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Original Research Paper

Study on Habitat Ecology and Phytoplankton Diversity of Nagathibelagalu Tank in Industrial town Bhadravathi, Karnataka, India

H. A. Sayeswara, T. Vasantha Naik*, H. S. Ravikumar Patil and Mahesh Anand Goudar*****
Deptt. of Zoology, Sahyadri Science College (Autonomous), Kuvempu University, Shivamogga-577 203, Karnataka, India
*Department of Botany, D. R. M. Science College, Davangere University, Davangere-577 004, Karnataka, India
**Department of Biotechnology, G. M. Institute of Technology, Davangere-577 006, Karnataka, India
***Department of Chemistry, D. V. S. College of Arts & Science, Shivamogga-577 201, Karnataka, India

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ABSTRACT

Physico-chemical characteristics and phytoplankton diversity of Nagathibelagalu tank of Bhadravathi town was studied for a period of twelve months from January to December 2008. The estimated water quality parameters were compared with the standard values prescribed by the Bureau of India Standards (BIS) and World Health Organization (WHO). The results of physico-chemical analysis revealed that water is polluted due to high BOD, free CO_2, phosphate and nitrate. A total of 44 species belonging to 29 genera of phytoplankton were recorded, of which Chlorophyceae and diatoms were found to be dominant among four classes. Pollution tolerant species such as *Scenedesmus* sp., *Coelastrum* sp., *Euglena* sp., *Trachelomonas* sp. and *Microcystis aeruginosa* were observed.

INTRODUCTION

Ponds and tanks are important natural and man-made water resources, utilized by the population around them. From an economic point of view, ponds and tanks serve as drinking water resources, irrigation, fisheries, tourism, etc. (Das 2005). Wetlands are highly valued for their high nutrient retention and their unique biodiversity (Trepel & Palmeri 2002). An increased rise in development around water bodies has made them vulnerable to problems such as pollution, rapid sedimentation and eutrophication (Chakrapani 2002). Contamination of water bodies might lead to a change in their trophic status and render them unsuitable for drinking. Any change in the physico-chemical characteristics of water not only alter its quality, but also disturbs aquatic environment and affects aquatic life (Pawar & Pandarkar 2011). Several investigators have studied the physico-chemical dynamics of varied lentic water bodies with the intent to assess the water quality (Sukunda & Patil 2004, Vishwanatha & Murty 2005, Sayeswara et al. 2011a, 2011b).

Phytoplankton are autotrophic in nature and the primary producers in aquatic habitats. Phytoplankton are very useful tools for the biomonitoring of a water body with regard to its pollution status (Stoermer 1977). Several studies have been done on the phytoplankton diversity in ponds and tanks (Baykal et al. 2006, Nafeesa Begum et al. 2010, Roy Goswami et al. 2011, Sayeswara et al. 2010). In the present investigation, an attempt has been made to assess the plankton diversity and suitability of water for human consumption and domestic purposes.

STUDY AREA

Nagathibelagalu tank is located at about 8 km away from Bhadravathi town, situated between 75°43'17" E longitude and 13°55'27" N latitude. The tank is a perennial one and acquires a total area of 25 acres with average depth of 9 feet. It is surrounded by paddy and sugarcane fields in all directions. The water is used for domestic purposes. The tank receives copious water supply from Bhadra canal. It also receives domestic sewage from Nagathibelagalu village. The water has undergone moderate changes in its physico-chemical properties due to ecological degradation, overflowing of water from adjacent paddy fields and other excessive human activities. The literature revealed that there is no scientific study carried out with respect to ecological characteristics of this pond. The basis of selection of Nagathibelagalu tank was that its water is used by a large population, and it receives huge quantity of wastewater and periodic flooding from surrounding plains.

MATERIALS AND METHODS

Sampling techniques: Samples of tank water were collected regularly during January to December 2008. Two-litre sam-

ple was collected for the analysis of physico-chemical parameters and one litre separately for studying planktonic composition in clean plastic cans between 9 am and 10 am once a month. The cans were rinsed twice with the sample water before collection.

Analysis techniques: Immediately after collection of samples each sample bottle was labelled and brought to the laboratory for analysis. The water temperature was recorded at sampling site itself. Dissolved oxygen was fixed on the spot in BOD bottles. Other physico-chemical parameters were analysed within 24 hours. Standard methods were adopted for the analysis of water samples (APHA 1998, Trivedy & Goel 1986). The planktonic sample was left in sediment column and planktons were concentrated as per Welch (1952) technique. Identification of phytoplankton was made with the help of Deshikachary (1959), Gandhi (1961), Welch (1952) and Prescott (1982).

