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PHYTOPLANKTON DIVERSITY AND ABUNDANCE IN THE PONDS OF DHANBAD, JHARKHAND, INDIA

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ABSTRACT

Phytoplankton have been an important biological indicator of water quality. Studies on the physical and chemical characteristics of water are essential for identifying the kind, degree, and water quality of pollution present in a water body. The current effort was performed to study the phytoplankton diversity along with the physico-chemical characteristics of three abandoned perennial ponds over the period of one year, from July 2020 to June 2021. A total of 21 species of phytoplankton under five classes which include Conjugatophyceae, Chlorophyceae, Bacillariophyceae, Cyanophyceae, and Euglenophyceae, were recorded, identified, and observed. Overall, the study's results showed a trend toward high physico-chemical parameter values and low phytoplankton diversity. As per the observed results, it was determined that even though the chosen ponds are currently in poor condition, they can be made appropriate for fish culture practice—but only after applying specific developmental management measures thereby enhancing the physico-chemical characteristics of the ponds' water by continuous monitoring. Future scientists conducting research in a related field can use the current study as a baseline information.

KEYWORDS: Phytoplankton, Diversity, Pond, India.

INTRODUCTION

Water is the key to the sustenance of life on the planet Earth and the entire fabric of life is woven around it. Ponds are of crucial significance to man as they are one of the sources of water. Though, ponds being the natural source of water, have been exploited by man at various levels either to address issues, or have been made for fulfilling various purposes, like - agricultural or domestic use, social magnification, swimming, fish cultivation.[1,2,3]

The necessity of water to every single living creation whether it is microorganisms or man, is an earnest challenge today since all water assets are more or less contaminated because of industrialization and urbanization. Natural ponds are estimated cover an area of about 0.72 million ha in India, and most of them are found nearby towns, spots of religious importance, etc.[4,5,6]

The data about phytoplankton abundance and composition gives information about the trophic status of aquatic environments that helps to assess the ideal use of them. Phytoplankton make the base of the food chain in an aquatic ecosystem [7,8] and are responsible for approximately 40% of the Earth's photosynthetic productivity.[9] Thus, variability in the community of phytoplankton tends to alter the overall productivity of an aquatic ecosystem where various organisms exist reliantly. Therefore, phytoplankton has been considered as an indicator of water quality as well as being helpful for biomonitoring of lentic freshwater bodies, where existence of multidimensional biological spectrum is found and environmental aggravation brought about by the changes of various physicochemical variables.[10,11] And these physicochemical factors of an aquatic ecosystem mostly depend upon the release of sewage of domestic origin, water from the agricultural runoff and other anthropogenic exercises.[12]

Therefore, not only the information about the qualitative and quantitative data of the phytoplankton community, but also the studies on physical and chemical characteristics of aquatic ecosystems are important in order to get a basic idea of the biodiversity of a particular region. Hence, the present work was aimed to study the diversity and seasonal variation of density of phytoplankton along with the physicochemical characteristics of pond water of the ponds located in the district of Dhanbad.

MATERIALS AND METHODS

Study area

The study was carried out in the state of Jharkhand where the district of Dhanbad is located. Dhanbad is a district well known for its coal- mining activities and is called as the 'Coal Capital' of India; however, present work has been performed preferably in the non-coal-mining parts of Dhanbad.

The examination was conducted at three distinct ponds which were deserted since long back and are not being utilized for any valuable reason. These ponds are situated in two blocks of Dhanbad, viz., Balliapur Block and Govindpur Block. The two blocks are the parts of non-coal-mining zones of Dhanbad where at present no coal-mining is practiced and out of these three forsaken ponds, one pond is located in the Govindpur Block, the Rejali pond (S_1) with the geographical location as 23°49'45.45"N /86°31'15.00"E, while another two are located in the Balliapur Block, the Kichinn pond (S_2) located in coordinates of 23°45'39.15"N /86°30'29.62"E, and the Bhokta pond (S_3) with the location of Latitude as 23°45'39.15"N and Longitude as 86°30'29.62"E.

