



Assessment of physico-chemical properties of pond water in relation to seasonal changes of algal floral composition at Balagarh, Hooghly in West Bengal, India

Nilu Halder[✉]

Department of Botany, Raja Peary Mohan College, Uttarpara-712258, Hooghly, W.B., India

✉Correspondence:

Department of Botany,
Raja Peary Mohan College,
Uttarpara-712258,
Hooghly, W.B.,
India
E-mail: niluhalder1@gmail.com

Article History

Received: 26 May 2016

Accepted: 1 July 2016

Published: October - December 2016

Citation

Nilu Halder. Assessment of physico-chemical properties of pond water in relation to seasonal changes of algal floral composition at Balagarh, Hooghly in West Bengal, India. *Climate Change*, 2016, 2(8), 274-282

Publication License



© The Author(s) 2016. Open Access. This article is licensed under a [Creative Commons Attribution License 4.0 \(CC BY 4.0\)](https://creativecommons.org/licenses/by/4.0/).

General Note



Article is recommended to print as color version in recycled paper. *Save Trees, Save Climate.*

ABSTRACT

The usual changes of water physico-chemical properties from one season to another resulted in the formation and development of different algal species in a stagnant aquatic ecosystem (pond) located at Balagarh, Hooghly in West Bengal, India. The shifting of climatic conditions as well as water nutrients status probably triggered the variations in the algal floral diversities in the studied freshwater pond. Taxonomically, 30 different algal species have been identified from this water body. During the study period in 2015, it has been found that Chlorophyceae was dominated over the other algal classes, followed by members of Myxophyceae, Bacillariophyceae and Euglenineae. Five algal species had been found throughout the year of investigation. Nine physico-chemical parameters like temperature, pH, DO, BOD, COD, nitrate-nitrogen, phosphate, turbidity and total alkalinity (TA) were analyzed in this work following the standard procedure of APHA (2005). The result of this study showed that water was alkaline and turbid with moderate range of COD and total alkalinity values. This study also exhibited that the pond was productive, beneficial for fish farming and combination of those factors encouraged the periodicity and diversity of algal flora.

Keywords: Pond, Physico-chemical properties, Algal diversity, Hooghly, West Bengal

1. INTRODUCTION

Water is an essential ingredient for life. The existence and survival of water living organisms like algae are totally dependent upon water chemistry (Hainz et al., 2009; Halder, 2016 a). India is a vast country and occupies several types of fresh water natural aquatic ecosystems. Among them, ponds are one of the most important traditional sources of water (Halder, 2015 a) like rivers, lakes, ditches and manmade reservoirs. During the last few decades a tendency of nutrient enrichment or eutrophication of pond water has become evident to us. It is undoubtedly been the most challenging global threat to maintain the water quality in freshwater ecosystems like ponds and a matter of serious concern throughout the world. In each and every water bodies, the abundance of aquatic flora are determined by the quality, nature and chemical composition of water, especially, its temperature, oxygen, pH, amount of organic and inorganic load (Khan and Ansari, 2005; Sharma et al., 2012; Halder, 2016 b). As algae grow in water bodies and its nutrients level supports their growth and occurrences, analysis of physico-chemical parameters of aquatic ecosystem is prerequisite to find out the impact between algae and their limiting factors which firmly exist within the aquatic environments.

Algae are primitive, photosynthetic plant that shows great variations in shape, size and morphology of thallus organization and reproduction. They may be microscopic or macroscopic. They are very useful to assess water quality, in the treatment of waste or sewage water (Stanier et al., 1971; Prabina and Kumar, 2012) and used as an excellent pollution indicator in heavily polluted water because they have the ability to bioaccumulation, biotransformation and recycling of metallic substances in freshwater systems (Levy et al., 2005). They can minimize the effect of arsenic (As) by remediation process and reduce the amount of thermodynamically stable As (V) to As (III) through absorption and further transform it into methylated and less harmful arsenic forms in natural or polluted environmental conditions (Sanders and Windom, 1980; Hellweger et al., 2003; Hellweger and Lall, 2004). Recently, it was documented in a Cyanobacterium *Microcystis aeruginosa* (Wang et al., 2013). The efficiency of decrease toxicity levels of copper and zinc metals by few freshwater algae are also well known to us (Wilde et al., 2006). Particularly, the species of *Chlorella*, *Scenedesmus*, *Cladophora glomerata*, *Closterium acerosum* and *Pediastrum simplex* have a profound effect on copper, lead and zinc uptakes. They can bind these metals on their surfaces of vegetative cells organically and decrease toxicity levels in polluted water (Keeney et al., 1976; Mierle and Stokes, 1976; Bilgrami and Kumar, 1997; Franklin et al., 2002). Therefore, they are important pollutant monitoring agents in aquatic systems.

