Periodical Assessment of Phytoplankton Diversity in Navalgund Lentic water body of Dharwad District in Karnataka, India

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Abstract

The present paper deals mainly with, the study of Phytoplankton belonging to five different classes of algae which vary in different months. Detailed Physico-chemical characteristics of this Lentic water body of Arekurahatti were analyzed at monthly interval for a period of one year from May-2012 to April-2013. The variation in water quality parameters played an important role in the diversity of Phytoplankton and favoured the maximum blooming of Euglenophyceae, Chlorophyceae, Bacillariophyceae and Cyanophyceae members especially during Monsoon over the population of Dinophyceae. But during winter and summer season much fluctuation was observed in the density of Euglenophyceae, Chlorophyceae, Bacillariophyceae and Cyanophyceae members. Surprisingly, Dinophyceae members were appeared only in the months of March and April, during summer season when phosphates were was observed found least in the lentic water body. On an average, the per cent occurrence of Cyanophyceae members was found maximum followed by Chlorophyceae, Euglenophyceae, Bacillariophyceae and Dinophyceae. Total of eighty one species were recorded throughout the year belonging to Euglenophyceae (7), Chlorophyceae (31), Bacillariophyceae (26), Cyanophyceae (16) and Dinophyceae (1). Based upon the recorded physicochemical parameters the status of the lentic water body in the present study indicates its oligotrophic nature. Therefore, investigation may suggest that the water of Arekurhatti Lake may be used for domestic purposes but not for drinking according to drinking water quality standards.

Keywords: Diversity, Phytoplankton, Physico-chemical parameters, Arekurahatti Lake, Periodical variation.

Introduction

Lentic water bodies are valuable water systems and intensively used for drinking, for fisheries and recreation. Since the time immemorial man has been settling around rivers and lakes and in later period, migrating human populations have had dug water bodies to nurture all life forms (Guru and Goswami, 2011). The quality of water is very important for any other aquatic ecosystems because any change in water directly or indirectly affects the biotic environment (Mary Kensa and Jeyakavitha, 2012). The aquatic plants and animals bring about changes in the chemical composition of water. Life in aquatic environment is always governed by physico-chemical characteristics (Kumawat and Jawale 2003; Panigrahi et al., 2005) and their stability. In all aquatic ecosystems Phytoplankton are the principal primary producers of the food chain. Phytoplankton, which include blue-green algae, green algae, diatoms, desmids, euglenoids etc, are important among aquatic flora. They are ecologically significant as, they form the basic link in the food chain of all aquatic floras (Ravikumar et al., 2006). Therefore, conservation of water bodies with basic biological output is the major challenge before biologists and the environmentalists (Senapati et al., 2011; Hosmani, 2012; Jaiswal, 2013) in most Asian countries. These water bodies became polluted by the discharge of sewage, agricultural runoff, bathing animals, washing clothes and vehicles. The phytoplankton diversity in lentic water body of Arekurahatti in Navalgund taluk of Dharwad district has not been studied till today. Therefore in the present study phytoplankton diversity in relation to Physico-chemical parameters of Arekurahatti Lake has been under taken.

Description of study area

Navalgund is a taluk in Dharwad district, Karnataka state, India (Fig.1). It is located 41 kms away from Dharwad and 374 kms from Bangalore. Navalgund is situated at 15.57° North latitude, 75.37° East longitude and 578 (1,896 ft above the sea level) meters elevation. Annual rainfall recorded was as follows: in 2011 - 462.9 mm, in 2012 - 262.2 mm and in 2013 – 624.0 mm. Winter temperature - 17^{o}C, summer temperature - 39^{o}C. Arekurahatti Lake is large sized lake occupying the area about 16 acres 11 guntas (water spread area is about 560 guntas) situated in the village Arekurahatti (Fig.2). Approximately, the length of the lake measures about 327.72 meters (1,075.2 ft) and width measures about 236.5 meters (775.93 ft). Depth of the lake measures about 6 meters and average water level is 3.5 meters. The lake water is used for drinking and also for domestic purposes. This lake is linked to Malaprabha River through channel connection. Twice in a year, when Lake water level decreases it will be get filled with water of Malaprabha River through the channel during winter (November) and summer (March). This lake water is the only source to the villagers for drinking and domestic purposes. Village population is 3718 (as per 2011 census). This lake is monitored by Grama Panchayat Karyalaya, Yemanur. A watchman belonging to that Arekurahatti village, guard that lake to prevent the entry of cattles, washing of clothes and vehicles.