Sample collection and analysis

Multiple samples of water were collected from the ponds to study the physico-chemical and biological parameters. Water sampling was done monthly between 09:00 to 11:00 a.m. from July 2020 to June 2021. Sampling, preservation, transportation, and analysis of samples were performed as per the standards provided in the APHA 2005.[13]

Physicochemical analysis

For the study of each parameter a total of five replicates of the sample were collected in order to integrate and record the final results (Table-1). The temperature of water and air was recorded at the sampling site by the help of a centigrade thermometer graduated to 100° C. Electrical conductivity, pH, and Total Dissolved Solids (TDS) were measured using the Water and Soil Analysis Kit from Labtronics, model LT - 62 at the sampling site. Dissolved oxygen (DO), free Carbon dioxide (free CO_2), total alkalinity, Biochemical Oxygen Demand (BOD), nitrate, phosphate, Sodium and Potassium were estimated according to the standard methods.[13]

Phytoplankton analysis

The phytoplankton samples were collected by filtering 25 liters of water through a plankton net made of bolting silk cloth (25 µm) mesh net and preserved with 5% formalin. Phytoplankters were then studied in the laboratory under the microscope (Magnus MLXi- Plus LED Binocular) connected with camera and the identification was done with the help of keys given in monographs.[13,14,15,16,17] Quantitative analysis was made using a plankton-counting cell (Sedgwick rafter). And the data thus collected was used to calculate the diversity and abundance of phytoplankton in the studied site as per the formulations mentioned below:

Shannon-Wiener diversity index

$$H' = \sum_{n=1}^{s} Pi \ln \, ni/N$$

where H' is Diversity Index, ni is Number of individuals of each species (cells), S is Number of taxa, N is Total individuals of all species, and Pi is Proportion of number of individuals.

Evenness Index

$$E = \frac{H'}{H'max}$$

where E is Evenness index, H' max is ln S, and H' is Diversity index.

Simpson's Dominance Index

$$D = \frac{1}{\sum_{i=1}^{s} p_i^2}$$

where Pi is Proportion of number of individuals of a particular species divided by total number of individuals, and s is the number of species.

RESULTS AND DISCUSSION

Abiotic factors

Monitoring of physicochemical factors is important in the aquatic environment to understand their effects on aquatic diversity.[18] Temporal variations in different physico-chemical factors of the studied ponds are given in Table 1. Changes in these factors affect the biota of the ponds.

Through the measurement of electrical conductivity of water, which is correlated with TDS or dissolved ions, the ability of water to carry electric current has been determined. The sampling locations recorded its mean value as the lowest in case of S_3 as 737 µS/cm while the highest mean value was recorded in S_1 as 1064.5 µS/cm. Actually, electrical conductivity is a key marker of changes to the aquatic system and is influenced by evaporation, natural flooding, and pollution load. According to studies[19,20], an increase in water electrical conductivity reduces the phosphorus availability to phytoplankton, which leads to a fall in phytoplankton populations.

The range of air temperature varied from 19°C to 36°C in S_1, 20°C to 35°C in S_2, and 19°C to 36°C in S_3; whereas the range of water temperature was recorded between 16°C and 34°C in case of S_1, 17°C and 34°C in S_2, and 16°C and 34°C in S_3. The water temperature range of 13.5°C to 32°C has been found to be acceptable for the growth of various planktonic organisms.[5,21] It should be noted that an increase in 1°C of water temperature increases the movement and solubility of ions which in turn proliferates conductivity by 2–4%.[22]

Among the three ponds the pH value ranged between a minimum of 6.1; being slightly acidic to a maximum of 8.2; being slightly alkaline, during the study period that too in case of S_1 which shows that this pond water although being polluted, can support a good span of life in terms of aquatic life including fish culture.[23]

The total dissolved solids (TDS) include the salts in natural water, such as carbonates, bicarbonates, sulphates, chlorides, and nitrates of calcium, magnesium, sodium, potassium, and iron, etc. Because of the high TDS, which decreases the solubility of gases like oxygen, such water is unsuitable for home, industrial, and drinking objectives. The mean TDS was measured as 592.91 mg/l in S_1, 555.08 mg/l in S_2, and 381.58 mg/l in S_3 during this work. A water reservoir's status improves due to a high TDS concentration, which is what causes the eutrophication of aquatic environment.

