International Journal of Advanced Life Sciences (IJALS)

ISSN 2277 – 758X

Vinutha et al.,, IJALS, Volume (8) Issue (4) November - 2015. RESEARCH ARTICLE

Diversity of diatoms and its correlation with water quality of Chikkarasinakere Lake, Karnataka, India

G.P.Vinutha, N.K. Hemanth kumar*, Shankar P Hosmani and Shobha Jagannath***

***Department of Studies in Botany, University of Mysore, Manasagangotri, Mysore-570 006, India,**

****Department of Biotechnology, SBRR Mahajana First Grade College, Jayalakshmipuram, Mysore - 570 012, India**

E-mail : nkhemanthkumar@yahoo.in

Corresponding Author

N.K. Hemanth kumar

Department of Studies in Botany,

University of Mysore,

Manasagangotri,

Mysore-570 006, India,

Email : nkhemanthkumar@yahoo.in

Article History

Received on 21 September, 2015;

Received in revised form

06 October, 2015; Accepted

18 October, 2015

Abstract

Diversity of diatoms and its correlation with water quality and CCME-WQI was studied in Chikkarasinakere, lake in Karnataka state, India. The diatom data of the lake were subjected to OMINIDA software to obtain the ecological values; it reveals that organic pollution indicators of diatom species are *Navicula cryptocephala*, *Nitzschia palea* and the anthropogenic pollution of diatom species are *Navicula rhynchophylla* and *Synedra ulna*. The results of CCME reveal that the water quality is poor for the overall purpose. Drinking, aquatic, recreation and irrigation are categorized as marginal and livestock is categorized as marginal during April, May and February and in March as fair.

Keywords: Diatom, CCME, OMINIDA, ecological value, *Navicula cryptocephala*, *Nitzschia palea*, *Synedra ulna* and pollution

Introduction

Water is the most indispensable natural resource in the world for the existence of life. Water quality is a critical health concern in India. Thus the estimation of water quality is very important for proper assessment of associated hazards (Warhate *et al.*, 2006). The quality of water can be determined by using various techniques as water quality indices and one such technique is the Canadian Council of Ministries of the Environment (CCME) Water Quality Index (WQI). It facilitates to evaluate surface water for protection of aquatic life with the help of specific guidelines. The guidelines for each parameter are numeric values that define physical, chemical or biological characteristics of the water that cannot be exceeded without causing harmful effects (CCME, 1999).

Plankton, particularly phytoplankton, has long been used as indicators of water quality. Because of their short life span and quick responses to environmental changes their standing crops and species composition indicate the quality of water in which they are found. Clean water supports a great diversity of organisms, whereas, very few organisms survive in polluted water with one or two dominant forms. Phytoplankton constitutes the basis of the nutrient cycle of an ecosystem and hence play an important role in maintaining equilibrium between living organisms and abiotic factor (Saladia, 1997).

The diatoms (*Bacillariophyceae*) are important contributors of primary production in shallow aquatic ecosystem (Wetzel, 1990). Some of the genera of diatoms are pollution tolerant like *Synedra acus* and *Gomphonema* sp. They are generally found in organic rich water and play a key role in water quality evaluation. Hence, in the present study an attempt has been made to assess the water quality of Chikkarasinakere Lake (Fig.-1) using diatom indices and CCME WQI.

Materials and Methods

Collection of water samples

Samples for the estimation of diatoms were collected from the surface water at various places of the lake. Samples were collected at an interval of 30 days in plastic cans. An approximate amount of 25 ml, 4% formaldehyde followed by a few drops of Lugol's iodine was added to the sample which was sedimented in glass columns as described by Welch (1948). The amount of this sediment was further reduced to 20 ml by centrifugation and on certain occasions when the plankton population was thin it was adjusted to 10 ml or less. These samples were preserved and stored for further analysis.

CCME-WQI for Chikkarasinakere lake

The Canadian Council of Ministries of the Environment (CCME) Water Quality Index (WQI) allows evaluating surface water quality for the purpose of protection of aquatic life such as fish, plants, with the help of certain guidelines (Table -1). The water body to which the index applies can be defined as a station. The National Sanitation Foundation (NSF) developed a WQI which was based on a few physico-chemical parameters and was suitable for testing drinking water supplies (Princy *et al.*, 2001).