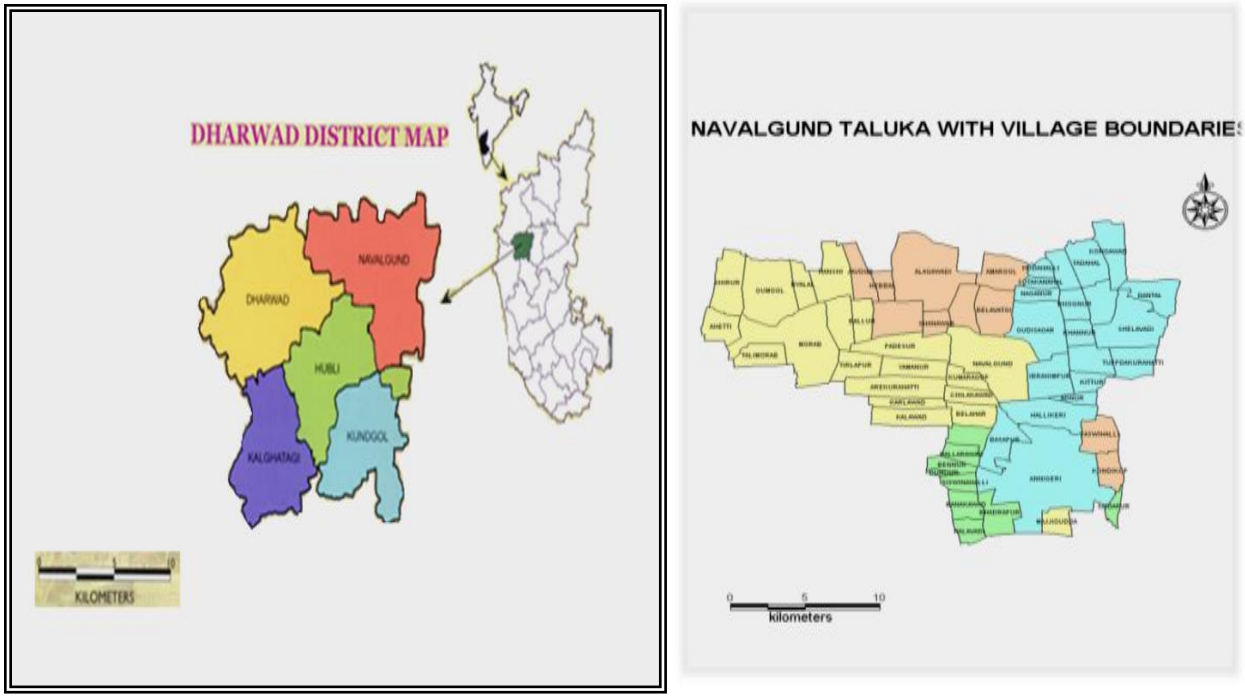

Figure 1: Showing the location of selected site Arekurahatti Lake, Navalgund Taluk of Dharwad District in Karnataka – India.

Figure 2: Showing the Satellite view and Photograph of Arekurahatti Lake

Materials and methods

Water samples were collected for the estimation of Physico-chemical parameters from the Arekurahatti lake of Navalgund taluk for a period of one year from May 2012 to April 2013 at an interval of one month. The samples were collected in pre-cleaned polyethylene carbonyl cans of one liter with necessary precautions and utmost care according to APHA, 1995. Samples were brought to the laboratory to study their physico-chemical parameters. Winklerization was made in separate 350 ml BOD bottles for the estimation of dissolved oxygen. From the collected sample of lentic water body, sedimentation was made in acid Lugol's solution and the supernatant was discarded. The phytoplankton sediment was concentrated to 30 ml by centrifugation. The centrifuged sample was observed under high resolution optical microscope for phytoplankton identification (Desikachary, 1959). A high resolution optical microscope was used for photography, identification and in the counting of phytoplankton with different eye pieces such as 40X and 100X. For qualitative and quantitative analysis of phytoplankton was done by Lackey's drop (1938) method. The species belonging to each group were noted down and number of individuals in each species was counted. The number of organisms was expressed in total organisms per liter.

