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Research Article

Relationships between Physico Chemical Parameters and Diatom Assemblage in Karimudanahalli Lake, Mysuru District, Karnataka

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ABSTRACT

In this study, the diatom diversity was investigated with physico- chemical parameters to reveal the water quality. The samples were collected every month from three different sites of the lake for a period of 12 months from January 2015 to December 2015. During investigation, a total of 63 diatom species were found. The dominant species in the study period were Nitzschia palea, N. frustulum, Cyclotella meneghiniana, Fragilaria ulna, Gomphonema gracile, Cymbella affinis, Eunotia arcus, Synedra acus, Synedra ulna, A. minutissima, Gomphonema sp. and Pinnularia gibba. Achnanthidium minutissimum and Cymbella affinis were present especially in unpolluted areas and Nitzschia palea and N. frustulum were observed in eutrophic sites. The distribution of diatom are not similar in all the sites, distribution of diatom species in the sampling site were explained by variations in physico- chemical parameters such as pH, EC, temperature, DO, TDS, TH, TA, BOD and COD. This study concludes that diatom taxa in relation to physico- chemical variables will be helpful to design water quality monitoring programs.

Keywords: *Physico- chemical, Diatom, Bioassessments, Water quality, Lake.*

INTRODUCTION

Better quality of water is described by its physical, chemical and biological characteristics. The physico- chemical methods are used to detect the effects of pollution on the water quality. Changes in water quality are reflecting in the biotic community structure. Water pollution occurs when water body is adversely affected due to the addition of undesirable materials to the water. Monitoring studies involve investigations on changing environmental factors that vary in complex ecosystems, ranging from physical, chemical and biological factors to geological, morphological and global climate change in a wetland (Guntenspergen et al., 2002).

Water quality or ecological health should be embodied in the response of all kinds of aquatic organisms, especially those that are considered to be sensitive to changes of environmental conditions, such as diatoms, zooplankton, macro-invertebrates (Chen et al., 2016).

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The presence or abundance of specific organisms in a particular habitat and their ability to grow and out compete with other organisms under particular conditions of water quality explains the ecological significance of those organisms and their use as bioindicators.

The use of bioindicators provides an integrated measurement of water quality as experienced by the aquatic biota and offers a useful addition to chemical-based water quality. Diatoms are widely used in bioassessments and a substantial number of diatom indices have been developed for estimation of water quality in various geographic areas. Diatoms have been used for the assessment of short- and long-term environmental change (Dixit, 1992). Diatoms are dominant microalgae almost in all aquatic ecosystems, contribute 20- 25% primary production, have an important role in the silica and carbon cycle (Soeprobowati et al., 2012). Diatoms are largely cosmopolitan in distribution, and are ubiquitous and abundant in most aquatic environments (Dixit et al., 1992, Reid et al., 1995, & Wu et al., 1997). Diatoms quickly respond and are sensitive to a number of environmental pressures including changes in salinity, pH, nutrients, turbidity, various pollutants, water depth, substrate availability etc. Diatoms can provide valuable information for monitoring rivers, particularly on organic pollution (Sládeˇcek, 1986).

MATERIALS AND METHODS

Study area:

A preliminary study was carried out to select a study area. Lake was selected based on the different anthropogenic activities, sewage inflow and outflow in sites. For the present study Karimudnahalli lake from Mysore district was selected. The lake has been used for multipurpose activities like agriculture, fishing, washing, bathing and for ethical incarnation. It is about 35Km from Mysore, near Gaddige in Shanthipura village with latitude of 12º12´07″N, longitude of 76º21´50.1″E.

Physico- chemical Analysis:

For physico- chemical analysis surface water samples were collected from Karimudnahalli lake every month in three different spots for a period of Jan 2015- Dec 2015 and 16 physico-chemical parameters have been analyzed following standard methods given in APHA (2005) and Trivedy and Goel (1997). pH, electric conductivity (EC), water temperature (WT), salinity and total dissolved solids (TDS) were measured in field by using digital meter (Multi parameter tester 35 devises, Eutech. Instruments, (APHA, 2005). Carbon di oxide (CO_2) and dissolved oxygen (DO) were measured in field by Titrimetric method (APHA, 2005) and Winkler's iodometric (APHA, 2005) method. Turbidity was measured in the field by Hanna turbidiometer (model H1- 93703, & APHA, 2005). Rest of the chemical analyses was done at laboratory, for which samples were carried to laboratory on the same day of sampling. Total hardness (TH), calcium (Ca), chloride (Cl), total alkalinity (TA) and chemical oxygen demand (COD) were done according to APHA (2005). Bio chemical oxygen demand (BOD), nitrate and phosphate were carried out according to Trivedy and Goel (1997).

