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Seasonal variations of physico-chemical factors and diversity of desmids (Algae) in Shahpura lake of Bhopal, India

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Abstract

The study aimed at determining the seasonal variations of physico-chemical aspects and their effects on diversity of desmids in Shahpura Lake of Bhopal, India. The physico-chemical parameters of the Lake, like, water temperature, transparency, pH, DO, total hardness, calcium hardness, chloride, phosphate, and nitrate were studied and data analyzed. The Desmidaceae taxa of winter, summer, monsoon and post monsoon seasons from December 2006 to November 2007 have been identified, resulting 36 species in 5 genera, and their monthly variations are presented.

Key words: Desmid diversity, eutrophication, green algae, isthmus, limnological study, Shahpura Lake

Introduction

Shahpura Lake is limnologically very important, which is known as the third Lake of Bhopal, after Upper Lake and Lower Lake. The area under study having latitude 23° 12' E and longitude 77° 25' N enjoys a subtropical climate with pronounced summer, winter and rainy seasons. The lake has a catchment area of 8.29 km sq and a submerged area of 0.96km sq. This lake is surrounded by human habitation and receives untreated sewage from various point and non point sources. It is located across nullah and tributary of Kaliasote River in Huzur Tehsil of Bhopal district near Academy of Administration (Figure 1). The lake in most parts is muddy due to the accumulation of silt but towards the northwestern side, it has hard and clayey substratum. The main inlet, the nullah joins the lake at its northern end. The man-made water impoundment was constructed in the southern part of the city near Chuna-Bhatti village in 1974-75 under the Betwa irrigation scheme. Although irrigational use of reservoir water became secondary but from 1975 onwards fisheries and recreational activities have been promoted. The lake was constructed on a small stream, which was used to bring the overflow of the oxidation ponds, situated near Mata Mandir, which is about 3 km in the upstream of the oxidation ponds.

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In the year 1977-78 the stream carried only the storm water and sewage draining in the lake. Besides this, the lake also receives sewage and wastewater through number of drains. The water quality of the lake is deteriorating on account of untreated sewage inflow, siltation, encroachments and excessive growth of aquatic weeds, grazing in the fringe area, and washing of clothes, unmanaged fisheries and outflow through spillway. Desmids are distinctive group within the green algae (Chlorophyceae). The desmid cells typically consist of two symmetrical half-cells, called semi cells, separated by a median, constricted zone, the isthmus. The incision caused by the isthmus between the semi cells is called the sinus and it may be narrow, nearly closed, or have various degrees of divergence. The nucleus of the cell is located in the isthmus and is embedded in cytoplasm. In those desmids lacking a median constriction the nucleus is centrally located.

Materials and Method

Collection of water samples and their analysis:

Water samples were collected from the selected sites for one year from December 2006 to November 2007 (Fig. 1). The samples were collected regularly in the first week of every month at an interval of about 30 days. Sampling usually commenced between 8 am to 11 am and water was collected at a depth of half a meter. All precautions were taken to avoid leaves, debris etc. and the

bubbling of air in the bottle. From every station, two water samples were collected. One sample was immediately Winklerized for oxygen determination and the second sample was brought to the laboratory for the determination of physico-chemical characteristics of water. Except temperature and transparency all other factors were detected out in the laboratory. The methods for analysis were followed as described in "Standard methods for examination of water and waste water" 15th edition made by American Public Health Association (APHA 1985). Sampling for algal and limnological studies was done monthly during December 2006 to November 2007 with the help of glass bottle sampler from the sub-surface water.