In rainy season, average annual rainfall occurs near Ca 1500 mm in this district of West Bengal (Halder, 2016 c) due to the activity of South-West monsoon wind and it should be mentioned that this site is situated over Indo-Gangetic plain. Monsoon water is the only source of water in this studied pond located at Balagarh, Hooghly in West Bengal of India. The pond water of this site is mainly used by the local people for bathing, washing and fishery purposes. The present investigation was carried out as an attempt to assess the physico-chemical parameters of pond water along with the seasonal fluctuations of algal flora.

2. MATERIALS AND METHODS

Water and algal samples from the pond study site at Balagarh (23°13'N; 88°19'E) were collected from January, 2015 to December, 2015. Water samples were analyzed for physico-chemical parameters as prescribed earlier research papers by the author/s (Halder, 2015 b, c, d; Halder and Sinha 2014, 2015; Halder 2016 a, b) and turbidity was measured by Nephelometer (model CL-52D).

The algal samples were preserved in 4% formaldehyde solution. The collected algal forms were identified by referring to the standard literatures on algae (Desikacharya, 1959; Randhawa, 1959; Sarode and Kamat, 1984; Gupta, 2005).

3. RESULTS & DISCUSSION

In this paper, an attempt has been made to correlate the periodicity of algal flora with limnological parameters of the freshwater pond, situated in Hooghly, West Bengal, India. The observation of periodicity (table 1) was continued for 12 months in the year 2015. Winter is composed of 4 months (November-February), summer is from March-June while monsoon is lasting from July-October. Among the three seasons (fig. 1), monsoon exhibited lower number of algal species probably, since the water was disturbed during this time. The paucity of algal species during the monsoon or rainy season was also evident earlier (Zafar, 1967). In the present work (fig. 2), species of Chlorophyceae were found to be dominant as seen also in the previous report on the river Dwarakeshwar from Hooghly (Halder, 2015 e) and here, the Chlorophycean algae represented by 12 species. These were *Chlorococcum humicola*, *Eudorina elegans*, *Characium nasutum*, *Pediastrum simplex*, *Coelastrum microporum*, *Scenedesmus bijuga*, *Cladophora glomerata*, *Oedogonium sociale*, *Spirogyra bififormis*, *Mougeotia viridis*, *Closterium moniliferum* and *Cosmarium tenue*. Among them, *Chlorococcum humicola*, *Scenedesmus bijuga* and *Cladophora glomerata* were found throughout the investigating year. *Eudorina elegans*, *Characium nasutum*, *Pediastrum simplex* and *Coelastrum microporum* were noticed after monsoon to till before the end of winter. *Oedogonium sociale* was observed from the period August to December, 2015 while *Spirogyra bififormis* and *Mougeotia viridis* observed mainly in the months of winter and *Closterium moniliferum* as well as *Cosmarium tenue* dominated in monsoon. Bacillariophyceae included 6 species only. These were *Synedra ulna*, *Gomphonema olivaceum*, *Gomphonema parvulum*, *Navicula cuspidata*, *Navicula pygmaea* and *Nitzschia obtusa*. Among them, *Synedra ulna* was observed in more or less throughout the period of study. Species of *Gomphonema* exhibited their profound growth in winter whereas, species of *Navicula* and *Nitzschia obtusa* showed their periodicities in summer. It was noticed that all the members of Euglenineae viz. *Euglena acus*, *Euglena proxima*, *Phacus caudatus* and *Trachelomonas armata* accelerated their growth and periodicity in the months of summer. Myxophyceae was dominated by *Aphanocapsa pulchra*, *Aphanothece pallida*, *Myxosarcina spectabilis*, *Lyngbya stagnina*, *Oscillatoria princeps*, *Phormidium ambiguum*, *Aphanizomenon flos-aquae* and *Anabaena anomala*. Except three species, all the other members of Myxophyceae were flourished in summer. *Oscillatoria princeps* was noted almost in all the months of the year. This study revealed that Euglenineae and Myxophyceae prefer to grow in hot and humid warm climatic conditions whereas, other the algal classes grow in either monsoon or winter. Besides these, positive correlations were found between Myxophyceae and Euglenineae whereas, negative correlation between Chlorophyceae and Myxophyceae was encountered in this investigation. Similar result has also been reported by few workers (Hosmani et al., 1999; Kumari and Julie, 2009).

