Research Journal of Environmental Sciences

ISSN 1819-3412

Academic
Journals Inc.

www.academicjournals.com

Research Journal of Environmental Sciences 8 (7): 391-398, 2014
ISSN 1819-3412 / DOI: 10.3923/rjes.2014.391.398

Periphytic Algal Community of Dal Lake in Kashmir Valley, India

[1]Ashok K. Pandit, [1]Saleem Farooq and [2]Javaid Ahmad Shah
[1]Post Graduate Department of Environmental Science,
[2]Centre of Research for Development, University of Kashmir, Srinagar, 190006, Jammu and Kashmir, India

Corresponding Author: Javaid Ahmad Shah, Centre of Research for Development, University of Kashmir, Srinagar, 190006, Jammu and Kashmir, India

ABSTRACT

The present study deals with the general ecological study of periphytic algal community in terms of species composition and density of Dal lake. During the present study a total of 31 taxa belonging to 3 major classes namely Bacillarophyceae, Chlorophyceae and Cyanophyceae were recorded. The most common periphytic species encountered across all the study sites were *Diatoma* sp., *Cymbella* sp., *Synedra* sp., *Fragillaria* sp., *Oedogonium* sp., *Tabellaria* sp., *Cosmarium* sp., *Scendesmus* sp. and *Oscillatoria* sp. Among 31 species observed the maximum number of species were recorded at site 3 (Ruplank) followed by site 2 (Nishat basin) and at site 1 (Hazratbal basin) with equal number of species and site 4 (Gagribal basin). Bacillarophyceae dominated quantitavely at each site followed by Chlorophyceae and Cyanophyceae in terms of species richness. The overall percentage contribution in terms of population density of the three classes of periphytic algae at all the four studied sites were as, Bacillariophyceae 45%, Chlorophyceae 36% and Cyanophyceae 19%.

Key words: Periphyton, Dal lake, Bacillarophyceae, Chlorophyceae, Cyanophyceae

INTRODUCTION

Periphyton comprises of organisms living on submerged surfaces including both the attached forms and the organisms associated therewith. Periphyton is an extremely heterogenous and complex association of organisms on sub-aquatic natural and artificial substrates. The group consists of algae and filamentous bacteria, attached protozoans, bryozoans, rotifers and also the free swimming, creeping or lodging among the attached forms. Thus, the group is composed of three principle types of living organisms producers, consumers and reducers (Pandit, 2002).

Periphyton growing on substrates in freshwater ponds also serves as an additional food source for cultured organisms (Azim and Wahab, 2005). Based on previous reports by several researchers who has used periphyton in improving production and water quality mostly in freshwater fish ponds (Wahab *et al*., 1999; Azim *et al*., 2001; Van Dam *et al*., 2002; Milstein, 2005). An important benefit of periphyton communities is their ability to absorb dissolved and suspended matter, inclusive of organic matter from the water column, reducing bottom accumulation while maximizing the percentage of organic matter remaining exposed to aerated conditions in the water column. Besides entrapping organic detritus, periphyton removes nutrients from the water column and helps to control the dissolved oxygen concentration and pH of the surrounding water (Azim *et al*., 2002; Dodds, 2003; Bender *et al*., 2004; Rashid and Pandit, 2005; Cattaneo *et al*., 2012; Kumar *et al*., 2013; Nelson *et al*., 2013).

As with phytoplankton, periphyton can be found in almost every type of water body from small ponds to large oceans and in trophic conditions that range from the most oligotrophic to the most eutrophic (Azim and Asaeda, 2005). Periphyton, in terms of structure, diversity, composition and the process of colonization has received less attention from limnologists than phytoplankton. It is in this context, the present study is aimed to collate data on the species composition and population density of periphytic algae at different ecozones of Dal lake in world famous Kashmir Himalaya.

