Emer Life Sci Res (2015) 1(2): 35-40

E-ISSN: 2395-6658
P-ISSN: 2395-664X

Research Article

Effect of Water Quality on Phytoplankton Abundance in Selected Ponds of Nedumangad Block Panchayat, Kerala

Asha M.S. Nair, J.K. Reshma, Anu Mathew and Aswathy Ashok J.A

Received: 1 September 2015, Accepted: 23 November 2015

Abstract

The present study was carried out to analyze the plankton diversity of 36 selected ponds in Nedumangad Block Panchayat. It is crucial to observe the physico-chemical features of a water body for different term investigations as the survival and activity of organisms depends on the environmental characteristics of that water body. Plankton analysis showed the presence of phytoplankton belonging to the class *Cyanophyceae, Chlorophyceae, Bacillariophyceae* and zooplanktons found are Zoea larvae and *Mysis* larvae of prawn. Moreover, phytoplankton reflects the water environmental condition at the time of growing and sampling.Phytoplanktons are greatly affected by ecological conditions like salt stress, temperature, pH, biological oxygen demand and other environmental factors. The plankton abundance was calculated for 10 selected ponds. Carl Pearson's correlation coefficients were calculated for abundance with pH, EC, DO and temperature. Abundance depends on the temperature variations and levels of DO as they are positively correlated while abundance does not have any interdependence on both the EC and pH as they are negatively correlated. Results of plankton abundance of various ponds at Nedumangad as studied in the present investigation clearly shows that the water is not good for human consumption and also struggling for their existence. Algal analysis thus showed that water quality of the pond has reached at threshold level and therefore, it needs some corrective measures to maintain the water chemistry of the pond and this will help the society to get an awareness of the quality of the water they are using for daily consumption and thereby rectify the present condition.

Keywords abundance, dissolved oxygen, phytoplankton, water quality, zooplankton

Introduction

Today, organic pollution of water resources has become a crucial concern. Increasing human population and activities imposes great burden on freshwater resources. Among fresh water resources, ponds are small but attributed with profuse aquatic macrophytes development (Penny *et al*, 2003). Phytoplankton are microscopic plants containing chlorophyll A, that float or swim on the upper surfaces of water or are suspended in the water column, where they are dependent on sunlight for photosynthesis (Penny *et al*, 2003). Carbon dioxide is the main source for providing carbon to phytoplankton that in turn serve as food for zooplankton and fish (Arya *et al*, 2011). Phytoplankton, being primary producers, holds a significant place in aquatic food chain and all the life forms including zooplanktons are dependent on them (Pace *et al*, 2004).

Phytoplankton and zooplankton retort rapidly to any alterations in nutrient changes in water bodies indicating the growing nutrient pollution. Effect of pollutants on aquatic life and a reduction in biotic diversity can be easily understood by analyzing phytoplankton. Phytoplankton analysis gives an overall idea of the environmental condition of the water body both at the time of growing and sampling. Although phytoplankton is present in water bodies, their supply as food supplement can be increased through external supply from cultures or by development of prevailing algae through fertilization (Boyd, 2004). On one hand where phytoplankton serves as food source, on the other hand some forms causes fish poisoning due to

A.M.S. Nair, J.K. Reshma, A. Mathew✉, A.J.A. Aswathy
Post Graduate Department of Environmental Sciences, All Saints' College, Thiruvananthapuram- 695007, Kerala
✉anumathew85@yahoo.co.in

release of toxins during blooms (Boyd, 2004). Thus, these reasons make it very essential to estimate the levels of planktons in each pond samples which will in turn indicate its water quality.