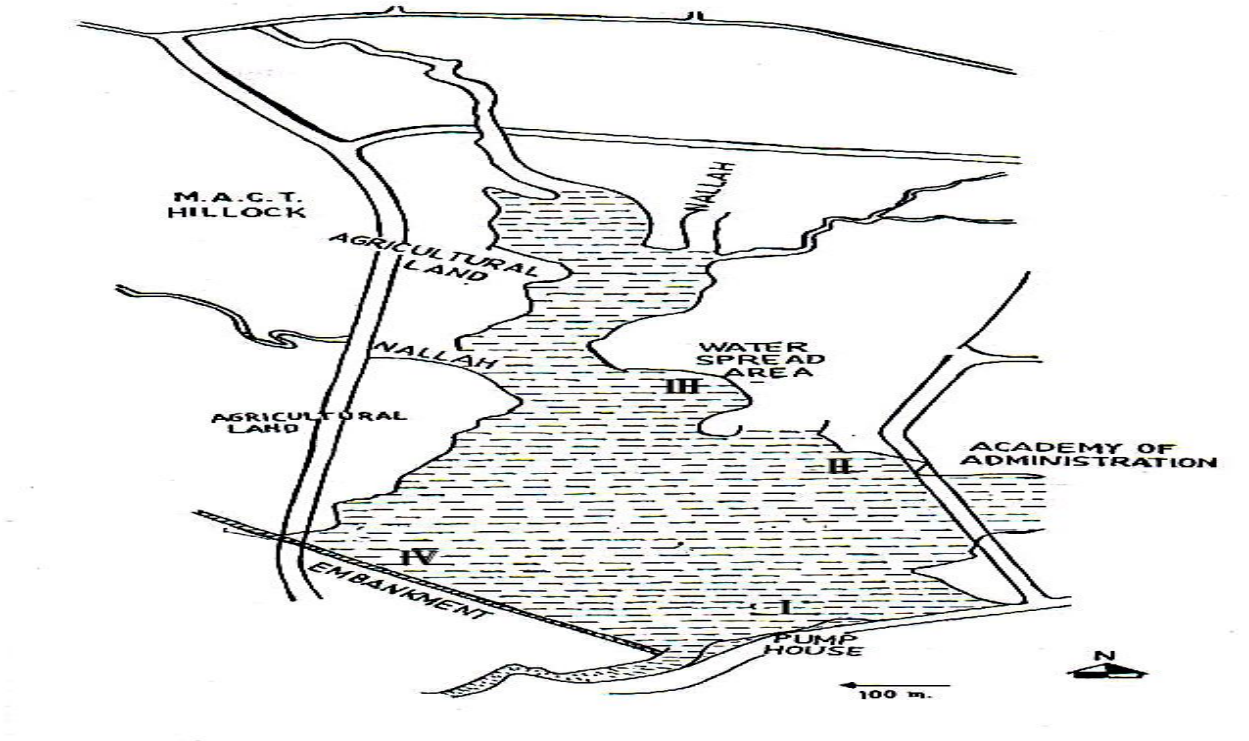

Figure 1; Map showing sampling sites of Shahpura Lake, Bhopal.

Collection, preservation and examination of algal forms:

Algal samples were collected every month from each sampling site from surface up to a depth of half a meter. The samples were brought to the laboratory in 200ml bottles. The epilithic and epiphelic forms were collected. Aquatic angiosperms were plucked and squeezed to obtain the attached algal forms. Submerged twigs, dead clumps of aquatic plants, decaying leaves, stones, were also collected in polythene bags. Regular field notes were prepared for each collection. All algal samples were examined freshly under the light microscope or with the material preserved in 4% formalin. Identification of the forms has been made by consulting Croasdale and Gronblad (1964), Hinode (1966), Bicudo (1969), Agarkar(1971), Agarkar and Agarkar (1979).