RESULTS AND DISCUSSION

The results of monthly and seasonal variation of physico-chemical characteristics of Nagathibelagalu tank are given in Tables 1 and 2.

Temperature: Temperature is one of the important physical parameters. Water temperature plays an important role in either decreasing or increasing the concentration of certain chemical characteristics, largely influenced by local climatic conditions. Values ranged from 20.3°C to 25.9°C, the minimum being in July and maximum in April.

Turbidity: Turbidity is a measure of the cloudiness of water. Turbidity in natural water arises due to the presence of suspended matter such as clay, silts, finely divided organic and inorganic matter, phytoplankton and other microscopic organisms. The values fluctuated between 9.3 to 62.3 NTU, the minimum being in March and maximum in July. The variations of turbidity depend on the inflow of rain water carrying suspended particles (Nafeesa Begum et al. 2006). In natural water bodies, turbidity may impart a brown colour to water (George 1997).

pH: pH refers to a scale of intensity of acidity or alkalinity. This is regarded as a measure of concentration of H^+ ions in water. pH influences the survival and nourishment of most biological life. The pH of water was acidic to slightly alkaline and found within permissible limit of 6.5 to 7.4 as per the Bureau of Indian Standards (BIS 1982). Higher values were observed during July (7.4) and lower during January (6.5). The pH is important since aquatic organisms are well adapted to a specific pH range and do not withstand abrupt changes in it (George 1997).

Dissolved oxygen: DO is one of the most important chemical parameters to indicate water quality. DO is an index of physical and biological process occurring in water. The unpolluted water is normally saturated with dissolved oxygen, while presence of oxygen demanding pollutants causes rapid depletion of DO from water. It showed a distinct pattern of fluctuation and ranged from 1.9 to 3.1 mg/L. The highest and the lowest values were in August and April, respectively. The variations depend on the primary production and respiration of aquatic organisms.

Biochemical oxygen demand: BOD test is essentially a bioassay procedure involving the measurement of oxygen consumed by living organisms (mainly bacteria) while utilizing the organic matter present in water (Debnath Palit & Mukherjee 2011). BOD and other microbial activities generally increase by the introduction of sewage (Hynes 1971). In the present study, BOD values fluctuated between 10.3 mg/L (May) and 6.1mg/L (July). The high values indicate the high levels of biodegradable materials.

Free carbon dioxide: CO_2 values fluctuated between 15.9 and 25.4 mg/L. The lowest and the highest values were recorded in February and March, respectively. The variation of CO_2 was due to its absorption by plants in photosynthesis and activity of other living organisms. Free CO_2 helps in buffering the aquatic environment against rapid fluctuation in the acidity or alkalinity and also regulates biological process of aquatic communities (Prasannakumari et al. 2003).

Total alkalinity: Alkalinity is the ability of water to neutralize acids. Alkalinity in the water is primarily a function of carbonate, bicarbonate and hydroxide content. It ranged from 56.2 mg/L (October) to 81.4 mg/L (February). It is within permissible limit of 600 mg/L (BIS 1982).

Total hardness: Total hardness of water is not a pollution parameter but of water quality mainly in terms of Ca^{2++} and Mg^{2++}. The values ranged from 78 to 117 mg/L; the minimum in October and maximum in May. Total hardness above 200 mg/L is not suitable for drinking and cleaning (WHO 1991).

Total suspended solids: The values ranged between 95 and 416 mg/L, being maximum in July and minimum in April. The higher values during monsoon might be due to surface runoff. They were however, within permissible limit of 1500 mg/L (BIS 1982).

Chloride: Chloride is an important parameter in assessing the water quality. It controls the salinity of water and osmotic stress on biotic communities (Banerjee 1967). The chloride values fluctuated between 62.3 mg/L (September) and 90.3 mg/L (July). Chlorides increase the degree of eutrophication (Goel et al. 1980).

Phosphate: Phosphorus occurs in natural water as various types of phosphates. The most important sources of phosphates are the discharge of domestic sewage, detergents and

Table 1: Physico-chemical characteristics of Nagathibelagalu pond water.