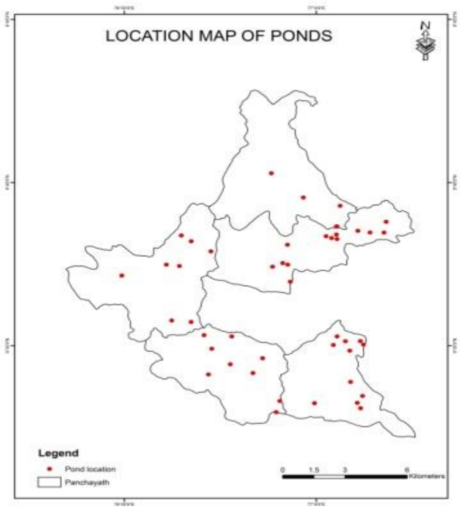


Fig-1 Location map showing pond sampling sites in Nedumangad panchayath

Material and Methods

The phytoplankton samples were labelled and transported to the laboratory, stored at 40C in the refrigerator for analysis of selected parameters. Samples were collected in plastic containers (Can) previously rinsed with distilled water. The present study was carried out in 36 ponds of 5 panchayaths within Nedumangad Block in Thiruvananthapuram dist., Kerala, India. Ex-situ measurements were conducted for each physical parameter.

Plankton Analysis

Phytoplankton samples were collected by filtering a known volume of water through plankton net as per standard methods (APHA, 2005) from 10 representative ponds. The collected samples were fixed in 4-5% formaldehyde and brought to laboratory for analysis. Counting is done as per APHA (2005), Trivedy and Goel (1986). Identification of plankton were done by observing through the microscope and by using standard keys for plankton identification.

Results and Discussion

The main phytoplanktons were classified in class Cyanophyceae, Chlorophyceae, and Bacillariophyceae and zooplanktons found are Zoea larvae and Mysis larvae of prawn.

Table 1 Plankton species identified in various pond water samples

Plankton species	S1	S 2	S 3	S 4	S5	S 6	S 7	S 8	S 9	S 10
Oscillatoria sp.	+	+	+	_	+	+	_	_	+	_
Selenastrum sp.	+	_	_	_	_	_	_	_	_	_
Cosmarium sp.	_	_	+	_	+	+	+	+	_	_
Spirogyra sp.	_	_	+	_	+	+	_	+	_	+
Scenedesmus sp.	_	_	+	_	_	+	_	_	_	_
Navicula sp.	_	_	_	+	+	+	+	+	+	+
Cladophora sp.	_	_	_	+	_	_	+	_	_	_
Tabellaria sp.	+	_	_	+	+	_	+	+	_	_
Pinnularia sp.	_	_	_	_	_	_	+	_	+	_
Oedogonium sp.	_	_	_	_	+	+	_	_	_	_
Mysis larva	_	_	_	_	+	+	_	_	_	_
Zygnema sp.	_	_	_	_	_	+	_	_	_	_
Zoea larva	_	_	_	_	_	_	+	_	_	_
Mougeotia sp.	_	_	_	_	_	_	_	_	+	_
Ulothrix sp.	_	_	_	_	_	_	_	_	+	_

Phytoplanktons were dominated by Chlorophyceae followed by Bacillariophyceae. Navicula sp.was present in 7 pond samples. Oscillatoria were found in 6 ponds and Cosmarium,Spirogyra and Tabellaria were present in 5 pond samples. Scenedesmus and Cladophorawere present in 2 ponds. The remaining planktons Zygnema, Selenastrum, Zoea larva and Ulothrix were found only in one pond as shown in table 1.The poor diversity of plankton may be caused by several factors such as poor light penetration due to surface growing macrophytes as revealed in the study of Kamini and Madhura (2013).

Though physico-chemical features of water resource is a crucial indicator of water quality, it cannot be considered completely descriptive and reliable in absence of information about ecological factors (Karr et al., 2000). Since a biotic community is the outcome of the integration and interaction of different physical, chemical and geo-morphological characteristics of any water body, biological assessment is a useful alternative in assessing those systems (Stevenson and Pan, 1999). Low Dissolved Oxygen levels may also be the reason for poor plankton diversity.

