Patra 2013: Studies on seasonal variations in phytoplankton diversity of River Mahanadi, Cuttack city, Odisha, India. *Indian journal science research,* Vol. 4(2): 211-217.

Trivedi, S. and A. Karode 2015: Diversity of phytoplankton in Kshipra River- Triveni station, Ujjain (M.P.). *International Journal of Research – GRANTHAALAYAH* , Vol. 3(9) : 1-4.