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Research Article

A Study on Diversity and Abundance of Micro-Phytoplankton in River Cauvery and its four Upstream Tributaries in South Karnataka, India

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ABSTRACT

The phytoplanktons are the common primary producers contribute substantial amount of dissolved oxygen. Dynamics of all aquatic ecosystems center on the primary productivity. Over all investigation revealed that the presence of phytoplankton species like, Gomphonema, Navicula, Cyclotella, Melosira, Nitzschia, Synedra, Scenedesmus, Chlorella, Ankistrodesmus, Oocystis, Closterium, Gloeocystis, Crucigenia, Chlorococcum, Spirogyra, and Ulothrix etc., were recognized as pollution indicators. One liter of mid stream surface water samples were collected and preserved in 10% Lugols–Iodine. Phytoplanktons were counted by Lackey's drop method using Epifluorescence microscope. SNK test revealed that river Lakshmanatheertha exhibit significant difference. Calculations of Pearson's correlation coefficients ($p<0.01$) showed positive correlation of mean abundance of micro phytoplanktons with micro zooplankton. Further, utilization of organic matter in aquatic environments by the bacteria is through the phytoplankton. Several physico-chemical factors and varying influx conditions cause changes in phytoplankton abundance and diversity. Chlorophyll-a is considered as the most reliable index of phytoplankton abundance and biomass. Temperature, pH and conductivity were important in the distribution and abundance of phytoplanktonic species. Increased algal growth was recorded in the presence of micro nutrients such as chloride, TASA and calcium. The initial hypothesis that the four upstream tributaries are similar to each other in mean abundance of micro phytoplankton, but are markedly different from that of main river Cauvery was rejected. In this investigation more abundance of phytoplankton was noticed in the river Lakshmanatheertha, this was due to more contamination of industrial and sewage pollution, suggests that this river was more favorable to abundance of micro phytoplankton.

Keywords: *Micro phytoplankton, Zooplankton, Rivers, Environmental variables, Microbial variables*

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INTRODUCTION

Phytoplanktons are the primary producers of any aquatic habitat, they floats passively in water surface and sometimes, they may extend down to various depths where light is available for photosynthesis. Phytoplanktons, include green algae, blue green algae, diatoms, desmids, euglenoids etc., are important among the aquatic flora. They are ecologically significant as they form the basic link in the food chain of all aquatic animals, and when in large numbers they make the water greenish (Misra et al., 2001; Harsha & Malammanavar, 2004), Several, physico-chemical factors (Homyra and Sabrina Naz, 2006) and varying influx conditions (Hunszar & Reynolds, 1997) can markedly influence the aquatic system, and cause changes in the phytoplankton abundance, diversity and succession Sharma *et.al* 2007. In case of blooms or scum, Cyanobacteria pose a series of problems for water quality, fisheries resources, agriculture and human health (Codd, 1995). The planktonic algae contribute substantial amount of dissolved oxygen in the aquatic systems (Harilal, 2005). Micro algae are indeed the biological starting point for energy flow in the food chain in most aquatic ecosystems (Rahaman & Sosamma E., 2003), and also gives information relating to the amount of energy available to support bioactivity of the system (Saha et al., 2001). The dynamics of all aquatic ecosystems center around primary productivity for supports different food chain and food webs (Mishra and Tripathi, 2002). The magnitude and dynamics of primary production has become an essential parameter to assess the state of pollution in aquatic ecosystems. In polluted environment majority of plants and animals find it difficult to survive but those which could tolerate the stress of pollution alone may survive. These individuals can act as indicator of pollution, more specifically bioindicators of the trophic state of the ecosystem (Danielkutty & Sobha, 2006, Malik & Umesh Bharti, 2012). Algae are simplest plants inhabiting all kinds of habitats and are sensitive to pollution, hence are called biological indicators of water quality (Hegde and Sujata, 1997). Algae are significantly involved in water pollution and they bring about an enrichment of algal nutrients in water and this may selectively stimulate the growth of a few types producing massive surface growths or "blooms" that inturn reduce the water quality. Certain algae are able to flourish in water polluted with organic wastes and play an important part in 'Bio – purification' of the water body (Palmer, 1980). Generally, in aquatic environment more information is available on abundance of phytoplankton with respect to marine and lentic waters only. Very few studies are available on Indian lotic fresh waters, *viz.* on physico-chemical (water quality) parameters of river Mahanadi (Mithra, 1995), on pollution status of river Sabarmati at Kheda (Jamson & Rana, 1996), impact of sewage on Diatom community in river Alakananda (Nautiyal et al., 1996), on toxic metals of river Ramaganga at Moradabad (Sharma and Pande, 1999), on river Parvathyputhanar (Prasanthan & Nayar, 2000), on Quality of water in Parvathyputhanar in Thiruvananthapuram (Jayashree, 2002), on Vamanapurum river of Thiruvanathapurum, Kerala (Mini et al., 2003) and on lotic ecosystems in and around Courtallam, Tamil Nadu (Drusilla et al., 2005). Earlier studies carried out on river Cauvery includes, rotifers as biological indicators of water quality (Sampath *et al*., 1979), phytoplankton as indicators of water quality (Somashekar, 1985; Suvarna & Somashekar, 1997a and 1997b). However, not much more information is available on the abundance of micro-phytoplankton in river Cauvery and its important tributaries in Karnataka state, India.