Study area and site description: Dal lake is situated towards North-East of Srinagar city at an altitude of about 1,584 m above mean sea level. The lake lies between 34°6′N and 34°10′N latitude and 74°50′E and 74°54′E longitude is regarded as one of the most beautiful lake in the world. Dal lake, situated in the northeast of Srinagar (the summer capital of Jammu and Kashmir) in Kashmir valley and the second largest lake of the state. Of the total area, only about 11.4 km^2 is open water and the rest is under floating gardens most of which have now settled permanently. The lake has a large mountainous catchment spread over 316 km^2 and has four main interconnected basins namely Hazratbal, Bod dal, Gagribal and Nagin. More than 80% of the water enter into the lake from its catchment through a perennial inflow channel, the Telbal Nallah entering in Hazratbal basin on its northeast side. Hazratbal basin receives water also from Doubkoul, Harishkoul and Boutkoul. Many springs rising from the lake bed contributes 10% water to the lake.

Study sites: Four study sites were chosen from the Dal lake for carrying out the study on periphytic algal community namely: Hazratbal basin, Nishat basin, Ruplank and Gagribal basin (Fig. 1).

Site 1: Hazratbal basin. This study site was located at 34°08'16.06"N latitude and 74°50'49.07"E longitude and is highly polluted due to regular addition of sewage and human waste dumped into the lake along with sediment run off from the waste drainage basin around it. It receives major quantity of water from the Telbal Nallah.

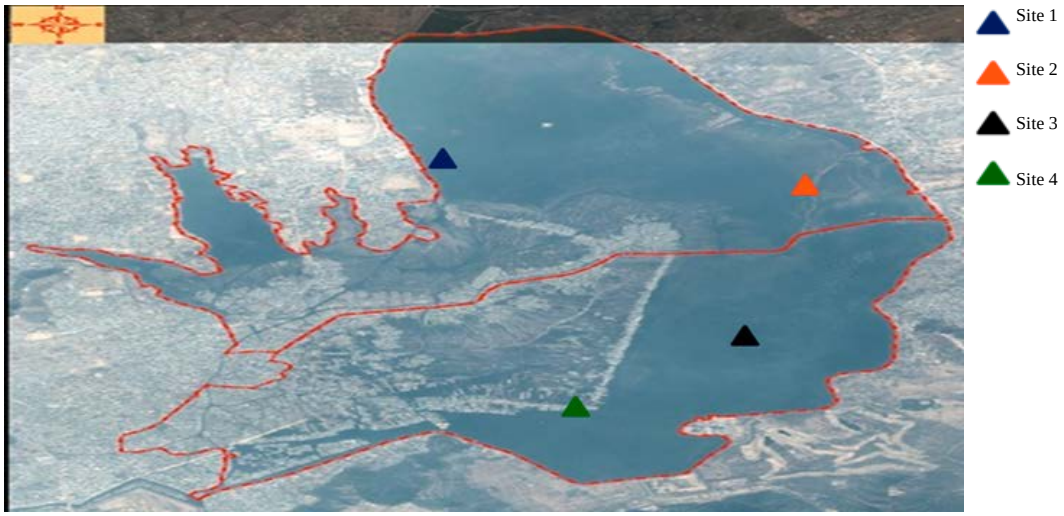

Fig. 1: Map showing study area and study sites

Site 2: Nishat basin. The site location was at 34°07'20.04"N latitude and 74°52'24.03"E longitude. This basin has the famous Nishat garden located on its shore. The large quantity of disposable items and polythenes was seen floating along the shore. Macrophytes were profusely found at this site.

Site 3: Ruplank. It is an island located in Bod dal at 34°06"53.01"N altitude and 74°52'33.02"E longitude marked with four chinar trees at the four corners thus also known as Char Chinar. This small land has only excess by boats and is a tourist site. Sufficient growth of floating and submerged macrophytes in the water could be seen around the site.

Site 4: Gagribal basin. The site location was at 34°05'54.04"N latitude and 74°51'23.02"E longitude. This basin is also highly polluted due to large number of house boats. Sewage from these house boats flows directly into lake. The basin is also chocked by floating market and floating gardens towards the interior of the basin.

MATERIAL AND METHODS

Periphyton collection: The sampling of periphytic algae was done on monthly basis. The samples were collected in four months: June, July, September and October 2013 by scraping the surface of different substrata using blade, scale and brushes viz.:

- Hazratbal basin ---- Boat bottom
- Nishat basin ---- *Potomogeton natans*
- Ruplank ---- Wooden log
- Gagribal basin ---- *Nymphaea* sp.

Preservation: The collected samples were preserved in 4% formalin and stored in small vials having capacity of 25 mL and raised to the volume of 25 mL by adding distilled water. There was no need of centrifugation as material collected was in good amount.

