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RESEARCH ARTICLE

DIATOMS AS INDICATORS OF WATER QUALITY IN THONNUR LAKE AND SULEKERE LAKE OF MANDYA, KARNATAKA, INDIA

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ABSTRACT

Diatoms in particular are of utmost importance, as potential indicators of water quality due to their sensitivity and strong response to many physical, chemical and biological changes. As a major contributor to primary productivity in the aquatic ecosystem, diatoms play a pivotal role in the food chain. Due to their ubiquitous nature, they are abundantly present in aquatic environments. This paper presents data on the water quality assessment using diatoms in Thonnur and Sulekere *lakes* of Mandya district, Karnataka, India. Organic as well as anthropogenic pollution indicators were found in both the lakes. Anthropogenic pollution was high in case of Thonnur lake compared to Sulekere lake. Indicators of organic pollution comprised of *Nitzschia palea*, *Gomphonema parvalum* and *Nitzschia fragalis*. Indicators of Anthropogenic pollution were found to be *Synedra acus* and *S. ulna* whereas *S.ulna* was found to be common in all sites of both the lakes because of high anthropogenic activity. About 10-12 species were identified in sulekere lake and 5-6 species in thonnur lake were recorded. Hence, diatoms play an imperative key role in water quality monitoring and also they are important resource for identifying ecological condition of the lake. So our findings highlighted that Sulerkere lake is more polluted than Thonnur lake. Worsening of water quality in both the lakes was due to human activities and organic pollution.

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INTRODUCTION

Diatoms nowadays are grabbing interest and are used as bio-indicators of water pollution Jadhav *et al*. (2017). Biomonitoring has been proven to be essential and hence the consequence of diatoms as ecological indicators of water quality has been stressed out (Sawaiker and Rodrigues, 2017). Freshwater ecology in the southern parts of Karnataka was initiated as far back as in 1973, as the first work on Limnological studies in ponds and lakes of Dharward (Bharathi and Hosmani, 1975). Phytoplankton diversity in lakes is significantly important (Hosmani, 2010). Diversity measures are more useful in lake ecosystems which harbour a large variety of algal species in general and species diversity within genera. Therefore application of species richness indices is very essential. Secondly it is necessary to apply models that describe the distribution of species abundance. The diversity of a community may therefore be described by referring to a model which provides the closest fit to the observed pattern of species abundance.

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Nine diversity indices were calculated for 10 lakes and the variations have been discussed. During recent times application of multivariate analysis to the ecological data has gained importance. Statistical multivariate analysis for lake water quality parameters (Mahadev *et al.,* 2010) indicated that total alkalinity is a major factor that was controlling the growth of phytoplankton in these lakes. Total alkalinity had highest similarity to desmids. The Trophic State Index (TSI) was applied to 15 lakes of Mysore city (Hosmani, 2010). Algal blooms affected the TSI in these lakes and there was an exchange in the hypolimnetic oxygen and fish species. Phosphorous concentrations influenced the trophic state and accelerated algal biomass leading to hyper eutrophic nature of at least six lakes studied. Five diversity indices using PAST programme was applied to a lake in Mysore (Basavarajappa *et al.,* 2011).

MATERIALS AND METHODS

A-Thonnur lake

This lake is situated in Thonnur village Pandavapura taluk, Mandya District, Karnataka. It is located in "76º 38' 30" N longitudes and "12º 34' 30" N latitude having a capacity to store 13.66 mcft of water.

