INTERNATIONAL JOURNAL OF PHARMACEUTICAL RESEARCH AND BIO-SCIENCE

COMMUNITY STRUCTURE ANALYSIS OF PHYTOPLANKTON IN WATER BODIES OF EAST KOLKATA WETLANDS

ATANU ROY[1], SUFIA ZAMAN[2], SUBHASMITA SINHA[3], DEBABRATA BERA[4], MADHUMITA ROY[1], ABHIJIT MITRA[3]

1. Department of Biotechnology, Techno India University, Salt Lake Campus Kolkata 700091.
2. Department of Oceanography, Techno India University, Salt Lake Campus, Kolkata 700091.
3. Department of Marine Science, University of Calcutta, 35 B.C. Road, Kolkata 700 019.
4. Department of Food Technology, Techno India, Salt Lake Campus, Kolkata 700091.

Accepted Date: 07/06/2015; Published Date: 27/06/2015

Abstract: Phytoplankton population density and diversity of three selected ponds at East Kolkata Wetlands were monitored during April, 2015. The hydrological parameters (like surface water pH, surface water temperature, dissolved oxygen, nitrate, phosphate and silicate) were also analyzed during the present study. Surface water temperature, pH and D.O ranged between 32.6^0 C - 34.6^0 C, 8.5 – 8.8 and 4.64 mg l^{-1} – 6.02 mg l^{-1} respectively. The nitrate (NO_3), phosphate (PO_4) and silicate (SiO_3) ranged between 23.66 – 31.02 µg gm at l^{-1}, 2.04 – 3.11 µg gm at l^{-1} and 45.77 – 53.66 µg gm at l^{-1} respectively. The diversity index was computed to evaluate the condition of the aquatic environment. Correlation coefficient was computed to get a clear picture of the inter-relationships between phytoplankton species diversity and the hydrological parameters.

Keywords: Phytoplankton, phytoplankton population density, Shannon-Weiner species diversity index, East Kolkata Wetlands.

Corresponding Author: MR. ATANU ROY

Access Online On:

www.ijprbs.com

How to Cite This Article:

Atanu Roy, IJPRBS, 2015; Volume 4(3): 261-268

PAPER-QR CODE

INTRODUCTION

The sewage fed ponds in East Kolkata Wetlands are rich in nutrients which may be attributed to high concentration of nitrate and phosphate in the waste generated from industrial and anthropogenic activities. Silica is also released from several industries. These materials finally find their way into the canal systems and water bodies that are ultimately discharged *via* Dry Weather Flow (DWF) and Storm Weather Flow (SWF) canals into the Matla estuary. On either side of the DWF and SWF canals a large number of aquacultural farms exists in which phytoplankton oscillates as a function of nutrient and volume of waste discharge. The phytoplankton, being the main foundation in the food web of the aquatic system, transfers the energy to the secondary and tertiary level of the system. It is therefore important to know the type and standing stock of phytoplankton in order to evaluate the dynamics of energy flow in the aquatic phase of East Kolkata Wetlands.

The present paper is an attempt to evaluate the population density and diversity of phytoplankton in three selected water bodies of East Kolkata Wetlands. Another aim of the present study is to monitor the hydrological parameters (nitrate, phosphate, silicate, dissolved oxygen, surface water temperature, and pH), so as to understand the inter-relationships between phytoplankton diversity, density and selected hydrological parameters.

MATERIALS AND METHODS

Study area

The East Kolkata wetland is situated between 20^0 25’ N - 20^0 35’ N and 88^0 20’ E - 88^0 35’ E. The wetland and its adjacent area experience a subtropical climate with an annual mean rainfall around 1900 mm. The maximum air temperature is witnessed during premonsoon (~ 39.5^0 C), while minimum temperature is recorded during postmonsoon (~11^0 C). The temperature of the aquatic phase ranges between 12^0 C (in postmonsoon) to 36^0 C (in premonsoon). The wetland is unique because of two reasons namely:

i) Absence of any major catchment area.

ii) Approximately 250 million gallons of sewage per day is introduced into the system.

Three ponds in the wetland system have been selected for the present study to evaluate the diversity of the phytoplankton (Table 1).

Analysis of hydrological parameters

Surface water temperature was recorded by using a 0^0- 100^0C mercury thermometer. Surface water pH were measured by using a portable pH meter (sensitivity = ± 0.02). The dissolved

oxygen was measured by DO meter in the field and subsequently cross-checked in the laboratory by Winkler's method [1].

Surface waters for nutrient analysis were collected in clean TARSON bottles and transported to the laboratory in ice-freezed condition. Triplicate samples were collected from the same collection site to maintain the quality of the data. The standard spectrophotometric method of Strickland and Parsons (1972) [2] was adopted to determine the nutrient concentration in the surface water. Nitrate was analysed by reducing it to nitrate by passing the sample with ammonium chloride buffer through a glass column packed with amalgamated cadmium fillings and finally treating the solution with sulphanilamide. The resultant diazonium ion was coupled with N-(1-napthyl)-ethylene diamine to give an intensely pink azo dye. Determination of the phosphate was carried out by treatment of an aliquot of the sample with an acidic molybdate reagent containing ascorbic acid and a small proportion of potassium antimony tartarate. Dissolved silicate was determined by treating the sample with acidic molybdate reagent. The resultant silico-molybdic acid was reduced to molybdenum blue complex by ascorbic acid and incorporation of oxalic acid prevented formation of similar blue complex by phosphate.

