Universal Journal of Environmental Research and Technology
All Rights Reserved Euresian Publication © 2013 **eISSN 2249 0256**
Available Online at: **www.environmentaljournal.org**
2013 Volume 3, Issue 4: 473-482

Open Access **Research Article**

Fresh Water Algae as Indicators of Water Quality

Shankar P. Hosmani

Department of Biotechnology, SBRR Mahajana First Grade College, Jayalakshmipuram, Mysore-570012

Corresponding author: prof_sph@yahoo.co.in

Abstract:
Algae as indicators of organic pollution in 20 lakes of southern Karnataka have been studied. The Palmer's algal index of organic pollution has been discussed. The IDSE/5 Diatom index is calculated using the OMNIDA software. The order of tolerance to organic pollution was calculated using the Garrett ranking technique. Nestedness of species in the lakes was also determined using the Nestedness calculator. According to the Palmer's index all the 20 lakes are organically polluted. Bogadi Lake was least while Dadadahalli Lake and Karanji Lake were heavily polluted. The present work compares the use of old and new techniques of detecting water quality. It also enables to understand weather algae can be of importance in conserving organically polluted lake waters. The nestedness analysis helps in detecting the autocathonous algae in each lake in contributing to organic pollution. The species index indicated that Doddakere Lake, Kabini Lake, Kalale lake, Kurubara lake, Hadhinaru Lake and Bogadi lake had low organic pollution. The diatom index showed that all lakes ranged between moderate and high organic pollution, but the degradation levels in the water were always high. Dadadahalli Lake has the highest organic pollution while Kalale Lake and Makanahally Lake were heavily polluted. Species of *Euglena* and *Scenedesmus* were the most tolerant species. Algae were highly nested in Dadadahalli Lake, Dalvoi Lake, Karanji Lake and were the most hospitable sites for growth of algae while most of the other lakes had idiosyncratic species. The matrix fill was low (59.5%) and the system temperature was warm (34.22^{o}) indicating poor distribution of algal species. The use of modern tools in determining levels of organic pollution in lake ecosystems has been discussed.

Keywords: Algae, Diatom, Garrett, Idiosyncratic, Nestedness, Organic Pollution, Palmer, Ranking,

1.0 Introduction:
As early as (1980) Hosmani and Bharathi, investigating polluted and unpolluted waters of Karnataka, published a paper on "Algae as indicators of organic pollution". This study was based on the classic work of Palmer (1969) who developed "Algal index of Pollution" and it was based on the observations of 269 reports by 165 authors who reported algae tolerant to organic pollution. Details of this calculation are presented in Palmer (1969). The pollution index is based on the relative number of total points scored by each alga. The index has been used by several researchers till date. However, as time progressed many new algal genera or species indicating organic pollution have not been added to this list. Secondly, algal appearance in polluted waters changes from region to region. Nygaard(1976) also proposed an index based on the plankton count but was of lesser importance. Kelly (2006) used diatoms with other algae as indicators of ecological status and explained the precise method of sampling diatoms for calculating the water quality index. A more advanced pollution index is that of Louis-Laclereq (IDSE/5) (2008) which is based on the occurrence of only diatom species in any water body. This index not only estimates organic pollution, but also determines the percentage or status of anthropogenic pollution in the range of low to very high. It also determines the degradation levels in the water. The index can be calculated by using the OMNIDA software (Lecointe, 2003) and is therefore most appropriate. Diatoms are considered to be more precise indicators as compared to other algae that may be of allocathonus origin .Publications related to the study are those of Hosmani(2012a), on the application of benthic diatom community in lake water quality monitoring, Hosmani and Mruthunjaya(2013)on the impact of plankton diversity on the water quality index in lakes. Attempts were also made by Hosmani(2012b) to

apply multivariate analysis for distribution of Euglenaceae while Sudeep *et al*.,(2007) applied the Principal Component Analysis for water quality evaluation. These studies however were not very precise in explaining the water quality index of lake waters.

Further, the Palmer's (1969) index has no measure for rating of the level of pollution in fresh waters and a ranking technique is also essential to study lake systems in order to compare them. It is also necessary to understand whether the algae were indigenous to the lakes or were brought into the lake by human disturbances. The present work discusses the possibility of using newer techniques involving algae as indicators of organic pollution based the Palmer's (1969) index. The study involves algae collected from 20 lakes of Mysore district and its surroundings. (Fig.1) The collections were made seasonally for a period of at least 10 years (2003 to 2013).

2.0 Materials and Methods:

2.1 Study area: Mysore district lies between 11^0 39' and 12^0 50' north latitude and 75^0 45' and 77^{0}45' east longitude. It is situated in the southern part of Deccan Peninsula and it forms the southern district of Karnataka State. Irrigation by channels is the characteristic feature of the district. Many lakes which are fed by the river Cauvery and its tributaries form the major wetlands of the district. Additionally rains fed freshwaters are also abundant.(Fig.1)

2.2 Sampling stations: Sampling for algae was done from 20 lakes which are situated at a distance of 20 kms apart. They differ in size and shape, in the nature of aquatic life, usage and level of human disturbance. Some of them become occasionally dry but are again refilled by channels.