Phytoplanktons are also the indicators of water pollution. Several researchers informed on a number of algal species as water quality indicator (Naik et al., 2005; Nandan and Aher, 2005; Zargar and Ghosh, 2006). In a study on Kadra reserviour of Karnataka in 2006, Zargar and Ghosh reported on several algal forms belonging to Chlorophyceae, Cyanophyceae, and Bacillariophyceae as water pollution indicators. Nandan and Aher (2005) concluded that the algal genera, Oscillatoria, Scenedesmus and Navicula are the species found in organically polluted waters. These species were found in the samples of the present study also. However, the ponds in the present study is characterized by abundance of chlorophyceae followed by Cyanophyceae, which indicates the absence of pollution, as supported by earlier workers (Verma and Mohanty, 1994; More and Nandan, 2000; Nandan and Aher, 2005; Tas and Gonulal, 2007).

Plankton abundance

Phytoplankton is one of the potent groups of any water bodies. They hold direct liability for net productivity of a water system and serve as primary energy source in water bodies based food chain. Different phytoplankton species are habitat specific in nature and their distribution reveals the features of water where they survive (Bhatt, et al., 1999; Saha et al., 2000). Hence, phytoplankton can be deliberated as a potential tool for determining the quality and pollution status of water bodies (Palmer, 1959). The production of freshwater community that regulates the fish growth is controlled by its physico-chemical and biotic background (Wetzel, 1989).

Generally, nutrients available control the profusion of planktonic algae in a water resource. Wood, fields, human activities, pond fertilization and several other forms of ecological cycle can be source of pond nutrients. Although, abundance of phytoplankton is advantageous for providing food and oxygen, it excess is equally disastrous. So, its analysis is done in this study using four parameters (Table 2). When water visibility is restricted to less than 12 inches due to abundance of phytoplankton, there is a risk of oxygen depletion. Phytoplankton growth increases during warm and nutrient rich environment. At very low concentrations, oxygen dissolves in water; however, it was noteworthy to have more than 10 ppm oxygen dissolved in water in a pond sample from station Karakulam i.e., KRKM- 4 (10.7 ppm). The physicochemical and biological features largely control the plankton production and biology of the cultured organisms.

Osmotic concentrations, dissolved oxygen and nutrients are crucial for phytoplankton growth (Bais and Agarwal, 1990). If there are nutritional changes in aquatic environment, plankton diversity also fluctuates quickly. These ecological attributes are chief factors determining growth rates and development of zooplankton (Jhingran, 1991). Additionally, climatic conditions effect water quality and in turn, biodiversity of water resources (Boyd, 1988). Statistical association between parameters and abundance reflects the control of factors on growth of phytoplankton and zooplanktons. Graph 1 shows a direct association between plankton abundance and temperature ($r = 0.38$). Profusion of planktons depends on light availability, both directionally and seasonally.

DO levels are influenced by temperature and salinity. DO shows a positive correlation ($r=0.06$) with abundance (Graph 1) which implies that as the there is a hike in the levels of phytoplankton the DO also increases but it owes an indirect relation with

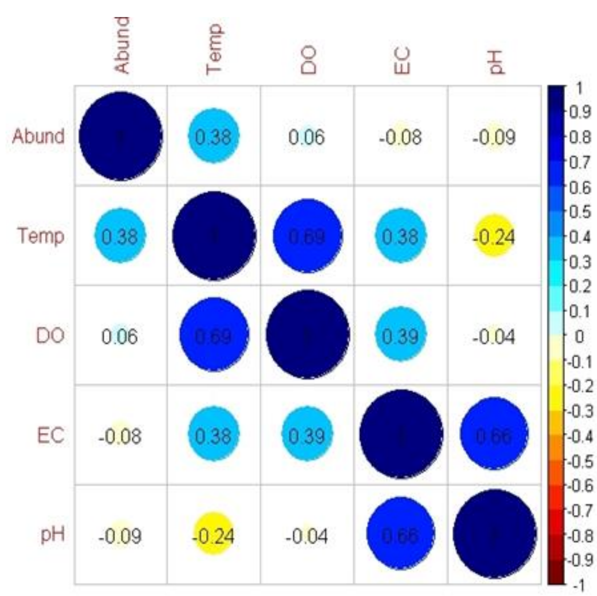
Table 2: Abundance of plankton species based on physico-chemical parameters