Statistical analysis

The diatom data of the lake were subjected to OMINIDA software to obtain the ecological values (Lecointe *et al.*, 2003)

Results and Discussion

Occurrence of fresh water diatoms in Chikkarasina-kere lake

The fresh water diatoms observed are presented in the Table - 2. Among the different types of diatom species observed, *Navicula cryptocephala* (Fig.-2I) is present predominantly in all the four months in contrast to different types of diatoms. This is followed by *Synedra ulna* (Fig.- 2N) *Pinnularia gibba* (Fig.-2M), *Navicula rhyncocephala* (Fig.-2K), *Fragillaria capucina* (Fig.-2G), *Achnanthes microcephala* (Fig.-2B), *Achnanthes affinis* (Fig.- 2D) and *Pinnularia gibba* (Fig.-2M). *Achnanthes lanceolata* (Fig.-2A) and *Nitzschia obtusa* (Fig.- 2L) were entirely absent during the month of March but present in other months. *Achnanthes minutissima* (Fig.-2C), *Synedra ulna* (Fig.-2N), and *Cymbella cymbelliformis* (Fig.-2E), were absent in April and present in the remaining months *Gyrosigma kuetzinji* (Fig.- 2H) and *Nitzschia obtusa* (Fig.-2L) were absent in May and March respectively and present in the remaining months studied.

Ecological Values

The ecological value for fresh water diatoms are presented in the Table - 3. During February the pH was circumneutral, salinity was fresh brackish and the nitrogen uptake metabolism was autotrophic. An oxygen requirement was moderate (above 50%), the saprobility was alpha-mesosaprobous and the trophic state was hypo- eutrophentic. Indicators of organic and anthropogenic pollution are *Navicula cryptocephala*, *Nitzschia palea*, *Navicula rhyncocephala* and *Synedra ulna* respectively. The numbers of species of diatoms were 12 in February and the total population consists of 14280 species, diversity index was 2.86, species evenness was 0.80 and the number of genera of diatoms

Fig.-1. The map showing location of Chikkarasinakere and aerial view of the lake

Table - 1. CCME WQI – and categorization of water quality

Sl. No.	Rating	WQI	Categorization
1.	Excellent	95-100	Water quality is protected with virtual absence of threat or impairment conditions very close to natural level
2.	Good	80 – 94	Water quality is protected with only a minor degree of threat, condition rarely deviate from natural condition.
3.	Fair	65 – 79	Water quality usually protected, but occasionally threatened; conditions often deviate from natural levels.
4.	Marginal	45 – 64	Water quality is frequently threatened; conditions often deviate from natural levels
5.	Poor	0-44	Water quality almost always threatened, conditions regularity deviate from natural levels.

Table - 2. Occurrence of fresh water diatoms in Chikkarasinakere lake (OMINIDA software analysis)

*Acronyms	Diatom Species	February	March	April	May
ALAN	*Achnanthes lanceolata*	25	0	14	6
AMIC	*Achnanthes microcephala*	9	16	30	23
AMIN	*Achnanthes minutissima*	19	8	0	20
AOFF	*Achnanthes affinis*	13	2	11	15
CCYM	*Cymbella cymbelliformis*	5	9	0	3
EMON	*Eunotia monodon*	8	2	6	8
FRAP	*Fragillaria rapucina*	19	25	31	24
GKUE	*Gyrosigma kuetzinji*	2	6	5	0
NCRY	*Navicula cryptocephala*	56	39	51	45
NCUR	*Navicula curpidata*	12	35	29	26
NRHY	*Navicula rhyncocephala*	13	26	20	23
NOBT	*Nitzschia obtusa*	9	0	3	6
PGIB	*Pinnularia gibba*	25	29	31	32
SULN	*Synedra ulna*	36	29	39	40

*First letter of genera and three letters of species

Table – 3. Fresh water Diatoms as Indicators of Water Quality: Ecological Values (OMINIDA Lecointe *et al.*, 2003)