Results and Discussion

The results of the Physico-chemical analysis recorded for one year during the study of Arekurahatti Lake are presented in Table 1 and 2.

Table 1: Showing the average values of physico-chemical parameters in Arekurahatti Lake during May 2102 to April 2013

Parameters	Minimum - Maximum	Mean ± SD
Air Temperature	23.00 - 33.00	28.17 ± 3.32
Water Temperature	20.00 - 29.00	26.25 ± 2.74
Turbidity	2.80 - 82.00	18.03 ± 24.99
pH	7.40 - 8.43	7.99 ± 0.29
Electric conductivity	220.00 - 330.00	273.33 ± 41.41
Total Alkalinity	72.00 - 112.00	91.67 ± 13.04
Total dissolved solids	143.00 - 215.00	177.92 ± 27.03
Total hardness	66.00 - 114.00	88.17 ± 15.10
Calcium	32.00 - 60.00	48.83 ± 8.63
Magnesium	3.40 - 15.55	9.52 ± 3.11
Chlorides	60.00 - 126.00	96.17 ± 23.78
Sulphates	2.80 -14.00	8.21±3.88
Nitrates	0.10 - 1.80	0.79± 0.52
Phosphates	0.70 - 11.00	4.68 ± 2.99
Sodium	20.00 - 52.50	35.79 ± 10.79
Potassium	1.50 - 3.20	2.24 ± 0.58
Dissolved Oxygen	5.80 - 9.00	6.78 ± 0.81
Chemical Oxygen Demand	15.70 - 73.60	29.90± 15.25
Biological Oxygen Demand	0.18 - 12.25	4.46± 3.29

All parameters are in mg/L, except pH, Turbidity in NTU, Temperature in ˚C and EC in µmhos/sec

Table 2: Showing the Monthly variation in the physicochemical parameters of Arekurahatti Lake during May 2012 to April 2013.

Month	Parameters																	
	AT	WT	TUR	pH	T.Alk	EC	TDS	TH	Ca	Mg	Cl	SO4	NO3	PO4	Na	K	DO	COD
May	26	29	5.1	8.1	112	330	215	90	40	12.2	92	10	0.6	11	45	1.8	5.8	73.6
June	31	26	10	8	88	300	195	86	48	9.23	60	8	1.8	6.4	25	1.8	6.6	22.4
July	28	27	27	8.2	96	250	163	66	52	3.4	70	7.5	0.4	5.7	24	1.7	6.8	16
Aug	33	28	54	8.2	100	300	195	100	60	9.72	110	13	0.6	6.3	45	3.2	6.5	19.2
Sept	32	28	82	8.3	108	310	202	114	50	15.6	120	14	0.1	5.9	53	2.9	7	25.6
Oct	32	28	12	7.9	92	260	169	80	40	9.72	110	5.4	0.8	6.4	49	3.1	7	32
Nov	28	24	2.8	8.2	76	220	143	70	32	9.23	66	11	1.5	5.9	26	2	9	28
Dec	28	24	3.5	7.9	84	230	150	80	50	7.29	70	12	1.4	2.8	20	2	7	28
Jan	23	20	4.5	7.4	76	240	156	86	44	9.72	110	2.9	0.9	1.7	38	2.5	6	30
Feb	27	24	6.4	7.6	72	220	143	78	52	6.32	100	7.9	0.7	1.6	30	1.9	7	31
Mar	27	28	3	8	92	290	189	96	58	9.23	120	2.8	0.3	1.8	35	2.5	6.5	15.7
April	23	29	6	8.4	104	330	215	112	60	12.6	126	4	0.4	0.7	40	1.5	6.2	37.3