MATERIALS AND METHODS

One liter of mid stream surface water samples from rivers Lakshmanatheertha, Harangi, Hemavathy, Lokapavani and Cauvery were collected in polythene cans for the study of micro phytoplankton fortnightly during the study periods. The water samples were preserved in 10% Lugols–Iodine solution, since, absorption of Iodine from Lugols solution by plankton cells promotes settling of the cells. Further, it stains the cells and also preserves flagella intactly. Micro phytoplankton, from one liter preserved samples was concentrated by sedimentation method for 24 hours. The sedimentation was concentrated to only 20ml, by siphoning off the remaining 980ml of the supernatant. Their abundance was counted by Lackey's (1938) drop method. The total number of Phytoplanktons was counted separately by examining one drop of water on a slide under 40X magnification using Epifluorescence microscope (BX40, Olympus, Japan). Identification was done by following Fritsch (1975), Desikachary (1959) and Anand (1998). The number of micro phytoplankton was calculated by using the formula of (Nomita Sen et al., 1992).

$$\text{Number of Organisms } ml^{-1} = \frac{\text{A X 1 / L X n / V}}{1000}$$

Where A= Number of organisms per drop.
V= Volume of one drop (0.05 ml)
n= Total volume of concentrated sample (20 ml)
L= Volume of original sample (1 liter).

The mean abundance of log $_{10}$ transformed values of micro-Phytoplanktons data were used for one-sample Kolmogorov-Smirnov test, the Student–Neuman-Keuls test, one-way ANOVA, calculation of Pearson's correlation coefficients and stepwise multiple regression analysis.

RESULTS

A summary of abundance of micro phytoplankton, measured for all the rivers studied revealed that, the mean abundance of micro-phytoplankton was similar in the rivers Harangi (11 Org. ml^{-1}) and Hemavathy (10 Org. ml^{-1}), but was significantly more in river Lakshmanatheertha (19 Org. ml^{-1}) followed by river Cauvery (14 Org. ml^{-1}) and river Lokapavani (13 Org. ml^{-1}). The SNK test showed that, the mean abundance of micro-phytoplankton in the river Lakshmanatheertha was more and also significantly different from all the rivers studied. Whereas, in the river Cauvery and Lokapavani it was similar and also significantly different than other three water courses. It is noteworthy that the lowest number (5 Org. ml^{-1}) of micro-phytoplankton was recorded in the rivers, Lakshmanatheertha, Harangi, Hemavathy and Lokapavani, and highest number (69 Org. ml^{-1}) in the river Lakshmanatheertha were the lowest and highest numbers among the five rivers (Table 1).

The abundance of micro phytoplankton, showed few correlations with the other microbial and physico-chemical (water quality) variables (Tables 2 and 3). In the river Lakshmanatheertha the mean abundance of micro phytoplankton showed positive correlations with Abundance of micro zooplankton and total micro plankton among other microbial variables, and with Temperature, Conductivity, BOD, Carbon di-Oxide, Chloride, TASA, Calcium and Chlorophyll-a, and negatively correlated only with the SWV among water quality variables. In the river Harangi, it showed positive correlation with the abundance of particle bound bacteria, abundance of total bacteria, micro zooplankton and total micro plankton and with pH (F), Conductivity, Chloride, TASA, Nitrate and Chlorophyll-a and negatively correlated with Rainfall and COD. In the river Hemavathy, the micro phytoplankton was positively correlated with the abundance of free living bacteria, total bacteria and total plankton and negatively correlated only with pH (L). In the river Lokapavani, it was positively correlated only with the total plankton and negatively with the CFU's and only with Chlorophyll-a among the water quality variables. In the river Cauvery, the abundance of micro phytoplankton was positively correlated with the micro zooplankton and total plankton; and only negatively correlated with pH (L).