Results and Discussion

The results are tabulated in Tables 1 and 2. The temperature at the surface ranged from 17.1°C to 31.8°C. Minimum temperature was recorded in the month of January and maximum in the month of May. The Secchi transparency varied from 12.8 cm to 49.5 cm. Maximum Secchi value was recorded

during summer month of April and minimum in the month of July. The low transparency value can be attributed to the incoming silt from the catchment area on account of precipitation during monsoon season. The pH ranged from 7.4mg/l to 8.8mg/l. the maximum value was observed in the month of May and minimum in the month of April. The lake water remained near alkaline throughout the study period. Summer increase in pH value has been related to the photosynthetic activity. DO ranges from 9.4mg/l to 6.1mg/l. oxygen depletion in rainy season may be due to the low photosynthetic or respiratory activity of heterotrophic organisms (Singhal *et. al.,* 1986) and also probably due to the biological oxidation of organic matter and combined effects of temperature and photosynthetic activity (Sampath Kumar and Kannan, 1998). The main sources of dissolved oxygen are dissolution from atmosphere and photosynthesis. It depends on factors like temperature, salinity and density of phytoplankton (Maruthi et. al., 2012a and Sreenivasulu et. al., 2014). The DO concentration above 5mg/l throughout the year shows that the lake is very much productive (Banerjea, 1967). The total hardness fluctuated between 145mg/l to 295mg/l. The maximum value of hardness was observed in the month of June and minimum in the month of September and may be termed as hard (Moyle, 1946). Khabade and Mule (2003) found maximum hardness during summer and Sreenivasulu et. al., (2014) observed maximum hardness in pre-monsoon season which is in accordance with the present observation. Calcium is an important nutrient for aquatic organisms. Its concentration was maximum during winter months

Table 1: Monthly variations in physico-chemical parameters of water of Shahpura Lake (from December 2006 to November 2007)

Parameter → Months↓	Water temp. °C	Transparency (cm)	pH	DO (mg/l)	Total Hardness (mg/l)	Calcium Hardness (mg/l)	Chloride (mg/l)	Phosphate (mg/l)	Nitrate (mg/l)
Dec.	19.3	24.5	7.8	9.1	190	66.5	40.6	0.23	19.3
Jan	17.1	42	8.4	8.8	188	80.2	37	0.22	17.1
Feb.	18.5	39	8.5	9	215	82.1	40.1	0.25	18.5
March	20.3	33	8.2	6.9	250	65.2	41.5	0.26	20.3
April	30.7	49.5	7.4	8.8	280	67	47.1	0.625	30.7
May	31.8	29.5	8.8	6.7	291	72	49.7	0.19	31.8
June	30.2	19.5	8.7	8.1	295	63.5	55.6	0.49	30.2
July	25.3	12.8	8.6	7.2	170	57.2	48.7	0.48	25.3
Aug.	22.8	21	7.5	6.1	162	56.5	39.1	0.40	22.8
Sept.	26.0	25.9	7.8	6.2	145	59	39.5	0.43	26
Oct.	24.2	19.3	7.6	6.3	218	67.5	39.9	4.2	24.2
Nov.	21.5	17	8.1	9.4	210	70.1	39.5	0.29	21.5

which could be due to its higher solubility at low temperature. Calcium ranged from 57.2mg/l to 82.1mg/l indicating that water body is calcium rich (Ohle, 1934). The maximum value was observed in the month of February and minimum in the month of July. The chloride content showed the highest value of 55.6mg/l in the month of June and lowest value of 37mg/l in the month of January. Chloride is one of the important parameter in assessing the water quality. Munawar (1974) is of the opinion that higher concentration of chloride indicate higher degree of organic pollution. In the present study chloride was found to be high during summer and low during winter. As similar observations was made by Shastry *et. al.,* (1970); Patil *et. al.,* (1986). Phosphate content in Shahpura lake ranged from 0.19mg/l to 4.2mg/l. The maximum concentration of phosphate was recorded in the month of October and minimum in the month of May. Nitrate content ranged from 17.1mg/l which was minimum in the month of January to 31.8mg/l which was maximum in the month of May. The nitrogen is very

