Jagannath University Journal of Life and Earth Sciences, **7**(1): 33-42 pISSN 2414-1402, eEISSN 2791-1845

Research Article JnUJLES

EVALUATION OF ORGANIC POLLUTION BY PALMER'S ALGAL GENUS INDEX AND PHYSICO-CHEMICAL ANALYSIS OF THREE PONDS AT OLD TOWN IN DHAKA

Sumaiya Ahmed[1*], Asma Ferdousy[1] and Sujan Kumar Datta[2]

[1]*Department of Zoology, Jagannath University, Dhaka-1100, Bangladesh*

[2]*Department of Zoology, University of Dhaka, Dhaka-1000, Bangladesh*

Received: 23 November 2021, Accepted: 19 April 2022

ABSTRACT

A study was conducted to evaluate the organic pollution of three selected ponds of old Dhaka from July 2016 to June 2017. Some physico-chemical parameters of water i.e., pH, temperature, transparency and DO were determined as ranged from 7.1 to 7.9, 22 to 31°C, 22 to 78 cm and 4.8 to 7.9 mg/l, respectively in P1; 7.1 to 8, 22 to 32°C, 14 to 48 cm and 4 to 8.5 mg/l, respectively in P2; 7.1 to 8.2, 19 to 32°C, 21 to 65cm and 4.4 to 7.4 mg/l, respectively in P3. A total of 27 species belong to under 21 genera were recorded from three ponds during investigation. Eight pollution tolerant genera i.e., *Euglena, Scenedesmus, Phacus, Lepocinclis, Micractinium, Pandorina, Synedra* and *Nitzschia* were found from the list of 20 pollution tolerant genus of Palmer's algal genus index. Among three ponds Baldha garden pond and Nazira bazar pond pollution index scored 18 and 16 respectively which indicate moderate to high organic pollution. However, Bangshal pond pollution index scored 14 that indicates low organic pollution. The value of Shannon-Weiner diversity index (H´) was ranged 2.41 to 1.685 and Simpson1-D was ranged 0.8884 to 0.4561. Diversity index (Shannon-Weiner) showed moderate organic pollution. Physico-chemical parameters of studied ponds are moderately good but possibilities of organic pollution. So, proper monitoring system should be developed for the betterment of these ponds.

Keywords: *Phytoplankton, algae, physico-chemical parameters and palmer index*

Introduction

Phytoplankton, an autotrophic component of plankton community are the key part of oceans, seas and freshwater basin ecosystems. They are the primary producer from which the energy is moved to higher organisms through food chain (Tiwari and Chauhan 2006, Saifullah *et al.* 2014. They release about 50% of the world's O_2 is produced via phytoplankton photosynthesis (Roach 2004, NASA 2009) that has controlled the atmospheric CO_2 and O_2 balance (Tappan 1968, NASA 2014). The spatial heterogeneity of phytoplankton is considered structural and functional characteristics of aquatic ecosystems (Armengol *et al*. 1999). Its presence often controls the growth, reproductive capacity and population characteristics of other aquatic organisms (Ariyadej

[*]**Correspondence:** *sumibd_15@yahoo.com*

et al. 2008). The dynamics and species diversity of phytoplankton are greatly influenced by the physico-chemical and biological factors of water (Reynolds 1986, Sommer 1989). Water quality affects phytoplankton communities through changes in its abundance, distribution, growth pattern, dominance and succession pattern (Gharib *et al*. 2011)

On the other hand, algae are one of the most speedy bio indicator of water quality changes because they are small, sessile, species-rich, short living, easy countable and more sensitive to pollutant at lower concentration. Many scientists used algae as indicator of environmental status (Patrick 1949, Venkateswarulu 1981) and has been emphasized algae as an indicator of organic pollution. Palmer (1969) published a composite rating (0 to ≥ 20) of algal species that could be used to indicate clean and polluted water especially for organic pollution. It is an easy, rapid and inexpensive test to recognize organic pollution and eutrophic level (Gokce 2016)

Old Dhaka is one of the most densely populated (13,09,689; census 2011) areas in Dhaka city, a historic place of Bangladesh. There are some historical ponds like Bangshal pond, Nazira bazar pond, Baldha garden pond, Nawabbari pond, Islampur bazar pond, Sikkatuli pond, DIT pond, Dhupkhola pond etc. which serve as sources of drinking and recreational purpose and these are not sufficient for the huge number of inhabitant. These ponds are currently under threat due to urbanization as well as industrialization. Recently many of these traditional ponds are destructed by landfilling. As a result, water logging is created by seepage from canal, infiltration of rain water, heavy nutrient loading in water bodies which causes eutrophication, an impairment of water bodies Therefore, present study was carried out to evaluate the pollution status of three historical ponds (Bangshal pond, Nazira bazar pond and Baldha garden pond) of Dhaka city using some physico-chemical and biological parameters. In this research, we consider phytoplankton as a pollution indicator.

