PHYTOPLANKTONS AS INDICATORS OF ECOLOGICAL STATUS OF CERTAIN LAKES OF MANDYA DISTRICT

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ABSTRACT

Phytoplankton of seven lakes of Mandya district has been analyzed and the results have been utilized to determine the water quality. Phytoplanktons are the primary producers, sensitive to environmental changes and thus act as early indicators of pollution and eutrophication of lakes. The negative effect of eutrophication is seen as a result of decrease in biodiversity and increase in dominance of phytoplanktons. In the present study, only diatoms were used to study the ecological status. Bacillariophyta members like *Aulocoseira crenulata, Cosinodiscus centralis, Cymbella tumida, Cymbella turgid, Diatoma vulgare, Fragillaria virescens, Gomphonema parvalum, Melosira granulate, M. varianas, Navicula gracilis, Nitzschia amphibian, N. linearis, N. palea, Pinnularia borealis, P. gibba, P. viridus, Synedra acus* and *S. ulna* were dominant. The data were subjected to Louis-Leclercq software to determine the ecological status of the water bodies.

Key words: Phytoplanktons, Louis-Leclercq index, Ecological indicators

No: of Tables: 5 **No:of Figures: 1** **No: of References:27**

INTRODUCTION

Lakes capture rain water and check floods. It is exploited by humans for domestic and agricultural use and for industries and recreation. As it supports aquatic flora and fauna it also maintains ecological balance in aquatic ecosystem (Abila *et al*., 2012). Phytoplanktons are the primary producers and form the first trophic level of aquatic ecosystem. They help in circulation of material by growth, reproduction and death and decomposition (Lv *et al*., 2014). Abundance of algae depends on physical, chemical and biological characteristics of water. As algae are sensitive to environmental changes, they act as pollution indicator and play a major role in water quality monitoring programmes. Study of phytoplankton is an important tool to understand the basic features of water and assess quality of lake water. Members of Bacillarophyceae like *Navicula, Nitzschia* and *Syendra* species can tolerate pollution and can be used as indicators of sewage pollution (Shekhar *et al*., 2008). In shallow nutrient rich turbid water diatom like *Cyclotella, Stephanodiscus, Asterionella, Diatoma, Fragilaria, Navicula, Nitzschia, Melosira* and *Synedra* exist in higher density (Airill *et al.,* 2016). Diatoms are used to track the effect of climate (Ruhland *et al*., 2008) and nutrient enrichment (Hall and Smol, 2010). They help in trophic status assessment like the presence of *Fragilaria capucina* and *Tabellaria fenestrata* indicate eutrophy, *Fragilaria crotonensis and Urosolenia eriensis* indicate oligotrophy-eutrophy (Pappas, 2010).

Mandya district is popularly called as 'Land of Sugar' and is in the south east of Karnataka state and shares its borders with Mysore, Hassan, Tumkur and Bangalore districts (Fig. 1). The district lies between 76°19' and 77°22' east longitude and 12°13' and 13°4' north latitude. The district is situated at the height of 762 to 914 m, from the mean sea level. Mandya district has moderate climate. Rainy season is mostly from June to November. There are seven taluks in the district- K.R. Pet, Maddur, Malavalli, Mandya, Nagamangala, Pandavapura and Srirangapatna. In the present study one lake each from one taluk has been selected for the study (Table 1). As the Bacillariophyceae members survive under stress in lake water they can be used in the study of lake water pollution.

Table 1: Sampling spots

No. of sampling spots	Name of the lake
S1	Ballekere lake
S2	Bookanakere lake
S3	Doddaarsinakere lake
S4	Malavalli lake
S5	Raghurampur lake
S6	Thaggahalli lake
S7	Thonnur lake

