Journal of Academia and Industrial Research (JAIR)
Volume 2, Issue 6 November 2013

ISSN: 2278-5213

RESEARCH ARTICLE

Impact of Physico-chemical Characteristics on Phytoplankton Diversity of Nalligudda Lake, Bangalore

S. Gayathri*, N. Latha and M. Ramachandra Mohan
Dept. of Zoology, Bangalore University, Bangalore-560056, India
gsgayathris5@gmail.com*; +91 9448241251

Abstract

Physico-chemical parameters of water are a prime consideration to assess the water quality of a lake for its best utilization for drinking, irrigation and fisheries. In the present investigation, the study of monthly variation of different physico-chemical characteristics and phytoplankton diversity were carried out from January to December 2011 to know the water quality of Nalligudda Lake of Bangalore. Physico-chemical parameters of the water samples such as water temperature (24.2-32.3°C), pH (7.1-8.5), total dissolved solids (300-800 mg/L), electrical conductivity (468.75-1250 µmhos/cm), dissolved oxygen (3.9-7.15), biological oxygen demand (2.4-7.2), chemical oxygen demand (9.9-41.4), phosphate (0.32-3.1 mg/L) and nitrate (2.86-6.4 mg/L) were recorded in the present investigation. Totally 51 species of phytoplankton belonging to different taxonomic groups were identified. Among these, 22 species belonged to Chlorophyceae, 8 species to Euglenophyceae, 2 species to Chrysophyceae, 2 species to Dinophyceae, 10 species to Bacillariophyceae and 7 species to Cyanophyceae. Chlorophyceae formed the dominant group. Dominance, Shannon index, Simpson index and Evenness of the species were also calculated.

Keywords: Physico-chemical parameters, Nalligudda lake, water quality, phytoplankton diversity, Shannon index.

Introduction

Water the essence and sustenance of life, is among the biggest and the most crucial natural resource both in terms of quantity and quality. Disputes on water are on increasing day by day and water is becoming an issue of concern. Though defilement of water and deterioration of aquatic systems is as old as civilization, however, escalating industrialization, urbanization and agricultural activities have brought irreversible change in such systems. Unplannned and excessive exploitation and mounting anthropogenic influences in and around aquatic ecosystems have resulted in pollution problems. Lakes, being fragile ecosystems are vulnerable to such problems. Pollution caused by plethora of human activities primarily affects physico-chemical characteristics of water leading to destruction of community disrupting delicate food webs, deteriorating lake environments. Phytoplanktons form the vital source of energy as primary producers and serves as a direct source of food to aquatic plants and animals. Diversity, distribution, abundance and variation in the biotic factors provide information of energy turnover in the aquatic systems (Forsberg, 1982). As the population increases, the need for water availability and accessibility will continue to grow dramatically and will extend additional stress on our limited resources. To maintain the availability of water, all needful efforts are being made in the field of research and development to meet the demand for domestic, agricultural and industrial uses (Bhaisare and Goel, 1992). Hence, monitoring the water quality is fundamental for understanding the water resources as it gives insight into the consequences of its management due to the increasing public interest in water as a resource and on increasing awareness of the need to protect water quality. The present investigation is aimed to study the physico-chemical characteristics and phytoplankton diversity of Nalligudda Lake, Bangalore.

Materials and methods

Study area: The lakes of Bangalore occupy about 4.8% of the city's geographical area (741 km²) covering both urban and rural areas. The study area selected was Nalligudda lake (12^0 56^1 58.05^{11} N latitude and 77^0 27^1 32.80^{11} E longitude and elevation of 2654 ft.). The water is being used for multipurpose utilities such as irrigation, fish catching, washing and bathing (Fig. 1).

Fig. 1. Nalligudda Lake, Bangalore.

Table 1. Seasonal variation of physico-chemical parameters of Nalligudda Lake, Bangalore.