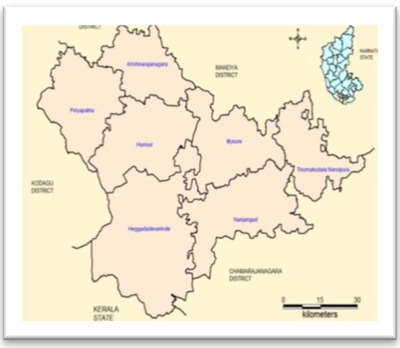


Fig. 1. Sampling sites of Mysore district.

2.3: Collection and analysis of samples: Collection, preservation, identification and enumeration of algae were done by Lackey's drop method (1938) modified by Suxena(1987). Algae were identified using the monographs of Desikachary(1959), Prescott(1982),Scott and Prescott(1961),Sarode and Kamath(1984), Philipose(1960), Gandhi(1998) , Taylor *et al*.,(2007) and West and West(1909), Collections were made seasonally over a period of 10 years (2003 to 2013).Omnida. GB 5.3 software (Lecointe *et al*.2003)was used to calculate the Louis-Laclereq Index (2008).The orders of merit given by Palmer's algal index(1969) were converted to ranks by using the formula: Percentage position=10(R_{ji}-0.5)/Nj; where R_{ji}= rank given for the ith item jth individual; N_j=number of items ranked by the jth individual. The percentage position of each rank thus obtained was converted into scores by referring to the table given by Henry Garrett (1924). Each of the scores of the index and individuals were added and divided by the total number of observations (number of lakes) for whom the scores were added. The mean scores for all the factors were arranged in the order of their ranks and inferences drawn. Alternate to these indices Blanco and Blanco (2012) have used the Duro Diatom Index using weighted average method to derive autoecolgical profiles of diatoms to water chemistry. (DDI)The Nestedness software was used to detect the matrix fill and system temperature and the most nested or idiosyncratic species and lakes were determined according to the software. (Atmar and Patterson, 1995)

3.0 Results and Discussion:

The microphotographs of algae indicating organic pollution reported by Palmer (1969) are presented in Plate 1.The index for the genera is shown in Table 1. The highest organic pollution index is in Dadadahalli Lake, Karanji Lake, Doddakere Lake and Dalvoi Lake. The values reach as high as 33. The least index is observed in Bogadi Lake, while all other lakes range between a minimum of 20 to a maximum of 33. Species of *Euglena, Oscillatoria, Scenedesmus* and *Synedra* appear in almost all lakes and are the most prominent indicators of organic pollution. The twenty most algal species tolerant to organic pollution are shown in Table 2. *Euglena acus, Scenedesmus quadricauda* and *Synedra ulna* are the most tolerant species. According to the index, a score of 20 or more for a sample is an indication of organic pollution, while a score of 15 to 19 is taken as probable evidence of high organic pollution. Lower values indicate that the organic pollution is not high. Appling these values to the present study it is observed that all the twenty lakes are organically polluted, since they have a score above 20. The species index gives an indication that Hadhinaru Lake and Bogadi Lake fall under the category of low organic pollution(Total score of 14) but are tending to be organically polluted. The species index also indicates that all lakes are organically polluted. Hosmani(2010) studied the phytoplankton diversity in lakes of Mysore district and no attempt was made to apply the data to derive pollution indices.