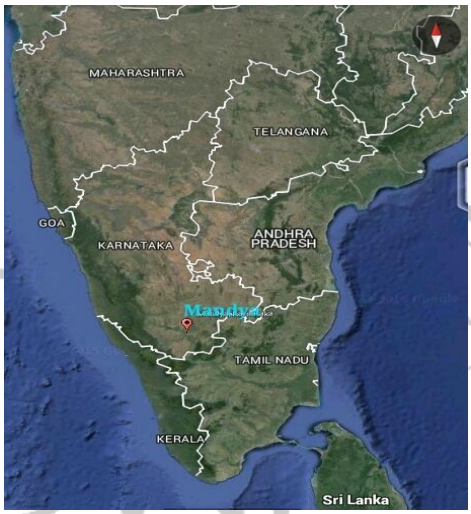

Fig. 1. Location of Mandya

Materials and Methods

The water samples were collected from sampling lakes for plankton analysis in plastic containers of one liter by avoiding filamentous algae and other floating debris. For about 25 ml of 4% formaldehyde was added to one liter of water sample. Few drops of Lugol's iodine were added, to preserve the sample until analysis. Sedimentation was done in glass columns; the sediment was finally reduced to 20 ml and was preserved in a glass vial. A drop was mounted on a slide from each vial and a cover slip was carefully placed over it. Five high power fields (15 × 5l), one in each corner of the cover slip and one at the centre were made and the algal populations were estimated. Random observations were made and it was repeated four times for each sample. This procedure was repeated for each sample and the number of each organism was extra plotted to estimate the number of organism/l (Rao, 1995). Identification of plankton to species level were made using

the monographs of Welch (1948), Philipose (1960), Prescott (1982), Sarode and Kamath (1984), and Taylor *et al*. (2007). The collection, preservation, enumeration of plankton was made as described by Hosmani and Kumar (1996). The count was made using Lackey's drop method (1938) as mentioned in APHA, (1985) and modified by Saxena (1987).

Louis-Leclercq Diatomic Index of Saprobity- Eutrophication:

The Louis-Leclercq Diatomic Index of Saprobity- Eutrophication (IDSE/5) (2008) is the diatom index of saprobity with index values from 1 to 5 and it indicates the levels of degradation in the lake. It also classify the lakes based on organic pollution and eutrophication for group E of taxa with saprobic values from 3.0 to 3.5, and group S of taxa with valves from 1.0 to 2.9. It groups the pollution range from non-existent-low-moderate-high-very high. OMNIDA software can be used for diatom based bio monitoring (Leconinte *et al*., 1993). This is an advanced pollution index and is based only on the occurrence of diatom species in the aquatic ecosystems. This index determines the trophic state of an ecosystem based on the ecological indicator values, degradation levels, percentage indicators of organic and anthropogenic pollution and the species indicating organic and anthropogenic pollution (Martin *et al*., 2010; Hosmani , 2012) (Table 2).

Table 2: Classification of ecological indicators value (Van Dam *et al*., 1994)

<table>
<tr><th colspan="4">(R) pH (1-6)</th><th colspan="3">(H) Salinity (1-4)</th></tr>
<tr><td colspan="4">1. Acidobiontic- Optional occurrence at pH<5.5
2. Acidophilous- Mainly occurring at pH<7
3. Circumneutral- Mainly occuring at pH valves about 7
4. Alkaliphilous- Mainly occurring at pH>7
5. Alkalibiontic- Exclusively occurring at pH>7
6. Indifferent- No apparent optimum</td><td colspan="3">Cl- (mg- L) 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 1.8-9.0</td></tr>
<tr><th colspan="4">(N) Nitrogen uptake (1-4)</th><th colspan="3">(M) Moisture (1-5)</th></tr>
<tr><td colspan="4">1. Nitrogen-autotrophic taxa tolerating very small concentrations of organically bound nitrogen.
2. Nitrogen-autotrophic taxa tolerating elevated concentrations of organically bound nitrogen.
3. Facultatively 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</td><td colspan="3">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.</td></tr>
<tr><th colspan="4">(S) Saprobity (1-5)</th><th colspan="3">(T) Trophic state (1-7)</th></tr>
<tr><td></td><td>Water quality class</td><td>Oxygen saturation</td><td>BOD5 20 mgL^{-1}</td><td colspan="3" rowspan="6">1. Oligotrophic
2. Oligo-mesotrophentic
3. Mesotrophentic
4. Meso-eutrophentic
5. Eutrophentic
6. Hypereutrophentic
7. Oligo to eutrophentic (hypoeutrophentic</td></tr>
<tr><td>1. Oligosaprobus</td><td>I, I-II</td><td>>85</td><td><2</td></tr>
<tr><td>2. β- mesosaprobus</td><td>II</td><td>70-85</td><td>2-4</td></tr>
<tr><td>3. α- mesosaprobus</td><td>III</td><td>20-70</td><td>4-13</td></tr>
<tr><td>4.α- Meso / polysaprobus</td><td>III-IV</td><td>10-25</td><td>13-22</td></tr>
<tr><td>5. Polysaprobus</td><td>IV</td><td><10</td><td>>22</td></tr>
<tr><td colspan="4">Oxygen requirements (1-5) (O)</td></tr>
</table>