Estimation of phytoplankton population density in the selected water bodies

Phytoplankton samples were collected (from the three selected ponds during April, 2015) through a vertical tow of plankton net (20 µm effective mesh size) at each study site. The plankton net was approximately 50 cm long, with a 26 cm diameter mouth and a 10 cm diameter opening at the cord end, which was tied to a 125 ml TARSON collection bottle. In each time of plankton collection 100 litre of water was passed through plankton net. The volume of plankton concentrate was 75 ml. The concentrates collected were preserved by using 2% neutral formalin to identify the phytoplankton species. Population counts from the collected samples were done through Sedgwick Rafter plankton counting chamber and the count were subsequently expressed in cells/L. The final phytoplankton count (expressed in cells/L) was done as per the standard expression.

N = nv/V

Where,

N = Total number of phytoplankton cells per litre of water filtered.

n = Average number of phytoplankton cells in 1 ml of phytoplankton sample.

v = Volume of phytoplankton concentrate (ml)

V = Volume of total water filtered

Estimation of phytoplankton population diversity

The Shannon-Weiner diversity index [3] was calculated based on the relative abundance value of phytoplankton species in selected ponds as per the following expression:

$$H' = -\sum_{i=1}^{S} p_i \cdot \ln(p_i)$$

Where,

H' = Shannon Weiner species index

P_i = ni/N (ni = Number of individuals of i^{th} species and N = total number of individuals of all the species).

Statistical analysis

The inter-relationships between hydrological parameters and phytoplankton diversity were enumerated through computation of correlation coefficient (r) values. All statistical calculations were performed with SPSS 9.0 compatible to Windows platform.

RESULTS

The present study shows 28 genera of phytoplankton of which Chlorophyceae, Bacillariophyceae and Myxophyceae encompass 11, 7 and 10 genera respectively (Table 2).

Table 3 reflects the hydrological parameters in the selected ponds in the study area. The nitrate (NO_3) level ranged from 23.66 µg gm at l^{-1} (in Pond I) – 31.02 µg gm at l^{-1} (in Pond III). The phosphate (PO_4) level ranged from 2.04 µg gm at l^{-1} (in Pond I) – 3.11 µg gm at l^{-1} (in Pond III) and silicate (SiO_3) level ranged between 45.77 µg gm at l^{-1} (in Pond I) – 53.66 µg gm at l^{-1} (in Pond III). The pH and the surface water temperature were almost uniform in the selected ponds with minor deviations. The D.O level varied from 6.02 mg l^{-1} (in Pond I) - 4.64 mg l^{-1} (in Pond III).

DISCUSSION

It is evident from Table 2 that Pond I has maximum diversity (3.314) followed by Pond II (3.302) and Pond III (2.296).

The value of *H* has several ecological explanations. As Margalef, (1968) [4] stated that, 'the ecologists find in any measure of diversity an expression of the possibilities of constructing feedback system'. Higher diversity then signifies longer food chains and more cases of

symbiosis (mutualism, commensalisms *etc*.) and greater probabilities for negative feedback control, which reduces the drastic oscillation and hence increases stability. The value of *H* is a unique indicator of environmental stress. As the sensitive species gradually shift or get eliminated from the habitat with the increase of magnitude of environmental stress, therefore the species diversity index has been claimed as an effective statistics for predicting the change in environment [5, 6].

In a Shannon-Weiner legislation the aquatic environment of soil and water is divided as good when H >4, good quality is 4-3, moderate quality 3-2, poor quality 2-1 and very poor quality < 1. The Shannon-Weiner index in the present study is within the range of (2.114-2.863) which indicates less environmental stress on the macro-benthic molluscan species inhabiting the east coast of India. The distribution of species (in terms of population density) becomes more dissimilar as the environmental stress increases and accordingly species diversity decrease with poor water quality.

The difference in nutrient level may be attributed to input of fertilizers by local fishermen. Pond III is used for pisiculture and therefore artificial fertilizers are introduced for fertilizing the pond. The artificial churning of the substratum and the water surface to keep the D.O level high has increased the silicate level in the aquatic phase. In the present study, the lowest species diversity in Pond III may be attributed to maximum environmental stress to the aquatic system of the pond. The highest level of nutrients in this particular pond supports the view.