Parameters	Months: 2008											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature	22.9	23.1	24.2	25.9	24.6	22.1	20.3	22.1	23.1	23.7	22.9	23.4
Turbidity	13.2	11.7	9.3	9.8	15.2	42.1	62.3	29.8	30.7	24.1	17.2	13.7
pH	6.5	6.6	6.7	7.2	7.3	6.9	7.4	6.8	7.2	7.2	6.7	6.6
DO	2.6	2.2	2.1	1.9	2.7	2.3	2.9	3.1	2.8	2.6	2.5	2.4
BOD	8.9	8.6	9.1	10.1	10.3	6.2	6.1	6.7	7.2	6.3	6.9	7.2
CO_2	16.3	15.9	25.4	25.2	22.1	19.3	18.3	20.1	18.9	20.3	22.1	23.7
TA	79.2	81.4	69.3	80.2	73.7	63.4	72.1	63.1	66.2	56.2	57.3	62.2
TH	93	91	106	101	117	98	86	79	89	78	85	87
TSS	145	135	110	95	165	360	416	383	295	265	215	195
Chloride	82.2	69.3	81.1	89.7	78.4	69.2	90.3	72.3	62.3	75.2	77.1	68.3
Phosphate	1.4	1.2	1.7	1.4	1.6	1.8	1.7	1.5	1.3	1.4	1.7	2.2
Nitrate	5.9	6.1	6.3	6.2	6.9	7.2	6.3	6.1	5.6	5.3	6.2	6.3
Sulphate	9.8	10.1	7.9	7.6	10.3	8.6	8.5	8.2	10.1	9.2	9.8	7.7

All values are expressed in mg/L except pH, temperature (°C) and turbidity (NTU).

Table 2: Seasonal variation in physico-chemical characteristics of Nagathibelagalu tank water.

Parameters	Pre-monsoon (Mean ± SD)	Monsoon (Mean ± SD)	Post-monsoon (Mean ± SD)
Temperature	24.2 ± 1.37	23.3 ± 1.29	23.07 ± 0.20
Turbidity	19.1± 13.48	36.72 ± 13.48	13.95 ± 2.02
pH	7.02 ± 0.24	7.15 ± 0.24	6.6 ± 0.07
DO	2.25 ± 0.30	2.85± 0.18	2.42 ± 0.15
BOD	8.92 ± 1.64	6.57 ± 0.42	7.9 ± 0.86
CO_2	23 ± 2.50	19.4 ± 0.83	19.5± 3.45
TA	71.65 ± 6.14	64.4 ± 5.73	70.02 ± 10.45
TH	105.5 ± 7.23	83 ± 4.64	89 ± 3.16
TSS	182.5 ± 105.74	339.75 ± 61.80	172 ± 33.45
Chloride	79.6 ± 7.31	75.02 ± 10.03	74.22 ± 5.73
Phosphate	1.62 ± 0.15	1.47± 0.15	1.62 ± 0.38
Nitrate	6.65 ± 0.42	5.82 ± 0.40	6.12 ± 0.15
Sulphate	8.6 ± 1.05	9 ± 0.73	9.35 ± 0.96

All values are expressed in mg/L except pH, temperature (°C) and turbidity (NTU).

Table 3: Correlation-coefficient between physico-chemical parameters of Nagathibelagalu tank water.

	Temp	Turb.	pH	DO	BOD	CO_2	TA	TH	TSS	Chloride	Phosphate	Nitrate	Sulphate
Temp.	1	-0.812**	0.021	-0. 624*	0.766**	0.617*	0.242	0.529	-0.811**	0.102	-0.174	-0.60	-0.74
Turb.		1	0.514	0.552	-0.705*	-0.386	-0.235	-0.335	0.910**	0.073	0.131	0.148	-0.075
pH			1	0.262	-0.049	0.110	-0.023	0.145	0.365	0.292	-0.173	-0.006	0.035
DO				1	-0.484	-0.433	-0.336	-0.434	0.715**	-0.174	-0.046	-0.207	0.302
BOD					1	0.320	0.717**	0.781**	-0.834**	0.342	-0.270	0.173	0.108
CO_2						1	-0.228	0.361	-0.367	0.251	0.476	0.195	-0.599*
TA							1	0.505	-0.487	0.412	-0.439	0.141	0.144
TH								1	-0.524	0.251	0.055	0.623*	0.080
TSS									1	-0.188	0.154	0.060	-0.74
Chloride										1	-0.020	0.87	-0.310
Phosp.											1	0.500	-0.516
Nitrate												1	-0.158
Sulphate													1

*Correlation is significant at the 0.05 level (2-tailed); **Correlation s significant at the 0.01 level (2-tailed)

Table 4: List of phytoplankton recorded in Nagathibelagalu tank.