Diatom analysis:

Different types of habitats such as stones (epilithic), submerged macrophytes (epiphytic) and attached on sediments/soil (episammic) were selected for diatoms sample collection following the standard collection techniques (Taylor et al., 2007b; & Karthick et al., 2010). Even though habitats are known to be present in the same water bodies, species assemblages are known to vary depending on the habitats. Samples were transferred in to polythene bottles immediately after collection and carried to laboratory for observation in order to photograph live diatoms followed by preserving in 70% ethanol. Diatom samples were cleaned by $KMnO_4$ acid as per standard protocols (Taylor et al., 2007 b & Karthick et al., 2010). 400 frustules in each slide were counted using light microscope (Labomed trinocular microscope (LX400) with image transferor DCM 35 USB 2.0) for microphotographic system. Diatoms were identified using taxonomic literatures of Hustedt, 1909, 1933; Krammer and Lange-Bertalot, 1986, 1988, 1991; Lange-Bertalot, 2001 and Taylor et al. 2007a.

RESULTS AND DISCUSSION

Water quality monitoring is the process of sampling and analyzing conditions and characteristics of water. Mainly physical, chemical and biological factors can be used as parameters to describe the water quality. Physical parameters of water consist of pH, temperature, EC, TDS, salinity and turbidity etc. Chemical parameters are a measure of substances such as nutrients like sodium, nitrate, phosphate etc. Physico- chemical parameters thus help in identifying factors responsible for causing stress on the ecosystem.

During the study period investigation was carried out to analyze physico- chemical parameters in Karimudnahalli lake of Mysore district (Table 1). pH value in lake ranges from 8.29 to 9.02 which indicates water is alkaline in nature. Increased pH value was observed during summer season it may be due to runoff of nutrients from agriculture or due to anthropogenic activities which leads to increased growth of algae.

Table 1: Analysis of Physico-Chemical Parameters of Karimudnahalli Lake during the study period January 2015 to December 2015

	pH	WT	EC	TDS	Sal	Tur	CO_2	DO	TH	Ca	Cl	TA	COD	BOD	NO_3^-	PO_4^{3-}
Jan	8.43	27.20	530.67	376.33	256.67	36.07	2.35	6.49	242.67	60.39	26.51	373.33	39.11	8.65	0.04	0.02
Feb	8.29	29.36	569.00	403.33	275.67	47.33	5.86	8.11	260.00	20.31	29.35	366.67	55.11	12.98	0.05	0.08
Mar	8.54	28.60	581.00	411.33	282.00	38.23	0.00	10.55	288.00	32.60	31.24	400.00	34.67	17.30	0.10	0.06
Apr	8.48	33.10	515.33	364.30	248.67	25.07	5.86	8.38	217.33	35.80	31.24	353.33	60.44	15.14	0.06	0.01
May	8.73	26.76	546.33	248.60	264.33	54.14	0.00	10.28	262.67	32.06	42.60	353.33	39.11	12.98	0.03	0.01
Jun	8.74	27.66	558.00	394.30	270.67	32.33	2.13	10.82	236.00	33.67	31.24	360.00	49.78	15.14	0.16	0.03
Jul	8.58	26.56	362.33	254.30	173.00	8.30	0.00	6.49	157.33	35.80	23.67	220.00	33.78	15.14	0.05	0.01
Aug	8.65	27.36	384.67	272.60	186.33	0.00	0.00	12.71	164.00	34.74	24.61	206.67	51.56	17.30	0.08	0.01
Sep	9.02	30.86	346.67	245.60	152.00	0.00	1.76	10.82	153.33	32.06	26.51	180.00	32.00	19.46	0.07	0.02
Oct	8.57	28.50	397.33	281.60	192.33	0.00	0.00	8.11	184.00	37.94	62.48	240.00	40.89	10.81	0.06	0.01
Nov	8.55	24.27	508.33	361.00	245.33	0.31	0.00	9.20	240.00	40.61	31.24	306.67	77.33	17.30	0.05	0.01
Dec	8.59	25.80	530.67	381.00	257.67	0.00	0.00	8.65	260.00	37.94	31.24	333.33	42.67	17.30	0.10	0.05

Note: All values are expressed in mg/L except pH, WT (° C), EC (µs) and turbidity (NTU). WT- Water temperature, EC- Electric conductance, TDS- Total dissolved solids, Sal- Salinity, Turb- Turbidity, CO_2- Carbon di oxide, DO- Dissolved oxygen, TH- Total hardness, Ca- Calcium, Cl- Chloride, TA- Total alkalinity, COD- Chemical oxygen demand, BOD- Biochemical oxygen demand, NO_3^- Nitrate and PO_4^{3-}- Phosphate.