Parameters	Summer			Pre-monsoon			Monsoon			Post-monsoon		
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Water Temp. (°C)	29.7	31.8	32.3	29.0	26.2	26.4	26.8	27.2	27.9	24.2	27.8	28.6
pH	7.2	7.4	7.1	7.6	8.1	8.5	7.9	7.4	7.3	7.4	7.3	7.5
TDS (mg/L)	600	800	700	500	400	300	400	500	400	500	400	400
EC (µmhos /cm)	937.5	1250	1093.75	781.25	625	468.75	625	781.25	625	781.25	625	625
DO (mg/L)	3.9	4.55	5.2	6.5	6.5	7.15	6.5	6.5	5.2	4.5	4.55	5.2
BOD (mg/L)	6.7	7.2	4.61	5.2	5.2	5.2	5.19	4.82	4.51	2.4	5.82	4.89
COD (mg/L)	34.2	38.9	41.4	17.6	11.6	12.8	9.9	10.6	12.9	28.8	24.6	29.7
Phosphate (mg/L)	0.41	0.32	0.6	1.8	2.3	2.8	3.1	2.2	1.8	1.4	1.2	0.5
Nitrate (mg/L)	3.9	4.2	3.3	5.1	6.3	6.4	5.9	4.1	3.81	2.86	2.6	4.1

Experimental design: During the period of investigation (January to December 2011), monthly analysis of the surface water samples and its physico-chemical parameters were made by collecting the water in clean polythene containers. Sampling was made in the morning between 7:30 a.m. to 9:30 a.m. water temperatures were measured at the site using centigrade thermometer. pH was measured in the field using pH meter. For analyzing dissolved oxygen (DO) and biological oxygen demand (BOD), the water samples were collected in BOD bottles (300 mL). DO was also fixed on the spot. All the measurements and estimations were made following APHA (2005). Phytoplankton samples were collected by towing a plankton net (mouth dia 0.35 mm) made up of bolting silk (no. 30; mesh size 48 µ) for 30 min. 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. Counting and identification were done as per APHA (1989).

Statistical analysis: Statistical analysis was made by subjecting the plankton data to a software program PAST (Hammer *et al.,* 2001) which generates the diversity indices of planktons.

Results and discussion

Monthly variations in physico-chemical parameters of Nalligudda Lake are depicted in Table 1. Temperature is an important factor, which regulates the biogeochemical activities in the aquatic environment. Maximum of 32.3°C was recorded during May and minimum of 24.2°C in December. The variation in the water temperature in the present investigation may be due to seasonal variations (Jayaraman *et al.,* 2003; Tiwari and Goel, 2004). pH varied from 7.1-8.5 (alkaline range) with a minimum in May and maximum in August. Water pH is considered to be the reflection of many chemical and biological processes takes place in natural water. Shanbhag *et al.* (2003) reported variation in water pH is considered to be the indicator of health of the Lake. The values of total dissolved solids (TDS) in water varied from a minimum of 300 mg/L in August and maximum of 800 mg/L in April. The highest value of TDS is due to accumulation of the anthropogenic activity which hampered the quality of water.

The maximum of 1250 µmhos/cm electrical conductivity (EC) was observed in April and minimum of 468.75 µmhos/cm in August. Conductivity and dissolved solids are directly proportional to each other mainly due to ionic composition of water. The factors such as rainfall and biodiversity changes in ionic composition and nature of bottom deposits influence the conductivity (Anitha, 2002). The maximum of 7.15 mg/L dissolved oxygen was recorded in August and minimum of 3.9 mg/L in March. Lower dissolved oxygen in summer was due to high temperature and low solubility of oxygen in water, further consequently affecting BOD (Singh *et al*., 1991). The maximum of 7.2 mg/L BOD was recorded in April and minimum of 2.4 mg/L in December. Maximum of 41.4 mg/L of COD was recorded in May and minimum of 9.9 mg/L in September. Chemical oxygen demand is a measure of oxygen required for complete oxidation of organic matter by a strong oxidant. The chemical oxygen demand was high during summer due to high rate of oxidation (Parvateesam and Sudha Gupta, 1994). The values of phosphate in water varied from a minimum of 0.32 mg/L in April to a maximum of 3.1 mg/L in September. Phosphate concentration is maximum during monsoon and minimum during summer. Similar results were reported by Lendhe and Yeragi (2004). Maximum of 6.4 mg/L of nitrate was recorded in August and minimum of 2.86 mg/L in December. Atmospheric nitrogen fixed into nitrates by the nitrogen fixing organism is also a significant contributor to nitrates in water (Trivedi and Goel, 1987).