The density of micro phytoplankton under different classes is given in the Table 4. All the phytoplankton identified in the five watercourses was classified under Chlorophyceae, Cyanophyceae, Bacillariophyceae and Euglenophyceae. Members of Bacillariophyceae and

Chlorophyceae were dominant followed by Cyanophyceae and Euglenophyceae. Further, the Bacillariophyceae showed more abundance than the Chlorophyceae in all the five rivers. Generally, Euglenophyceae members represented less in number compared to other three groups. Species composition and frequency distribution of four different classes revealed that, total 57 types of micro phytoplankton were identified up to generic level. The largest and most diverse group was Chlorophyceae comprising 30 genera followed by Bacillariophyceae 14 genera, Cyanophyceae 10 genera and Euglenophyceae 3 genera However, frequency of occurrence of Bacillariophyceaean genera were more compared to Chlorophyceaean genera (Tab. 5).

Table 1: Mean values of Micro-Phytoplankton variable in the surface waters of the rivers Lakshmanatheertha, Harangi, Hemavathy, Lokapavani and Cauvery

Microplankton variables	River Lakshmanatheertha			River Harangi			River Hemavathy			River Lokapavani			River Cauvery		
	Mean	(Range)	CV (%)	Mean	(Range)	CV (%)	Mean	(Range)	CV (%)	Mean	(Range)	CV (%)	Mean	(Range)	CV (%)
Phytoplankton (Org ml^{-1})	19.00*	(0.5.00-69.00)	73	11.00^{b}	(05.00-27.00)	52	10.00^{b}	(05.00-17.00)	35	13.00^{c}	(05.00-34.00)	44	14.00^{c}	(06.00-38.00)	42

Mean Values with different superscripts are significantly different (P<0.05, Student-Newman-Keuls test, after log_{10} transformation).
CV = Coefficient of Variation.

Table 2: Relationships between Micro-phytoplankton (Org l^{-1}) and other Microbial variables

Sampling sites	DC-FLB	DC-PBB	DC-TB	CFUs	%CCFUs	CFUs as% of AODCs	SGR	ML-FLB	ML-PBB	Zooplankton	Total plankton
Phytoplanktons											
River Lakshmanatheertha	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.57***	0.98***
River Harangi	NS	0.30*	0.29*	NS	NS	NS	NS	NS	NS	0.45***	0.99***
River Hemavathy	0.30*	NS	0.30*	NS	NS	NS	NS	NS	NS	NS	0.96***
River Lokapavani	NS	NS	NS	-0.34*	NS	NS	NS	NS	NS	NS	0.98***
River Cauvery	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.33*	0.97***

DC-FLB= Directly Counted Free Living Bacteria, DC-PBB= Directly Counted Particle Bound Bacteria, DC-TB= Directly Counted Total Bacteria, CFUs=Colony Forming Units, CCFUs = Chromogenic Colony Forming Units, CFUs as% AODCs= Colony Forming Units as Percentage of Acridine Orange Direct Counts, SGR = Specific Growth Rate, ML-FLB = Mean length of Free Living Bacteria, ML-PBB= Mean length of Particle Bound Bacteria.

Table 3: Relationships between Micro-phytoplankton (Org l^{-1}) and Environmental variables

Sampling sites	Ph(F)	pH (L)	Temp	Cond	Turb	SWV	RF	DO	BOD	COD	CO_2	Cl_2	NO_3	SO_4	TASA	Cal	PO_4	TSS	POM	Chl-a
Phytoplanktons																				
River Lakshmanatheertha	NS	NS	0.44**	0.44**	NS	-0.32*	NS	NS	0.37*	NS	0.40**	0.44**	NS	NS	0.42**	0.40**	NS	NS	NS	0.72***
River Harangi	0.333*	NS	NS	0.44**	NS	NS	-0.30*	NS	NS	-0.28*	NS	0.32*	0.35*	NS	0.29*	NS	NS	NS	NS	0.57***
River Hemavathy	NS	-0.36*	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
River Lokapavani	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.34*
River Cauvery	NS	-0.30*	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