WT value ranges from 24.27°C to 33.10°C. WT mainly depends on the intensity of sun light. During current study WT fluctuated throughout the year and highest temperature was recorded during summer season because it may depend upon the season, geographic location, sampling time (Desai, 1995) and corresponding with air temperature indicating that the samples collected from shallow zone have direct relevance with air temperature as shallow water reacts quickly with changes in atmospheric temperature (Welch, 1952). High WT reduces the solubility of CO_2. The high value of CO_2 is related to the high rate of decomposition in the warmer months (Manjare et al., 2010).

Lake showed the EC ranging between minimum of 347µs during September to a maximum of 581µs during March. EC is the measure of the amount of dissolved salts in water. Conductivity is used to estimate the amount of TDS rather than measuring each dissolved substances separately. TDS is the measure of amount of dissolved substances such as potassium, sodium, chloride, carbonate, sulphate, calcium and magnesium present in the water. Presence of all these ions in water contribute to dissolved solids in water. Measuring TDS is a way to estimate the suitability of water for irrigation and drinking. TDS value varied with a minimum of 245mg/L during September to a maximum of 411.33 mg/L during March. Salinity is the measure of dissolved salts in water. Source of salinity may include urban and rural runoff containing salts, fertilizers and organic matter. High level of salinity may occur due to excessive irrigation and runoff containing TDS from industry, sewage and agriculture. High level of salinity makes water unsuitable for irrigation and drinking. As the values of EC, Salinity and TDS mainly depend on the concentration of dissolved salts in lakes; they are interdependent on each other and vice verse. During the study the value of EC, Salinity and TDS have highly fluctuated throughout the year in the lake. The variation in value were observed seasonally was mostly due to increase in the concentration of salts, because of evaporation (Trivedy et al., 1989).

During investigation turbidity was found high during summer. High turbidity can cause increased water temperature because suspended particles absorb more heat and can reduce the amount of light penetrating the water. As light penetration reduces it leads to less photosynthesis ultimately it reduces the dissolved oxygen in water and affects the flora and fauna present in aquatic ecosystem. Altogether leads to a eutrophic condition of water.

Total hardness of water is mainly governed by the content of calcium and magnesium which largely combine with bicarbonates and carbonates as temporary hardness and with sulphate, chlorides and other anions of minerals as permanent hardness (Singh et al., 2011). TH ranged from a minimum of 153.33mg/L to a maximum of 288mg/L. It was found to be high during summer months in the lake. High values of hardness are probably due to the regular addition of large quantities of sewage and detergents in the water body from the nearby residential localities (Kaur, 1996). Increase in calcium is directly correlated with the TH. High chloride values were observed during January. High chloride content in water may be an indication of organic pollution due to animal origin and also due to presence of large amount of organic matter.

During the study DO values fluctuated throughout the year in the lake, it is mostly due to fluctuation in temperature and low solubility of oxygen in water (Singh et al., 1991). The value of total alkalinity was observed maximum during March. It is due to the presence of hydroxide, carbonate and bicarbonate ions in the sample and might be due to high pH.

COD determines organic pollutants in water and BOD measures the amount of oxygen required by the microbes for degrading organic matter present in water. During present study COD and BOD values were observed high which indicates the eutrophic condition. The main source of nitrate and phosphate are fertilizers, untreated sewage as well as domestic and animal waste water. During the present study nitrate and phosphate values were found to be more during summer and rainy season due to precipitation of water and runoff from agriculture.

Table 2: List of diatom diversity in Vaddaragudi Lake during the study period January 2015 to December 2015

Species name	
Achnanthes hungarica (Grunow) Grunow	*Gomphonema lagenula* Kützing
Achnanthes inflata (Kützing) Grunow	*Gomphonema parvulum* Kützing
Achnanthidium eutrophilum Lange-Bertalot	*Gyrosigma attenuatum* (Kützing) Cleve
Achnanthidium exiguum (Grunow) Czarnecki	*Gyrosigma spencerii* W.Smith
Achnanthidium minutissimum (Kützing)	*Mastogloia smithi* Thwaites
Achnanthidium pyrenaicum (Hustedt) H.Kobayasi	*Melosira granulata* (Ehrenberg) Ralfs