Table1 Periodicity of algal flora at sampling site

Sl. No.	Name of the algal taxa	Class	Periodicity of algal flora (months wise)												
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
1	<i>Chlorococcum humicola</i>	Chl.	+	+	+	+	+	-	-	+	+	+	+	+	
2	<i>Eudorina elegans</i>	"	+	-	-	-	-	-	-	-	-	-	+	+	+
3	<i>Characium nasutum</i>	"	+	+	-	-	-	-	-	-	-	-	+	+	+

4	<i>Pediastrum simplex</i>	"	+	-	-	-	-	-	-	-	+	+	+	+
5	<i>Coelastrum microporum</i>	"	+	-	-	-	-	-	-	-	-	+	+	+
6	<i>Scenedesmus bijuga</i>	"	+	+	+	+	-	-	+	+	+	+	+	+
7	<i>Cladophora glomerata</i>	"	+	+	+	+	+	+	+	+	+	-	-	+
8	<i>Oedogonium sociale</i>	"	-	-	-	-	-	-	-	+	+	+	+	+
9	<i>Spirogyra biformis</i>	"	+	+	+	-	-	-	-	-	-	-	-	+
10	<i>Mougeotia viridis</i>	"	+	+	+	+	-	-	-	-	-	-	-	+
11	<i>Closterium moniliferum</i>	"	-	-	-	-	-	+	+	+	+	+	-	-
12	<i>Cosmarium tenue</i>	"	-	-	-	-	+	+	+	+	+	-	-	-
13	<i>Synedra ulna</i>	Bacill.	+	+	+	+	+	-	+	+	+	-	-	+
14	<i>Gomphonema olivaceum</i>	"	+	+	-	-	-	-	-	-	-	-	-	+
15	<i>Gomphonema parvulum</i>	"	+	+	-	-	-	-	-	-	-	-	-	+
16	<i>Navicula cuspidata</i>	"	-	+	+	+	+	-	-	-	-	-	-	-
17	<i>Navicula pygmaea</i>	"	-	+	+	+	+	-	-	-	-	-	-	-
18	<i>Nitzschia obtusa</i>	"	-	+	+	+	+	-	-	-	-	-	-	-
19	<i>Euglena acus</i>	Eugl.	-	-	+	+	+	+	-	-	-	-	-	-
20	<i>Euglena proxima</i>	"	-	-	+	+	+	+	-	-	-	-	-	-
21	<i>Phacus caudatus</i>	"	-	-	+	+	+	-	-	-	-	-	-	-
22	<i>Trachelomonas armata</i>	"	-	-	-	+	+	+	+	-	-	-	-	-
23	<i>Aphanocapsa pulchra</i>	Myx.	-	-	-	-	-	-	+	+	+	+	-	-
24	<i>Aphanothece pallida</i>	"	-	-	-	-	-	-	+	+	+	+	+	-
25	<i>Myxosarcina spectabilis</i>	"	+	+	-	-	-	-	-	-	-	-	-	+
26	<i>Lyngbya stagnina</i>	"	+	+	+	+	+	-	-	-	-	-	-	-
27	<i>Oscillatoria princeps</i>	"	+	+	+	+	+	+	+	+	+	+	-	-
28	<i>Phormidium ambiguum</i>	"	-	-	+	+	+	+	+	-	-	-	-	-
29	<i>Aphanizomenon flos-aquae</i>	"	-	-	+	+	+	+	-	-	-	-	-	-
30	<i>Anabaena anomala</i>	"	-	-	-	-	-	-	-	+	+	+	+	-

+ and - indicate presence and absence; Chl.=Chlorophyceae, Bacill.=Bacillariophyceae, Eugl.=Euglenineae and Myx.=Myxophyceae.