Identification: The process of identification of algae up to generic level was carried under microscope with standard works (Prescott, 1939, 1951; Edmonson, 1992; Cox, 1996; APHA, 1998; Biggs and Kilroy, 2000).

RESULTS

Species composition: The periphytic algal community of Dal lake was comprised of 31 species belonging to Bacillariophyceae, Chlorophyceae and Cyanophyceae (Table 1). The most common genera encountered were *Diatoma* sp., *Cymbella* sp., *Synedra* sp., *Fragillaria* sp. and *Oedogonium* sp. The dominance pattern in algal groups in terms of species diversity and density were Bacillariophyceae> Chlorophyceae> Cyanophyceae (Table 2). There was evident spatial variation among the study sites throughout the study. At site 1, a total of 18 species of periphytic algae were recorded of which 10 belonged to Bacillariophyceae, 6 to Chlorophyceae and 2 to Cyanophyceae. At site 2, a total of 18 species of periphytic algae were recorded of which 11 belonged to Bacillariophyceae, 5 to Chlorophyceae and 2 to Cyanophyceae. At site 3, a total of 24 species of periphytic algae comprised of 13 Bacillariophyceae, Chlorophyceae 7 and Cyanophyceae 4 and at site 4 a total of 16 species of periphytic algae were recorded, Bacillariophyceae contributes

Table 1: Composition and distribution of different species of periphytic algae at four study sites of Dal lake

	Site			
Species	1	2	3	4
Bacillariophyceae				
Diatoma sp.	+	+	+	+
Navicula sp.	+	+	+	+
Fragillaria sp.	+	+	+	+
Cymbella sp.	+	+	+	+
Synedra sp.	+	+	+	+
Nitzchia sp.	+	+	+	-
Pinnularia sp.	-	-	+	-
Gomphonema sp.	+	+	+	+
Tabellaria sp.	+	+	+	+
Cyclotella sp.	+	+	+	+
Meridion sp.	-	+	+	+
Didmosphenia sp.	-	-	+	-
Amphora sp.	-	-	+	-
Stauronies sp.	+	+	-	+
Chlorophyceae				
Cosmarium sp.	+	+	+	+
Scendesmus sp.	+	+	+	-
Closterium sp.	+	-	+	-
Ravularia sp.	+	-	-	-
Oedogonium sp.	+	+	+	+
Tetrastum sp.	+	-	-	-
Chlorella sp.	-	+	+	+
Pediastrium sp.	-	+	-	-
Ulothrix sp.	-	-	+	-
Maugeotia sp.	-	-	+	-
Chlorococcum sp.	-	-	-	+
Cyanophyceae				
Oscillatoria sp.	+	+	+	+
Nostoc sp.	+	-	+	-
Microcystic sp.	-	-	+	-
Anabaena sp.	-	-	+	-
Triconema sp.	-	+	-	-
Spirulina sp.	-	-	-	+
No.of species	18	18	24	16

+: Present, -: Absent

10, Chlorophyceae 4 and Cyanophyceae 2 taxa. Thus, 31 species observed the maximum number of species were registered at site 3 (Ruplank) followed by site 2 (Nishat basin) and equal number of species at site 1 (Hazratbal basin) and site 4 (Gagribal basin).

Density: A perusal of the data based on the population density of different algal groups at various sites revealed the steady growth of algal population. In general Bacillariophyceae exhibited its maximum share (68%) to the overall periphytic community followed by Chlorophyceae (22%) and Cyanophyceae (16%) (Fig. 2). Shannon and Wiener (1949) index was calculated highest for site 3 and lowest for site 4 (Fig. 3).