The correlation coefficient values in table 4 suggest significant inverse relationships between nutrients (NO_3, PO_4 and SiO_3) and the diversity of phytoplankton, which reflects the uptake of nutrients by phytoplankton species in the selected ponds. The inverse relationship between surface water temperature and diversity index clearly depicts the adverse impact of excessive high temperature in phytoplankton diversity. This may serve as proxy to climate change through development of long term data bank. The direct proportionality of D.O and phytoplankton diversity is the reflection of photosynthetic activity during day time (the time of our sampling).

The overall discussion leads to two core finding:

(i) The ponds in the study area exhibits variability in terms of phytoplankton diversity, nutrient level and D.O level

(ii) The regulatory role of nutrients on phytoplankton diversity is confirmed through significant negative relationships between nutrients and phytoplankton diversity. The productivity of the selected ponds is thus sewage dependent.

Table 1: Pond description.

Pond Code	Co-ordinates	General description
I	22^0 34' 20.2" N 88^0 26' 20.6" E	**Local Name:** Munshir Bheri **Area (sq. m):** ~ 130000
II	22^0 33' 06.2" N 88^0 24' 38.4" E	**Local Name:** Captain Bheri **Area (sq. m):** ~ 300000
III	22^0 32' 59.8" N 88^0 25' 30.2" E	**Local Name:** Natur Bheri **Area (sq. m):** ~ 230000

Table 2: Pond wise phytoplankton species diversity.

Class	Species	Pond I ($\times 10^5$)	Pond II ($\times 10^5$)	Pond III ($\times 10^5$)
Chlorophyceae	*Closterium sp.*	1.8	2.2	1.9
	Chlorella sp.	2.7	3.1	0.7
	Planktospherica sp.	4.4	5.5	1.8
	Scenedesmus sp.	3.9	6.1	4.6
	Phytoconis sp.	1.5	3.0	2.1
	Asterionella sp.	3.8	6.2	4.1
	Schroederia sp.	4.6	8.8	5.4
	Chodatella sp.	3.8	4.1	4.7
	Tetraedron sp.	4.6	2.8	3.3
	Actinastrum sp.	1.2	10.4	8.9
	Cosmarium sp.	2.0	3.4	2.9
Bacillariophyceae	*Fragillaria sp.*	2.0	4.5	0.4
	Diatoma sp.	3.0	5.1	0.6
	Synedra sp.	3.1	5.0	9.9
	Nitzschia sp..	2.9	5.5	0.2
	Navicula sp.	3.1	6.4	0.5
	Pleurosigma sp.	4.4	2.9	3.1
	Cocconeis sp.	6.1	8.2	0.3
Myxophyceae	*Oscillatoris sp.*	2.1	5.9	9.7
	Spirullina sp.	5.6	6.0	0.3
	Anabena sp.	3.2	5.2	3.1
	Microcystis sp.	2.9	5.6	0.2
	Schizothrix sp.	4.4	4.9	8.5
	Closteropsis sp.	5.2	5.5	0.4
	Calothrix sp.	5.4	4.9	1.1

	Glotrichia sp.	3.8	5.0	6.1
	Lyngbya sp.	4.0	3.9	4.1
	Phormidium sp.	3.7	5.8	0.6
N		107.9	147.9	90.6
H		3.314	3.302	2.296

Table 3: Hydrological parameters of selected ponds.

Pond Code	NO_3 (µg gm at l^{-1})	PO_4 (µg gm at l^{-1})	SiO_3 (µg gm at l^{-1})	pH	Surface water Temperature (^0C)	D.O (mg l^{-1})
I	23.66	2.04	45.77	8.50	32.6	6.02
II	29.67	2.99	49.02	8.80	33.6	4.98
III	31.02	3.11	53.66	8.70	34.2	4.64

Table 4: Inter-relationship between diversity index of phytoplankton and hydrological parameters.

Correlation	r value	p value
H' x NO_3	-0.64954	< 0.01
H' x PO_4	-0.59430	< 0.01
H' x SiO_3	-0.91633	< 0.01
H' x pH	-0.19900	Insignificant
H' x surface water Temperature	-0.79202	< 0.01
H' x D.O.	0.69798	< 0.01

REFERENCES

1. Winkler, LW: Die Bestimmung des in Wasser gelösten Sauerstoffen, Berichte der Deutschen Chemischen Gesellschaft 1888; 21: 2843–2855.

2. Strickland JDH and Parsons TR: A practical handbook of seawater analysis. Second Edition, Bulletin 167. Fisheries Research Board of Canada, Ottawa; 1972.

3. Shannon CE and Weiner W: A mathematical theory of communication. Bell System Technical Journal, 1949; 27: 379–423.

4. Margalef R: Perspectives in ecological theory. Univ. Chicago Press, Chicago, 1968; 3, 111.

5. Cairns J (Jr.) and Dickson KL: A simple method for the biological assessment of the effects of waste discharges on aquatic bottom-dwelling organisms. Journal of Water Pollution Control Federation, 1971; 43 (5): 755-772.

6. Wilhm JL and Dorris TC: Species diversity of benthic macro-invertebrates in a stream receiving domestic and oil refinery effluents. The American Midland Naturist Journal, 1968; 76: 427-449.