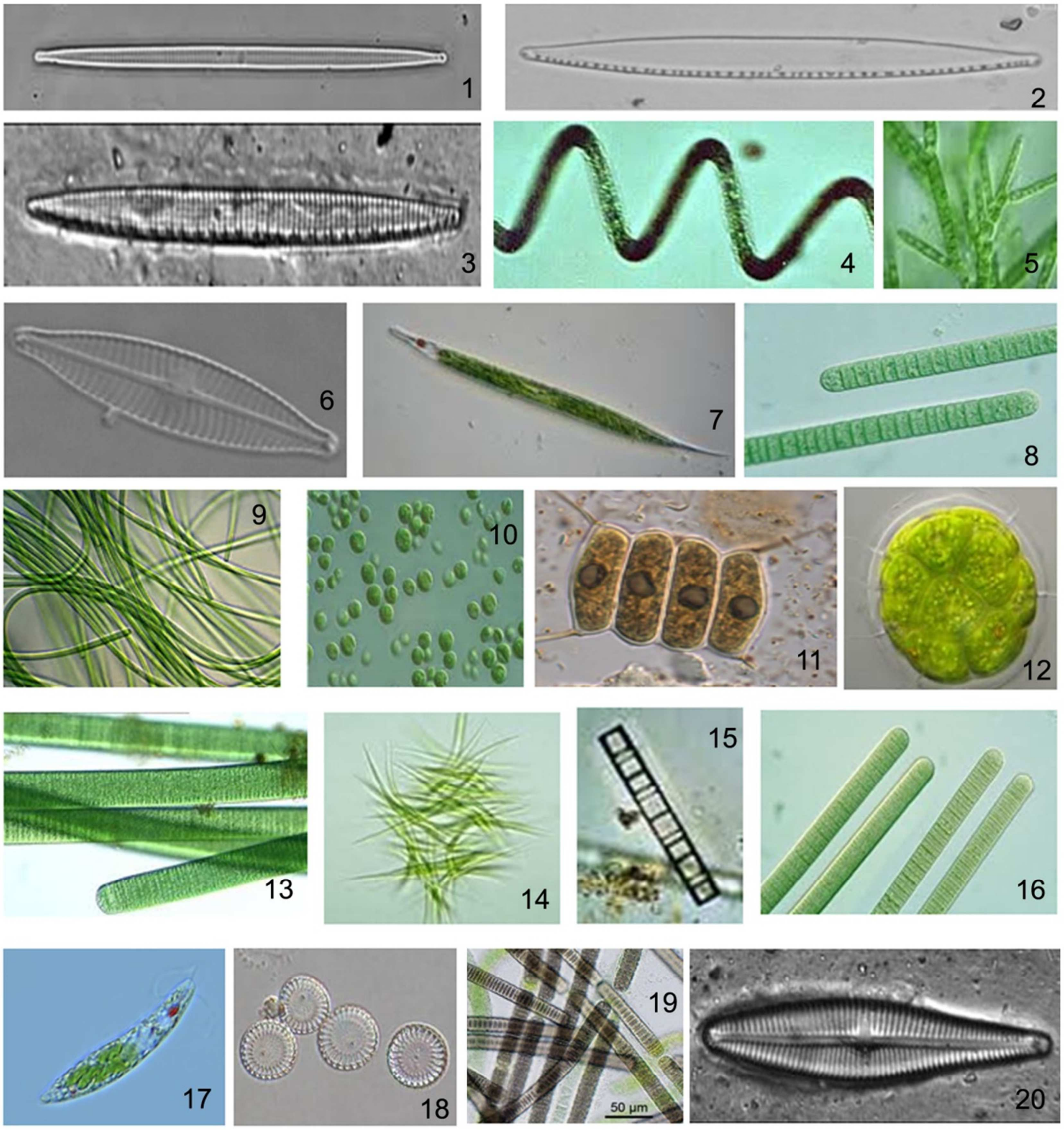
The Louis-Laclercq(2008) index of pollution derived from the OMNIDA GB5.3 is presented in Table 2. The percentage indicators of organic pollution are very high in Bilikere Lake, Arasankere Lake, Karnaji Lake, Dalvoi Lake, and Kurabura Lake. The level of organic pollution is low in Bannur Heggere Lake and Hadhinaru Lake; it is high in 4 lakes and moderate in 9 other lakes. The table also depicts the level of disturbance by human activity (Anthropogenic pollution). Doddakere Lake, Chikkahunsur Lake and Alagudu Lake are heavily polluted due to human interference while the rest of the lakes are highly disturbed. Only 8 lakes are moderately disturbed. The level of degradation in these lakes is always high. The index is derived mainly on the basis of the distribution of diatom species throughout the period of study. Diatom cells often remain undissolved for a longer duration and hence can serve as important indicators of organic as well as anthropogenic pollution.

Further, in such studies were large number of lakes are involved, it is necessary to rank lakes in the order of pollution. The Garrett ranking technique (1924) is an important tool in attributing the ranks. The ranking of each lake is presented in Table 3.The highest polluted lake is Dadadahalli Lake (ranking 1) followed by Dalvoi Lake (ranking 2). The least polluted lakes are Kalale Lake, Makanahalli Lake and ShettyKere Lake. The remaining lakes lie between these values. (Table3). This ranking enables researchers to select lakes for conservation strategies.

At this stage it is necessary to know, whether the indicator algae were indigenous to each of the lakes (allocathonous) or whether they were of occasional occurrence. Some may have been brought into the lake whenever there were rains or must have been introduced by human activity surviving for a few months only. There must have been others that were autochthonous (originating in the lake itself) and completing their life cycles, some of them resulting as blooms during certain seasons. To understand the distribution the data in Table 1 was subjected to Nestedness software (Atmar and Patterson, 1995) and the results are presented in Fig. 2. Nestedness analysis has become increasingly popular in the study of biogeographic patters of species occurrence and the concept of nestedness was proposed independently by Hulten(1937), Darlington(1957) and Daubenmire (1975), Hausdrof and Hennig(2003) to describe patterns of species composition within continental biota and isolated habitats such as islands and landscape fragments(Ulrich *et al*.,2009). Nestedness data are usually organized as a familiar binary, presence-absence matrix; each row is a species, each column is a site (or sampling time) and the entries indicate the presence (1) or absence (0) of a species in a site (Mckoy and Heck, 1987).According to Atmar and Patterson(1995), typically, the matrix is ordered according to the marginal row and column sums, with common species placed in the upper rows, and species rich sites placed in the left hand columns(Fig.2). When the data are organized, nestedness is expressed as a concentration of presence in the upper left triangle of the matrix. The nestedness calculator measures the biogeographic heat of the matrix using the distribution of unexpected species presence and absence within the matrix. Colder the matrix temperature, more packed will be the matrix. The presence-absence matrix contains two levels of information. In addition to specifying which species occur at which site, these matrices reflect the relative hospitability of sites to the species under study as well as the prevalence of environmental conditions needed to support each species. The top most sites are judged to be the most hospitable and the left most species are the ones where niche requirements are not common and prevalent; making it the most resistant to extinction or most prone to colonization. All these explanations are derived from Atmar and Patterson (1995).