Materials and Methods

Study area

The water samples were collected from three ponds i.e., Bangshal pond as P1 (23˚42'56.53"N and 90˚24'26.89"E); Nazira bazar pond as P2 (23˚43'26"N and 90˚24'24.00"E) and Baldha garden pond P3 (2 3˚43'26"N and90˚24'24.00"E) (Fig. 1). The source of water of these ponds is supply water and rain water. These ponds are used for fish culture, bathing and washing purposes.

Fig. 1. Map of the study area showing location of three ponds (Source: Google map).

Sample collection and analysis

100 ml of water sample was collected by filtering 100 Liter water by using plankton net of 20 µm mesh size. The phytoplankton sample was preserved in Lugol's solution. Some physico-chemical parameters like pH, Dissolved Oxygen (DO), Free Carbon di oxide (CO_2) were determined by ecological HACH test kit (Model FF2, cat.no.2430-01) and nitrate nitrogen, phosphate phosphorus was estimated by Colorimeter (DR/850). Air temperature and rainfall data was collected from Dhaka Meteorological office. Phytoplankton was enumerated as cells per liter using a Sedgewick-Rafter counting chamber (S-R cell) under a compound microscope at ×400 magnifications. The phytoplanktons were identified by identifying characteristics and specific figures following (Whitford and Schumacher 1973, Bellinger 1992). Quantitative analyses of phytoplankton were carried out by using the following formula (Welch 1952, Apha 2005).

Phytoplankton enumeration formula: N= {(A×C)/L} ×1000

Where, N= Total number of phytoplankton per litter of original water.

A= Average number of phytoplankton counted per ml of concentrated sample.

C= volume of concentrated sample.

L= Volume of original water passed through the phytoplankton net.

Statistical Analysis was performed by Paleontological Statistics (PAST) version 2.17, a software package (Ryan *et al*. 1995). Species Diversity was performed using four different indices viz., Species richness, Dominance Indices, Shannon-Wiener diversity and Evenness in temporal and spatial spectrum.

The dominance index (Harper 1999) was measured to determine the dominate species in a particular aquatic system. It would be a beneficial index of assessing monopolization of single or group of taxa over a community.

Dominance index;

$D = \sum(\frac{n1}{n})$, Where $n =$total number of individuals

n_1= the total number of individual of taxon

Diversity of species expressed by Shannon Weiner diversity index (Shannon 1948; Shannon and Weaver 1949) using the following formula;

H= $sum(\frac{n_1}{n})\text{logn}(\frac{n1}{n})$, where, n=total number of individuals

n_1 = the total number of individual of taxon

Margalef index (*d*) (Margalef 1968) was used to measure species richness.

$d = (\frac{S-1)}{In\ (n)})$; where, *S* is total species and *n* is total individuals.

Buzas and Gibson's evenness (Harper 1999) was measured by following formula;

$E = \frac{e^H}{S}$Where, S= species richness, H= Shannon index diversity, E= evenness,

e= natural logarithm base

Results and Discussion

Some physico-chemical parameters of three studied ponds are summarized in Table 1. Water temperature ranged from 19-32°C. Average maximum (28.41±0.933) and minimum (28±1.022) temperature were recorded from P2 and P1 respectively. Water pH values were more or less same and among them highest (7.65±0.10) was in P3. On the other hand, maximum (51.5±5.97) and minimum (30.12±3.55) water transparency recorded from P1 and P2 respectively. Similarly, dissolved oxygen concentration attained maxima (6.53±0.31mg/l) in P1 and minimum (5.53±0.43mg/l) in P2. Average free CO_2 ranged from 23±2.25 to 31.66±5.22mg/l.