important element in lake productivity. The main source of nutrients i.e. nitrogen and phosphorus appears to be dependent upon rainfall, drainage and surface runoff, as the maximum concentration of nutrients was observed in pre- monsoon season and findings of Khan *et. al.,* (1986) and Singh *et. al.*, (1991) confirmed above observations. Low phosphate content in summer may be due to low decomposition of organic matter during summer season (Sreenivasan, 1967). A total of 36 taxa belonging to 5 genera were observed during the study period (Table 2). Seasonal variations are evident in all the physico-chemical parameters examined. Temperature is one of the most important ecological feature that is a limiting factor for the growth and distribution of flora and fauna in any aquatic ecosystem. Many workers while discussing the periodicity, distribution and growth of Desmidaceae have laid stress on water temperature. Gonzalves and Joshi (1964) recorded desmids in large number when water experienced low temperature. But in the present study desmids were noted in winter and early monsoon when temperature was low. This does not confirm the observations of Rao (1955) and Pearsall (1932) who noted abundance of desmids in high temperature. Venkateswarlu (1983) observed that high DO favors growth of desmids, but later due to increase in temperature their periodicity becomes temperature dependent. Maximum number of desmids was found in winter months when DO was high. Davis (1955) inferred that pH of water is a good indicator of pond or lake productivity. Von Oye (1934) has pointed out that when pH increased desmids also increased. According to him desmids flourished between pH 8.1 to 10. Singh and Swarup

Table 2: Monthly variations of Desmid flora of Shahpura Lake (From December 2006 to November 2007)

Desmidiaceae taxa↓	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.
Closterium abruptum var. brevius	-	-	-	-	-	-	-	-	-	-	+	-
C. ehrenbergii	-	+	+	+	+	-	-	+	+	-	-	+
C. kuetzingii	-	+	-	+	+	-	-	-	-	-	-	-
C. prichardianum	+	-	-	+	-	-	+	+	+	-	-	-
C.pronum var. breviusfa. Sigmoideum	+	+	-	-	-	-	-	-	-	-	-	-
C. venus	-	-	-	-	-	-	-	-	-	-	-	+
Euastrum binale	+	-	-	-	-	-	-	-	-	-	-	-
E. irregulare	-	-	-	-	-	-	-	-	-	-	+	-
E. spinulosum	-	-	-	-	+	-	-	-	+	-	-	-
E.substellatum forma	-	-	-	-	+	-	-	-	-	-	-	-
Cosmarium beatum	-	-	-	-	-	-	-	-	-	-	+	-
C. bengalense	-	-	-	-	-	-	+	-	-	+	-	+
C. blyttii	-	+	-	+	+	-	-	-	-	-	-	-
C. cyclicum	+	+	+	-	+	-	+	-	-	-	-	+
C. divergens	-	-	-	-	-	-	-	-	-	-	-	+
C. granatum	-	-	+	-	-	-	+	-	+	-	-	-
C. humile	-	+	-	-	-	-	-	+	-	-	-	+
C. javanicum	-	-	+	+	-	-	-	-	+	-	-	-
C. lundellii var. circulare	-	+	+	-	-	-	-	-	-	-	-	-
C. mansangense	-	-	+	-	-	-	-	-	-	-	-	-
C. paradoxum	+	+						+	+			

C. quadratum var. applanatum	-	-	-	-	-	-	+	-	-	+	-	-
C. reniforme	-	+	+	+	+	-	+	+	+	-	-	-
C. subcostatum	-	-	-	-	-	+	-	-	-	-	-	-
C. submamillatum	+	-	+	-	-	-	-	+	-	-	-	-
C. subspeciosum	-	+	-	-	-	-	-	+	-	-	-	-
C. subtumidum	-	-	-	-	-	+	-	-	-	-	-	-
C. wittrockii	-	-	-	-	-	-	-	+	-	-	-	-
Staurastrum excavatum var. minimum	-	+	-	+	-	-	-	-	-	-	-	-
S. furcatum	-	-	+	-	-	-	-	-	-	-	-	-
S. hexacerum	-	-	-	-	-	+	-	-	-	-	-	-
S. muticum	-	-	-	-	+	-	+	-	-	-	-	-
S. punctulatum	-	-	+	+	-	-	-	-	-	-	-	-
S. sebaldi	-	-	-	+	-	-	-	+	-	-	-	-
S. tetracerum	-	-	-	-	-	-	-	-	-	+	-	-
Sphaerozosma granulatum	-	-	-	-	+	-	-	-	-	-	-	-