In the present study (Fig.2.) Dadadahalli Lake, Dalvoi Lake, Karanji Lake and Doddakere Lake can be judged to be the most hospitable sites; while Chikkahunsur Lake, Makanahalli Lake, Hadhinaru Lake and Kalale Lake take the bottom position in supporting the growth of algae.

Plate1. Indicators of organic pollution



1. Synedra ulna; 2. Nitzschia palea; 3.Nitzschia cryptocephala; 4. Arthrospira jenneri; 5. Stegioclonium tenue; 6. Navicula cryptocephala; 7. Euglena acus; 8. Oscillatoria tenuis; 9. Oscillatoria chlorine; 10. Chlorella vulgaris; 11. Scenedesmus quadricauda; 12. Pandorina morum; 13. Oscillatoria princeps; 14. Ankistrodesmus falcatus; 15. Melosira islandica; 16. Oscillatoria limosa; 17. Euglena viridis; 18. Cyclotella meneghiniana; 19. Oscillatoria putrida; 20. Gomphonema parvalum

Table 1: Algal Index of Genera (Palmer, 1969)(Genera only)

Algal Genera	PI	**L_1**	**L_2**	**L_3**	**L_4**	**L_5**	**L_6**	**L_7**	**L_8**	**L_9**	**L_{10}**	**L_{11}**	**L_{12}**	**L_{13}**	**L_{14}**	**L_{15}**	**L_{16}**	**L_{17}**	**L_{18}**	**L_{19}**	**L_{20}**
Microcystis	1	-	-	1	-	-	-	1	-	1	1	1	-	-	-	1	1	-	-	1	-
Ankistrodesmus	2	2	-	-	2	2	2	2	2	2	2	2	2	2	-	2	-	2	-	-	-
Chlamydomonas	4	4	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	4	4	-	4
Chlorella	3	-	-	-	-	-	-	-	-	-	3	3	3	3	3	-	-	-	-	-	-
Closterium	1	1	1	1	1	1	-	1	-	1	1	1	1	1	1	1	1	-	1	-	1
Cyclotella	1	1	1	1	1	1	-	1	-	-	-	-	-	-	-	1	1	1	-	-	-
Euglena	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	-
Gomphonema	1	1	1	1	1	1	-	-	1	1	1	1	-	-	1	1	1	1	-	-	1
Lepocinclis	1	1	1	1	1	-	1	1	1	1	1	1	1	1	1	1	1	1	1	-	1
Melosira	1	-	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-
Micractinium	1	-	-	1	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-
Navicula	3	-	3	3	3	3	-	-	3	3	3	3	3	3	3	3	3	3	-	3	3
Nitzschia	3	-	3	3	3	3	3	3	3	3	3	3	-	-	3	3	-	-	-	3	3
Oscillatoria	4	4	4	4	4	4	4	4	4	4	-	4	4	4	4	-	-	-	-	4	-
Pandorina	1	1	-	1	1	1	1	1	-	-	1	-	1	-	-	-	-	-	1	1	-
Phacus	2	-	2	2	2	-	-	2	2	2	2	2	2	2	2	2	2	2	2	2	-
Phormidium	1	1	1	1	1	-	-	-	1	1	1	1	1	-	1	1	1	1	1	-	1
Scenedesmus	4	4	4	4	4	4	4	4	4	4	4	-	4	4	4	4	4	4	4	4	4
Stegioclonium	2	2	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
Synedra	2	2	2	2	-	2	2	2	2	2	2	2	-	2	-	2	2	2	2	2	2
Total Score		**29**	**28**	**33**	**31**	**28**	**22**	**27**	**28**	**33**	**31**	**29**	**27**	**28**	**28**	**27**	**22**	**27**	**23**	**25**	**20**

PI=Palmer's Pollution Index;L_1=Bherya Lake; L_2=Bilikere Lake; L_3= Dadadahalli Lake; L_4= Doddakere Lake; L_5=Kabini Lake; L_6=Kalale Lake; L_7=Makanahalli Lake; L_8=Arsankere Lake; L_9= Karanji Lake; L_{10}= Dalvoi Lake; L_{11}= Chikkahunsur Lake; L_{12}= Santhe Lake; L_{13}= Kagglipura Lake; L_{14}=Kurabara Lake; L_{15}=Alagudu Lake; L_{16}= BannurHeggere Lake; L_{17}=Yennehole Lake; L_{18}=Shettykere Lake; L_{19}=Hadhinaru Lake; L_{20}=Bogadi Lake.