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

Result and Discussion

During the study period Bacillariophyta members like *Aulocoseira crenulata, Cosinodiscus centralis, Cymbella tumida, Cymbella turgid, Diatoma vulgare, Fragillaria virescens, Gomphonema parvalum, Melosira granulate, M. varianas, Navicula gracilis, Nitzschia amphibian, N. linearis, N. palea, Pinnularia borealis, P. gibba , P. viridus, Synedra acus* and *S. ulna* were dominating in most of the lakes during many seasons. Various forms of diatoms observed in the lake water sample during the study period are mentioned in Table 3.

Table 3: List of some of the commonly occurring diatoms in lake water samples

Organisms	Acronym	Organisms	Acronym
Achnanthes lanceoluta	ALAN	*N. halophila*	NHAL
Amphora veneta	AVEN	*N. pupula*	NPUP
Aulocoseira crenulata	AUCR	*N. radiosa*	NRAD
A. distans	AUDI	*N. rhynchocephala*	NRHY
Campylodiscus clypeus	CCLY	*N. viridula*	NVIR
Cocconeis placentula	CPLA	*N. vulpina*	NVUL
C. centralis	CCEN	*N. westii*	NWES
Cyclotella kutzingiana	CYKU	*Nitzschia amphibia*	NIAMP
C. menegheniana	CMEN	*N. constricta*	NICO
C. ocellata	COCE	*N. gracillis*	NIGR
Cymbella gracilis	CGRA	*N. linearis*	NLIN
C. tumida	CTUM	*N. palea*	NIPA
C. turgid	CTUR	*N. similis*	NISI
Diatoma vulgare	DVUL	*Pinnularia borealis*	PBOR
Diploneis elliptica	DELL	*P. conica*	PCON
D. oblongella	DOBL	*P. gibba*	PGIB
Fragillaria virescens	FVIR	*P. gracilioidis*	PGRA
Gomphonema germinatum	GGER	*P. subsolaris*	PSUB

G. gracile	GGRA	*P. viridus*	PVIR
G. olivaceum	GOLI	*Rhopalodia gibba*	RGIB
G. parvalum	GPAR	*Stephenodiscus astrea*	SAST
G. tenuis	GTEN	*Surirella tenera*	STEN
G. truncatum	GTRU	*Synedra acus*	SACU
Melosira elegans	MELE	*S. tabulate*	STAB
M. granulata	MGRA	*S. ulna*	SULN
M. varianas	MVAR	*Ulnaria acus*	UACU
Navicula cuspidate	NCUS		
N. cryptocephala	NCRY		
N. gracilis	NGRA		

Louis-Leclercq Diatomic Index of Saprobity- Eutrophication

First year of sampling

In S1, the number of genera and species and population was 10, 14 and 32,900 respectively. IDSE/5 index was 4; percentage of organic and anthropogenic pollution was 15 and 26 respectively. Degradation and anthropogenic eutrophication was low to moderate and organic pollution was either absent or moderate in certain seasons (Maishale and Ulavi, 2015). Organic pollution indicators were *Diatoma vulgare, Melosira granulate, Nitzschia amphibian, Navicula cuspidate* and *Nitzschia palea* and anthropogenic pollution indicators were *Cymbella tumida, Rhopalodia gibba, Synedra acus* and *S. ulna*. In S2, number of genera and species and population was 10, 12 and 23,800 respectively. IDSE/5 index was 3; percentage of organic and anthropogenic pollution was 28 and 31 respectively. Degradation and anthropogenic eutrophication was low to moderate and organic pollution was low to high. Organic pollution indicators *Diatoma vulgare, Gomphonema parvalum, Melosira granulate, Nitzschia amphibian, Navicula cryptocephala, N. cuspidate* and *Nitzschia palea* and anthropogenic pollution indicators are *Cymbella tumida, Pinnularia viridus, Rhopalodia gibba* and *Synedra ulna* (Nautiyal and Mishra, 2013).