An important consideration in estimating the degree of pollution in a body of water is the biochemical oxygen demand (BOD). BOD is not a pollutant and doesn't cause any direct harm, but it can have a negative impact on fish life and other beneficial applications by lowering DO concentration levels. Due to favourable environmental factors for microbial activities at higher temperatures, BOD values are higher. The S_1 recorded BOD readings between 0.03 mg/l and 5.09 mg/l; S_2 recorded between 0.01 mg/l and 4.7 mg/l; and S_3 recorded 0.11 mg/l and 5.03 mg/l.

It has been suggested that the most important factor in determining the health of an aquatic body is dissolved oxygen DO. It has been viewed as a clear indication of quality evaluation. DO is wholly dependent on an aquatic body's environmental factors. The ratio of DO concentration to water body temperature is exact opposite. Lower DO concentrations are found at higher temperatures.[24] The annual mean value of DO recorded were 4.94 mg/l in S_1, 5.09 mg/l in S_2, and 5.46 mg/l in S_3.

At the sites, free carbon dioxide is always measured. A high degree of pollution is indicated by a high concentration of free CO_2.[25,26] The average level of free CO_2 was noted during the study period were 3.44 mg/l, 3.44 mg/l, and 2.57 mg/l in S_1, S_2, and S_3 respectively.

The sum of the alkalinities from carbonates and bicarbonates is known as the total alkalinity. Higher alkalinity water has a stronger buffering effect than lower alkalinity water. Alkalinity levels for freshwater systems should be between 5 mg/l and 500 mg/l.[27] According to Boyd,[28] total alkalinity in fertilised ponds should be greater than 20 mg/l since it enhances fish productivity.

One of the crucial nutrients and a limiting element in the preservation of reservoir fertility is phosphate. According to Kelly[29] the build-up of degraded solid waste causes labile phosphorus to be released into the water column. According to Boyd[28] the ideal concentration of phosphate in water is between 0.005 and 0.2 mg/l. Phosphates also determine the level of pollution and the eutrophic state of an aquatic freshwater body.[30,31] The phosphate range was noted between 0.3 mg/l - 1.07 mg/l in S_1, 0.23 mg/l - 0.75 mg/l in S_2, and 0.18 mg/l - 0.5 mg/l in case of S_3. A water body's aquatic plant and dense algae growth will increase if the phosphate level gets too high.

Nitrate levels determine whether or not a body of water is eutrophic.[30] At the sampling locations, the yearly means of nitrates were noted as 0.19 mg/l in S_1, 0.58 mg/l in S_2, and 0.44 mg/l in S_3. According to Boyd,[28] the ideal nitrate content for aquaculture is between 0.2 mg/l and 10 mg/l. Sewage and other pollutants high in nitrates can also contaminate surface water. Nitrate concentration in receiving waters is significantly impacted by runoff from farming operations and waste disposal sites.

Additionally, two significant minerals that are widely distributed in water bodies are sodium and potassium. Most naturally occurring waters contain sodium ion, which makes up between 53 and 69% of the total cations and is the major ion among the cations in general. This is, as a result of the weathering of silicates and/or the dissolution of salts in the soil caused by evaporation, human activity, agricultural activity, and poor drainage conditions. Although sodium ion makes up the majority of the salt in water, and generally speaking, relatively low sodium ion levels are preferred. In the study ponds, the concentration of sodium ions varied significantly amongst the three ponds and was generally higher in one pond (S_1: 555 mg/l - 993 mg/l) than the other two (S_2: 413 mg/l - 821 mg/l, S_3: 198 mg/l - 502 mg/l). The potassium ion is an element that naturally occurs, its concentration is still much lower than that of sodium ion. As a vital plant nutrient, potassium ions are required for processes like protein synthesis, ion absorption and transport, photosynthesis, and respiration.[32] The maximum value of 524 mg/l of potassium ion has been recorded from the S_1 while the minimum value stands as 87 mg/l of potassium ion in the pond S_3 under the tested conditions.