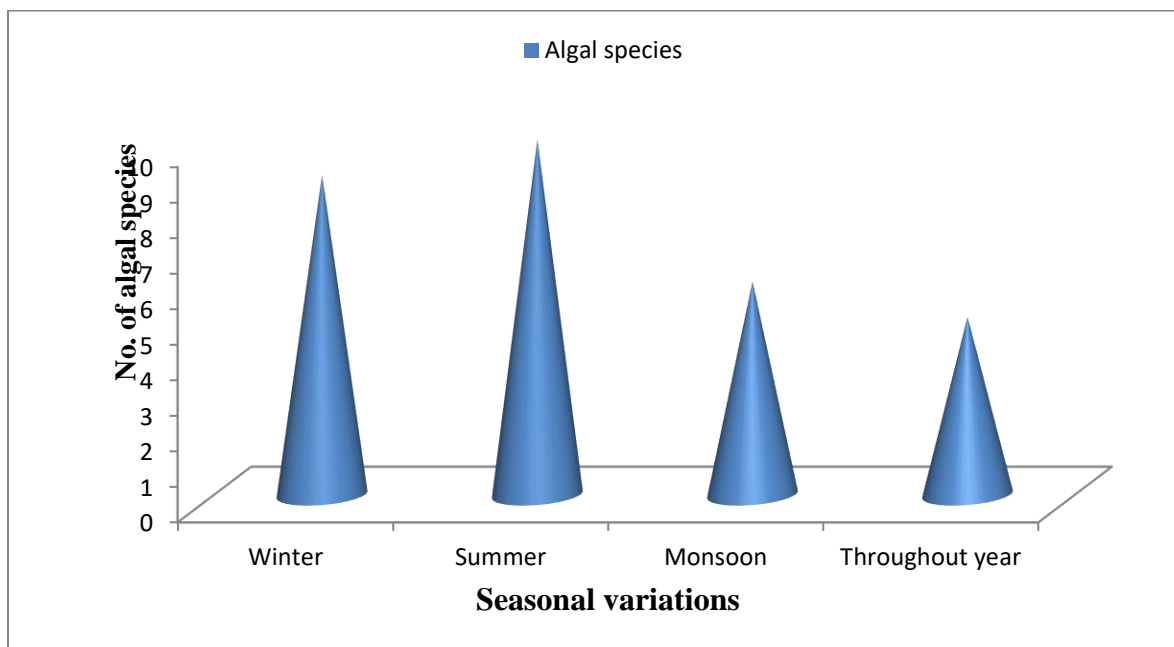


Figure 1 seasonal variation of algal species at sampling site

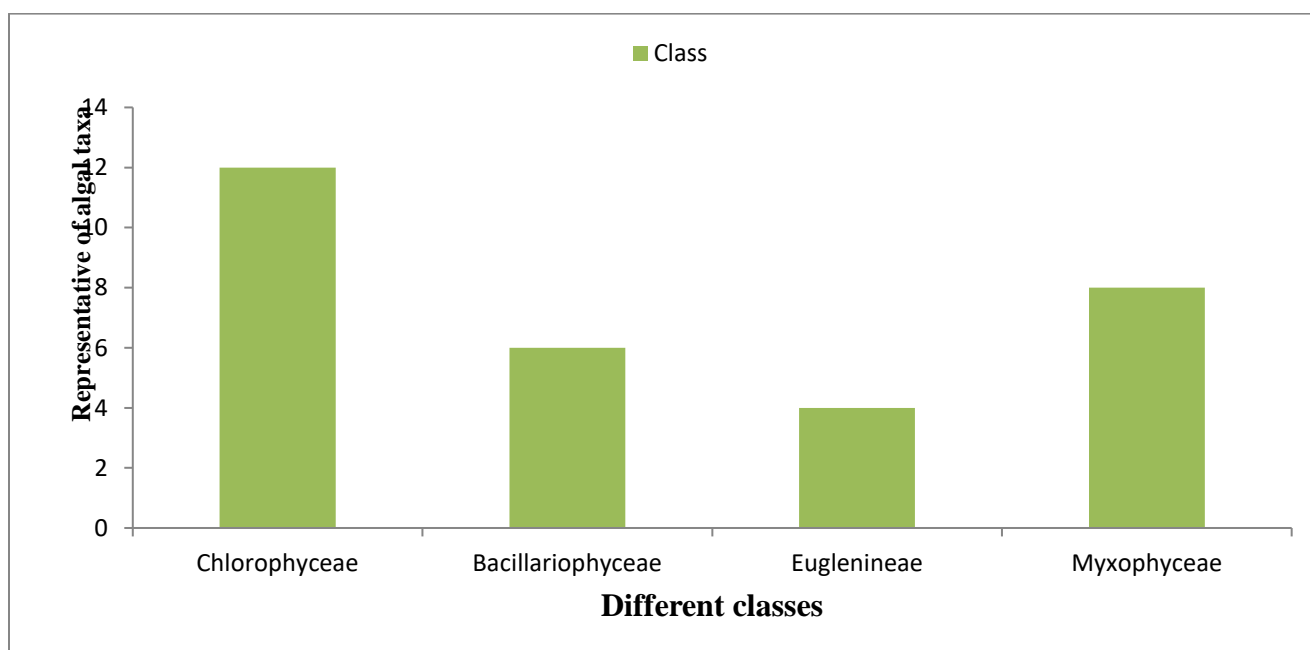


Figure 2 Different classes of algae and their representatives at sampling site

The seasonal analysis of pond water (table 2) during the period of January, 2015 to December, 2015 showed different values of water chemical parameters. The Higher (31.5°C) and lowest water temperature (18.0°C) were recorded during summer and winter respectively which could be due to the influence of increase and decrease of atmospheric temperature. Here, pH of water showed alkaline in nature (7.3-7.8). It was higher during winter, which attributed the increase rate of photosynthesis by algal flora in this aquatic body as well as lower rate of respiration and decomposition processes. Philipose (1960) also observed that different algal floras including diatoms were abundant in alkaline water. So, the present study confirmed the previous argument. Generally, the amount of dissolved oxygen (DO) in water is dependent on various limiting factors like water temperature, photosynthetic activity, respiration and organic load exist in any aquatic ecosystems. The maximum value of DO was noted in monsoon, might be due to higher solubility of oxygen gas in the pond water during rainfall. It was ranged from 6.4-7.2 mg/l. BOD is the dissolved oxygen concentration required for aerobic decomposition of organic matters by water living microorganisms like bacteria. It has been considered as an important parameter for measuring the status of pollution in aquatic ecosystems. In the present work, certain interesting relationships between few parameters were noticed. DO and BOD as well as DO and COD values showed inverse relationships whereas, BOD and COD exhibited positive correlations in this work. Both BOD and COD values were higher in summer that might be due to scarcity of water and higher water temperature in the studied pond as compared