A total of 51 species of phytoplankton were represented by diverse groups namely Chlorophyceae (22), Euglenophyceae (8), Chrysophyceae (2), Dinophyceae (2), Bacillariophyceae (10) and Cyanophyceae (7). The percentage composition showed marked variation with Chlorophyceae occupying dominant position of 43.13%. List of recorded phytoplankton species are shown in Table 2. Species such as *Pediastrum simplex*, *Scenedesmus obliquus, Tetraedron, Navicula viridula* occurred in all seasons. During summer season *Euglena proxima, Phacus caudate, Synedra acus, Microcystis aeruginosa, Merismopedia elegans, Aphanizomenon, Gloeocapsa and Spirulina* were observed abundantly. In the present study, the dominance of the species ranged 0.4 to 0.52 (Table 3, Fig. 2a).

Table 2. List of recorded phytoplankton species in Nalligudda Lake.

A. Chlorophyceae
1. Pleodorina
2. Elakatothrix
3. *Pediastrum simplex*
4. *P. simplex* var. *duodenarium*
5. *P. simplex 4-celled*
6. *P. clathratum var baileyanum*
7. *Ankistrodesmus falcatus*
8. *Kirchneriella*
9. *Tetraedron*
10. *Tetraedron trigonum*
11. *Scenedesmus obiquus*
12. *S. quadricauda*
13. *S. abundans*
14. *Desmidium swartzi*
15. *Hydrodictyon*
16. *Spirogyra*
17. *Coelastrum*
18. *Gonium*
19. *Eudorina*
20. *Volvox*
21. *Sphaerocystis*
22. *Schroederia*

B. Euglenophyceae
1. *Euglena proxima*
2. *E. oxyuris*
3. *E. albragei*
4. *Phacus caudata*
5. *P. longicauda*
6. *Trachelomonas volvocina*
7. *Lepocinclis acuta*
8. *L. playfairiana*

C. Chrysophyceae
1. *Dinobryon social*
2. *D. divergens*

D. Dinophyceae
1. *Peridinium*
2. *Ceratium*

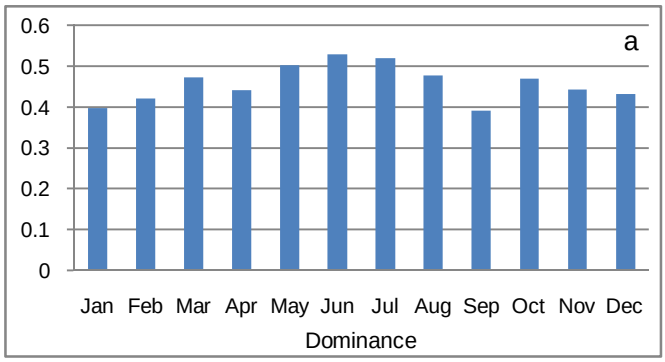
E. Bacillariophyceae
1. *Melosira islandica*
2. *Synedra acus*
3. *Pinnularia viridis*
4. *Cymbella aspera*
5. *C. lonceolata*
6. *Navicula viridula*
7. *N. papula*
8. *N. archibaldii*
9. *Cyclotella meneghiniana*
10. *Fragilaria*