Study and Sampling sites

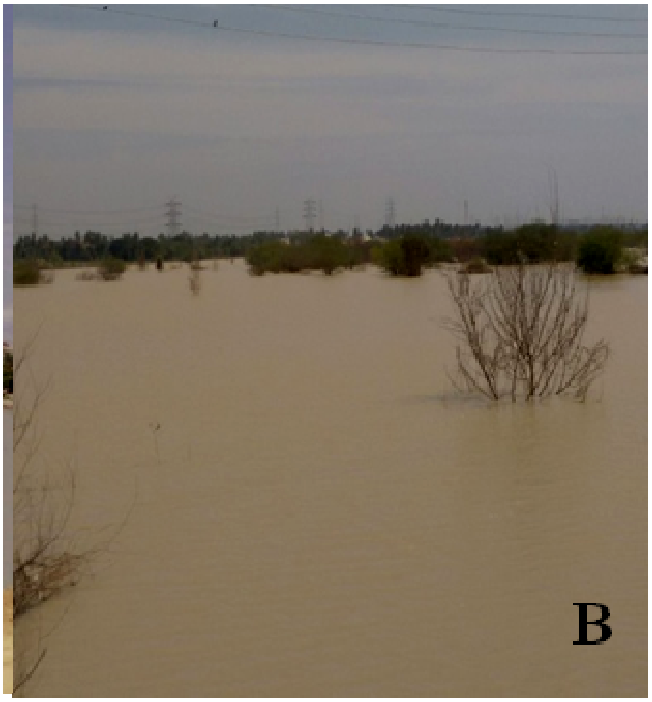

Fig 1. (A) Thonnur lake (B) Sulekere lake

B- Sulekere lake

It is situated in Nagamangala taluk, Mandya district, Karnataka. It is located in "12º48'30" N latitude to 76º44'15"E longitudes. It has 10-12 mcft of water storing capacity. All the data regarding the above lakes were collected from the respective departments of irrigation, agriculture and fisheries respectively. Additional information was also recorded by enquiring with the local people.

Sampling

The sampling was made in the month of January and February 2015.

The water was sampled from three different sites of two different lakes i.e. Thonnur lake and Sulekere lake with an interval of 15 days. The sampling was made in the early morning from different locations of both the lakes. By scrubbing the upper surface of water the samples were collected about 1-2 feet depth.

Assessment of water sample for indicator organisms

The samples were taken to the laboratory and preserved by adding 4% formaldehyde. For 100ml of each water sample about 4ml Lugol's iodine solution to each sample bottles was added to sustain the colour of organisms for the purpose of identification and it is was kept for 1-2 days for segmentation process. After segmentation the supernatant is decanted and the remaining lower portion of the solution was transferred to a clean bottle, observed the samples under microscope (10X & 40X magnifications).

A drop of segmented sample was taken on a clean slide with a drop of safranin stain and was observed with the preferred magnification. The identified diatoms are converted into diatoms/ litre (1 ml = 28 drops). The data recorded was tabulated by using Van Dam software for monitoring diatoms as ecological indicators (Van Dam *et al*., 1994).

Analysis of ecological values for Thonnur and Sulekere lakes

Based on the assessment of diatoms as indictor organisms the data obtained was tabulated by using Van Dam software for monitoring analysis for ecological values for 3 different sites sampled for different variables in both the lakes.

Taxonomic guidance

While analysing the data to identify the organisms taxonomic guides consulted included Shankar P. Hosamani *et al*. 2012), Taylor *et al*. (2007) and Karthick *et al*. (2011). The two lakes selected for present study are Thonnur lake and Sulekere lake, here the diatoms identified were subjected to Van Dam *et al*. (1994) software for obtaining the ecological condition of these lakes.

Statistical analysis

The data of the present study in the months of January and February (2015) analyzes the ecological condition of the lakes with respect to present environmental conditions based on the data given by Van Dam *et al*., (1994) the diatoms were identified. Identification of diatoms was done with respect to their values through the data given by Kelly *et al*. (2009).

RESULTS

In order to access the water quality of Thonnur and Sulekere lake of Mandya District was done using (Van dam *et al*., 1994) software which included all the ecological values. In the present study diatoms were identified in both lakes and their ecological values are determined. The diatoms of both the lakes were identified along with the acronyms indicated in Table 1. Ecological values for identified diatoms from both lakes were identified in Table 2. The general ecological indictor values are predicted in Table 3**.**

Table 1. Ecological values for Thonnur and Sulerkere lakes of Mandya District

Sl. No.	Ecological values	Thonnur lake	Sulerkere lake
1	pH	Alkaliphous	
2	Salinity	Fresh brackish	Fresh brackish
3	Nitrogen tolerance	Autotrophic	Autotrophic
4	Oxygenation	Moderate	Moderate
5	Saprobity	Alpha/ meso/ poly	Alpha/ meso/ poly
6	Trophic status	Oligo-eutrophic	Oligo-eutrophic
7	Moisture tolerance	Aquatic to wet soil	Aquatic to wet soil
8	IDSE/5 index	2.8-3.5 % (low)	3.4-3.6% (low)
9	% of organic pollution	13-14%	5-19%
10	Organic pollution	Low	Low
11	% of anthropogenic pollution	40-60%	4-13%
12	Anthropogenic eutrophication	High	Low
13	Indicators of organic pollution	NPAL	GPAR,NFRU&NPAL
14	Indicators of anthropogenic pollution	SACU&SULN	SULN
15	No. of species	6	11
16	Population	13066	42933
17	Diversity	2.09	3.1
18	Evenness	0.95	0.91
19	No. of genera	5	10