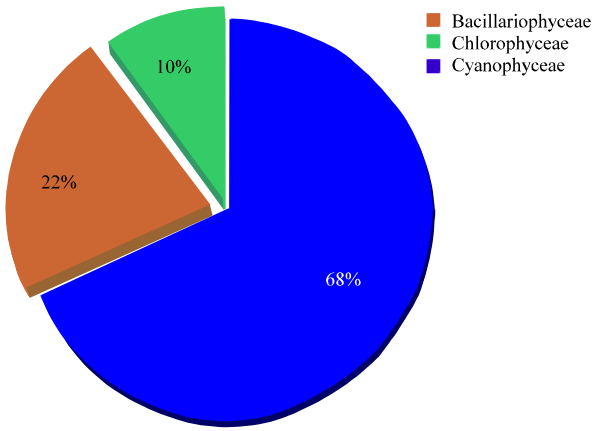

Fig. 2: Overall relative density (%) of periphytic algae at four sites

Table 2: Mean variations in density (ind./cm^2) of periphytic algae at different sites in Dal lake

Class and site	June	July	September	October	Mean
Bacillarophyceae					
1	1255	846	1242	1590	1217.00
2	744	676	1296	835	887.75
3	1228	930	1631	2396	1567.00
4	1190	1083	1527	2011	1452.50
Total	4417	3535	5696	6832	5124.25
Chlorophyceae					
1	242	291	411	347	322.75
2	163	299	297	175	233.50
3	734	851	539	699	714.75
4	461	431	318	542	438.00
Total	1600	1872	1565	1763	1700.00
Cyanophyceae					
1	291	98	64	237	172.50
2	366	179	54	143	185.50
3	63	198	307	344	228.00
4	152	252	187	37	156.75
Total	872	727	612	761	742.75
Grand total	6889	6134	7873	9356	7567.00

DISCUSSION

During the current study on a total of 31 genera of periphyton were observed, of which 14 genera belonged to Bacillarophyceae, 11 genera to Chlorophyceae and 6 genera to Cyanophyceae. The most frequently encountered groups were Bacillarophyceae, Chlorophyceae and Cyanophyceae in decreasing order of dominance. Diatoms have been extensively used in the assessment of past and present ecological conditions in the aquatic habitats in which they live (Stoermer and Smol, 1999; Olele and Ekelemu, 2008; Lone *et al*., 2011). Dominance of Bacillarophyceae may be due to reason that they are resistant to sloughing and are not easily washed away by water movement from the surface of substratum as compared to Cyanophyceae and Chlorophyceae (Stevenson, 1996). Maximum density of Bacillariophyceae in the month of October can be attributed to the

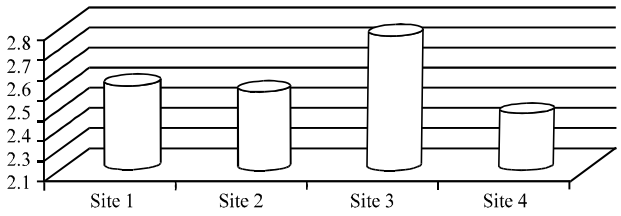

Fig. 3: Shannon-wiener diversity index (H) of periphytic algae at four sites

reason that they thrive well in cold waters (Roy, 1955; Wetzel, 1983; Pandit, 1983; Sarwar and Zutshi, 1988; Sarwar, 1999; Wetzel, 2001). Since the periphytic algal community at each site was dominated by diatoms which in turn were dominated by *Diatoma* sp., *Cymbella* sp., *Synedra* sp., *Navicula* sp. and *Fragillaria* sp. that can be attributed to the presence of good concentration of SiO_2 in water body which help in frustule (cell wall made of hydrated silicon dioxide) formation (Wetzel and Likens, 1991). On monthly basis, the maximum density of Chlorophyceae was obtained in the month of July at all the study sites. This may be attributed to the warm conditions and more light intensity as the growth and abundance of Chlorophyceae during warm water periods and at sites having high light intensity may be related to its excessive reproduction. The rise in temperature provides optimum conditions for the growth and reproduction of Chlorophyceae (Palmer, 1969; Kant and Kachroo, 1980). Low population of Cyanophyceae at all the four study sites may be due to the fact that Cyanophyceae often dominate at high irradiance levels and high temperature (Vass and Zutshi, 1979; Van der Grinten *et al*., 2004; Mieczan, 2009; Piska and Krishna, 2009).

Eleven genera belonging to various algal classes (Bacillariophyceae, Chlorophyceae and Cyanophyceae) were found common to the four sites throughout the study period. Among these Bacillariophyceae with 8 taxa was more common than other classes (Chlorophyceae and Cyanophyceae) at all study sites which is an indicative of more or less similar environmental factors such as temperature of water, nutrients, substratum, watershed vegetation and geology found in lake and resulting in the growth and multiplication of these periphytic algae which further corroborates the general eutrophy of the lake.