Number of genera and species and population in S3 was 9, 15 and 39,900 respectively. IDSE/5 index was 4 and percentage of organic and anthropogenic pollution was 11 and 18 respectively. Degradation was low to medium. Organic and anthropogenic pollution was nil to moderate. Organic pollution indicators were *Cyclotella menegheniana, Diatoma vulgare, Navicula cryptocephala* and *N. cuspidate*. Anthropogenic pollution indicators were *Aulocoseira distans, Gomphonema olivaceum, Synedra acus* and *Synedra ulna*. Number of genera and species and population in S4 was 10, 18 and 66,500 respectively. IDSE/5 index was 3 and percentage of organic and anthropogenic pollution was 16 and 23 respectively. Degradation and anthropogenic eutrophication was

moderate and organic pollution was low to moderate (Basavarajappa *et al*., 2011). Organic pollution indicators were *Cyclotella menegheniana, Diatoma vulgare,, Navicula cuspidate* and *Nitzschia palea* . Anthropogenic pollution indicators were *Cymbella tumida, Synedra acus* and *S. ulna*.

In S5, the number of genera and species and population was 13, 23 and 37,100 respectively. IDSE/5 index was 3; percentage of organic and anthropogenic pollution was 31 and 10 respectively. Degradation was moderate; organic pollution was low to moderate and anthropogenic eutrophication was either absent or low. Organic pollution indicators *Gomphonema parvalum, Melosira granulata, M. varianas, Nitzschia amphibian, Navicula cuspidate, Nitzschia constricta* and *N. palea* and anthropogenic pollution indicators were *Navicula rhynchocephala, Rhopalodia gibba, Synedra acus* and *Synedra ulna.* Number of genera and species and population in S6 was 11, 22 and 41,750 respectively. IDSE/5 index was 3 and percentage of organic and anthropogenic pollution was 32 and 13 respectively. Degradation and organic pollution were moderate. Anthropogenic pollution was either absent or low. Organic pollution indicators were *Cyclotella menegheniana, Gomphonema parvalum, Melosira granulate, Melosira varianas, Nitzschia amphibian, Navicula cryptocephala, N. cuspidate, N. halophila* and *Nitzschia palea* (Nautiyal and Mishra, 2013). Anthopogenic indicators are *Cymbella tumida, Gomphonema olivaceum, Nitzschia gracillis, Navicula rhynchocephala, Synedra acus* and *S. ulna.* In S7, number of genera and species and population was 9, 16 and 39,900 respectively. IDSE/5 index was 4; percentage of organic and anthropogenic pollution was 1 and 25 respectively. Degradation was absent and organic pollution was absent. Anthropogenic eutrophication was low to moderate (Maishale and Ulavi, 2015). Anthropogenic pollution indicators are *Cymbella tumida, Pinnularia viridus, Rhopalodia gibba, Synedra acus* and *S. ulna* (Table 4).

Table 4: Louis-Leclercq Diatomic Index of Saprobity- Eutrophication of lakes in first sampling year

Particulars	S1	S2	S3	S4	S5	S6	S7
Number of species	14	12	15	18	23	22	16
Population	32900	23800	39900	66500	37100	41750	39900
Diversity	4	3	3	4	4	4	4
Evenness	1	1	1	1	1	1	1
Number of genera	10	10	9	10	13	11	9
pH	Alkaliphilous				Circumneutral	Alkaliphilous	