Table 2: Species index (Palmer, 1969)

Algal Species	PI	**L_1**	**L_2**	**L_3**	**L_4**	**L_5**	**L_6**	**L_7**	**L_8**	**L_9**	**L_{10}**	**L_{11}**	**L_{12}**	**L_{13}**	**L_{14}**	**L_{15}**	**L_{16}**	**L_{17}**	**L_{18}**	**L_{19}**	**L_{20}**
Ankistrodesmus falcatus	3	3	-	3	3	-	3	3	3	3	3	3	3	3	3	-	3	3	-	-	-
Arthrospira jenneri	2	-	-	2	-	-	-	-	2	-	2	2	-	2	2	2	-	2	2	-	2
Chlorella vulgaris	2	-	-	-	-	-	-	-	-	-	-	2	2	2	-	2	-	-	-	-	-
Cyclotella meneghiniana	2	-	2	2	-	2	2	2	-	-	2	-	-	-	-	-	2				
Euglena viridis	1	1	1	-	-	-	-	-	1	-	-	-	-	-	-	1	-	1	-	-	-
Euglena acus	6	6	6	6	-	-	-	6	-	6	6	6	6	6	-	6	6	6	6	6	-
Gomphonema parvalum	1	1	1	-	1	-	-	-	1	-	1	-	1	-	-	1	1	1	-	-	1
Melosira islandica	2	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Navicula cryptocephala	1	-	-	1	1	1	-	-	-	-	1	1	1	1	1	-	1	1	1	1	1
Nitzschia cryptocephala	1	1	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	1	1	-	1
Nitzschia palea	5	-	5	-	-	-	-	-	5	5	5	-	-	-	5	5	5	-	-	-	-
Oscillatoria chlorina	2	-	-	-	-	-	-	2	2	-	-	2	-	-	-	-	-	-	2	-	-
Oscillatoria limosa	4	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-
Oscillatoria princeps	1	1	-	-	1	-	-	-	-	1	1	-	-	1	-	1	1	-	1	-	-
Oscillatoria putrida	1	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Oscillatoria tenuis	4	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-
Pandorina morum	3	-	-	3	3	3	3	3	-	-	-	-	3	-	-	-	-	3	-	-	-
Scenedesmus quadricauda	4	4	4	4	4	-	4	4	4	4	-	4	4	4	4	-	4	4	4	4	4
Stegioclonium tenue	3	-	-	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Synedra ulna	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Total score		**20**	**22**	**28**	**19**	**15**	**16**	**23**	**21**	**22**	**25**	**23**	**27**	**22**	**18**	**21**	**26**	**25**	**24**	**14**	**14**

PI=Palmer's Pollution Index;L_1=Bherya Lake; L_2=Bilikere Lake; L_3= Dadadahalli Lake; L_4= Doddakere Lake; L_5=Kabini Lake; L_6=Kalale Lake; L_7=Makanahalli Lake; L_8=Arsankere Lake; L_9= Karanji Lake; L_{10}= Dalvoi Lake; L_{11}= Chikkahunsur Lake; L_{12}= Santhe Lake; L_{13}= Kagglipura Lake; L_{14}=Kurabara Lake; L_{15}=Alagudu Lake; L_{16}= BannurHeggere Lake; L_{17}=Yennehole Lake; L_{18}=Shettykere Lake; L_{19}=Hadhinaru Lake; L_{20}=Bogadi Lake.

Table 3: Louis-Laclercq (IDSE/5): Ecological indices of Pollution (OMNIDA software) Based on the appearance of diatoms only

Name of the Lake	% indicators of organic pollution	Rating	% indicators of Anthropogenic Pollution	Rating	Degradation level inside the lake
L_1.Bherya Lake	40.00	Moderate	60.00	High	High
L_2. Bilikere Lake	72-73	Very high	27.27	Moderate	High
L3.Dadadahalli Lake	42.86	Moderate	42.86	Moderate	High
L4.Doddakere Lake	25.00	Moderate	75.00	Very high	High
L5. Kabini Lake	37.50	Moderate	37.50	Moderate	High
L6. Kalale lake	50.00	High	50.00	High	High
L7. Makanahalli Lake	50.00	High	50.00	High	High
L8.Arsankere Lake	66.67	High	33.33	Moderate	High
L9. Karanji lake	62.50	High	37.50	Moderate	High
L10. Dalvoi Lake	72.73	Very high	27.27	Moderate	High
L11. Chikkahunsur Lake	25.00	Moderate	75.00	Very high	Moderate
L12. Santhe Lake	40.00	Moderate	60.00	High	High
L13. Kaggilipura Lake	40.00	Moderate	60.00	High	High
L14. Kurabara Lake	66.67	High	33.33	Moderate	High
L15.Algudu Lake	25.00	Moderate	75.00	Very high	High
L16. BannurHeggere lake	20.00	Low	60.00	High	High
L17. Yennehole lake	60.00	High	30.00	Moderate	High
L18. Shettykere Lake	20.00	Low	60.00	High	Moderate
L19. Hadhinaru Lake	20.00	Low	60.00	High	Moderate
L20. Bogadi Lake	40.00	Moderate	60.00	High	High

Table. 4 Ranking of Lakes according to Henry Garrett based on Palmers algal Index values