Table 2. Distribution of Diatoms in Thonnur and Sulerekere lakes of Mandya District (O/L)

Sl. No:	species	Thonnur lake			Sulekere lake		
		Site 1	Site 2	Site 3	Site 1	Site 2	Site 3
1	*Achnathes lanceolata* (ALAN)	-	-	-	2800	1400	1400
2	*Cocconies placentula* (CPLA)	1400	2800	2800	5600	4200	1400
3	*Cymbella cymbelliformis* (CCYM)	-	2800	-	5600	2800	1400
4	*Eunotia monodon* (EMON)	-	-	-	8400	1400	1400
5	*Gomphonema parvalum* (GPAR)	-	-	-	2800	1400	2800
6	*Gyrosigma kuetzingii* (GYKU)	-	-	-	5600	4200	5600
7	*Navicula rhombic* (NRHO)	-	-	-	4200	2800	5600
8	*Nitzschia fragalis* (NFRU)	-	-	-	1400	00	1400
9	*Nitzschia palea* (NPAL)	00	2800	1400	4200	4200	1400
10	*Pinnularia gibba* (PGIB)	2800	4200	00	1120	5600	1400
11	*Cynedra acus* (SACU)	1400	2800	1400	-	-	-
12	*Synedra ulna* (SULN)	2800	5600	4200	8400	1400	2800

Diversity of diatoms in Thonnur and Sulekere Lakes

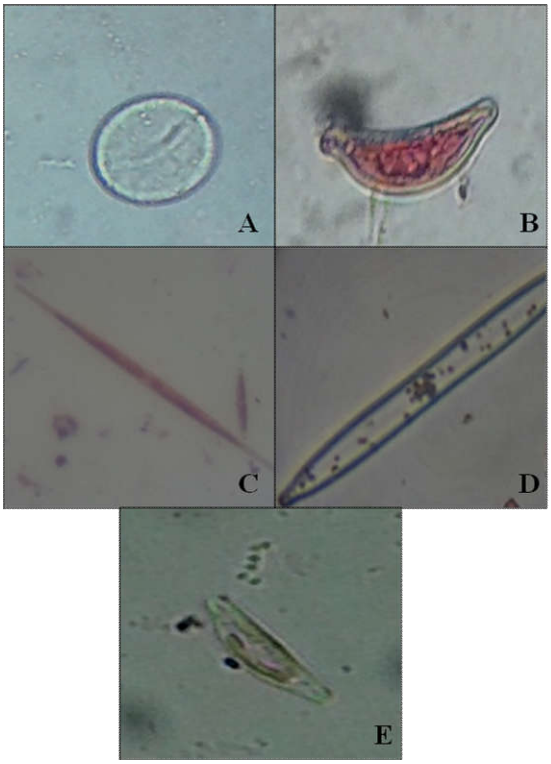

Fig 2. A- *Cocconeis placentula* (CPLA) ; B- *Cymbella cymbelliformis* (CCYM); C- *Eunotia monodon* (EMON); D- *Synedra ulna* (SULN) ; E- *Synedra acus* (SACU).

Classification of ecological indicator values (Van Dam, Martens and Sinkeldam, 1994)

Table 2.1: To identify pH values

pH	Classes	pH Range
1	Acidobiontic	Optional occurrence at pH < 5.5
2	Acidophilous	Mainly occurring at pH < 7
3	Circumneutral	Mainly occurring at pH values about 7
4	Alkaliphilous	Mainly occurring at pH > 7
5	Alkalibiontic	Exclusively occurring at pH > 7
6	Indifferent	No apparent optimum

Table 2.2: To identify Salinity values

	Water	Cl^-(Mg l^{-1})	Salinity
1	Fresh	<100	<0.2
2	Fresh brackish	<500	<0.9
3	Brackish fresh	500-1000	0.9-1.8
4	Brackish	1000-5000	1.8-1.9