Salinity	Fresh brackish						
Nitrogen uptake	Nitrogen-autotrophic taxa tolerating elevated concentrations of organically bound nitrogen						
Moisture	Mainly occurring in water bodies, sometimes on wet places	Mainly occurring in water bodies, also rather regularly on wet and moist places	Mainly occurring in water bodies, sometimes on wet places	Mainly occurring in water bodies, also rather regularly on wet and moist places			Never or only very rarely occurring outside water bodies
Saprobity	α- mesosaprobus		β-mesosaprobus	α- mesosaprobus			β- mesosaprobus
Trophic state	Eutrophentic	Hypereutrophentic	Eutrophentic		Hypereutrophentic	Eutrophentic	Hypereutrophentic
Oxygen requirement	Moderate	Moderate	Fairly high	Low	Moderate	Fairly high	Low
IDSE/5	4	3	4	3	3	3	4
Per cent indicators of organic pollution (%)	15	28	11	16	31	32	1
Per cent indicators of anthropogenic eutrophication (%)	26	31	18	23	10	13	25
Degradation	L-M	L-M	L-M	M	M	M	L
Organic pollution	N-M	L-H	N-M	L-M	L-M	M	N
Anthropogenic eutrophication	L-M	L-M	N-M	M	N-L	N-L	L-M
Organic pollution indicators	DVUL MGRA NAMP NCUS NPAL	DVUL GPAR MGRA NAMP NCRY NCUS NPAL	CMEN, DVUL NCRY, NCUS	CMEN DVUL NCUS NPAL	GPAR MGRA MVAR NAMP NCUS NICO NPAL	CMEN GPAR MGRA MVAR NAMP NCRY NCUS NHAL NPAL	Nil
Anthropogenic pollution indicators	CTUM RGIB SACU SULN	CTUM PVIR RGIB SULN	AUDI CTUM GOLI SACU, SULN	CTUM SACU SULN	NICR NRHY RGIB SACU SULN	CTUM GOLI NIGR NRHY SACU SULN	CTUM PVIR RGIB SACU SULN

Second year of sampling

Number of genera and species and population in S1 was 13, 19 and 42,805 respectively. IDSE/5 index was 3 and percentage of organic and anthropogenic pollution was 29 and 20 respectively. Moderate degradation with low to high organic pollution and low anthropogenic eutrophication was

observed in S1 sample. Organic pollution indicators were *Amphora veneta, Cyclotella menegheniana, Diatoma vulgare, Gomphonema parvalum, Melosira granulata, M. varianas, Nitzschia amphibian, Navicula cuspidate* and *N. pupula*. Anthropogenic pollution indicators were *Cymbella tumida, Rhopalodia gibba, Synedra acus* and *Synedra ulna*. Number of genera and species and population in S2 was 14, 22 and 29,232 respectively. IDSE/5 index was 3 and percentage of organic and anthropogenic pollution was 26 and 22 respectively. Moderate degradation with low to moderate organic pollution and anthropogenic eutrophication was observed in S2 sample (Basavarajappa *et al*., 2011). Organic pollution indicators were *Amphora veneta, Cyclotella menegheniana, Diatoma vulgare, Gomphonema parvalum, Melosira granulata, M. varianas, Nitzschia amphibian, Navicula cryptocephala, N. cuspidate, Nitzschia palea* and *Navicula pupula*. Anthropogenic pollution indicators were *Cymbella tumida, Gomphonema olivaceum, Pinnularia viridus, Rhopalodia gibba, Synedra acus* and *S. ulna*.

In S3, the number of genera and species and population was 7, 11 and 29,050 respectively. IDSE/5 index was 4; percentage of organic and anthropogenic pollution was 25 and 12 respectively. Low degradation, low to moderate organic pollution and anthropogenic eutrophication was either absent or it was moderate in few seasons. Organic pollution indicators were *Cyclotella menegheniana, Diatoma vulgare, Nitzschia amphibian, Navicula cuspidate* and *N. viridula* and anthropogenic pollution indicators were *Aulocoseira distans, Cymbella tumida,* and *Synedra acus*. In S4, number of genera and species and population was 8, 12 and 31,150 respectively. IDSE/5 index was 3; percentage of organic and anthropogenic pollution was 29 and 12 respectively. The range of degradation was low to moderate, organic pollution was moderate to high and anthropogenic eutrophication was low to moderate (Maishale and Ulavi, 2015). Organic pollution indicators were *Cyclotella menegheniana, Diatoma vulgare, Navicula cuspidate* and *N, viridula* and anthropogenic pollution indicators were *Synedra acus* and *S. ulna*.