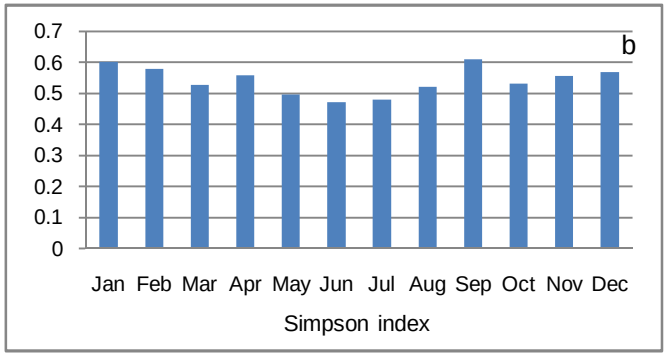
F. Cyanophyceae
1. *Microcystis aeruginosa*
2. *M. incerta*
3. *Merismopedia elegans*
4. *M. glauca*
5. *Aphanizomenon*
6. *Gloeocapsa*
7. *Spirulina*

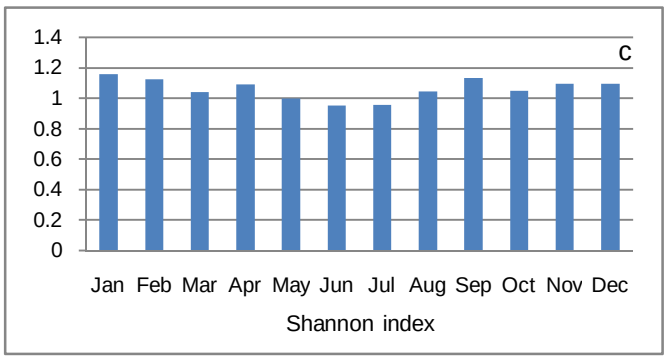
Table 3. Diversity index of phytoplankton in Nalligudda Lake.

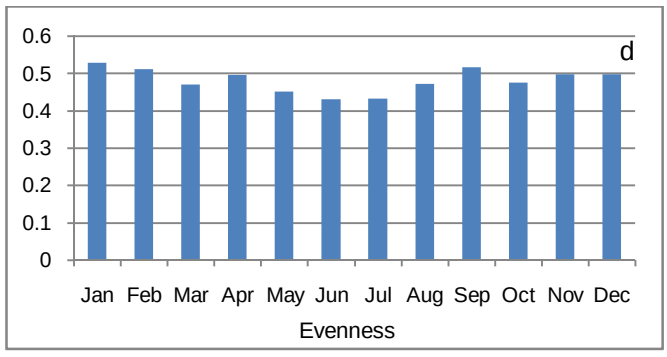
Parameters	Summer			Pre-monsoon			Monsoon			Post-monsoon		
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Individuals	340	312	369	413	406	320	300	284	301	256	231	257
Dominance_D	0.3986	0.4221	0.4738	0.4418	0.5028	0.5293	0.5204	0.4783	0.3915	0.4693	0.4441	0.4322
Shannon_H	1.156	1.122	1.039	1.091	0.9997	0.9507	0.9553	1.043	1.133	1.049	1.096	1.094
Simpson_1-D	0.6014	0.5779	0.5262	0.5582	0.4972	0.4707	0.4796	0.5217	0.6085	0.5307	0.5559	0.5678
Evenness_e^H/S	0.5293	0.5118	0.4713	0.4964	0.4529	0.4313	0.4332	0.4732	0.5175	0.4757	0.4985	0.4978

Fig. 2a-d. Monthly variations in phytoplankton species in Nalligudda Lake.