SL. No.	Ecological values	February	March	April	May
1.	pH (R)	Circumneutral (3)	Alkaliphilous (4)	Circumneutral (3)	Alkaliphilous (4)
2.	Salinity (H)	Fresh brackish (2)	Fresh brackish (2)	Fresh brackish (2)	Fresh brackish (2)
3.	Nitrogen uptake metabolism (N)	Autotrophic (2)	Autotrophic (2)	Autotrophic(2)	Autotrophic (2)
4.	Oxygen requirements (O)	Moderate (3)	Moderate (3)	Moderate (3)	Moderate (3)
5.	Saprobility (S)	Alpha-mesosaprobous (3)	Polysaprobous (4)	Alpha-mesosaprobous (3)	Polysaprobous (4)
6.	Trophic state (T)	Hypoeutrophentic (7)	Hypoeutrophentic (7)	Hypoeutrophentic (7)	Hypoeutrophentic (7)
7.	Indicators of organic pollution	NCRY, NPAL	NPAL	NCRY, NPAL	NCRY, NPAL
8.	Indicators of Anthropogenic pollution	NRHY, SULN	NRHY, SULN	NRHY, SULN	NRHY, SULN
9.	Moisture tolerant (M)	Aquatic (2)	Aquatic (2)	Aquatic (2)	Aquatic (2)
10.	No. of species	12	14	12	10
11.	Population	14280	10080	10920	47600
12.	Diversity index	2.86	3.19	2.98	3.05
13.	Species Evenness	0.80	0.84	0.83	0.92
14.	No. Of genera of Diatoms	7	9	7	6

NCRY- *Navicula cryptocephala*, NPAL - *Nitzschia palea*, NNRHY - *Navicula rhyncocephala*, SULN - *Synedra ulna.*

were 7. During March the pH was alkaliphilous, salinity was fresh brackish and the nitrogen uptake metabolism was autotrophic. An oxygen requirement was moderate (above 50%), the saprobility was poly-saprobous and the trophic state was hypoeutrophentic. Indicators of organic and anthropogenic pollution of diatom species were *Nitzschia palea* and *Navicula rhyncocephala* and *Synedra ulna* respectively. The numbers of species of diatoms were 14 in March and the total population consists 10080 species. The diversity index was 3.19, species evenness was 0.84 and the number of genera of diatoms were 9.

During April the pH was circumneutral, salinity was brackish and the nitrogen uptake metabolism was autotrophic. An oxygen requirement was moderate (above 50%), the saprobility was alpha-mesosaprobous and the trophic state showed hypoeutrophentic level. Indicators of organic and anthropogenic pollution of diatom species were *Navicula cryptocephala*, *Nitzschia palea* and *Navicula rhyncocephala* and *Synedra ulna* respectively. The numbers of species of diatoms were 12 in this month and the total population consists of 10920 species. The diversity index contains 2.98, species evenness was 0.83 and the number of genera of diatoms were 7. During May the pH was alkaliphilous, salinity was brackish and the nitrogen uptake meta-bolism was autotrophic. An oxygen requirement is moderate (above 50%). The saprobility was polysapro-bous; the trophic state contains hypoeutrophentic level. Indicators of organic and anthropogenic pollution

Table – 4. CCME WQI of February, March, April and May

CCME WQI for February						
Data Summary	**Overall**	**Drinking**	**Aquatic**	**Recreation**	**Irrigation**	**Livestock**
CWQI	35	43	16	1	54	70
Categorization	Poor	Poor	Poor	Poor	Marginal	Fair
F1 (Scope)	36	29	75	100	33	17
F2 (Frequency)	36	29	75	100	33	17
F3 (Amplitude)	100	90	100	97	64	47
CCMEWQI for March						
CWQI	32	39	16	1	53	68
Categorization	Poor	Poor	Poor	Poor	Marginal	Fair
F1 (Scope)	45	43	75	100	33	17
F2 (Frequency)	42	38	75	100	33	17
F3 (Amplitude)	100	89	100	97	66	50
CCMEWQI for April						
CWQI	35	43	16	1	47	60
Categorization	Poor	Poor	Poor	Poor	Marginal	Marginal
F1 (Scope)	36	29	75	100	33	17
F2 (Frequency)	36	29	75	100	33	17
F3 (Amplitude)	100	90	100	97	79	66
CCMEWQI for May						
CWQI	35	43	16	1	50	64
Categorization	Poor	Poor	Poor	Poor	Marginal	Marginal
F1 (Scope)	36	29	75	100	33	17
F2 (Frequency)	36	29	75	100	33	17
F3 (Amplitude)	100	90	100	97	73	57