ACKNOWLEDGMENTS

The study carried out is the part of M.Sc. programme of second author. The author would like to express his sincere gratitude to his research guide and teacher Prof. (Dr.) A.K. Pandit and Prof. Bashir Ahmad Ganai, Head, Department of Environmental Science, University of Kashmir, Srinagar, India.

REFERENCES

APHA, 1998. Standard Methods for Examination of Water and Waste Water. 20th Edn., American Public Health Association, Washington, DC.

Azim, M.E. and M.A. Wahab, 2005. Periphyton-Based Pond Polyculture. In: Periphyton: Ecology, Exploitation and Management, Azim, M.E., M.C.J. Verdegem, A.A. van Dam and M.C.M. Beveridge (Eds.)., CABI Publishing, UK., pp: 207-222.

Azim, M.E. and T. Asaeda, 2005. Periphyton Structure, Diversity and Colonization. In: Periphyton-Ecology, Exploitation and Management, Azim, M.E., M.C.J. Verdegem, A.A. van Dam and M.C.M. Beveridge (Eds.). CABI Publishing, Wallingford, England, pp: 15-33.

Azim, M.E., M.A. Wahab, A.A. van Dam, M.C.M. Beveridge, A. Milstein and M.C.J. Verdegem, 2001. Optimization of fertilization rate for maximizing periphyton production on artificial substrates and the implications for periphyton-based aquaculture. Aquacult. Res., 32: 749-760.

Azim, M.E., M.C.J. Verdegem, M.M. Rahman, M.A. Wahab, A.A. van Dam and M.C.M. Beveridge, 2002. Evaluation of polyculture of Indian major carps in periphyton-based ponds. Aquaculture, 213: 131-149.

Bender, J., R. Lee, M. Sheppard, K. Brinkley, P. Phillips, Y. Yeboah and R.C. Wah, 2004. A waste effluent treatment system based on microbial mats for black sea bass *Centropristis striata* recycled-water mariculture. Aquac. Eng., 31: 73-82.

Biggs, B.J.F. and C. Kilroy, 2000. Stream periphyton monitoring: Manual. The New Zealand Ministry for the Environment, National Institute of Water and Atmospheric Research, Christchruch, New Zealand.

Cattaneo, A., M. de Seve, G. Morabito, R. Mosello and G. Tartari, 2012. Periphyton changes over 20 years of chemical recovery of Lake Orta, Italy: Differential response to perturbation of littoral and pelagic communities. J. Limnol., 70: 177-185.

Cox, E.J., 1996. Identification of Freshwater Diatoms from Live Material. 1st Edn., Chapman and Hall, London, UK., ISBN: 9780412493805, Pages: 158.

Dodds, W.K., 2003. The role of periphyton in phosphorus retention in shallow freshwater aquatic systems. J. Phycol., 39: 840-849.

Edmonson, W.T., 1992. Ward and Whipple Fresh Water Biology. 2nd Edn., International Books and Periodicals Supply Service, New Delhi.

Kant, S. and P. Kachroo, 1980. Limnological studies in Kashmir lakes-1. Hydrobiological features, composition and periodicy of phytoplankton in the Dal and Nigeen lakes. Phykos, 16: 77-97.

Kumar, P., R. Mishra and D.K. Singh, 2013. Species composition of periphyton community in ponds of chapra district, Bihar, India. Int. J. Zool. Res., 3: 49-53.

Lone, S.A., A.K. Pandit and S.U. Bhat, 2011. Dynamics of periphytic algae in some crenic habitats of district Anatnag, Kashmir. J. Himalayan Ecol. Sustianable Dev., 7: 28-34.

Mieczan, T., 2009. Periphytic ciliates in three shallow lakes in eastern Poland: A comparative study between a phytoplankton-dominated lake, a phytoplankton-macrophyte lake and a macrophyte-dominated lake. Zool. Stud., 49: 589-600.

Milstein, A., 2005. Effect of Periphyton on Water Quality. In: Periphyton: Ecology, Exploitation and Management, Azim, M.E., M.C.J. Verdegem, A.A. van Dam and M.C.M. Beveridge (Eds.)., CABI Publishing, UK., pp: 179-190.