Sample	Abundance	Temp.	DO	pH	EC
PAN-2	245	26.8	2.61	6.25	88.2
AND-1	360	32.5	7.37	6.13	112.5
AND-11	290	28.1	7.58	5.77	58.44
AND-14	370	30.9	8.06	5.31	44.81
VEM-3	200	28.3	7.66	6.32	80.5
VEM-6	255	26.4	5.31	5.59	65.86
KRKM-2	310	28.5	7.69	7.24	145.4
KRKM-4	225	31.2	10.7	6.23	145.5
KRKM-5	265	25.5	5.5	6.55	58.59
AVKA-3	210	30.2	7.7	5.59	79.25

temperature. The solubility of oxygen, or its ability to dissolve in water, decreases as the water's temperature and salinity increase as shown in the graph plot. The DO concentration within a water body can experience large daily fluctuations. Aquatic plants and algae produce oxygen as a by-product of photosynthesis by day. But at night, they consume oxygen through respiration (Diurnal fluctuations) and hence in this study the DO concentration is seen to be lower as the sample was collected early morning, when the level of carbon dioxide might have been more due to respiration. Productive lakes, lakes with large populations of aquatic plants or algae, are likely to experience the greatest DO fluctuations.

As represented in graph plot the value of correlation (r) of abundance and EC is -0.08 (Graph 1), it can be concluded that they show a negatively correlated trend among themselves. EC is an indication of extent of salinity in the pond water samples collected as EC is a numerical expression of the ability of an aqueous solution to carry electric current. This ability depends on the presence of ions, their total concentration, mobility, valence and relative concentrations and on the temperature of measurement.

pH of the water samples decides whether an aquatic flora and fauna is able to survive in the present condition in the water and thus the abundance of the both phyto- and zooplanktons in the ponds under consideration is a measure of its water quality. Abundance and p H also show a negative correlation (r = -0.09) (Graph 1).



Graph 1: shows correlation and interdependence of temperature, DO, EC, pH and abundance of planktons

Therefore, this study attributes the fact that as the pH of the pond water increases abundance proportionately decreases. Hence, water resources with strong acidic water may sustain only acid tolerant species. Natural acid-base balance of aquatic systems is affected by increase in pH levels due to photosynthesis and respiration of algae.

Therefore, from this study it can be concluded that abundance depends on the temperature variations and levels of DO to some extent as they are positively correlated but at the same time, abundance does not have any interdependence on both the electrical conductivity and pH as they are negatively correlated.

Conclusion

Results leads to a clear cut picture that there is an immediate need of restoration, improvement and proper management of these secret water bodies for the human and environment. Dominance of pollution tolerant genera Oscillatoria sp. (in pond samples 1,2,3,5,6,9), Scenedesmus sp., (in pond samples 3,6) and Navicula sp. (in pond samples 4,5,6,7,8,9,10) round the year also supports the view to categorize the ponds as eutrophic in nature as also reported by Nandan and Aher (2005) and Shekhar *et al*. (2008). Algal analysis thus showed that water quality of the pond has reached at threshold level and therefore, it needs some corrective measures to maintain the water chemistry of the pond. Basic pond management principles are designed to maintain good water quality and reduce incidence of disease. It is important to develop a plan of action to be taken when a water quality measurement approaches being outside the desirable range and stressful concentrations. This is why monitoring regularly and recording data is important—it will aid in anticipation of needed action.

Acknowledgements

The authors are extremely thankful for the support and laboratory facilities provided by IIUCNRM, University of Kerala in addition to the financial support of the UGC-MRP and PG Department of Environmental Sciences, All Saints' College, University of Kerala for carrying out this study successfully.

References

APHA: Standard methods for examination of water and wastewater. 21st Edn. APHA, AWWA, WPCF, Washington DC, USA (2005).

B. Tas and. A. Gonulol (2007). An ecologic and taxonomic study on phytoplankton of a shallow lake, Turkey. J. Environ. Biol., 28: 439-445.