All parameters (mean values) are in mg/L, except pH, Turbidity in NTU, Temperature in ˚C and EC in µmhos/sec

pH is one of the very significant chemical characteristic of all water bodies which influences the survival and nourishment of biological life (Amte and Gore, 2012). Throughout the study period, water indicated alkaline property and pH values were ranged from 7.4 to 8.4 and maximum pH value was observed in the month of April and lowest pH value in the month of January. Turbidity values were found high during September month and low turbidity value was observed during November in Arekurahatti Lake. It has been well documented that the variation in water temperature can be correlated with seasonal variation. The water was comparatively warmer during the April, May and August months.The temperature was reduced to 20˚C in the month of January (during winter season). Electric Conductivity (EC) was varied from the minimum 220µs/cm to maximum of 330µmhos/cm in Arekurahatti Lake.

In the present study Alkalinity was increased in the month of April, May and September and low in the month of February. High values of total Alkalinity may be attributed to the increase in organic decomposition during which carbon dioxide is liberated. This reacts to form bicarbonate thereby increasing total alkalinity in summer (Mahadev and Hosamani, 2010). Total alkalinity is due to salts of

weak acids and bicarbonates .The highly alkaline water is not potable. Total hardness, Sodium and Magnesium were found high in the month of September. Calcium was found high in the month of April and August. But Calcium and Chloride were found minimum in the month of November. Chlorides were found maximum in the month of March, April, August and September. Chloride concentration is the most useful parameter for evaluating the atmospheric input to sub-surface water (Shiva Kumar, 2009). High concentration of chloride in the water gives an undesirable taste to water. This higher concentration of chloride reduced the algal population in the present work. Magnesium and BOD values were found minimum in the month of July. BOD values were found maximum in the month of November and least in the month of June. Sodium and Sulphates were found high in the month of September and these were found minimum in the month of December and March respectively. Nitrates were found maximum in the month of June and minimum in the month of September. Nitrates, Sulphates and Chlorides play an important role in the eutrophication (MeeraBai, 2010). Sulphates and Nitrates were found within the desirable range (WHO, 1990). Margalef, 1964, 1968 has suggested that phytoplankton population is rich in fertile water. Phosphorus is another factor that deviated considerably in the Lake waters. Chrost and Olson, 1991 and Airsang and Lakshman, 2015 who had under the opinion that phosphates are common inside cells but can be excreted outside the cell or be associated with the exterior cell surface. Phosphatase enzymes cleave dissolved organic phosphorous to liberate phosphate. Excretion of extracellular phosphates increases when, phosphorous becomes scarce. The ubiquitous nature of these compounds in lakes leads to rapid turnover of many organic phosphorus compounds leading to high amounts of phosphorus in Lakes. Total Phosphate and COD were found high in the month of May and least in the month of April and March respectively. Chemical oxygen demand is the amount of oxygen required for oxidation of organic constituents with strong oxidizing agent (acidified potassium dichromate). Thus it is used as measure of organic equivalent of the organic matter present in the sample. The values obtained are not acceptable according to drinking water quality standards (WHO, 1990). Potassium was found maximum in the month of August and minimum in the month of April. Turbidity values were ranged between 3 NTU (March) to 82 NTU (September) in Arekurahatti Lake. TDS (total dissolved solids) values were varied between 143 mg/L to 215 mg/L during the study period. Dissolved oxygen plays an important role in regulating inside waters. DO was higher in the months of November and lower in month of May.