Name of the Lake	$R_1(5)$	R_1x65	$R_2(4)$	R_2x 69	$R_3(3)$	R_3x73	$R_4(2)$	R_4x78	$R_5(1)$	R_5x88	Total core	Average score	Rank
L_1.Bherya Lake	1	65	3	207	0	00	3	234	6	528	1034	51.70	**5**
L_2. Bilikere Lake	1	65	2	138	2	146	2	156	5	440	805	40.25	**13**
L_3.Dadadahalli Lake	1	65	2	138	2	146	3	234	8	704	1287	64.35	**1**
L_4.Doddakere Lake	1	65	2	138	2	146	3	234	6	528	1111	55.55	**4**
L_5. Kabini Lake	1	65	2	138	2	146	2	156	5	440	945	47.25	**10**
L_6. Kalale lake	1	65	2	138	1	73	2	156	2	176	608	30.40	**18**
L_7. Makanahalli Lake	1	65	2	138	1	73	2	156	2	176	608	30.40	**18**
L_8.Arsankere Lake	1	65	2	138	2	146	3	234	3	264	847	42.35	**12**
L_9. Karanji lake	1	65	3	207	2	146	3	234	6	528	1180	59.00	**3**
L_{10}. Dalvoi Lake	1	65	1	69	3	219	3	234	7	616	1203	60.15	**2**
L_{11}. Chikkahunsur Lake	1	65	1	69	3	219	2	156	5	440	949	47.45	**9**
L_{12}. Santhe Lake	1	65	2	138	2	146	3	234	4	352	935	46.75	**11**
L_{13}. Kaggilipura Lake	1	65	2	138	2	146	1	78	3	264	691	34.55	**16**
L_{14}. Kurabara Lake	1	65	2	138	3	219	3	234	4	352	1008	50.40	**6**
L_{15}.Algudu Lake	1	65	1	69	2	146	2	156	6	528	964	48.20	**8**
L_{16}. BannurHeggere lake	1	65	1	69	1	73	3	234	6	528	969	48.45	**7**
L_{17}. Yennehole lake	1	65	2	138	1	73	3	234	5	440	950	47.50	**9**
L_{18}. Shettykere Lake	1	65	2	138	0	00	3	234	4	352	789	39.45	**14**
L_{19}. Hadhinaru Lake	1	65	2	138	2	146	2	156	2	176	622	31.10	**17**
L_{20}. Bogadi Lake	0	00	2	138	2	146	1	78	4	352	714	35.70	**15**

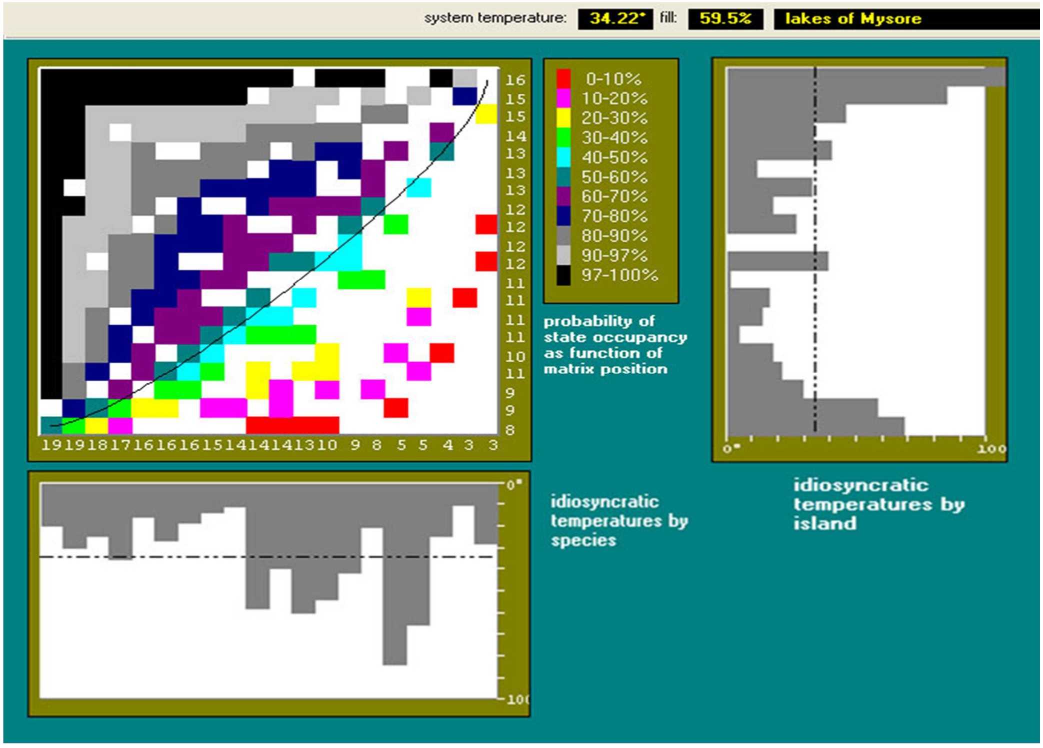


Fig.2. Nestedness of algae in lakes of Mysore district.