The highest water temperature (32°C) was measured in June 2017, while the lowest (22°C) was measured in January 2017 (mean±SD= 28.41±0.933 at P2). Studied pond temperature showed somewhat fluctuated value than standard value 25°C, according to Bangladesh standard for fisheries (EQS 1997). Water pH value varies between 7.1 (January'17) to 8 (February'17). Mean water pH is 7.45± .097 (mean ± SD) for P2 and Standard pH value ranged from 6.5 to 8.5 (EQS 1997). So, it can be said that water pH condition at three stations is favorable condition for aquatic life. Dissolved oxygen concentration attained maxima in November'16 (8.5 mg/l) and minima in April'17 (4mg/l) whereas mean value is 5.53 ± 0.43 (mean ± SD). Standard DO value ranged from 4 to 6 mg/l (EQS 1997). Studied pond DO value is somewhat higher than standard value in the month like September, December. It may be due to high photosynthetic rate of phytoplankton communities in clear water that results in higher value of dissolved oxygen (Sharma and Rathore 2000). Free CO_2 ranged from 10 to 63 (mean ± SD = 30.5 ±5.28) at P2. According to Boyd and Lichtkoppler (1979) fish avoid free CO_2 levels as low as 5 mg/l but most species can survive in water containing up to 60 mg/l carbon dioxide. Transparency minima (14cm) in March'17 and maxima (48cm) in August'16 whereas mean value (mean ± SD =30.12±3.55) at P2. Standard value of transparency is 40 cm, anthropogenic activity like bathing, washing and waste discharging may be the cause of low transparency level. Here the range of NO_3-N was 0.01-0.02 mg/l (mean ± SD =0.015±0.0052; P2) that indicates the good water quality, PO_4-P range was 0.11-.4 mg/l (mean ± SD =0.225±0.0938; P2) but plant growth can be stimulated by levels above 0.1 mg/l (Chapman *et al*. 1996). Average rainfall of July'16 to June'17 is 175.5mm. This enormous rainfall actually created sufficient dilution of chemical parameters. The monthly mean sunshine hours are 77-133h. This might have affected autotrophic organisms through enhanced primary production.

Table 1. Some physico-chemical parameters of pond water of three station of old Dhaka.

Parameters	**Range** **Mean ± Standard Deviation**		
	P1	**P2**	**P3**
pH	7.1-7.9 7.47±0.07	7.1-8 7.45±0.097	7.1-8.2 7.65±0.10
Water Temperature (°C)	22-31 28±1.022	22-32 28.41±0.933	19-32 28.08±1.25
Transparency (cm)	22-78 51.5±5.97	14-48 30.12±3.55	21-65 41.83±3.87

Parameters	Range Mean ± Standard Deviation		
	P1	**P2**	**P3**
Dissolved Oxygen (mg/l)	4.8-7.9 6.53±0.31	4-8.5 5.53±0.43	4.4-7.4 6.15±0.29
Free CO_2 (mg/l)	14-62 31.66±5.22	10-63 30.5±5.28	13-35 23±2.25
Phosphate-phosphorus PO_4–P (mg/l)	0.11-0.35 0.155±0.0631	0.11-0.4 0.225±0.0938	0.11-0.34 0.1991±0.0676
Nitrate-Nitrite NO_3–N (mg/l)	0.01-0.02 0.0158±0.00514	0.01-0.02 0.015±0.0052	0.01-0.02 0.0133±0.0049
Average Rainfall (mm)	0-450 154.188±159.85		
Average Sun Hours	77-133 103±15.90		

During the study period, a total of 27 species belonging to 21 genera under four major group were recorded in three ponds during the study period (Table 2).

Table 2. Showing different genus and species found study ponds.

Division	Species
Euglenophyta	*Lepocinclis salina, Lepocinclis ovum, Phacus longicauda, Phacus helikoides, Phacus tortus, Trachelomonas, Trachelomonas armata , Euglena, Euglena charkowiensis*
Chlorophyta	*Pediastrum biradiatum, Pediastrum duplex, Scenedesmus, Desmidium baileyi, Schizochlamys gelatinosa, Myrmecia pyriformes, Oocystis, Micractinium pusillum, Coelastrum microporum, Dictylosphora pulchellum, Actinastrum hantzschii, Microspora loefgrenii, Pandorina morum*
Chrysophyta	*Synedra ulna, Nitzschia*
Cyanophyta	*Anabaena, Merismopedia, Spirulina*

It was observed that, highest 3420 individual /l was recorded in P1during September. However, highest 870 ind./l phytoplankton recorded at P2 in May and 2310 ind./l recorded in February from P3 (Table 3).