The monthly variation in total Phytoplankton number was due to various factors such as temperature, intensity of light, bicarbonates and organic matter. Certain plankton population apparently disappeared at a specified period and reappeared during the other period. This disappearance might be due to the fact that some species either became scare or occur in the form of spores, which cannot be easily detected. However on the return of favorable conditions, spores again germinated and plankton appeared. It is also observed that some species which are present in less abundance during some months reappeared during other months when the conditions become favorable. Infact in the present study, temperature, pH, alkalinity and nutrient content in Arekurahatti Lake water played a vital role. During the investigation phytoplankton distribution was varied in different months and seasons from May 2012 to April 2013. Similar findings were reported by Pulle and Khan, 2003; Kumar and Hosamani, 2006, 2011; Mahadev et al*.,* 2010. Dissolved oxygen, Phosphate, Nitrate and pH are the most significant parameters operating in this water body. Sreenivasan et al*.*,

1964; Mary Kensa and Jeyakavitha, 2012; Airsang and Lakshman, 2013, have observed that the peaks of phytoplankton occurred at different period in different years. Therefore only temperature was not responsible for the fluctuation in numbers but high pH, alkalinity, carbon dioxide and nutrients are also responsible for their organic production.

The periodical variations in water quality parameters were played an important role in the diversity of Phytoplankton (Table 4). Total of eighty one species of Phytoplankton were recorded throughout the year belonging to Euglenophyceae (7), Chlorophyceae (31), Bacillariophyceae (26), Cyanophyceae (16) and Dinophyceae (1). Increased nutrients have increased the number of Bacillariophyceae, Cyanophyceae, Euglenophyceae and Chlorophyceae members which were found dominant during Monsoon over the population of Dinophyceae. Cyanophyceae members were recorded maximum during the month of May and least in the month of November. Chlorophyceae members were recorded maximum during the month of September and least in the month of May. Bacillariophyceae members were recorded maximum during the month of February and least in the month of March. Euglenophyceae members were recorded maximum during the month of July and least in the month of February. On an average the percentage of occurrence of Cyanophyceae members was found maximum followed by Chlorophyceae, Euglenophyceae, Bacillariophyceae and Dinophyceae (Table 3 and Chart 1). Dinophyceae members were recorded maximum during the month of March and least in the month of April. Surprisingly, Dinophyceae members were appeared only in the months of March and April, during summer season when phosphates were found least in the lentic water body. In the present investigation, phosphates were found between 0.7 mg/L to 11.0 mg/L and these values lie between 0.0 mg/ L to 12.0 mg/L. Therefore, the trophic status of the selected lentic water body is designated as oligotrophic (Lillie and Mason, 1983). During March and April the phosphate values were too low and ranged between 0.7 mg/L to 1.8 mg/L. Subsequently, these values were favored the blooming of Dinophyceae members only during these two months.

Table 3. Showing the variation in phytoplankton density (Org/lit) in Arekurahatti Lake belonging to different Genera under five classes during May 2012 to April 2013.

Months/ Classes	Cyanophyceae Organism/L	Chlorophyceae Organism/L	Bacillariophyceae Organism/L	Euglenophyceae Organism/L	Dinophyceae Organism/L
May	31,800	240	600	3,240	-
June	6,360	1,680	1,680	2,640	-
July	4,200	3,840	3,120	7,200	-
Aug	960	4,560	1,080	3,720	-
Sept	600	4,800	1,920	720	-
Oct	3,600	600	1,200	1,080	-
Nov	360	2,160	600	1,920	-
Dec	1,200	3,600	1,080	720	-
Jan	600	3,600	1,320	1,200	-
Feb	6000	840	6000	120	-
Mar	480	1,200	120	720	1,920
April	1,800	600	2400	1,440	120
Average	**4,830**	**2310**	**1760**	**2060**	**1020**
Pecentage	**40%**	**19%**	**15%**	**17%**	**9%**

Chart 1: Showing the percentage of average occurrence of Phytoplankton in Arekurahatti Lake during May 2012 to April 2013.