pH(F) = pH measured in the field, pH (L) = pH measured in the lab, Temp = Temperature, Cond = Conductivity, Turb = Turbidity, SWV = Surface Water Velocity, RF = Rainfall, DO = Dissolved Oxygen, BOD = Biological Oxygen Demand, COD = Chemical Oxygen Demand, CO_2 = Free Carbon di-Oxide, Cl_2 = Chloride, NO_3 = Nitrate, SO_4 = Sulphate, TASA = Total Anions of Strong Acids, Cal = Calcium, PO_4 = Inorganic Phosphate, TSS = Total Suspended Solids, POM = Particulate Organic Matter, Chl-a = Chlorophyll-a.

Table 4: Density of Micro-phytoplankton (Org l^{-1}) under different classes

Sl. No.	Classification	River Lakshmanatheertha	River Harangi	River Hemavathy	River Lokapavani	River Cauvery
1	Chlorophyceae	7,92,000	4,13,000	2,45,000	2,36,000	3,50,000
2	Cyanophyceae	2,47,000	1,11,000	86,000	1,37,000	1,49,000
3	Bacillariophyceae	12,02,000	7,87,000	7,76,000	9,89,000	11,73,000
4	Euglenophyceae	1,56,000	1,19,000	45,000	72,000	50,000

Table 5: Species composition and frequency distribution of different groups of Phytoplankton

Sl. No.	Phytoplanktons	River Lakshmana - theertha	River Harangi	River Hemavathy	River Lokapavani	River Cauvery
	Chlorophyceae					
1	*Chlorella* sp.	+++	++	+	+	++
2	*Ankistrodesmus* sp.	+	+	+	+	+
3	*Spirogyra* sp.	+++	+	-	+	+
4	*Crucigenia* sp.	+	-	-	-	-
5	*Tetraedron* sp.	+++	+	+	+	+
6	*Cosmarium* sp.	-	++	++	+	+
7	*Kirchneriella* sp.	+	-	+	-	-
8	*Pediastrum* sp.	+	-	-	-	-
9	*Palmella* sp.	+	+	-	-	+
10	Scenedesmus sp	+++	+	+	+	+
11	*Oocystis* sp.	+++	+	+	+	+
12	*Westella* sp.	+	+	-	-	-
13	*Closterium* sp.	+++	+	-	+	+
14	*Schroederia* sp.	++	+	+	+	-
15	*Golenkinia* sp.	+	+	+	+	-
16	*Chlorococcum* sp.	+	+	+	+	+
17	*Tetrastrum* sp.	++	+	-	-	-
18	*Phytococineis* sp.	+	-	-	-	-
19	*Pondorina* sp.	+	-	-	-	+
20	*Actinastrum* sp.	-	+	+	-	+
21	*Zygnema* sp.	-	+	+	-	+
22	*Chlamydomonas* sp.	++	+	+	+	+
23	*Gloeocystis* sp.	+	-	-	-	-
24	*Eudorina* sp.	+	-	-	+	-
25	*Oedogonium* sp.	+	-	-	-	-
26	*Desmidium* sp.	-	+	-	-	-
27	*Pachycladon* sp.	-	-	-	-	+
28	*Ulothrix sp*	+++	-	-	+	-
29	*Coelastrum sp*	+	+	-	+	+
30	*Trochiscia sp*	+	-	-	-	-
	Cyanophyceae					
1	*Chlorococcus* sp.	+	-	-	-	-
2	*Oscillatoria* sp.	+++	+	++	++	++
3	*Phormidium* sp.	++	+	-	+	-
4	*Spirulina* sp.	+++	+	+	++	+
5	*Merismopedia* sp.	+++	+	+	+	+
6	*Anabaena* sp.	+	-	-	-	+
7	*Apanocapsa* sp.	+	+	-	+	+
8	*Raphidiopsis* sp.	+	-	-	-	-
9	*Lyngbya* sp	+	-	-	-	+
10	*Gomphosporia* sp	+	+	-	-	+
	Bacillariophyceae					
1	*Gomphonema* sp.	+++	++	++	++	+++
2	*Cocconeis* sp.	++	++	++	++	++