Nelson, C.E., M.B. Danuta and J.C. Bradley, 2013. Consistency and sensitivity of stream periphyton community structural and functional responses to nutrient enrichment. Ecol. Applic., 23: 159-173.

Olele, N.F. and J.K. Ekelemu, 2008. Physicochemical and periphyton/phytoplankton study of Onah Lake, Asaba, Nigeria. Afr. J. Gen. Agric., 4: 183-193.

Palmer, M.C., 1969. A composite rating of algae tolerating organic pollution. J. Phycol., 5: 78-82.

Pandit, A.K., 2002. Current research trends in limnological studies on periphyton. J. Res. Dev., 2: 149-209.

Pandit, S.N., 1983. Ecological studies of periphyton of two lake ecosystems of Kashmir. M. Phil. Thesis, University of Kashmir, Srinagar.

Piska, R.S. and S.V. Krishna, 2009. Comparative studies of periphyton diversity on added substrata in fish pond and minor reservoir. Asian J. Exp. Sci., 23: 45-49.

Prescott, G., 1951. Algae of the Western Great Lakes Area. Cranbook Institute of Science, Boomfield Hills, Detroit, Michigan.

Prescott, G.W., 1939. Some relationships of phytoplankton to limnology and aquatic biology. Publ. Am. Assoc. Adv. Sci., 10: 65-78.

Rashid, H. and A.K. Pandit, 2005. Periphytic algal community in relation to the physic-chemical features of seven water bodies of Ladakh region, Jammu and Kashmir. J. Res. Dev., 6: 71-80.

Roy, H.K., 1955. Plankton ecology of river Hoogly in Patna. West Bengal Ecol., 36: 169-175.

Sarwar, S.G. and D.P. Zutshi, 1988. Species distribution and community structure of periphytic algae on artificial substrate. Trop. Ecol., 29: 116-120.

Sarwar, S.G., 1999. Water Quality and Periphytic Algal Component of Anchar Lake, Kashmir. In: Land Water Resources, India, Prasad, D.M.K. and P.S. Pitchaich (Eds.). Discovery Publishing House, New Delhi, pp: 237-250.

Shannon, C.E. and W. Wiener, 1949. The Mathematical Theory of Communication. University Illinois Press, Urbana, IL., USA., ISBN-13: 9780252725487, Pages: 125.

Stevenson, R.J., 1996. An Introduction to Algal Ecology in Freshwater Benthic Habits. In: Algal Ecology: Freshwater Benthic Ecosystems, Stevenson, RJ., M.L. Bothwell and R.L. Lowe (Eds.). Academic Press, San Diego, ISBN: 9780080526942, pp: 3-30.

Stoermer, E.F. and J.P. Smol, 1999. The Diatoms: Application for the Environmental and Earth Sciences. Cambridge University Press, Cambridge.

Van Dam, A.A., M.C.M. Beveridge, M.E. Azim and M.C.J. Vedegem, 2002. The potential of fish production based on periphyton. Rev. Fish Biol. Fish., 12: 1-31.

Van der Grinten, E., M. Janssen, S.G.H. Simis, C. Barranguet and W. Admiraal, 2004. Phosphate regime structuring species composition in cultured phototrophic biofilms. Freshw. Biol., 49: 369-381.

Vass, K.K. and D.P. Zutshi, 1979. Limnological studies on Dal Lake Kashmir India Morphometry and physical features. Inland Fish. Soc., 11: 12-21.

Wahab, M.A., M.E. Azim, M.H. Ali, M.C.M. Beveridge and S. Khan, 1999. The potential of periphyton based culture of the native major carp calbasu, *Labeo calbasu* (Hamilton). Aquacult. Res., 30: 409-419.

Wetzel, R.G. and G.E. Likens, 1991. Limnological Analyses. W.B. Saunders, Philadelphia, USA.

Wetzel, R.G., 1983. Limnology. 2nd Edn., Saunders College Publishing, Philadelphia, PA., USA., ISBN-13: 9780030579134, Pages: 767.

Wetzel, R.G., 2001. Limnology. 3rd Edn., Academic Press, New York, ISBN-13: 9780127447605, Pages: 1006.