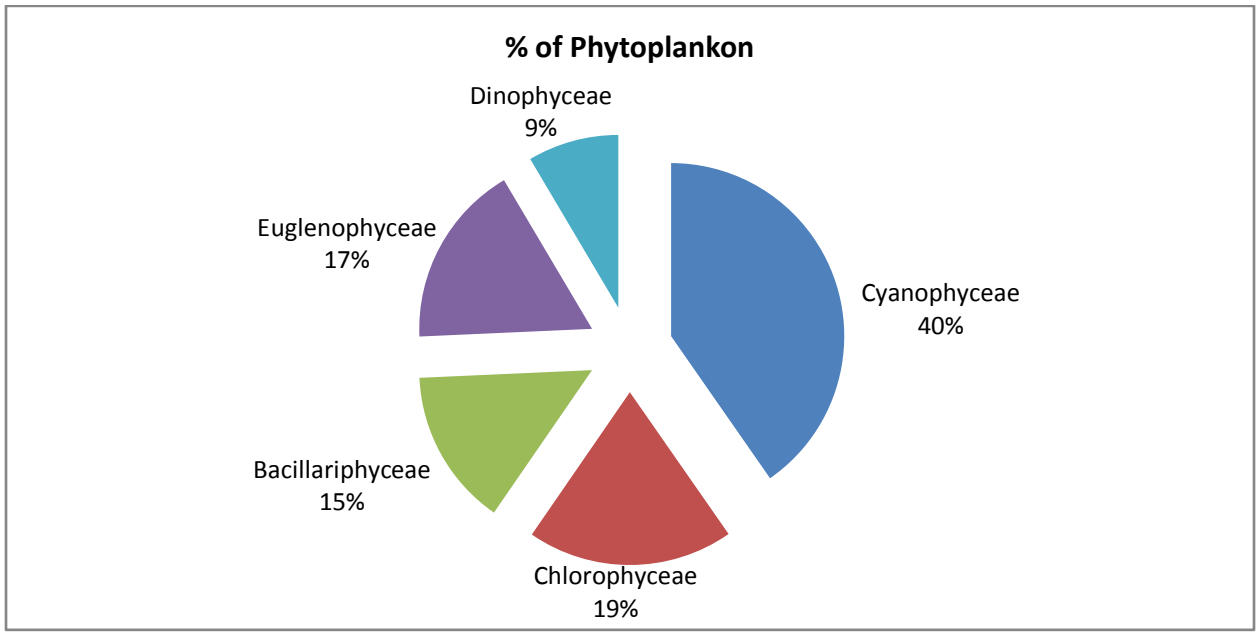

Table 4. Showing the distribution of some important Phytoplankton species in Arekurahatti Lake belonging to different Genera under five classes during May 2012 to April 2013.

S.No.	Classes	Genera	Species
1	**Cyanophyceae**	*Anabaena* sps.	
		Aphanocapsa sps.	
		Chroococcus	*tenax* (Kirchn.) Hieron.
		Chroococcus	*limneticus* Lemm.
		Lyngbya	*contarta* Lemm.
		Merismopedia	*glauca* (Ehrenberg) Kützing
		Merismopedia	*tenussima* Lemm.
		Oscillatoria	*formosa* Bory
		Oscillatoria	*pseudogerminata* Schmid
		Oscillatoria	*personata* Gomont

		Oscillatoria	*tenuis* Ag.
		Pseudanabaena	*galeata* Böcher
		Peliana sps.	
		Schizothrix	*tinctoria* Gomont
		Spirulina	*laxissima* West, G.S.
		Spirulina	*gigantea* Schmidle
2	**Chlorophyceae**	*Ankistrodesmus*	*falcatus* Corda
		Ankistrodesmus	*convolutus* (Corda) Ralfs
		Asterionella sps.	
		Closterium	*acutum* Brébisson
		Closterium	*cyathium* De Notaris
		Closterium	*parvulum* Nägeli
		Cosmarium	*reniforme* (Ralfs) W. Archer
		Crucigenia	*rectangularis* (Nägeli.) Gay
		Dictyosphaerium	*indicum* Nägeli
		Elekatothrix	*gelatinosa* Wille
		Gomphoshaeria	*aponina* Kützing
		Kirchneriella	*contorta* (Schmidle) Bohlin
		Kirchneriella	*curvata* Jäderholm
		Kirchneriella	*lunaris* (Kirchner) Möbius
		Kirchneriella	*minutum* (Nageli) Collins
		Kirchneriella	*obese* (West) West & G.S. West
		Microactinium sps.	
		Monoraphidium	*contortum* Thuret
		Oocystis sps.	
		Raphidiopsis	*curvata* F.E. Fritsch & M.F. Rich