3	*Synedra* sp.	+++	++	+	++	++
4	*Navicula* sp.	+++	+++	+++	+++	+++
5	*Fragilaria* sp.	+++	+++	++	++	+++
6	*Cyclotella* sp.	+++	+	+	+++	++
7	*Cymbella* sp.	++	+	+++	++	+++
8	*Nitzschia* sp.	+++	+	+	++	++
9	*Amphora* sp.	++	+	+	+	-
10	*Gyrosigma* sp.	+++	+	+	+	+
11	*Pinnularia* sp.	+	+	+	+	+
12	*Melosira* sp.	+	++	++	++	+
13	*Strauneis* sp	+	+	-	-	-
14	*Surirella* sp	-	+	-	+	+
Euglenophyceae						
1	*Trachelomonas* sp.	+++	++	+	+	+
2	*Euglena* sp.	++	+	+	+	++
3	*Phacus* sp	++	+	+	++	++

+++= Abundant, ++= Frequent, + = Rare, - = Absent.

Table 6: Multiple regression analysis between Micro-phytoplankton (Org l^{-1}) and physico-chemical variables in river Cauvery and its tributaries

Sampling sites	
Micro-phytoplankton variable	Physico-chemical variables
River Lakshmanatheertha	Chl-a (+), COND (+) , (R^2 = 0.56, F = 30.0, P<0.001), Temp (+), SWV (+), BOD (+), CO_2(+), Cl_2(+), TASA(+), Cal(+).
River Harangi	Chl-a (+), (R^2 = 0.32, F = 23.02, P<0.001), FpH (+), COND (+), Rainfall (-), COD (-), Cl_2 (+), NO_3 (+), TASA (+).
River Hemavathy	LpH (-), (R^2 = 0.13, F = 7.22, P<0.005).
River Lokapavani	Chl-a (+),(R^2 = 0.12, F = 6.37, P<0.001),
River Cauvery	LpH (-),(R^2 = 0.32, F = 23.02, P<0.001),

Note: pH(F) = pH measured in the field, pH (L) = pH measured in the lab, Temp = Temperature, Cond = Conductivity, Turb = Turbidity, SWV = Surface Water Velocity,
RF = Rainfall, DO = Dissolved Oxygen, BOD = Biological Oxygen Demand, COD = Chemical Oxygen Demand, CO_2 = Free Carbon di-Oxide, Cl_2 = Chloride,
NO_3 = Nitrate, SO_4 = Sulphate, TASA = Total Anions of Strong Acids, Cal = Calcium, PO_4 = Inorganic Phosphate, TSS = Total Suspended Solids, POM = Particulate
Organic Matter, Chl-a = Chlorophyll-a.

DISCUSSION

The result described here showed that, the mean abundance of micro-phytoplankton in the river Lakshmanatheertha was more and also significantly different than the other water courses studied. The initial hypothesis that the four upstream tributaries are similar to each other in mean abundance of micro phytoplankton, but are markedly different from that of main river Cauvery was rejected. The low level of water, maximum anthropogenic activities, discharge of sewage, agricultural wastes and other untreated effluents contamination, all of which enriches the nutrient level in the water, might be the reason for increased abundance of micro phytoplankton in the river Lakshmanatheertha. Similarly, Gadhia, et al., 2000, was reported that higher concentration of nutrient discharge causes increased abundance of micro phytoplankton. Somashekar (1988) reported the high algal growth in river Cauvery due to discharge of effluent. Calculations of Pearson's correlation coefficients (p<0.01) between mean abundance of micro-phytoplankton, and other microbial or environmental variables (Tables 2 and 3) did not show uniform pattern. In the rivers Lakshmanatheertha, Harangi and Cauvery, the micro phytoplankton showed significant positive correlation with micro zooplankton. This implies, the micro zooplankton represented the most important consumers of phytoplankton production (Froneman, 2000). Similarly, the maximum phytoplankton abundance often associated with high ciliate abundance (Alder et al., 2000). Further, the mean abundance of micro phytoplankton showed positive correlations with the abundance of particle bound bacteria and total bacteria in the river Harangi, and with free-living bacteria and total bacteria in the river