Biotic factors or the Phytoplankton Composition

In addressing some environmental problems, researching photosynthesis, comprehending aquatic ecosystems, and producing useful materials, phytoplankton is likely to be a key player. In addition to responding to natural changes in the ponds, phytoplankton populations can also alter as a result of human actions, either directly or indirectly through activities occurring throughout the basin as a whole. Because of these factors, the phytoplankton's structure and composition are altered. These adjustments can be seen in the abundance, richness, and diversity of the algal associations, the species that make up those associations, and other community-level factors. Finally, due to the interdependence that exists between the numerous organisms that make up systems, these variations in the phytoplankton populations translate to changes in the trophic chain and the productivity of the ponds. And phytoplankton diversity is significantly influenced by physical, chemical, and biological factors such riverine inflow, irrigation system output, temperature, habitat structure, water temperature and depth, agricultural runoff nutrients, and zooplankton grazing. Phytoplankton is helpful in biomonitoring the ecological disturbance brought on by a number of physico-chemical variables, sewage pollution, and other anthropogenic causes. The biological spectrum of the lentic freshwater bodies is multidimensional.

The phytoplankton species distribution and diversity reported from the three ponds (S_1, S_2, and S_3) are shown in Table 2; their abundance and percentage composition are shown in Figure 1.

21 phytoplankton species have been identified in total from the current study, representing 5 classes of phytoplankton which includes 2 species belonging to the Conjugatophyceae class, 3 to the Chlorophyceae class, 10 to the Bacillariophyceae class, 5 to the Cyanophyceae and 1 to the Euglenophyceae class. These namely were *Staurastrum* sp., *Closterium* sp., *Microspora* sp., *Chaetophora* sp., *Homidium* sp., *Bacillaria* sp., *Nitzschia* sp., *Cymbella* sp., *Diatoma* sp., *Fragilaria* sp., *Melosira* sp., *Navicula* sp., *Pinnularia* sp., *Tabellaria* sp., *Synedra* sp., *Nostoc* sp., *Anabaena* sp., *Spirulina* sp., *Oscillatoria* sp., *Microcystis* sp., and *Euglena* sp. According to the distribution of species, S_1 pond has 1626 organisms/L while S_2 pond has 1740 organisms/L and S_3 has 3502 organisms/L; making the pond S_3 with the highest concentration of phytoplankton and making the overall occurrence of phytoplankton density trend to go as $S_3 > S_2 > S_1$.

In terms of percentage contribution of the respective phytoplankton groups, in S_1 the descending order values were 45.6% (Cyanophyceae) > 38.6% (Bacillariophyceae) > 11.1% (Chlorophyceae) > 4.6% (Euglenophyceae); in S_2 it was 41.0% (Cyanophyceae) > 32.9% (Bacillariophyceae) > 19.1% (Chlorophyceae) > 7.0% (Conjugatophyceae); and in S_3 the values were 57.3% (Bacillariophyceae) > 22.2% (Cyanophyceae) > 12.5% (Conjugatophyceae) > 8.0% (Chlorophyceae). When compared to the other groups, the species of the Euglenophyceae reported were the least and poorly represented in the current study in all of the three ponds. Although 5 classes of phytoplankton were recorded from the investigation, not all of the class members were found to be present in the three studied ponds i.e., in S_1 Conjugatophyceae members were absent while in S_2 and S_3 no Euglenophyceae members were reported.

Many different algae species have been identified as indicators of water quality by numerous researchers.[33,34] In research on the Kadra Reservoir in Karnataka, Zargar and Ghosh[34] identified a number of algae species from the Chlorophyceae, Cyanophyceae, Euglenophyceae, and Bacillariophyceae as markers of water pollution. Algal species occurring in organically polluted waters are represented by the genera *Euglena*, *Oscillatoria*, *Navicula*, *Nitzschia*, and *Microcystis*.[33] The presence of filamentous phytoplankton from the Cyanophyceae and Chlorophyceae groups indicated that the reservoir's environment was relatively contaminated.[35,36] According to [37] the pollutants may have entered the water by surface runoff, particularly from the agricultural fields close to the ponds. Few Cyanophyceae species predominated, which was a sign of changing environmental conditions. At S_1 and S_3, it was discovered that the abundance of blue-green algae (Cyanophyceae) made up the majority of the phytoplankton population during the current study. The mild temperature, alkaline pH, low water volume, and strong sunlight may have contributed to this result by creating favourable conditions for greater proliferation of this kind of phytoplankton. Because Cyanophyceae are more effective at consuming CO_2 in environments with high pH levels and little light availability, their presence indicates that a body of water is eutrophic.[38]

