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Study on the Influence of Water Physico Chemical Properties on Phytoplankton Population in Kirumampakkam and Korkadu Lakes, Pondicherry Region, India

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The objectives of our research were to determine the influence of water physico chemical properties on phytoplankton population of two lake ecosystem (Kirumambakkam and Korkadu), Pondicherry region. Sulphate, Organic Carbon (OC), phosphate, sodium, potassium, DO, salinity and TDS were higher in Kirumamabakkam lake water samples. Ammonia, nitrate and BOD were higher in Korkadu lake water samples. During the study period 13 species of phytoplanktons were represented by diverse groups Chlorococcales (4), Volvvocales (3), Oscillatoriales (2), Euglenales (1), Nostocales (1) and Pennales (1). Population density ranged between 60 to 270 cells/l in Kirumamabakkam and Korkadu lakes. *Closterium sp.* was higher diversity in both lakes.

Introduction

Water is a necessary element for endurance of living on earth, which contains minerals, essential for humans as well as for earth and aquatic life industrial infrastructures and agriculture complexes have been built up in vicinity of rivers and other water bodies (Varis 1991). Lake, a large body of water surrounded by land and inhabited by various aquatic life forms, is subjected to various natural processes taking place in the environment and anthropogenic activities. Humans are responsible for choking several lakes to death due to a consequence of unprecedented development. Eutrophication is accelerated as a result of human activities near or in a body of water that generate residential wastes, untreated or partially treated sewage, agricultural runoff and urban pollutants (Sarma *et al.*, 2006). The major sources of nitrate in lakes and ponds are from the catchment area by rainfall, sewage effluents, agro waste, suspended organic matter when algae and other suspended microorganisms die and settle down to the bottom. They carry their nitrogen and phosphorous with them, during decomposition. This nitrogen is released and becomes available for subsequent growth of aquatic biota. Orthophosphate is the soluble reactive phosphorous which is also termed as inorganic phosphate. It plays a dynamic role in aquatic ecosystem which is taken up widely by phytoplankton (Rey *et al.,* 2004).

The phytoplankton is the base of most of the lake food webs and fish production is linked to phytoplankton (Ryder, 1974). Phytoplankton and micro invertebrates which in turn provide food to fishes and aquatic birds. Planktonic primals in fresh water are dominated by rotifers cladocerans and copepods. Rotifers are most sensitive bioindicators of water quality and their presence may be used as a reference to the physico-chemical characteristics of water (Harsha and Malammanavar 2004). Phytoplankton form good indicators of water quality as they have rapid turn-over time and are sensitive indicators of environmental stresses. Phytoplankton survey thus helps to find out the trophic status and the organic pollution in the ecosystem. Phytoplankton constitutes the basis of nutrient cycle of an ecosystem. Phytoplanktons have long been used as indicators of water quality. Because of their short life cycles, planktonic organisms respond quickly to environmental changes and hence their standing crop and species composition indicate the quality of water (Perumal *et al.,* 2009). Phytoplanktons are affected by physical, chemical and biological factors, making them valuable tool in monitoring programmes. On the basis of this, many workers have emphasized that algal communities as a whole serve as reliable indicators of pollution (Rojoand Rodríguez 1994; Soininen, *et al.,* 2009; Reavie *et al.,* 2010). This study were conducted to determine the nutrient status and influence of water physico chemical properties on phytoplankton population of two lake ecosystem (Kirumambakkam and Korkadu) which is lying to industrial as well as anthropogenic pressure.

Materials and Methods

Study area

Pondicherry is located along the Coramandel coast of peninsular India with the geographical coordinates $11^0$52’N, $79^0$45’E and $11^0$59’N and $79^0$52’ E covering an area of 480 km. The mean annual rainfall of the study area is about 1311-1172mm. The mean number of annual rainy days is 55; the mean monthly temperature ranges between 21^0 C and 30^0 C in the study area. The Puducherry region is bestowed with 83 tanks which scattered in all over the region usually fills up during the North East Monsoon. The study site, Kriumambakkam Lake (site 1, 2 and 3) and Korkadu (site 4, 5 and 6) were located 25 km away from the town. In the back drop of depletion of ground water table, water is stored in the tanks for replenishing the ground water. In such way, tanks are serving only as a recharging mechanism by which groundwater table have enhanced considerably simultaneous with the prevention of intruding seawater in to sweet water aquifers. Paddy is the principal crop amongst all the crops cultivated in the wet land for three crop season irrigated my means of tube wells. Ponds exist in all over Puducherry region but they are not used for agricultural activities.