Table 2.2: To identify Salinity values

	Water	Cl^-(Mg l^{-1})	Salinity
1	Fresh	<100	<0.2
2	Fresh brackish	<500	<0.9
3	Brackish fresh	500-1000	0.9-1.8
4	Brackish	1000-5000	1.8-1.9

Table 2.3: To identify Nitrogen uptake metabolism (N) values

1	Nitrogen-autotrophic taxa tolerating very small concentrations of organically bound nitrogen.
2	Nitrogen-autotrophic taxa tolerating elevated concentrations of organically bound nitrogen.
3	Facultative bound nitrogen-heterotrophic taxa needing periodically elevated concentrations of organically bound nitrogen.
4	Obligately nitrogen-heterotrophic taxa needing continuously elevated concentrations of organically bound nitrogen.

Table 2.4: To identify Moisture retention (M) values

1	Never or only very rarely occurring outside water bodies
2	Mainly occurring in water bodies, sometimes on wet places
3	Mainly occurring in water bodies also rather regularly on wet and moist places
4	Mainly occurring on wet and moist or temporarily dry places
5	Nearly exclusively occurring outside water bodies

Table 2.5: To identify Trophic (T) state

1	Oligotrophic
2	Oligo-mesotrophic
3	Mesotrophic
4	Meso-eutrophic
5	Eutrophic
6	Hypereutrophic
7	Oligo to eutrophic (Hypoeutraphentic)

Table 2.6: To identify Oxygen requirements (O) values

1	Continuously high (about 100% saturation)
2	Fairly high (above 75% saturation)
3	Moderate (about 50% saturation)
4	Low (above 30% saturation)
5	Very low (about 10% saturation)

Table 2.7: To identify Saprobity (S) values

	Saprobity	Water quality class	Oxygen saturation (%)	BOD 20 (mg l^{-1})
1	Oligosaprobous	I	>85	<2
2	β-mesosaprobous	II	70-85	2-4
3	α- mesosaprobous	III	25-70	4-13
4	α-meso-/polysaprobous	III-IV	10-25	13-22
5	Polysaprobous	IV	<10	>22

Van Dam software

Van Dam software for monitoring diatoms as ecological indicators is used. This software has an inbuilt with the ecological data for about more than 10000-15000 diatom species along with complete name, reference, family type, sensibility, pH, salinity, indicators & percentage of organic pollution, oxygen requirement, saprobity, trophic state, moisture retention, indicators & percentage of anthropogenic indicators.

DISCUSSION AND CONCLUSION

The present study predicts the dissimilarity in identified diatoms which can be influenced by environmental factors. These organisms are used as ecological indicators in water quality assessment. Density of the organisms is dependent on the abiotic factors either directly or indirectly in the aquatic ecosystem. *Synedra ulna* is the most common diatom which appears in both the lakes which indicates disturbances in lakes due to human activity correlated the works of Jadhav *et al*. (2017). *Nitzschia palea* is the only diatom indicating organic pollution in Thonnur lake. *N. palea* and *G. parvalum* are the two diatoms which indicated organic pollution in Sulekere lake. Compared to Thonnur lake, diatoms are well marked and in more numbers in Sulekere lake. Other results are in accordance with many studies demonstrated the relationship between diatoms and environment to analyse water quality by Van dam 1994, Martin Kelly (2003), Bellinger (2006), Sumedh *et al*. (2016), Basawarajappa (2011), Laganathan (2014), Srivastava *et al*. (2016) etc.

The Van dam *et al*. (1994) software serves as an important key in determining the ecological status of water bodies, diatoms are the major ecological indicators of water quality. Both Thonnur and Sulekere lakes are fresh water bodies and supports good diversity and density of Bacccillariophycean members. This study confirmed that diatoms are an important bioindicators for accessing ecological quality of lakes studied with respect to organic pollution and anthropogenic eutrophication. Overall identified diatoms in both the lakes are predicted as water quality indicators. *Synedra ulna* is considered as a most common anthropogenic eutropication indicator and *N. palea* is considered as organic pollution indicator in both the lakes. Thonnur and Sulekere lakes are polluted by the influence of human activity. Sulekere lake was found to be more polluted than Thonnur lake. If care is not taken both the lakes get severely polluted in future and may cause vital diseases to human, cattle and also crop failure.

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Conflict of interest: Declared None

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