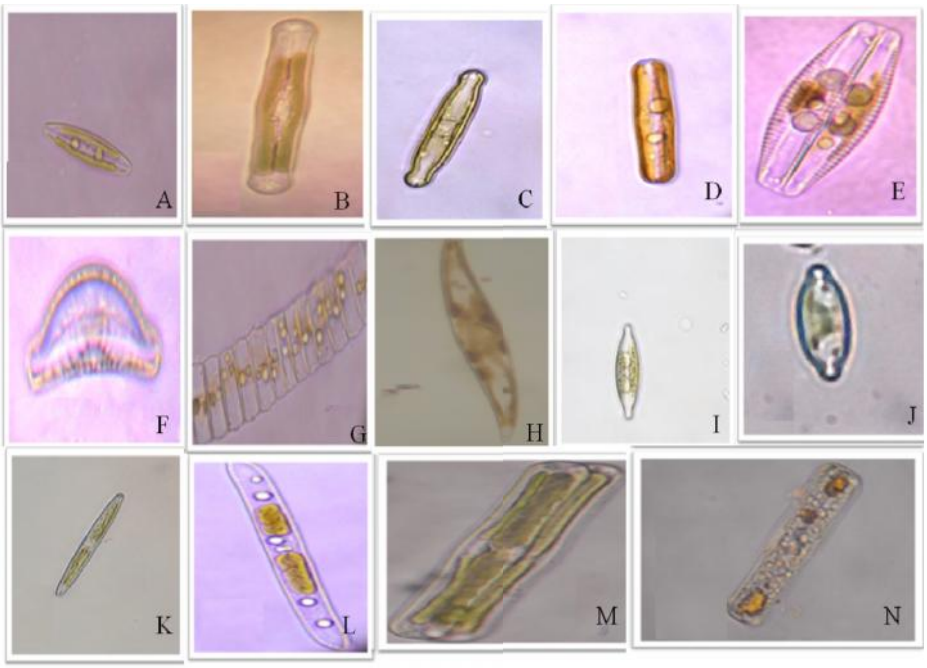

Fig. - 2. Different kinds of diatoms

2A: *Achnanthes lanceolata,*
2B: *Achnanthes microcephala,*
2C: *Achnanthes minutissima,*
2D: *Achnanthes affinis,*
2E: *Cymbella cymbelliformis,*
2F: *Eunotia monodon,*
2G: *Fragillaria capucina,*
2H: *Gyrosigma kuetzinji,*
2I: *Navicula cryptocephala,*
2J: *Navicula cupridata,*
2K: *Navicula rhyncocephala,*
2L: *Nitzschia obtuse,*
2M: *Pinnularia gibba,*
2N: *Synedra ulna.*

of diatom species *Nitzschia palea, Navicula cryptocephala* and *Navicula rhyncocephala*, *Synedra ulna* respectively. The numbers of species of diatoms were 10 in this month and the total population consists of 47600 species. The diversity index contains 3.05, species evenness was 0.92 and number of genera of diatoms were 6. According to Hosmani (1975) and Palmer (1983) excessive growth of blue green algae is known to indicate nutrient enrichment in lakes. Goldman and Horne (1983) concluded that some diatoms grow well in polluted waters while temperature and light intensity regulate the seasonal appearance of algal blooms.