Amphora copulata (Kützing) Schoeman *et* Archibald	*Melosira granulata var. angustissima* Otto Müller
Amphora pediculus (Kützing) Grunow	*Navicula antonii* Lange-Bertalot
Anomoeoneis sphaerophoria (Kutzing) Pfitzer	*Navicula arvensis* Hustedt
Aulacoseira ambigua (Grunow) Simonsen Manitoba	*Navicula rostrata* Ehrenberg
Aulocoseira granulata (Ehrenberg) Simonsen	*Navicula sp.*
Brachysira neoexilis (Grunow) D.G. Mann	*Navicula symmetrica* R.M.Patrick
Caloneis bacillum (Grunow) Cleve	*Navicula tripunctata* (O.F.Müller) Bory
Caloneis silicula (Ehrenberg) Cleve	*Navicula veneta* Kützing
Cocconeis placentula Ehrenberg	*Navicula cuspidata* (Kutzing) Kutzing
Craticula ambigua (Ehrenberg) D.G.Mann	*Navicula gracilis* Ehrenberg
Cyclotella atomus Hustedt	*Nitzschia frustulum* (Kützing) Grunow
Cyclotella meneghiniana Kützing	*Nitzschia gracilis* Hantzsch
Cymbella affinis Kützing	*Nitzschia palea* (Kützing) W.Smith
Cymbella cymbiformis Agardh	*Nitzschia sigma* (Kutzing) W.M. Smith
Cymbella powainia Gandhi	*Nizschia pura* Hustedt
Cymbella bengalensis Grunow	*Phormidium fragile* Gomont
Cymbella gracilis (Rabenhorst) Cleve	*Pinnularia viridis* (Nitzsch) Ehrenberg
Cymbella microcephala Grunow	*Pinnularia gibba* Ehrenberg
Cymbella tumida (Brébisson) van Heurck	*Pinnularia major* (Kützing) Rabenhorst
Diadesmis confervacea Kützing	*Pleurosigma elongatum* W.M. Smith
Eunotia monodon Ehrenberg	*Pinnularia stauroptera* (Grunow) Rabenhorst
Fragilaria biceps (Kützing) Lange-Bertalot	*Staurosirella pinnata*(Ehrenberg) D.M.Williams
Fragilaria tenera (W.M. Smith) Lange-Bertalot	*Surirella angusta* Kützing
Fragilaria ulna (Nitzsch) Lange-Bertalot	*Surirella ovata* Kützing
Fragilaria pinnata Ehrenberg	*Synedra acus* Kützing
Fragilaria rumpens (Kützing) G.W.F.Carlson	*Synedra tabulata* (C.Agardh) Kützing
Gomphonema affine (Kützing) A.Cleve	*Synedra ulna* (Nitzsch) Ehrenberg
Gomphonema angustatum (Kützing) Rabenhorst	*Tabularia fasciculata* (Agardh) D.M. Williams & Round
Gomphonema clavatum Ehrenberg	

Total 69 species of diatoms were recorded from the lake during the study period (Table 2) with species living in oligotrophic to species in eutrophic condition. In the present investigation it was found that summer and winter seasons showed high species assemblages whereas during monsoon season lake is characterized by low species assemblages. The difference in species richness among lake was not significant. *A. minutissima*, *Achnanthidium sp*., *Gomphonema sp*. were observed in the oligotrophic water and *Nitzschia palea* and *N. frustulum* were observed from eutrophic sites. *Nitzschia* is pollution tolerant species while *Cyclotella meneghiniana* was recorded to be more dominant at pH of 7.7 to 7.9 and increased EC (> 900µs cm^{-1}). This range of pH and EC confirms the distribution of *Cyclotella meneghiniana* to extremely eutrophic water condition. *A. minutissima*, *Gomphonema* and *Cymbella sp*. were abundant in Karimudnahalli lake. Highly nested species were *Nitzschia palea*, *N. frustulum*, *Cyclotella meneghiniana*, *Fragilaria ulna*, *Gomphonema gracile*, *Cymbella affinis*, *Eunotia arcus, Synedra acus, Synedra ulna*, *A. minutissima, Gomphonema sp*. and *Pinnularia gibba*. *Achnanthidium minutissimum* and *Cymbella affinis* were present especially in unpolluted areas because these taxa were sensitive to organic pollution.

CONCLUSION

High values in physico- chemical parameters indicate organic pollution, anthropogenic pollution and industrial pollution in lake. The study of diatom taxa in relation to physico-chemical variables will be helpful to design water quality monitoring programs. During the present study, identified diatom taxa of the lake revealed that diatom communities were dominant in eutrophic condition. The study of physical and chemical characteristics of water particularly pH, EC, temperature, DO, BOD and COD is closely linked to the distribution of diatom species. Results indicate that the water quality is poor. The water pollution and human impacts have become a big problem in lake, therefore responsible authorities need to take counter active measures to improve the water quality of lake and reduce public health risks. If the present state of pollution continues in lake, it might lead to a death of lakes or ecologically inactive lake. If suitable measures are not taken, the lake can soon undergo deterioration and may develop into a deteriorated habitat.

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