On consideration of the distribution of algal genera in the present study it is observed that *Euglena* and *Synedra* are genera where niche requirements are most common and prevalent. These are most resistant to extinction. Lower down are species of *Gomphonema* and *Oscillatoria.* However species of *Ankistrodesmus, Pandorina, Cyclotella, Chlamydomnas* and *Chlorella* are highly sensitive to environmental conditions and therefore appear occasionally. Species of *Euglena, Scenedesmus, Lepocinclis* and *Synedra* are highly resistant and are autochthonous in origin and appear regularly in almost all lakes. The matrix fill of the species in the present study is low (59.5%). This may be due to lack of species distribution in the lakes. Secondly the system temperature is also considerably warm (34.22^0).If the matrix is highly packed, the system temperature will be colder. Further, random matrices contribute to the temperature of the matrix in two ways. One is the random variation of environmental, demographic and possibly genetic stochasticity, while the other is coherent temperature of specific biogeographic events. The first sets produce uniform bands. In contrast, coherent events generate idiosyncratic spikes in species or site temperatures that are much hotter than the overall matrix temperatures (Atmar and Patterson(1995).(Fig. 2). The sites can be reorganized in descending order(Atmar and Patterson,1995) (Table 5 and Table 6).

Many of the genera selected as indicators of organic pollution by Palmer (1969) are those which were idiosyncratic or those that appeared occasionally when the environmental conditions were favourable. Probably these were predominant during all seasons and each author has reported based on their mere presence. Therefore it is essential to select organisms that are always present and indicate the level of organic pollution. Nestedness software (Fig.2) detects the algal species of autochthonous or allocathonous origin which can be used as indicators of water quality.

Table 5: Lake Reorganization Vector

Current row position	Original row position	Lake
1	3	Dadadahalli Lake*
2	10	Dalvoi Lake*
3	9	Karanji Lake*
4	4	Dodakere Lake*
5	1	Bherya Lake
6	15	Alagudu Lake
7	11	ChikkaHunsur Lake*
8	7	Makanahalli Lake*

9	17	Yennehole Lake
10	2	Bilikere Lake
11	5	Kabini Lake
12	16	Bannur Heggere Lake
13	13	Kaggilipura Lake
14	14	Kurabara Lake
15	8	Arsankere Lake
16	18	Shettykere Lake
17	12	Santhe Lake
18	19	Hadhinaru Lake
18	20	Bogadi Lake
20	6	Kalale Lake

(Original row position: Table 1)(* Idiosyncracytic temperatures for Lakes)

Table 6: Algal generation Reorganization Vector

Current row position	Original column Position	Species name
1	7	*Euglena*
2	18	*Scenedesmus*
3	9	*Lepocinclis*
4	20	*Synedra*
5	5	*Clsterium*
6	12	*Navicula*
7	16	*Phacus*
8	17	*Phormidium*
9	8	*Gomphonema**
10	14	*Oscillatoria**
11	13	*Nitrzschia*
12	2	*Ankistrodesmus**
13	15	*Pandorina**
14	6	*Cyclotella**
15	1	*Microcystis*
16	3	*Chlmydomonas**
17	4	*Chlorella**
18	19	*Stigioclonium*
19	11	*Micractinium*
20	10	*Melosira*

(Original column position: Table 1)(* Idiosyncratic temperatures for species showing unexpected absences))

4.0. Conclusions

The pollution index of Plamer(1969) developed for rating of water samples as high or low organically polluted is a useful technique, since algal populations are used. However the number of genera or species provides a limited scope for the study. There are several other genera that can indicate organic pollution but are not included in the list. So also there are newer techniques for detection of organic pollution. According to the Palmer's algal index all the lakes are categorized as organically polluted. One of the well developed technique for detection of organic pollution is the OMNIDA GB 5.3 soft ware. This software uses only diatoms for the detection of organic pollution. It can also suggest the levels of degradation in any water body and as well detect which diatoms are autochathonous and which are allocathonous.Diatoms remain as benthic or epiphytic forms and can serve as good indicators of organic pollution. While determining the quality of any water body it is of importance to take the help of well developed softwares that can give precise results. The consise results can be applied in the conservation of heavily polluted lakes.Further "Nestedness calculator" is an excellent tool to understand which algal species show unexpected absence of presence and whether the distribution of algal species is well marked or unevenly distributed. This is however based on the ecological factors controlling the growth of algae. The matrix fll and the systems temperature are important aspects of the software . Colder system temperatures, have a highly packed matrix. Idiosyncratic-species appearing or dissappearing suddenly can be marked and only algae that survive in the lakes for longer duration can be used for WQI.Dadadahalli Lake, Dalvoi Lake and Karanji Lake are the highest organically polluted and species of *Euglena, Scenedesmus, Lepocinclis* and *Synedra* are the top indicators of the water quality. The ranking technique is also another important aspect. The technique enables the researcher to place the sities under study from the most polluted to the least polluted or compare similar sites for conservation strategies. These techniques put together can be a better way of studying organic pollution in lakes. Palmer's index is highly useful but is based on the reports of authors and probably does not consider the season, number or the place of occurrence. The combination of all the newer techniques can be very useful in conservation strategies of lake ecosystems.The observations in the present study indicate that all the 20 lakes are organically polluted, but the degree of pollution varies to a greater extent.There is also a need to add more species to the list of algae tolerating organic pollution and apply integrated techniques of improving water quality in lakes.