Methodology

Water samples were collected from December-2013 to July - 2014 for the purpose of water physico chemical and trace element analysis. Phytoplankton samples were collected by towing a plankton net (mouth diameter 0.35 mm) made up of bolting silk (no.30; mesh size 48 µ) for half an hour. The samples were collected in black polythene bags and immediately preserved with 4% formalin for quantitative and qualitative analysis. Plankton counting was made by drop method. Specimens were then dehydrated through a graded series of acetone 12-15 min interval at 4ºC up to 70% of acetone and dispense 1 mL of the sample onto the Sedgewick-Rafter counting chamber. They were examined with face contrast microscope. Phytoplankton was identified by standard reference given in Desikachary (1959) and Anand (1998). Species diversity index (H') was calculated using Shannon and Weiner's (1949) and Pielous (1966) formulae respectively. Species richness (SR) was calculated as described by Simpson index.

For the study of physico-chemical analysis water samples were collected from the pond surface in a clean polythin container of one litre capacity. Some of the results were recorded at the sampling sites whereas the others were recorded in the laboratory. The parameters observed were pH, EC (Electrical conductivity), DO, BOD. TDS, Alkalinity, salinity, Ammonia, OC (Organic Carbon), Nitrate, Phosphate, Sulphate, sodium, potassium and trace elements. The analytical procedures adopted for the analyses of water quality were as detailed in the standard methods for examination of water and waste water (APHA, 2006).

Results and Discussion

Water Physico-chemical properties

Hydrogen ion concentration plays an important role in the biological process of almost all aquatic organisms. The average pH of surface water of the kirumbakkam and korkad lakes from 7.95 to 9. The water tends to be more alkaline when it possesses carbonates, but lesser alkaline when it supports more bicarbonates, free CO_2 and calcium (Omstedt *et al.,* 2010). The average EC surface water of two lakes were ranged from 1.06 to 1.47 ms/cm. due to dilution factor of precipition the EC decreases as the monsoon pickup (Chari and Abbasi, 2002). The highest EC value recorded in Kirumambakkam Lake Water. The dissolved oxygen concentration was found in of 4.1 to 5.8 mg/l the higher concentration was recorded at Kirumambakkam Lake.

Dissolved oxygen is an important constituent of water and its concentration in water is an indicator of prevailing water quality and ability of water body to support a well-balanced aquatic life. DO raised to its peak value, and it might be due to high rate of photosynthesis by phytoplankton population that forms the major source of DO (Sharma and Rathore, 2000). The lowest DO concentration observed at the lower reaches might be because of the influence of salinity, temperature, conductivity, currents and upwelling tides. The regional distribution of biological oxygen demand in between two lakes varied from 1.8 to 2.8 mg/l. the total dissolved solids salts were recorded at the different sites ranging from 539 to 750 mg/l. the highest value of TDS was found at both lakes (750 mg/l). High value EC designates pollution status of the lake (Davis, 1975) (Table 1). The salinity was found at different sites ranging from 1840 to 2560 mg/l. the highest salinity was found at the site of Korkadu Lake. The highest ammonium concentration was recorded at the site of Kirumambakkam site 3 (0.52 mg/l). Ammonium (NH_4^+) represented 80% of Dissolved Inorganic Nitrogen (DIN) and its highest values were always associated with fresh water inflow (Martin *et al.,* 2008). Sankaranarayanan and Qasim (1969) suggested that the spatial and temporal variation in ammonia concentration might also be due to its oxidation to other forms or reduction of nitrates to lower forms in lake waters.