Present = +, Absent = -

(1979) found in Suraha lake that when calcium was higher desmids were less in number. Yung et. al., (1986) reported a negative correlation between desmids species number and calcium concentration. Despite high calcium content species of Closterium and Cosmarium were observed frequently in the study area. Same trends were observed by Somashekar (1984). There was an increase in chloride concentration in summer and decrease in winter. Gonzalves and Joshi (1964), Singh (1965) have also reported same seasonal variation in chloride content. Therefore, there was less number of desmids species. The higher summer temperature which has direct effect on the rate of evaporation from the lake surface increases the chloride content (Aboo and Manuel, 1967). In the present study maximum desmids were found in winter season when phosphate was high. This agrees with the observation of Jayangoudar (1964). In the present study of Shahpura lake , 36 taxa belonging to 5 genera were recorded viz; 6 taxa of Closterium, 4 taxa of Euastrum, 18 taxa of Cosmarium, 7 taxa of Staurastrum and 1 taxon of Sphaerozosma. The genus Cosmarium was dominant amongst all the genera followed by Staurastrum, Closterium, Euastrum and Sphaerozosma.

Conclusion

With the help of observations it can be concluded that the water body under investigation is eutrophic and rate of eutrophication is increasing. Further, the presence of different species of Cosmerium and Closterium are indicator of pollution. It is advised that necessary steps should be taken up to check different sources of pollution which are resulting into eutrophication.

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References

Aboo, K. M. and Manue1, A.C. 1967. Preliminary observations on the Upper Lake of Bhopal.***Env.Helth***, 9: 22.

Agarkar, D.S. 1971. Contribution to the desmids of Gwalior, Madhya Pradesh, India 11. ***Phykos,*** 10: 54-69.

Agarkar, D.S. and Agarkar, M.S. 1979. Desmids from Bandhavgarh, Madhya Pradesh, India. ***Hydrobiologia***, 65: 213-223.

APHA 1985 *Standard Methods for the examination of water and waste water*, A.P.H.A., A.W.W.A., W.P.E.C. New York.

Banerjea, S.M. 1967. Water quality and soil condition of fish ponds in states of India in relation to fish production ***Ind. J. Fish.***, 14 (1&2), 114-115.

Bicudo, C.E.M. 1969. Contribution to the knowledge of the Desmids of the State of Sao-Paulo (Brazil). ***Nova Hedwigia,*** 16: 433-549.

Croasdale, H. and Gronblad, R. 1964. Desmids of Labrador 1. Desmids of the South Eastern Coastal Area ***Trans Am. Micro. Soc.*** 84: 301-335.

Davis, C.C. 1955. *The marine and freshwater plankton*.562 pp., 681 figs., Michigan State Univ. Press.

Gonzalves, E.A. and Joshi, D.B. 1964. Fresh water algae near Bombay. ***J. Bombay Nat. Hist. Soc.,*** 46 (1): 154 – 176.

Hinode, T. 1966. Desmids from the northern district of Tokushima Prefecture, ***J. Jap. Bot.***. 41(7): 214-222.

Jayangoudar, I. 1964. A bio-ecological study of Nuggikari Lake in Dharwar, Mysore State, South India.***Hydrobiologia***, 23 (3 - 4): 515 – 532.

Khabade, S.A. and Mule, M.B. 2003. Studies on physico-chemical parameters of Pundi water reservoir from Tasgaon Tahsil. *I.**J. Environ Prot.,*** 23(a): 1003-1007.

Khan, E., Kaiser, U.M., Habib, M.A.B. and Hasan, M.R. 1986.Interrelations andintrarelations of some water characteristics of a farm pond and meterological factor. Bangladesh. ***J. Agric II*** (4): 35-40.