to other seasons. Input of nutrients like NO₃-N and PO₄³⁻ had been found to increase probably, through circulation and mixing of surface water or agricultural runoff directly or indirectly that promoted the growth of algae in this pond. Total alkalinity value was recorded minimum during monsoon. Similar observation was made by Pahwa and Mehrotra (1966) while working on the river Ganga. In this study, the value was greater in winter (320mg/l) that could be associated with high pH of water during this period in the studied pond. The water parameter turbidity was recorded greater during monsoon and the maximum concentration was due to presence of more suspended solids in pond water. Therefore, this pond is characterized by the presence of high turbidity and DO values, low amount of NO₃-N, PO₄³⁻ and moderate COD and total alkalinity (TA) values of water.

Table 2 Seasonal variation of physico-chemical properties of water at sampling site

Sl. No.	Physico-chemical parameters	Winter (Mean ± SE)	Summer (Mean ± SE)	Monsoon (Mean ± SE)
1	Temperature (°C)	18.0°C±0.25	31.5°C±0.25	28°C ±0.25
2	pH	7.8±0.05	7.6±0.05	7.3±0.04
3	Dissolved oxygen (DO) mg/l	6.9±0.12	6.4±0.10	7.2±0.10
4	Biological oxygen demand (BOD) mg/l	5.2±0.10	6.6±0.11	5.0±0.12
5	Chemical oxygen demand (COD) mg/l	150±2.8	180±2.8	130±3.4
6	Nitrate-nitrogen (NO ₃ -N) mg/l	0.25±0.07	0.22±0.05	0.30±0.05
7	Phosphate (PO ₄ ³⁻) mg/l	0.34±0.08	0.38±0.10	0.42±0.10
8	Turbidity (NTU)	29±1.2	32±1.1	35±1.0
9	Total alkalinity (TA) mg/l	320±3.4	290±4.6	280±4.5

4. CONCLUSION

From an overview of the above described information, it could be concluded that algae grown better in less polluted water and their periodicity dependent on chemical parameters of water. Secondly, most of the algal species observed either in summer or winter. Thirdly, the pond could be used as a potential resource of fish production. In addition to these, this study will give a brief knowledge on ecology of algae for further research.