Table.1 Physico-chemical properties of Kirumambakkam and Korkadu lakes water samples

Water parameters	Kirumambakkam lake			Korkadu lake		
	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
pH	8.82±0.01	9±0.03	8.77±0.02	9.4±0.02	8.8±0.01	7.95±0.03
EC (ms/cm)	1.14±0.01	1.45±0.04	1.46±0.04	1.47±0.02	1.13±0.03	1.06±0.02
DO (mg/l)	5.8±0.9	4.1±0.3	5.3±0.5	4.1±0.1	4.2±0.8	4.1±0.3
BOD (mg/l)	1.9±0.08	2.1±0.09	1.8±0.02	2.8±0.07	2.1±0.04	2.6±0.07
Salinity (mg/l)	1960±12	2530±11	2540±13	2560±23	1970±26	1840±28
TDS (mg/l)	580±12	740±13	750±14.2	750±15.8	573±11.2	539±11
Organic carbon (mg/l)	7.64±0.09	7.19±0.06	7.55±0.07	7.74±0.02	7.10±0.80	7.05±0.09
Ammonia (mg/l)	0.51±0.01	0.51±0.01	0.52±0.03	0.50±0.02	0.50±0.01	0.50±0.02
Phosphate (mg/l)	0.31±0.01	0.30±0.01	0.30±0.01	0.28±0.01	0.28±0.01	0.28±0.01
Sulphate (mg/l)	39.29±1.20	30.11±1.30	30.99±0.90	19.07±1.10	23.50±0.98	24.13±1.02
Sodium (mg/l)	1073±20	1222±28	1355±24	1055±15	1106±16	1163±13

Table.2 Phytoplankton's identified in Kirumambakkam and Korkadu lakes water

Order	Species
Chlorococcales	*Chlorella sp.*
Chroococcales	*Chroococcus sp.*
Chroococcales	*Microcystis sp.*
Chroococcales	*Microcystis sp.*
Conjucales	*Closterium sp.*
Euglenales	*Euglena sp.*
Nostocales	*Anabaena sp.*
Oscillatoriales	*Oscillatoriasp*
Oscillatoriales	*Spirulina sp.*
Pennales	*Navicula sp.*
Volvvocales	*Chlamydomonas sp.*
Volvvocales	*Eudorina sp.*
Volvvocales	*Volvox sp.*

Table.3 Phytoplankton's population in Kirumambakkam Lake

Phytoplankton's sp	Density (cells/l)	Frequency	Relative density (%)	Relative frequency (%)
Anabaena sp.	200	6	10.93	8.96
Chlamydomonas sp.	190	5	10.38	7.46
Chlorella sp.	130	5	7.10	7.46
Chroococcus sp.	90	4	4.92	5.97
Closterium sp.	270	7	14.75	10.45
Eudorina sp.	170	8	9.29	11.94
Euglena sp.	120	5	6.56	7.46
Microcystis sp.	80	5	4.37	7.46
Microcystis sp.	80	4	4.37	5.97
Navicula sp.	170	4	9.29	5.97
Oscillatoria sp.	170	5	9.29	7.46
Spirulina sp.	60	2	3.28	2.99
Volvox sp.	100	7	5.46	10.45

Table.4 Phytoplankton's population in Korkadu Lake

Phytoplankton's sp	Density (cells/l)	Frequency	Relative density (%)	Relative frequency (%)
Anabaena sp.	170	5	11.41	8.62
Chlamydomonas sp.	150	5	10.07	8.62
Chlorella sp.	90	2	6.04	3.45
Chroococcus sp.	110	7	7.38	12.07
Closterium sp.	270	7	18.12	12.07
Eudorina sp.	50	2	3.36	3.45
Euglena sp.	60	3	4.03	5.17
Microcystis sp.	60	4	4.03	6.90
Microcystis sp.	90	3	6.04	5.17
Navicula sp.	120	6	8.05	10.34
Oscillatoria sp	170	5	11.41	8.62
Spirulina sp.	60	2	4.03	3.45
Volvox sp.	90	7	6.04	12.07