CCME – WQI in Chikkarasinakere Lake

CCME WQI of Chikkarasinakere lake during the month of February and March showed that the water quality was poor for overall purpose, drinking, aquatic and recreation, irrigation was categorized marginal and livestock was categorized as fair (Table - 4). CCME WQI of the chikkarasinakere lake for the months of April and May showed that the water quality was poor for overall purpose, drinking, aquatic and recreation, irrigation was categorized marginal and livestock was also categorized as marginal. Basavarajappa *et al.* (2011) concluded that OMINIDA software program serves as an important asset in determining the ecological status of the water body. Diatoms are the major indicators of water quality *Navicula rhyncocephala* (NRHY) occurred in the lake and can be considered as the most pollution tolerant species in the present study. The study, therefore indicates that diatom can be used as indicators of water quality, even without the analysis of water chemistry variables. Total hardness was found to be high in all the months of lake. This was highest in March and lowest during May. The hardness was due to the dominance of salts of calcium and magnesium, which indicated a surge in eutrophication of lakes. The presence of lower pH and higher hardness may affect their continued use (Chatterjee and Raziuddin, 2002). Kumar *et al.* (2014) concluded that physico-chemical analysis and CCME-WQI indicates that the lake is out of condition for use and reached the eutrophication state due to various anthropogenic activities, sewage disposal and organic contamination which become a threat to water body. The present studied lake showed similar observations.

Acknowledgement

The authors are grateful to the Department of Studies in Botany, Manasagangotri, University of Mysore for providing the facilities to carry out this work.

References

Basavaraja Simpi., Hiremath, S.M., Murthy, K.N.S., Chandrashekarappa, K.N., Anil N Patel. and Puttiah, E.T. 2011. Analysis of Water Quality Using Physico-Chemical Parameters Hosahalli Tank in Shimoga District, Karnataka, India. *Global Journal of Science Frontier Research.*, 1(3): 31 - 34.

CCME "Canadian water quality guidelines for the protection of aquatic life. 2001. Canadian Water Quality Index 1.0 Technical Report", In Canadian environmental quality guidelines,1999, Winnipeg, Manitoba.

Chatterjee, C. and Raziuddin, M. 2002. Determination of water quality index of a degrateded river in Asansol industril area, West Bengal. *Journal of Environmental Pollution.*, 1(2): 181-189.

Goldman, C.R. and Horne, A.J. 1983. Limnology. McGraw-Hill Book Co., New York. 464.

Hosmani, S.P. and Bharathi. 1975. Hydro biological studies in ponds and lakes of Dharwad. *Science Journal.*, 30: 151-156.

Kumar, M.M.K., Mahesh, M.K. and Sushmitha, B.R. 2014. CCME water quality index and assessment of physico chemical parameters of chikkakere, periyapatana, mysore district, Karnataka state, india. *International journal of innovative research in science, engineering and technology*., 3(8) : 15343 - 15347.

Lecoinite, C., Coste, M. and Prygeli, J. 2003. OMINIDA: Diatom index software including diatom data base with taxanomic names references and codes of 11645 diatom taxa.

Palmer, G.M. 1976. Algae of water supplies. U.S. public Health Services Publication. 675: 1 - 85.

Princy, J.M., Lydia, I.S. and Rafendran, A. 2001. Formulation of New Water quality Index WQI-3. *Ecotoxicology Environment Monitoring.*, 11 (2): 91- 99.

Saladia, P.K. 1997. Hydrobiological studies of Jait Sagar Lake, Bunch (Rajasthan). Thesis submitted to MDS University, Ajmer, India.

Warhate, S.R., Yenkie, M.K.N., Chaudhari, M.D. and Pokale, W.K. 2006. Impacts of Mining Activities on Water and Soil. *Journal of Environ Science and Engineering.*, 48 (2): 81-88.

Welch, P.S. 1952. Limnology, MC Grew Hill Book Co, Inc., New York.

Wetzel, R.G. 1990. Land-water interfaces: metabolic and limnological regulators. Verhandlungen der international Vereinigung fur theoretische und angewandte. *Limnologie.*, 24 6-24.

Corresponding Author : N.K. Hemanth kumar, Department of Studies in Botany, University of Mysore, Manasagangotri, Mysore-570 006, India, *Email : nkhemanthkumar@yahoo.in*