Number of genera and species and population in S5 was 14, 26 and 26,880 respectively. IDSE/5 index was 3 and percentage of organic and anthropogenic pollution was 22 and 18 respectively. The range of degradation, organic pollution and anthropogenic pollution was low to moderate. Organic pollution indicators were *Amphora veneta, Gomphonema parvalum, Melosira granulate, M. varianas, Nitzschia amphibian, Navicula cuspidate Nitzschia constricta* and *N. palea* (Nautiyal and Mishra, 2013). Anthopogenic indicators are *Cymbella tumida, Nitzschia gracillis, Rhopalodia gibba, Synedra acus and S. ulna*. In S6, the number of genera and species and population was 17, 30 and 25,710 respectively. IDSE/5 index was 3; percentage of organic and anthropogenic pollution was 40 and 12 respectively. Moderate degradation was

observed in S6. Organic pollution was moderate to high and anthropogenic eutrophication was either absent or low. Organic pollution indicators *Cyclotella menegheniana, Diatoma vulgare, Gomphonema parvalum, Melosira granulata, M. varianas, Nitzschia amphibian, Navicula cryptocephala, N. cuspidata,* and *Nitzschia palea* and anthropogenic pollution indicators were *Cymbella tumida, Nitzschia gracillis, Pinnularia viridus, Synedra acus* and *S. ulna* (Nautiyal and Mishra, 2013). In S7, number of genera and species and population was 9, 13 and 39,900 respectively. IDSE/5 index was 4; percentage of organic and anthropogenic pollution was 7 and 26 respectively. Low degradation, organic pollution was either absent or low and anthropogenic eutrophication was low to moderate (Maishale and Ulavi, 2015). *Gomphonema parvalum, Nitzschia amphibian and Nitzschia palea* were organic pollution indicators and *Cymbella tumida, Rhopalodia gibba, Synedra acus* and *S. ulna* were anthropogenic pollution indicators.

According to observed IDSE/5-Ecological indices of Pollution, number of species, diversity, evenness and number of genera was usually high in pre monsoon and winter and usually low in monsoon (Maishale and Ulavi, 2015). Overall population was high in post monsoon and winter seasons. Saprobity was usually maintained between β-mesosaprobus and a- mesosaprobus condition (Ramakrishnan, 2003). Trophic status varied between eutrophentic and hypoeutrophentic. IDSE/5 index varied from 3.1 (S6) to 3.8 (S7) and was usually high in monsoon. Per cent indicator of organic pollution varied between 4.1 (S7) and 36.2 (S6) and it usually high in pre monsoon. Percent indicator of anthropogenic pollution varied between 14.0 (S5) and 26.3 (S2) and was usually high in winter and pre monsoon (Table 5). Presence of *Amphora veneta, Cymbella tumida*, *Rhopalodia gibba, Synedra acus* and *Synedra ulna* indicate anthropogenic pollution (Maishale and Ulavi, 2015). *Cyclotella menegheniana, Diatoma vulgare, Gomphonema parvalum, Melosira granulate, M. varianas, Navicula cryptocephala, N. halophile, Nitzschia amphibian* and *N. palea* indicate organic pollution (Nautiyal and Mishra, 2013).

Table 5: Louis-Leclercq Diatomic Index of Saprobity- Eutrophication of lake water in second sampling year

Particulars	S1	S2	S3	S4	S5	S6	S7
Number of species	19	22	11	12	26	30	13
Population	42805	29232	29050	31150	26880	25710	39900
Diversity	4	4	3	3	4	4	3
Evenness	1	1	1	1	1	1	1
Number of genera	13	14	7	8	14	17	9
pH	Alkaliphilous						