Diversity Indices

One of the significant uses of diversity indices in phytoplankton investigations is for the evaluation of pollution level within a system. The biodiversity of the environment is frequently measured using the Simpson's index. Simpson's index reveals from the present study that species are not distributed equally in. The richness of the species and the evenness of the distribution of the individuals within these species determine the species diversity.[39] According to the Shannon - Weiner diversity index for Indian lakes, water that is larger than (> 4) is considered to be clean, whereas water that is between (> 4) and (> 4) and less than (2) is considered to be substantially contaminated.[11] Also entropy is represented by the Shannon - Weiner Index. It is a diversity indicator that takes both the total number of individuals and taxa into account.[40] This indicator can be used to assess a water body's level of pollution. Normal values lie between 0 and 4. According to Wilham and Dorris' [41] analysis, values of the index greater than 3 denote clean water, values between 1 and 3 denote moderate contamination, and values less than 1 denote extremely polluted water.[42] All of the three ponds are exhibiting moderate contamination level values as 2.318 (S_1), 2.489 (S_2), and 2.855 (S_3), as per this index. The current study's Simpson's index values for S1, S_2, and S_3 are 0.896, 0.912, and 0.937, respectively. According to Pielou's evenness index, a measure of variety that measures how equal the community is, species evenness is a diversity index.[43] S_1 evenness was 0.923, while S_2 was 0.926 and S_3 was 0.914. Euglenophyceae (0.8872, Table 2) had the highest evenness values, while Bacillariophyceae (minimum) had the lowest evenness values (0.6355). The Euglenophyceae group had the highest values for species dominance (0.2032) and the Cyanophyceae group had the lowest (0.1252) values. The family that was found with higher diversity was Bacillariophyceae in the present study. It is a very well-known fact that a combination of physical, chemical, and biological factors determines the distribution of the Bacillariophyceae in ponds.[44]

Aquatic Diversity Management

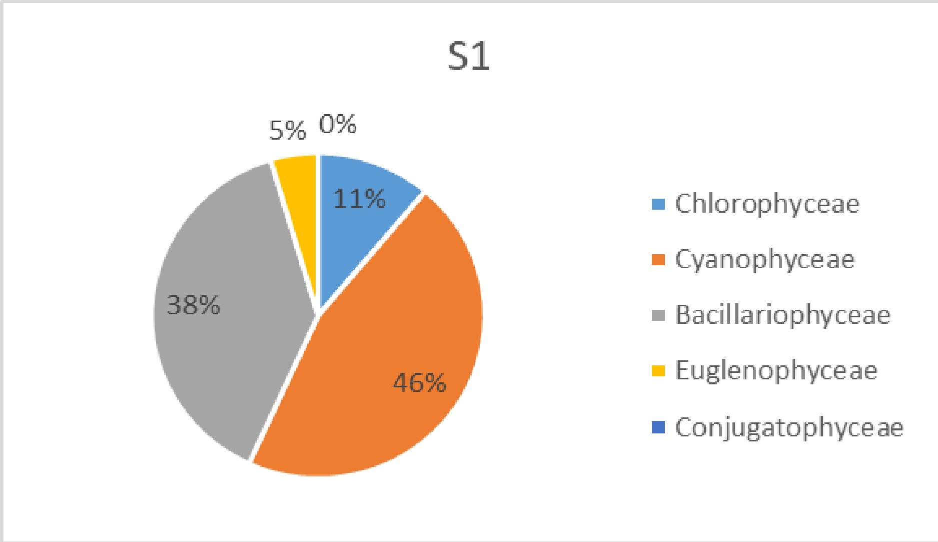
About 117 fish species have been recorded in Indian reservoirs, and 96.5% of these species are food fishes, which are the low-cost sources of animal protein for those who live nearby reservoirs.[45,46] After being introduced into a number of reservoirs in India, certain exotic fish have flourished.[46] A thorough investigation of the reservoir's ecology, limnology, and fish biology is necessary prior to the introduction of any species there. Because ecological traits vary depending on the region, a common management plan cannot be used for all reservoirs.