C. E. Boyd (2004). Water quality management for pond fish culture, Elsevier, New York eds.

C. E. Boyd and C. S. Tucker (1988). Pond Aquaculture Water Quality Management (Kluwer Academic Publisher London.

C. M. Palmer (1959). Algae in water supplies, US Department of Health, Education and Welfare, Public Health Service, Cincinnati. (Public Health Service publication No. 657).

J. P. Verma and R. C. Mohanty (1994). Evaluation of water quality of two fresh water ponds. Pollut. Res., 13: 69-74.

J. R. Karr, J. D. Allen and A. C. Benke (2000). River conservation in the United States and Canada. In P. J. Boon, Davies and B .R. Petts, G E (Ed.), Global perspectives on River conservation, pp 3–39 Science, Policy, and Practice. Wiley, New York.

K. Mahale and M. Malvankar (2013). The Study of Physico-Chemical Parameters and Plankton Diversity of the ponds in The V.P.M. Campus, Thane, Maharashtra, India. National Conference on Biodiversity: Status and Challenges in Conservation - 'FAVEO' Pp. 242-244.

L. R. Bhatt, P. Lacoul, H. D. Lekhal and P. K. Jha (1999). Physico-chemical characteristic and phytoplankton for Taudha lake, Kathmandu. Poll. Res., 18: 353-358.

M. L. Pace and A. T. Prairie (2004). Respiration in lakes. In P.A. del Giorgio and P. J. L. Williams [eds.], Respiration in aquatic systems. Oxford Univ. Press.

P. Williams, M. Whitfield, J. Biggs, S. Bray, G. Fox, P. Nicolet et al., (2003).Comparative biodiversity of rivers, streams, ditches and ponds in an agricultural landscape in Southern England, Biologic. Conserv., 115: 329–341.

R. G. Wetzel (1989). Limnology, 2nd edition (Saunders Co., Philadelphia, and PMCid: PMC534348V.

R. J. Stevenson and Y. Pan (1999). Assessing environmental conditions in Rivers and streams using diatoms. In E. F. Stoermer and J. P. Smol, (Ed.), The diatoms, Applications for the environmental and earth sciences, pp. 11–40 Cambridge University Press, Cambridge.

R. K. Trivedi and P. K. Goel (1986). Chemical and biological methods for water pollution studies, environmental publication, India.

S. Arya, V. Kumar, M. Raikwa, A. Dhaka and Minakshi (2011). Physicochemical Analysis of Selected Surface Water Samples of Laxmi Tal (Pond) in Jhansi City, UP, Bundelkhand Region, Central India, J. Exp. Sci., 2, 8, pp. 01-06.

S. Shekhar, S. Kiran, B. R. Puttaiah, Y. Shivaraj and K.M. Mahadevan (2008). Phytoplankton as index of water quality with reference to industrial pollution. J. Environ. Biol. 29: 233-236.

S. Zargar and T.K. Ghosh (2006). Influence of cooling water discharges from Kaiga nuclear power plant on selected indices applied to plankton population of Kadra reservoir. J. Environ. Biol., 27: 191-198.

S. B. Saha, S. B. Bhattacharya and A. Choudhury (2000). Diversity of phytoplankton of sewage pollution brackish water tidal ecosystems. Environ. Biol., 21: 9-14.

S. N. Nandan and A. H. Aher (2005). Algal community used for assessment of water quality of Haranbaree dam and Mosam river of Maharashtra. J. Environ. Biol., 26: 223-227.

U. G. Naik, S. H. Bhosale, J. L. Rathod and U. G. Bhat (2005). Diversity of phytoplankton groups in the river Kali, west coast of India. Proc.of the State Level UGC Sponsored Seminar on Biodiversity and its Conservation, Haveri, 28-29th July, pp. 192-196.

V. G. Jhingran (1991). Fish and Fisheries India. 3rd edition (Hindustan Publishing Corporation, India.

V. S. Bais and N. C. Agarwal (1990). Seasonal variations of nitrogen contents in the sediment and water of the Sagar lake. Bull. Environ. Sci., 8: 21-24.

Y. S. More and S. N. Nandan (2000). Hydro biological study of algae of Panzara River (Maharashtra). Ecol. Environ. Cons., 6: 99-103.