Hemavathy. Bacterial utilization of organic matter is significant in aquatic environments and its supply through the phytoplankton (Bertilsson & Jones, 2003; Cesar Daniel et al., 2005). Whereas, the negative correlation of micro phytoplankton with CFU's in the river Lokapavani suggest that both are considered to be competitors for dissolved mineral nutrients (Chrzanowski & Grover, 2001).The positive correlation between micro phytoplankton with Chlorophyll-a in the rivers Lakshmanatheertha, Harangi and Lokapavani, implies that Chlorophyll-a is considered as the most reliable index of phytoplankton abundance and biomass (Tripathy et al., 2005). Significant positive correlations with pH in river Harangi and with temperature in the river Lakshmanatheertha, revealed temperature and pH were important in the distribution and abundance of phytoplanktonic species (Bouvy et al., 2000). Similarly, the positive correlation of conductivity with phytoplankton abundance in Lakshmanatheertha and Harangi rivers, suggests, high electric conductivity in water influence the biological productivity (Sarojini, 1994), and also positively correlated with the BOD in the river Lakshmanatheertha only, this in agreement with the similar findings of Pandey et al., 2000. A significant positive correlation also noticed with the Nitrate in the river Harangi. The high concentration of Nitrate favored the phytoplankton abundance in fresh waters (Philiphose, 1959; Munawar, 1970). In the river Lakshmanatheertha, the mean abundance of micro phytoplankton was positively correlated with the Carbon di-Oxide. The important substances involved in this growth are nitrogenous compounds together with Carbon di-Oxide (Palmer, 1980). Similar positive correlation also noticed with the chloride and TASA in the rivers Lakshmanatheertha and Harangi, and with calcium in river Lakshmanatheertha, suggesting, Chloride, TASA and Calcium were the micro nutrients; their increased concentration in water might have favored the increased growth of algae (Sengar et al., 1985). Whereas, the surface water velocity in the rivers Lakshmanatheertha and Harangi, and rainfall in the river Harangi, showed significant negative correlations, because high flow due to rain influences the increased concentration of turbidity in the water, which inturn reduces the phytoplankton production and abundance (Yakovlev, 2001). Micro-phytoplankton plays a key role in maintaining proper equilibrium between abiotic and biotic components of ecosystem. Being an index of trophic status, phytoplankton reflects the overall environmental condition of the system and its potentiality (Agarwal et al., 1993). In the present investigation the group Bacillariophyceae showed dominance in terms of density in all the five watercourses studied. The finding is in conformity with the reports of Imevbore (1970) in the river Niger, and Tiwari et al., (2000) in the river Ganga. The group Bacillariophyceae particularly *Gomphonema* and *Navicula* species have also been selected as indicators of certain industrial wastes and sewage (Palmer, 1980). In this study *Gomphonema* sp. was abundant in rivers Lakshmanatheertha and Cauvery (Table. 4) which suggested that, these ecosystems were contaminated with industrial and sewage pollution. This condition was noticed in the river Lakshmanatheertha only. But, the sewage water carried by the river Lakshmanatheertha may enter the main river Cauvery, might be the reason for increased abundance of *Gomphonema* sp in the river Cauvery also. Along with this, other indicator species like, *Cyclotella*, *Nitzschia*, *Fragellaria*, *Gyrosigma*, *Amphora*, *Cocconeis* and *Synedra* in the rivers Lakshmanatheertha and Lokapavani, were also found abundant, which were mainly used to calculate the pollution index of water (Palmer, 1980). Further, the high abundance of species like *Oocystis*, *Scenedesmus*, *Spirogyra*, *Chlorella*, *Tetrahedron*, *Ulothrix*, *Tetrastrum*, *Schroederia* and *Closterium* in the river Lakshmanatheertha indicates the enrichment of water with nutrients, sewage and other effluent contaminations, which leads to eutrophication. Euglenoids was least in number compared to other groups all of which were used as indicator of pollution (Palmer, 1980).

CONCLUSION

Over all investigation was revealed that the presence of phytoplankton species like, *Gomphonema*, *Navicula*, *Cyclotella*, *Melosira*, *Nitzschia*, *Synedra*, *Scenedesmus*, *Chlorella*, *Ankistrodesmus*, *Oocystis*, *Closterium*, *Actinastrum*, *Golenkinia*, *Chlamydomonas*, *Gloeocystis*, *Crucigenia*, *Chlorococcum*, *Spirogyra*, *and Ulothrix etc.*, were recognized as pollution indicators. Generally, in the present investigation more abundance of Micro phytoplankton was noticed in the river Lakshmanatheertha, suggests that the river Lakshmanatheertha was more favorable to abundance of micro phytoplankton.

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