The maximum dominance was during June and minimum dominance was during September. The ranges of Shannon index, Simpson index and evenness were: 0.95-1.15, 0.47-0.60 and 0.43-0.52 respectively (Fig. 2a-d, Table 3). The population dominance trend showed gradual increase during pre-monsoon and summer season and attained the peak in the month of June. This may be due to the nutrient richness. The population condition was stable during the months of June and July. The dominance slowly declined during post-monsoon season and the lowest value was observed during the month of September. Phytoplankton community successions, the biological meaning of the established patterns resides in the fact that a significant increase in nutrient availability in a reservoir leads to an uncontrolled population growth causing faster growing population to become dominant and this is reflected in the decreasing iversity index (Margalef and Verband, 1958; Gilyarov, 1969).

Conclusion

This study showed detailed limnological characteristics and quality of water in Nalligudda Lake, Bangalore. The summer being the post-monsoon and pre-monsoon seasons showed seasonal fluctuations in various physico-chemical parameters. The values are within the limits of WHO standards except for chemical oxygen demand. The lake water is useful for irrigation as well as fish culture, since the water is highly rich in phytoplankton species and nitrogen fixing bacteria, this water supply to the agricultural fields can contribute much more yield than normal. Hence, there should be continuous monitoring of pollution level and maintain the favorable conditions essential for organisms present in Nalligudda Lake, Bangalore.

References

1. Anitha, G. 2002. Hydrography in relation to benthic macro invertebrates in Mir Alam Lake Hyderabad, A.P. Indian. Ph.D. Thesis submitted to Osmania University, Hyderabad.
2. APHA. 1989. Standard methods for examination of water and wastewater, 17th Edn. Washington, DC. USA.
3. APHA. 2005. Standard methods for the examination of water and waste waters, 21st Edn., Washington, DC. USA.
4. Bhaisare, A.R. and Goel, D.K. 1992. Ground water year book of Madhya Pradesh central ground water board, Bhopal. pp.4-9.
5. Forsberg, C. 1982. Limnological research can improve and reduce the cost of monitoring and control of water quality. *Hydrobiol*. 86: 143-146.
6. Gilyarov, M. 1969. Correlation between the biomass and species diversity in the planctonic community. *Zoologicheskii Zh*. 48(4): 485-493.
7. Hammer, O., Harper, D.A.T. and Rayan, P.D. 2001. PAST. Paleontological statistics software package for education and data analysis. *Palaenotological Electronica*. 4(1): 9.
8. Jayaraman, P.R., Ganga Devi, T. and Vasudevan Nayar, T. 2003. Water quality studies on Karamana river, Thiruvananthapuram district, South Kerala. *Ind. Pollut. Res*. 22: 89-100.
9. Lendhe, R.S. and Yeragi, S.G. 2004. Physico-chemical parameters and zooplankton diversity of phirange kharbav lake, Dist. Thane, Maharashtra. *J. Aqua. Biol*. 19(1): 49-52.
10. Margalef, R. and Verband. 1958. Trophic typology versus biotic typology, as exemplified in the regional limnology of Northern Spain. *Verh. Int. Ver. Limnol*. 13: 249-339.
11. Parvateesam, M. and Sudha Gupta. 1994. Physico chemical characteristics of lake receiving effluents from textiles mills in Rajasthan. *Pollut. Res*. 13: 317-321.
12. Shanbhag, A.B., Borges, S.D. and Walia, R. 2003. Carambolim Lake, an ideal freshwater wetland of Goa. In: Recent advances in environmental sciences. (Ed. K.G. Hiremath). Discovery publ. House, New Delhi. pp.278-310.
13. Singh, J.P., Yadav Singh, S. and Prasad, S.C. 1991. BOD contamination in Kali river at Sadhu Ashram in Aligarh, India. *J. Environ. Poll*. (5): 225.
14. Tiwari, S., Dixit, S. and Gupta, S.K. 2004. An evaluation of various physico-chemical parameters in surface waters of Shahpura Lake, Bhopal. *Pollut. Res*. 23: 829-832.
15. Trivedi, R.K. and Goel, P.K. 1987. Chemical and biological methods for water pollution studies. Environmental publications Karad, India.