SUMMARY OF RESEARCH

1. In this study, a trend of increasing of turbidity and COD values was observed which indicated that the pond is going to be high polluted very soon.
2. Moreover, the seasonal variations of limnological parameters exhibited direct relationships with the fluctuations of algal flora and those parameters were found helpful for the algal growth, periodicity and their diversities.
3. Lastly, the limnological parameters were found to be responsible for bringing up changes in the water quality as author also observed earlier in the river Dwarkeshwar (Halder, 2015 f).

ACKNOWLEDGEMENT

The author is grateful to Dr. S. N. Sinha, Dept. of Botany, University of Kalyani, Nadia, West Bengal for providing the opportunity to carry out this work in the Environmental Microbiology Research Laboratory and his co-operation.

REFERENCES

1. APHA. (2005). *Standard methods for the examination of water and waste water* (21st ed.). American Public Health Association, Washington, DC, USA.
2. Bilgrami, K. S. and Kumar, S. (1997). Effects of copper lead and zinc on phytoplankton growth. *Biological Plantarum*, 39, 315-317.
3. Desikachary, T. V. (1959). *Cyanophyta*. Indian Council of Agricultural Research, New Delhi, pp.1-686.
4. Franklin, N. M., Stauber, J. L., Lim, R. P. and Petocz, P. (2002) Toxicity of metal mixtures to a tropical freshwater alga (*Chlorella* sp.): The effect of interactions between copper, cadmium, and zinc on metal cell binding and uptake. *Environmental Toxicology and Chemistry*, 21, 2412-2422.
5. Gupta, R. K. (2005). *Algal Flora of Dehradun district Uttaranchal*. Botanical Survey of India, India, pp. 1-298.
6. Hainz, R., Wober, C. and Schagerl, M. (2009). The relationship between *Spirogyra* (Zygnematophyceae, Streptophyta) filament type groups and environmental conditions in central Europe. *Aquatic Botany*, 91, 173-180.
7. Halder, N. (2015a). Simple correlation matrix among different physicochemical parameters and physico-physiological parameters of pond water at Tribeni, Hooghly, West Bengal, India. *Climate Change*, 1(3), 217-221.
8. Halder, N. (2015b). Two species of *Zygnemopsis* (Skuja) Transeau from West Bengal, India. *Tropical Plant Research*, 2(2), 82-84.
9. Halder, N. (2015c). Morpho-taxonomy of *Hydrodictyon reticulatum* (L.) Lagerheim and *Pediastrum tetras* var. *tetraodon* (Corda) Hansgirg, Hooghly, West Bengal, India. *Tropical Plant Research*, 2(3), 168-171.
10. Halder, N. (2015d). Taxonomy and ecology of *Coleochaete irregularis* Pringsheim and *Coleochaete orbicularis* Pringsheim, West Bengal, India. *Journal of Algal Biomass Utilization*, 6(4), 47-49.
11. Halder, N. (2015e). Occurrence and population dynamics of different algal groups in the river Dwarkeshwar in Hooghly, West Bengal, India. *Cibtech Journal of Bio-Protocols*, 4(1), 22-26.
12. Halder, N. (2015f). Limnological study of Dwarkeshwar river water in the downstream at Arambagh, Hooghly district, West Bengal, India. *Spring*, 5, 10-14.