	Chlorophyceae		Euglenophyceae
01	*Chlorella vulgaris*	23	*Euglena acus*
02	*Coelastrum microporum*	24	*Euglena elastia*
03	*Coelastrum reticulatum*	25	*Euglena elongata*
04	*Crucigenia crucifera*	26	*Phacus curvidauda*
05	*Eudorina elegans*	27	*Phacus pleuronectes*
06	*Kirshikoviella limnetica*	28	*Phacus truqueter*
07	*Oocystis gigas*	29	*Trachelomonas gradiana*
08	*Pediastrum simplex*	30	*Trachelomonas robusta*
09	*Scenedesmus indicus*		**Bacillariophyceae**
10	*Selanastrum westii*	31	*Colonies pulchra*
11	*Tetraedon caudatum*	32	*Cymbella tumida*
12	*Tetraedon minimum*	33	*Cymbella affinis*
13	*Tetraedon trigonum*	34	*Diatoma vulgare*
	Cyanophyceae	35	*Diatoma elongata*
14	*Agmenellum* sp.	36	*Fragillaria rumens*
15	*Anabaena* sp.	37	*Gomphonema lanceolatum*
16	*Merismopedia glauca*	38	*Melosira granulate*
17	*Merismopedia tenuissima*	39	*Navicula palea*
18	*Microcystis aeruginosa*	40	*Navicula pupula*
19	*Oscillatoria sp.*	41	*Pinnularia major*
20	*Nostoc microscopium*	42	*Pinnulara gibba*
21	*Phormidium* sp.	43	*Synedra ulna*
22	*Synechocystis* sp.	44	*Tabullaria flocculosa*

agricultural runoff. The values ranged from 1.2 to 1.8 mg/L, being maximum in June and minimum in February. Phosphate concentration increases in water bodies that receive domestic waste (Nirmal Kumari 1984).

Nitrate: Nitrate is one of the major inorganic salts regulating the productivity. The nitrate values fluctuated between 5.3 mg/L (October) and 7.2 mg/L (June). The increase of nitrate is associated with the overflowing of water from adjacent paddy fields and sewage discharge.

Sulphate: Sulphate is naturally occurring anion found in almost all kinds of water bodies. The sulphates are derived from the discharge of domestic sewage, surface and agricultural runoff. Sulphate values fluctuated from 7.6 to 10.3 mg/L. The lowest and the highest values were recorded in April and May, respectively.

The relationship between various physico-chemical parameters of water samples was analysed statistically conducting the Pearson correlation analysis (Table 3). Correlation analysis is an important part of bivariate analysis which is concerned with the relation between two variables.

Planktonic composition: A total of 44 species belonging to 29 genera of phytoplankton were recorded (Table 4). Of these Chlorophyceae and diatoms were found to be dominant among the four classes. Relative abundance of phytoplankton in tank showed maximum of diatoms (31.81%), followed by Chlorococcales (29.54%), blue-greens (20.45%) and euglenoids (18.18%). Some of the pollution tolerant species were recorded from the study area are *Coelastrum microporum*, *Microcystis aeruginosa*, *Euglena elastica* and *Trachelomonas robusta*. *Microcystis aeruginosa* is used as the best indicator of pollution and associated with highest degree of civic pollution. The acidic pH favours the abundance of Chlorophycean members. The percentage composition of phytoplankton is depicted in Fig. 1.

CONCLUSION

In the light of WHO and BIS, the pond water can not be used for human beings, especially for drinking and cooking. In order to maintain the health of the tank with respect to water quality it is essential that authorities should take immediate step on the following points.

- The people should not be allowed to discharge domestic wastes directly in to the tank.
- The washing of clothes and vehicles should be prevented.
- People should be advised at least to boil the water to disinfect the pathogens before used for drinking purpose.
- The people should be educated by organizing awareness programs.

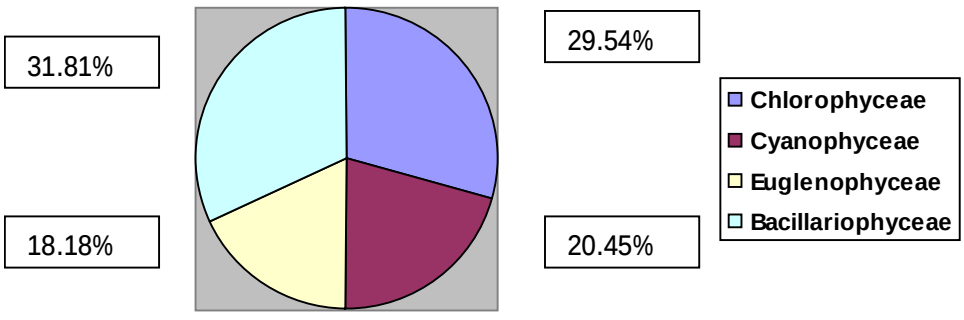

Fig. 1: Distribution of phytoplankton in Nagathibelagalu tank.

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