Table 3. Monthly variations in the abundance (ind./l) of different groups of phytoplankton in the P1, P2 and P3 during the period of July '16 to June '17.

Sites	Months												Monthly average
	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	
P1	360	550	3420	320	320	230	340	230	430	310	450	380	612
P2	400	750	380	240	390	690	560	260	400	280	870	730	496
P3	470	530	340	240	420	710	1950	2310	1380	110	250	230	737
Total	1230	1830	4140	800	1130	1630	2850	2800	2210	700	1570	1340	1853
Average	410	610	1380	267	377	543	950	933	737	233	523	447	

Diversity index

The Shannon_H diversity index of phytoplankton ranged from 1.195 to 2.41. From the diversity index it can be said that status of studied pond is moderately polluted (Gokce 2016). Highest dominancy found at P3 (0.5439) and lowest dominancy at P2 (0.1116). Highest dominancy indicates possibility of pollution. According to Margalef index, species richness is highest at P1 (2.135). Evenness-e^HS ranged (0.1836-0.5862) that indicate species evenness high at P2 and low at P3. From the above study, it can be said that water quality of three ponds are moderately good but there are some indication of pollution.

Pollution index

Organic pollution occurs when organic substances emit pollutants into the environment. These pollutants can usually be oxidized by naturally occurring micro-organisms. Throughout the world algal communities are used to study aquatic pollutions. The most important effect of organic pollution in water bodies is due to enrichment of nutrients and total number of algal species (Winter and Duthie 2000).

Palmer (1969) made the first attempt to identify and prepare a list of genera and species of algae tolerance to organic pollution. He prepared a list of 60 genera and 80 species tolerant to organic pollution. Algal pollution indices were developed for use in rating water samples for high or low organic pollution. Two indices, one based upon genus and the other on species. According to Palmer's Pollution Index values ≥ 14 indicates low organic pollution and score between15 to 19 means moderate organic pollution and >20 confined as high organic pollution.

In the present study, a total of 27 species under 21 genera recorded during the study period from three studied ponds. Among them, eight genus are organic pollution tolerant viz., *Euglena, Scenedesmus, Phacus, Lepocinclis, Micractinium, Pandorina, Synedra, Nitzschia* (Table 4). It was found that most pollution tolerant genus *Euglena* recorded in three stations. *Scenedesmus* also found in all three stations. *Nitzschia* found at P2 (Nzira bazaar pond) and P3 (Baldha garden