		Scenedesmus	*arcuatus* Lemmermann
		Scenedesmus	*bijugatus* Kützing
		Scenedesmus	*dimorphus* (Turpin) Kützing
		Scenedesmus	*capitatus* G.M. Smith
		Scenedesmus	*incrassatulus* Bohlin
		Scenedesmus	*obliquus* (Turpin) Kützing
		Selenastrum	*gracile* Reinsch
		Selenastrum	*minutum* Nägeli
		Selenastrum	*westi* G.M. Smith
		Tedraedron	*minimum* (A.Braun) Hansgirg
		Tedraedron	*regularis* Kützing
3	**Bacillariophyceae**	*Achanthes* sps.	
		Amphora	*ovalis* (Kützing) Kützing
		Craticula	*cuspidata* (Kützing) D.G. Mann
		Cocconeis	*pediculus* Ehrenberg
		Cocconeis	*placentula* Ehrenberg
		Cymbella	*aspera* (Ehrenberg) H. Peragallo
		Cymbella	*ventricosa* (C.agardh) C.agardh
		Epithemia sps.	
		Fragillaria sps.	
		Frustula	*vulgaris* (Thwaites) DeToni
		Gomphonema	*gracile* Ehrenberg
		Gomphonema	*parvulum* Kützing
		Gyrosigma sps.	
		Melosira sps.	
		Navicula	*cuspidata* (Kützing) Kützing

		Navicula	*grimmae* Krasske in Hustedt
		Navicula	*gottlandica* Grunow in Van Heurck
		Navicula	*radiosa* Kützing
		Nitzschia	*acicularis* (Kützing) W. Smith
		Nitzschia	*palea* (Kützing) W. Smith
		Pinnularia	*major* Kützing (Rabenharst)
		Pleurasigma sps.	
		Rhizosolenia sps.	
		Rhopalodia	*gibba* (Ehrenberg) O. Müller
		Stauroneis sps.	
		Synedra	*ulna* (Nitzsch) Ehrenberg
4	Euglenophyceae	*Euglena*	*deses* Ehrenberg
		Euglena	*gracilis* Klebs
		Euglena	*polymorpha* Dangeard
		Euglena	*proxima* Dangeard
		Trachelomonas	*fluviatilis* (Lemm.) Defl.
		Phacus	*longicauda* (Ehrenb.) Dujardin
		Lepocinclis	*glabra* Drezepolski
5	Dinophyceae	*Peridinium* sps.	

Conclusion

In the present study, temperature, pH, alkalinity and nutrient content in Arekurahatti Lake water played a vital role. During the investigation phytoplankton distribution was varied in different months and seasons from May 2012 to April 2013. Dissolved oxygen, Phosphate, Nitrate and pH are the most significant parameters operating in this water body. The nutrients accumulated in the lake water have

increased the number of Euglenophyceae, Chlorophyceae, Bacillariophyceae, and Cyanophyceae members to maximum during the months of Monsoon over the population of Dinophyceae. But during the months of winter and summer season much fluctuation in the density of Euglenophyceae, Chlorophyceae, Bacillariophyceae and Cyanophyceae members was observed. On an average the percentage of occurrence of Cyanophyceae members was found maximum followed by Chlorophyceae, Euglenophyceae, Bacillariophyceae and Dinophyceae. Surprisingly, Dinophyceae members were appeared only in the months of March and April, during summer season when phosphates were found least in the lentic water body. In the present investigation, phosphates were found between 0.7 mg/L to 11.0 mg/L and these values lie between 0.0 mg/ L to 12.0 mg/L. Therefore, the trophic status of the selected lentic water body is designated as oligotrophic. The investigation may suggest that the water of Arekurhatti Lake may be used for domestic purposes but not for drinking according to drinking water quality standards (WHO, 1990).

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