Table.5 Phytoplankton's diversity indices of Kirumambakkam and Korkadu Lakes

S. no	Diversity indices	Kirumambakkam lake	Korkadu lake
1.	Richness	13	13
2.	Dominance	0.09003	0.09788
3.	Simpson	0.91	0.9021
4.	Shannon	2.481	2.442
5.	Evenness	0.9194	0.8841
6.	Brillouin	2.344	2.283
7.	Menhinick	0.961	1.065
8.	Margalef	2.303	2.398
9.	Equitability	0.9672	0.952
10.	Fisher	3.199	3.425
11.	Berger-Parker	0.1475	0.1812

The Nitrate was recorded at the different sites ranging from 3.93 to 4.15 mg/l. the highest concentration of nitrate was recorded in site 1 of Kirumambakkam Lake. Nitrogen cycle involves elementary dissolved nitrogen oxides; NO_3, NO_2 and reduced forms: NH_4, NH_3 play a significant role in sustaining the aquatic life in marine environment. Nitrate is one of the most important indicators of pollution of water which represents the highest oxidized form of nitrogen. The most important source of the nitrogen is biological oxidation of organic nitrogenous substances, which derived from sewage and industrial waste or produced indigenously in the water (Sharma *et al.*, 2008). Zepp (1997) observed that variation in nitrate and its reduced inorganic compounds are predominantly the result of biologically activated reactions. In our study, both lake sites show slightly higher phosphate values than the WHO permissible limit (0.10 mg/l). The major cause for phosphate concentration in the lakes might be the agricultural run from the irrigated lands containing phosphate fertilizer. Gabche and Smith (2002) while working on two estuaries of Cameron concluded that the increased concentration of phosphate after monsoon was the result of agricultural run-off along with city drainage which in-turn will serve as important phosphate contributors to the coastal environment.

Phytoplankton's population

During the study period 13 species of phytoplanktons were represented by diverse groups Chlorococcales (4), Volvvocales (3), Oscillatoriales (2), Euglenales (1), Nostocales (1) and Pennales (1). Population density ranged between 60 to 270 cells/l in Kirumamabakkam and Korkadu lakes. *Closterium sp.* was higher diversity in both lakes (Tables 2-5). Phytoplankton population was higher in the Kirumambakkam due to presents of higher nutrient content in water. Joseph and Ouseph (2010), states that diatom growth is dependent on supplies of available silica, which tends to decrease with phosphorus enrichment. Thus, the high concentrations of *Nitzschia* during study period are favored by the relatively low concentrations of phosphates. Jouenne *et al.*, (2007) stated that phytoplankton composition varies with season and this can be ascribed to variation in nutrient access, light and temperature. Rey *et al.,* (2004) suggested that besides their importance as the primary producers in food webs and ensuring ecological balances, species of phytoplankton can be useful indicators of water quality. Phytoplankton needs a wide variety of chemical elements but the two critical ones are nitrogen and phosphorous. Constant input of wastewater not only contains waste of organic matter but also contains silt and other pollutants which might also be attributed to higher phytoplankton at upper reaches, this is in agreement with Saxena and Shrivastava (2001), while studying the sewage fed Shahpura Lake of Bhopal. Muhammad *et al.*, (2005) have suggested spatial differences in distribution of blue green algae which may occur due to high organic pollution load leading to nutrient rich condition.

The present study summarizes the influence of water physico chemical properties on phytoplankton population in Kirumampakkam and Korkadu lakes. The addition of nitrogenous compounds and phosphorus compounds from anthropogenic sources such as fertilizer output, as an effect of industrialization and from agricultural runoff in the Kirumambakkam Lake. From the present investigation it could be noted that the phytoplankton population of the Kirumamabakkam and korkadu lakes were closely related with physico chemical properties. Dynamic changes in pH, and concentrations of dissolved gases like oxygen, organic carbonand inorganic nutrients (nitrate, phosphate and sulphate) are all closely associated with fluctuations in phytoplankton composition. The overall study provides a good outline on the prevailing condition of the two lakes ecosystem.

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