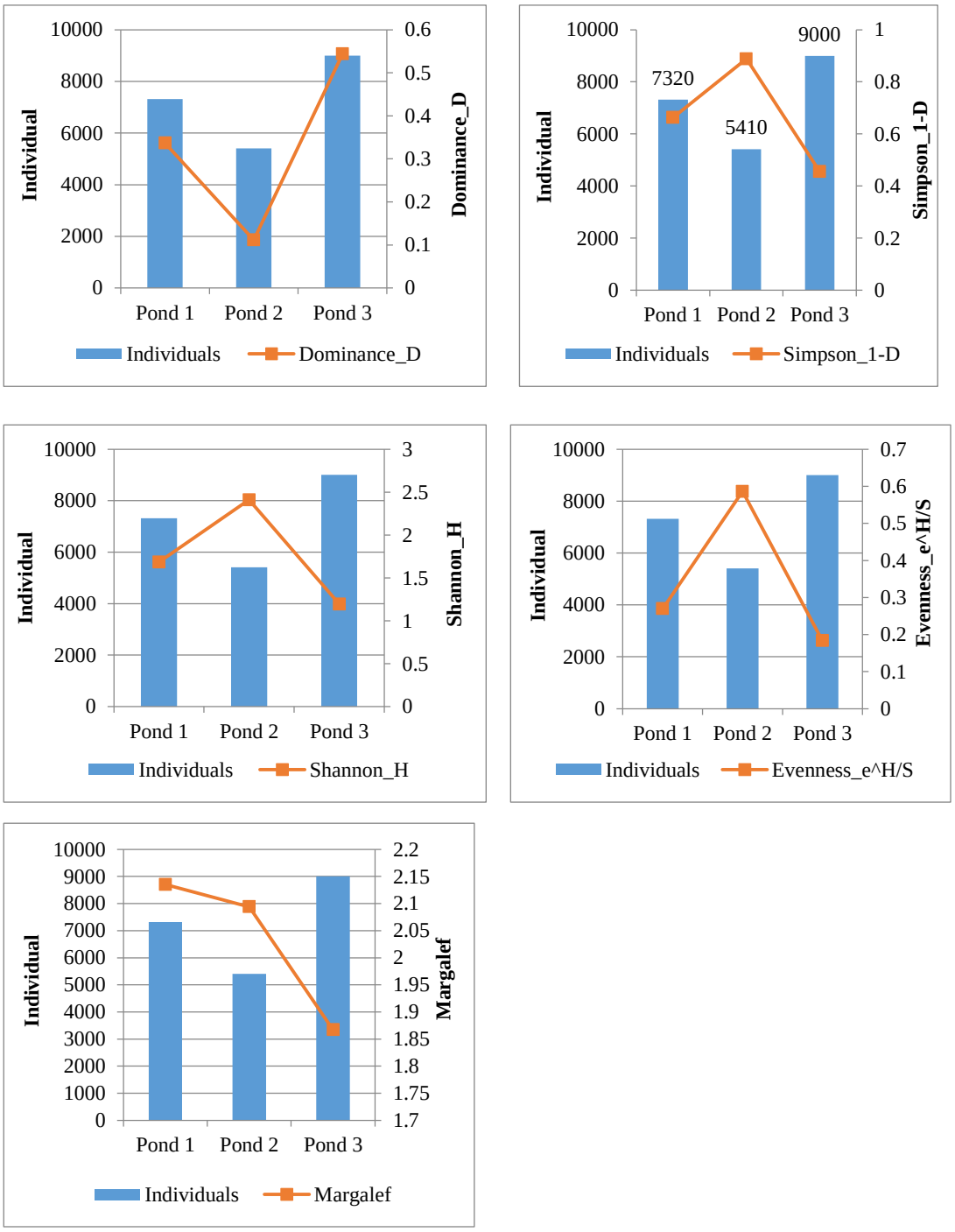

Fig. 2. Shannon index.

pond). *Synedra* found only in P3. *Phacus, Lepocinclis, Micractinium* was found in three ponds. *Pandorina* found only in P1. According to palmer's algal genus index, P1 showed low organic pollution (14). P2 and P3 showed moderate organic pollution as 16 and 18, respectively (Table 4).

Table 4. Palmer's algal pollution index values for three ponds.

Genus	Index	P1	P2	P3
Anacystis	1	-	-	-
Ankistrodesmus	2	-	-	-
Chlamydomonas	4	-	-	-
Chlorella	3	-	-	-
Closterium	1	-	-	-
Cyclotella	1	-	-	-
Euglena	5	5	5	5
Gomphonema	1	-	-	-
Lepocinclis	1	1	1	1
Melosira	1	-	-	-
Micractinium	1	1	1	1
Navicula	3	-	-	-
Nitzschia	3	-	3	3
Oscillatoria	5	-	-	-
Pandorina	1	1	-	-
Phacus	2	2	2	2
Phormidium	1	-	-	-
Scenedesmus	4	4	4	4
Stigeoclonium	2	-	-	-
Synedra	2	-	-	2
Total		14	16	18

It was evident from Table 4 that in P1 and P2 total 6 pollution tolerant genera found, whereas, 7 pollution tolerant genera found in P3.

Conclusion:

From the results of Palmerscore (14, 16, and 18) it can be said that Bangshal pond shows low organic pollution and Nazira bazar pond and Baldha garden shows moderate organic pollution. Diversity index (Shannon-Weiner) showed moderate organic pollution. Though physico-chemical parameters showed relatively good water quality but periodically measurements of parameter vary significantly with time frame. So the study concludes that potential hazard should be monitored to protect these ancient ponds.

References

Apha, A. (2005). WEF: Standard Methods for the Examination of Water and Wastewater. Centennial Edition. Washington, DC, 2671.

Ariyadej, C., Tansakul, P. and Tansakul, R. (2008). Variation of phytoplankton biomass as Chlorophyll a in Banglang Reservoir, Yala Province. *Songklanakarin Journal of Science & Technology*, 30(2): 159-166.

Armengol, J., Garcia, J. C., Comerma, M., Romero, M., Dolz, J., Roura, M., Han, B.H., Vidal, A. and Simek, K. (1999). Longitudinal processes in canyon type reservoirs: the case of Sau (NE Spain). *Theoretical reservoir ecology and its applications*, 313-345.