Salinity	Fresh brackish						
Nitrogen uptake	Nitrogen-autotrophic taxa tolerating elevated concentrations of organically bound nitrogen						
Moisture	Mainly occurring in water bodies , also rather regularly on wet and moist places		Mainly occurring in water bodies, sometimes on wet places		Mainly occurring in water bodies , also rather regularly on wet and moist places		Mainly occurring in water bodies, sometimes on wet places
Saprobity	α-mesosaprobus	β-mesosaprobus	α-mesosaprobus		β-mesosaprobus	α-mesosaprobus	β-mesosaprobus
Trophic state	Hypereutrophentic	Eutrophentic		Hypereutrophentic		Eutrophentic	
Oxygen requirement	Fairly high		Moderate				
IDSE/5	3	3	4	3	3	3	4
Per cent indicators of organic pollution (%)	29	26	25	29	22	40	7
Per cent indicators of anthropogenic eutrophication (%)	20	22	12	12	18	12	26
Degradation	M	M	L	L-M	L-M	M	L
Organic pollution	L-H	L-M	L-M	M-H	L-M	M-H	N-L
Anthropogenic eutrophication	L	L-M	N-M	L-M	L-M	N-L	L-M
Organic pollution indicators	AVEN CMEN DVUL GPAR MGRA MVAR NAMP NCUS NPUP	AVEN CMEN DVUL GPAR MGRA MVAR NAMP NCRY NCUS NPAL NPUP	CMEN DVUL NAMP NCUS NVIR	CMEN DVUL NCUS NPAL	AVEN GPAR MGRA MVAR NAMP NCUS NICO NPAL	CMEN DVUL GPAR MGRA MVAR NAMP NCRY NCUS NPAL	GPAR NAMP NPAL
Anthropogenic pollution indicators	CTUM RGIB SACU SULN	CTUM GOLI PVIR RGIB SACU SULN	AUDI, CTUM SACU	SACU SULN	CTUM NIGR NTGR RGIB SACU SULN	CTUM NIGR PVIR SACU SULN	CTUM RGIB SACU SULN

N- Nil; L-Low; M-Moderate; H-High.

Conclusion

The application of IDSE/5 on the recorded diatom species indicates low to moderate organic and anthropogenic pollution. Number of genus and species was high in S6 and the population was high in S4. Diversity index was 4 in all the lakes, but it was 3 in S2 and S3 in first year and S3 and S4 in second sampling year. Evenness valve was 1 in all the lakes throughout the sampling period. All the lake water showed alkaliphilous

condition, except S5 which was Circumneutral in first sampling year. All the lake water samples were fresh brackish throughout the sampling period. High organically bound nitrogen tolerating autotrophic organisms were present in all the lakes. The organism observed in these lake water samples usually occur in water as well as in wet moist places, but in S7 the observed organism rarely occurred outside water. β- mesosaprobus condition was maintained in S3 and S7 in first year and in S2, S5 and S7 in second sampling year. a- mesosaprobus condition was maintained in S1, S3, S4 and S6 in first sampling year and in S1, S3 and S6 in second sampling year. Thus β-mesosaprobus lakes water belongs to class II quality and a- mesosaprobus lakes water belongs to class III quality. Eutrophentic condition was maintained in S1, S3, S4 and S6 in first sampling year and S2, S3, S6 and S7 in second sampling year. Hypereutrophentic condition was maintained in S2, S5 and S7 in first sampling year and S1, S4 and S5 in second sampling year. Oxygen requirement was low in S4 and S7 in first sampling year and moderate in S1, S2 and S5 in first year and S3, S4, S5, S6 and S7 in second sampling year. It was fairly high in S3 and S6 in first year and S1 and S2 samples in second sampling year. Organic pollution was high in S6 in both the sampling year and anthropogenic eutrophication was high in S1 and S7 in second sampling year. *Cyclotella meneghenіana, Diatoma vulgare, Gomphonema parvalum, Melosira granulate, M. varianas, Nitzschia amphibian, Navicula cryptocephala; N. cuspidate and Nitzschia palea* were common organic indicators. *Cymbella tumida, Gomphonema olivaceum, Nitzschia gracillis, Pinnularia viridus, Rhopalodia gibba, Synedra acus; S. ulna* were common anthropogenic pollution indicators. Usually all the lakes were low to moderately polluted, but the Bookanakere lake in first year and Ballekere Lake, Malavalli taluk and Thaggahalli lake were highly polluted during the second sampling period. Certain conservative measures have to be made to avoid the entry of domestic and sewage waste of surrounding villages and thereby avoid eutrophication of lakes.

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