5.0 Acknowledgement
The author is greatful to Prof. K.V. Prabhakara, Principal for facilities and to M.Mahesh,Assistant Librarian for the technical assistance.

References:
1) Atmar.W. and B.D. Patterson (1995) The nestedness temperature calculator. A visual basic program including 294 presence absence matrices"AICS Research Inc. University Parle N.M. and the Field Museum. Chicago.IL
2) Blanco. I.A. and S. Blanco (2012) The Duro Diatom Index(DDI) for river water quality assessment in N.W. Spain: Design and Validation. Environ. Monit Assess DVI 10.1007/s 10661-012-2607z
3) Darlington,P.J (.1957). Zoogeography:the geographical distribution of animals-Wiley
4) Daubenmire,R.(1975). Floristic plant geography of eastern Washington and northern Idaho-J.Biogeorg,2:1-18
5) Desikachary. T.V.(1959). Cyanophyta. ICAR Publications, New Delhi
6) Gandhi.H.P. (1998). Freshwater diatoms of central Gujarat, with rivew and some others. Bishen Singh Mahendra Pal Singh Publishers, Deharadun
7) Garrett, Henrey (1924). An empirical study of the various methods of combining incomplete order of merrit ratings. Journal of Educational Psychology(15)3:157-171.
8) Hausdrof.B and Hening, C. (2003).Nestedness of north-west European land snail ranges as a consequence of differential immigration from Pleistocene glacial refuges-Oeclogia 135:102-109
9) Hosmani.S.P. and S.G. Bharathi (1980). Algae as indicators of organic pollution. Phykos 19(1):23-26
10) Hosmani.S.P. 2010. Phytoplankton diversity in lakes of Mysore district, Karnataka State, India. The Ecoscan 4(1)53-57.
11) Hosmani,S.P. (2012a). Application of benthic diatom community in lake water quality monitoring. OIIRJ.II(III):21-34.
12) Hosmani. S.P. (2012b).Multivariate analysis for distribution of Euglenophyceae in Karanji Lake of Mysore. PHYKOS 42(2)74-79
13) Hosmani.S.P and T.B. Mruthunjaya (2013.)Impact of plankton diversity on the water quality index in a lake at Thirumakudal Narasipura, Mysore district. International Journal of Innovative Research in Science, Engineering and Technology 2(5):1434-1441.
14) Hultein,E (1937). Outline of the history of Arctic and Boreal biota during the quartenary period.Thule, Stockholm.
15) Kelly. M.G (2006) A comparasion of diatoms with other phytobenthos as indicators of ecological status of streams of Northern England. In ed/Witowski.A. Proceedings of the 18th International Diatom Symposium. Bristol:131-151.
16) Lackey J.P. (1938) .Public Health Reports 53:2080-2091.
17) Lecoinite C., M.Coste and J. Prygeil (2003). OMNIDA: Diatom Index Software including diatom data base with taxanomic names, references and codes of 11645 diatom taxa.
18) Louis-Laclereq (2008). IDSE Diatom Index of saprobity-Eutrophication conception (in Lecoinite *et.al*. 1993)
19) McKoy,E.D. and Heck,K.L. (1987). Some observations on the use of taxanomic similarity in large-scale biogeography.J. biogeogr.14:79-87
20) Nygaard.G. (1976). Talverna fra Danst.Phytoplankton. Cyledandl. Pp.22.
21) Palmer. G.M. (1959) Algae of water supplies. U.S. Publ. Health Services Publication 657:1-85
22) Philipose.M.T. (1960). Chlorococcales. ICAR Publication New Delhi
23) Prescott.G.W. (1982). Algae of the Western Great Lakes Area. Otto Kaetz Science Publishers. W. Germany pp.977.
24) Sarode P.T. and N.D. Kamath (1984). Fresh water diatoms of Maharastra. Saikrupa Prakashan, Aurangabad.pp.338.
25) Scott.A. and G.W. Prescott (1961). Indonesian Desmids, Hydrobiologia XVIII. 25(4):131
26) Sudeep.B.M, T.B. Mruthunjaya and S.P. Hosmani(2007). Principal Component Analysis:an appropriate tol for water quality evaluation and management. Application n trwo lakes of Mysore District.Indian Hydrobiology.10(2):381-391
27) Suxena.M.R. (1987). Environmental Analysis: Water, Air and Soil. Agrobotanical Publishers, India
28) Taylor.J.C, W.R. Harding and C.G.M. Archibald (2007). An illustrated guide to common diatom species from South Africa. WRL Report TT 282.
29) Ulrich,W, Mario A. Neto and Nicholas J.G. (2009). A consumers guide to nestedness analysis. Okios 118: 3-17.
30) West.W and G.S. West (1909)The British Freshwater Plankton and the distribution of desmids.Proc.Roy.Soc.D.81:165-206.