Bellinger, E. G. (1992). *A key to common algae: Freshwater, estuarine and some coastal species*. London: institution of water and environmental management.

Boyd, C. E., and Lichtkoppler, F. (1979). Water quality management in fish ponds. *Research and development series*, 22: 45-47.

Chapman, D.V. (1996). Water quality Assessment: A guide to use biota, sediment and water. Environmental Monitoring, Second edition, UNESCO, WHO and UNEP. *E & FN Spon, London UK*, 629.

EQS (Environmental Quality Standard). (1997). Bangladesh Gazette, registered nr. DA-1, Ministry of Environment, Government of Bangladesh.

Gharib, S.M., El-Sherif, Z.M., Abdel-Hamim, A.M. and Radwan, A.A. (2011). Phytoplankton and environmental variables as a water quality indicator for the beaches at Matrouh, south-eastern Mediterranean Sea, Egypt: an assessment. *Oceanologia*, 53(3): 819-836

Gokce, D. (2016). Algae as an indicator of water quality, Algae organisms for imminent biotechnology, Nooruddin Thajuddin and Dharumadurai Dhanasekaran, *IntechOpen*, 81-101

Harper, D. A. T. (ed.) (1999). Numerical Palaeobiology. Computer-Based Modelling and Analysis of Fossils and their Distributions. x+468 pp. Chichester, New York, Weinheim, Brisbane, Singapore, Toronto: John Wiley & Sons.

Margalef, R. (1968). Perspectives in Ecological Theory. *University of Chicago Press, Chicago, IL*,111.

NASA, (2005). Satelite Sees Ocean Plants Increase, Coasts Greening. 2 March 2005.

NASA, (2009). Satelite Detects Red Glow to Map Global Ocean Plant Health. 28 May 2009.

Palmer, C.M. (1969). A composite rating of algae tolerating organic pollution 2. *Journal of Phycology*, 5(1): 78-82.

Patrick, R. (1949). A proposed biological measure of stream conditions, based on a survey of the Conestoga Basin, Lancaster County, Pennsylvania. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 101: 277-341.

Reynolds, C.S. (1986). The ecology of freshwater phytoplankton. *Cambridge university press*, 348.

Roach, J. (2004). Source of half earth's oxygen gets little credit. *National Geographic News*.

Ryan, P.D., Harper, D.A.T. and Whalley, J.S. (1995). PALSTAT, Statistics for palaeontologists. *Chapman & Hall (now Kluwer Academic Publishers).*

Saifullah, A.S.M., Abu Hena, M.K., Idris, M.H., Halimah, A.R., and Johan, I. (2014). Diversity of phytoplankton from mangrove estuaries of Sarawak, Malaysia. *World Applied Sciences Journal*, 31(5): 915-924.

Shannon, C.E. (1948). A mathematical theory of communication. *The Bell System Technical Journal*, 27: 379-423.

Shannon, C.E. and Weaver, W. (1949). The mathematical theory of communications. *University of Illinois Press*, Urbana, 117.

Sharma, R.K., and Rathore, V. (2000). Pollution ecology with reference to commercially important fisheries prospect in a rural based water body: The Lake SarsaiNawar, Etawah In U. P.(India). *Pollution Research*, 19(4): 641-644.

Sommer, U. (1989). The role of competition for resources in phytoplankton succession. *In Plankton ecology* (pp. 57-106). *Springer*, Berlin, Heidelberg.

Tappan, H. (1968). Primary production, isotopes, extinctions and the atmosphere. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 4(3): 187-210.

Tiwari, A. and Chauhan, S.V.S. (2006). Seasonal phytoplanktonic diversity of Kithamlake, Agra. . *J. Environ. Biol*. 27(1): 35-38.

Venkateswarlu, V. (1981). *Algae as indicators of River water quality and pollution*, In: WHO Workshop on Biological indicators and indices of environmental pollution, Central Board for Prevention and control of water pollution and Osmania University, Hyderabad, 93-100.

Welch, P.S. (1952). Limnology (No. 551.48). *McGraw-Hill*.xi-538.

Whitford, L.A. and Schumacher. G.J. (1973). A Manual of Fresh-Water Algae. *Sparks Press.*

Winter, J.G., and Duthie, H.C. (2000). Epilithic diatoms as indicators of stream total N and total P concentration. *Journal of the North American Benthological Society*, 19(1): 32-49.