Maruthi Kaizar Hossain, Y. Avasn and Goswami, A. 2012a. *Assessment of drinking water quality in some selected primary schools in Visakhapatnam*. Der Chemia, (USA), Pelagia Reaearch Library 2012, 3(5): 1071-1074.

Moyle, J.B. 1946. Some indices of lake productivity. ***Trans. Am. Fish. Soc.*** 76: 322-334.

Munawar, M. 1974. Limnological studies of fresh water ponds of Hyderabad, India IV. The Biocenose.Periodicity and species composition of unicellular and colonial phytoplankton in polluted environments.***Hydrobiologia,*** 35: 127-162.

Ohle, W. 1934.Chemische and physikalische under suchugennorddentschev seen. Arch. ***Hydrobiol.*** 26: 386-464.

Patil, M.K., Namboodiri, U. and Unni, K.S. 1986. *Changes after sediment removal in a sewage pond-physical-chemical characteristics.* All India seminar on water quality around urban ecosystem (Ed) 222.

Pearsall, W.H. 1932. Phytoplankton in the English Lake II. The composition of the phytoplankton in relation to dissolved substance. ***J. Ecol***., 20: 241 – 262.

Rao, C.B. 1955. On the distribution of algae in a group of six small ponds. II. Algal periodicity. ***J. Ecol.,*** 43: 291 – 308.

Sampatkumar, P. and Kanna, L. 1998. Seasonal variations in physico-chemical characteristics in the Tranquebar-Nagapattinam Region, South-East coast of India. ***Poll. Res***. 17 (4): 397-402.

Shastry, C.A., Aboo, K.M., Bhatia, H.L. and Rao, A.V. 1970. Pollution of upper lake and its effect on Bhopal water supply. ***Environ Health***, 12: 218-238.

Singhal, R.N., Swaranjeet and Davies, R.W. 1986. *The physico-chemical environment and the plankton of managed ponds in Haryana, India*. Proc. Ind. Acd.Ani. Sci. 95(3): 353-364.

Singh, J.P., Singh, R.P. and Singh, S.K. 1991.*Studies on the seasonal variations in physico-chemical factors and zooplankton of the river Sone in Bihar*. Proc. Ind. Sci. Cong. Indore, pp. 83-84.

Singh, M. 1965. Phytoplankton periodicity in a small lake near Delhi – I. ***Phykos***, 4: 61 – 68.

Singh, S.R. and Swarup, K. 1979. Limnological studies on Suraha Lake (Ballia). II The periodicity of phytoplankton. ***J. Ind. Bot. Soc***., 58 (4): 319 – 329.

Somashekar, R.K. 1984. Contribution to the algal flora of River Kapila, Karnataka I. Cyanophyceae and Chlorophyceae.***Phykos*** 23: 116 – 124.

Sreenivasan, A. 1967.Limnology of tropical impoundments. I. Hydrobiological features and fish production in Stantey reservoir, Metturdam. Int. Rev. Gas. ***Hydrobiologia***. 51 (2): 295-306.

Sreenivasulu, K., Kaizar Hossain and Damodharam, T. 2014. Seasonal variations in water quality and major threats to Nellore Cheruvu (tank), Nellore district, India. ***International Journal of Environment***, 3(2): 29-35.

Venkateswarlu, V. 1983.Taxonomy and Ecology of algae in the river Moosi Hyderabad India II-Bacillariophyceae.Bibliotheca ***Phycologica***. 66: 1 – 41.

Von Oye, P. 1934. QuelquesdonneessurI'ecologie des Desmidiees. ***Bull. Soc. Roy. Bot. Belg***., 67(1): 65 – 75.

Yung, Y.K., Stokes, P. and Gorham, E. 1986.Algae of selected continental and maritime bogs in North Amarica. ***Can. J. Bot.*** 64: 1825 – 1833.