13. Halder, N. (2016a). *Sirogonium sticticum* (J.E. Sm.) Kütz. and *Zygnemopsis scorbiculata* P. Sarma & Kargupta from Hooghly in West Bengal, India. *Bio Bulletin*, 2(1), 112-117.
14. Halder, N. (2016b). Taxonomy and periodicity of *Chlorococcum* fries, *Coelastrum* Näg. and *Scenedesmus* Meyen in Hooghly, West Bengal, India. *Mesopotamia Environmental Journal*, 2(2), 47-56.
15. Halder, N. (2016c). Note on *Ankistrodesmus* Corda and *Kirchneriella* Schmidle in Hooghly, West Bengal, India. *Mesopotamia Environmental Journal*, 2(2), 40-46.
16. Halder, N. and Sinha, S. N. (2014). New Records of *Euglena acus* (O.F. Müll.) Ehr. and *Phacus acuminatus* (A. Stokes) Huber-Pestalozzi of Euglenineae from Hooghly District, West Bengal. *Journal of Academia and Industrial Research*, 3(7), 333-336.
17. Halder, N. and Sinha, S. N. (2015). New report of four Bacillariophyceae algal species from West Bengal, India. *Journal of Algal Biomass Utilization*, 6(2), 28-31.
18. Hellweger, F. L. and Laa, U. (2004). Modeling the effect of algal dynamics on arsenic speciation in lake Biwa. *Environmental science and technology*, 38, 6716-23.
19. Hellweger, F. L., Farley, K. J., Lall, U. and Di Toro, D. M. (2003). Greedy algae reduce arsenate. *Limnology and Oceanography*, 48, 2275-2288.
20. Hosmani S. P., Vasanthakumar, L. and Partha, S. (1999). Ecological significance of biochemical parameters in certain fresh water lakes of Mysore. *Journal of Environmental Biology*, 20(2), 121-124.
21. Keeney, W. L., Breck, W. G., Van Loon, G. W. and Page, J. A. (1976). The determination of trace metals in *Cladophora glomerata*- *C. glomerata* as potential biological monitor. *Water Research*, 10, 981-984.
22. Khan, F. A. and Ansari, A. A. (2005). Eutrophication: An ecological vision. *The Botanical Review*, 71, 449-482.
23. Kumari, S. B. and Julie, M. P. (2009). Diversity of seasonal changes of Phytoplankton in the Ukkadam Pond of Coimbatore, Tamil Nadu. *Current Science*, 14(1): 32-36.
24. Levy, J. L., Stauber, J. L., Adams, M. S., Maher, W. A., Kirby, J. K. and Jolley, D. F. (2005). Toxicity, biotransformation, and mode of action of arsenic in two freshwater microalgae (*Chlorella* Sp. and *Monoraphidium Arcuatum*). *Environmental Toxicology and Chemistry*, 24(10), 2630-2639.
25. Mierle, G. M. and Stokes, P. M. (1976). Heavy metal tolerance and metal accumulation by planktonic algae. In DD Hemphill, ed., *Trace Substances and Environmental Health*. University of Missouri, Columbia, pp. 113-122.
26. Pahwa, D. V and Mehrotra, S. N. (1966). Observations on fluctuations in the abundance of plankton in relation to certain hydrological conditions of river Ganga. *The Proceedings of the National Academy of Sciences, India (B)*, 36(2), 157-189.
27. Philipose, M. T. (1960). Fresh water phytoplankton of inland fisheries. *Proceedings of symposium on Algology*. ICAR, New Delhi, pp. 272-291.
28. Prabina, B. J. and Kumar, K. (2012). Toxicity based evaluation of textile waste water treatment efficiency with algae on the growth and enzyme activity of the seedlings of *Helianthus annuus* L. *Academic Journal of Plant Sciences*, 5(4), 128-132.
29. Randhwa, M. S. (1959). *Zygnemaceae*. Indian Council of Agricultural Research, New Delhi, pp. 1-477.
30. Sanders, J. G and Windom, H. L. (1980). The uptake and reduction of arsenic species by marine algae. *Estuarine and Coastal Marine Science*, 10, 555-567.
31. Sarode, P. T. and Kamat, H. P. (1984). *Fresh water diatoms of Maharashtra*. Saikrupa Prakashan, Aurangabad, pp. 1-338.
32. Sharma, S. S., Singh, G. P. and Sharma, V. K. (2012). Seasonal phytoplanktonic diversity of Kalisil River in Keladevi Wildlife Sanctuary, district Karauli, Rajasthan, India. *International Journal of Pharma and Bio Sciences*, 3(3), 890-899.
33. Stanier, R. Y., Kunisawa, R. Mandel, M. and Cohen-Bazire, G. 1971. Purification and properties of unicellular blue-green algae (order: Chlorococcales). *Bacteriology Reviews*, 25, 171-305.
34. Wang, Z., Luo, Z. and Yan, C. (2013). Accumulation, transformation, and release of inorganic arsenic by the freshwater cyanobacterium *Microcystis aeruginosa*. *Environmental Science and Pollution Research*, 20(10), 7286-95.

35. Wilde, K. L., Stauber, J. L., Markich, S. J., Franklin, N. M. and Brown, P. L. (2006). The Effect of pH on the uptake and toxicity of copper and zinc in a tropical freshwater alga (*Chlorella* sp.). *Archives of Environmental Contamination and Toxicology*, 51, 174-185.
36. Zafar, A. R. (1967). On the Ecology of algae in certain fresh water ponds of Hyderabad, India. III-The periodicity. *Hydrobiology*, 30(1), 96 -112.