One of the most serious or significant issues of the current environmental burden is the deterioration of the freshwater biological system.[47] Today, the diversity of freshwater is threatened by both natural and man-made factors, which has an impact on the most essential part of the water cycle. Problems with the water quality can be managed by good technological control. Some basic suggestions may include:

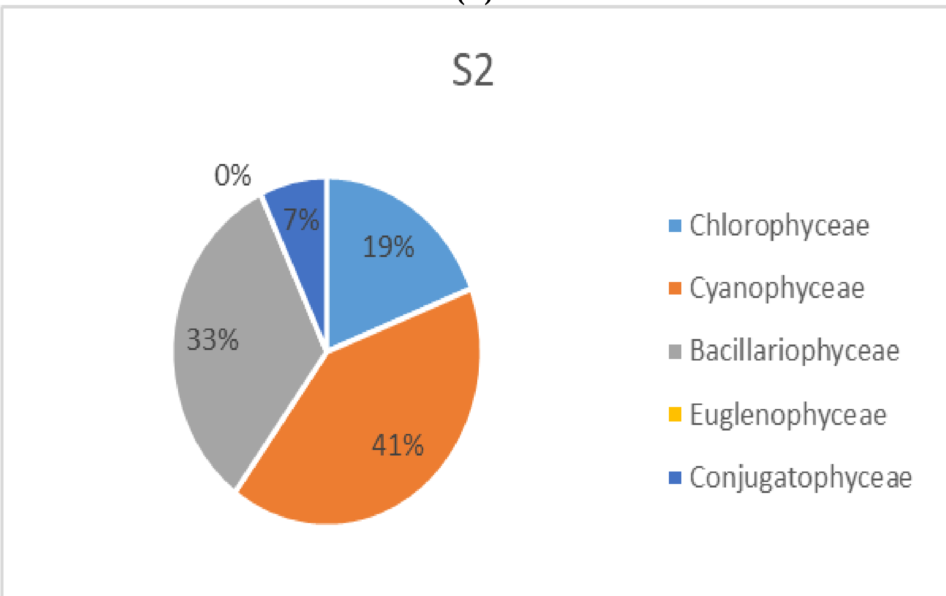
1. Regularly examine the pond water for any signs of pathogenic microbial load and other issues that could be eroding the water's quality.
2. Practicing fish culture and keeping the fish population high so that the pond water is naturally cleaned.
3. Regulate the growth of diatoms, algae, fungus, and aquatic plants.
4. Refrain from using pesticides to purify pond water.
5. Verify the direct passage of rainwater into ponds.
6. Ponds should not be allowed to accept surface water without sufficient treatment.

Table 1: Temporal changes in the Physicochemical parameters of three perennial and derelict ponds during the study period.

Parameters		**S_1**				**S_2**				**S_3**		
	Minimum value	Maximum value	Annual mean value	S.D.	Minimum value	Maximum value	Annual mean value	S.D.	Minimum value	Maximum value	Annual mean value	S.D.
Air Temperature (°C)	19	36	27.41	6.05	20	35	28	5.44	19	36	27.5	6.03
BOD (mg/l)	0.03	5.09	2.08	1.22	0.01	4.7	1.89	1.74	0.11	5.03	1.93	1.76
DO (mg/l)	0.9	8.1	4.94	2.2	1.9	8.1	5.09	1.96	2.2.	7.9	5.46	1.61
Electrical Conductivity (µS/cm)	926	1267	1064.58	115.23	836	1249	1009.58	132.04	605	898	737	105.27
Free CO_2 (mg/l)	0	5.8	3.44	1.86	0	4.9	3.44	1.49	0	4.6	2.57	1.95
K^+ (mg/l)	201	524	401.08	94.05	187	509	316.91	95.16	87	193	152.41	33.29
Na^+ (mg/l)	555	993	790.58	126.71	413	821	681.41	136.83	198	502	361.91	98.33
NO^{3-} (mg/l)	0.1	0.75	0.19	0.17	0.1	0.98	0.58	0.28	0.01	0.87	0.44	0.25
pH	6.1	8.2	7.18	0.69	6.3	8.1	7.32	0.55	7.3	8	7.71	0.19
PO43- (mg/l)	0.3	1.07	0.61	0.21	0.23	0.75	0.43	0.17	0.18	0.5	0.29	0.11
TDS (mg/l)	495	795	592.91	95.39	426	756	555.08	97.06	282	450	381.58	53.17
Total Alkalinity (mg/l)	201	550	365.33	117.28	250	630	403.5	135.49	150	572	309.25	125.73
Water Temperature (°C)	16	34	24.83	6.05	17	34	25.75	5.8	16	34	24.83	5.98



(A)



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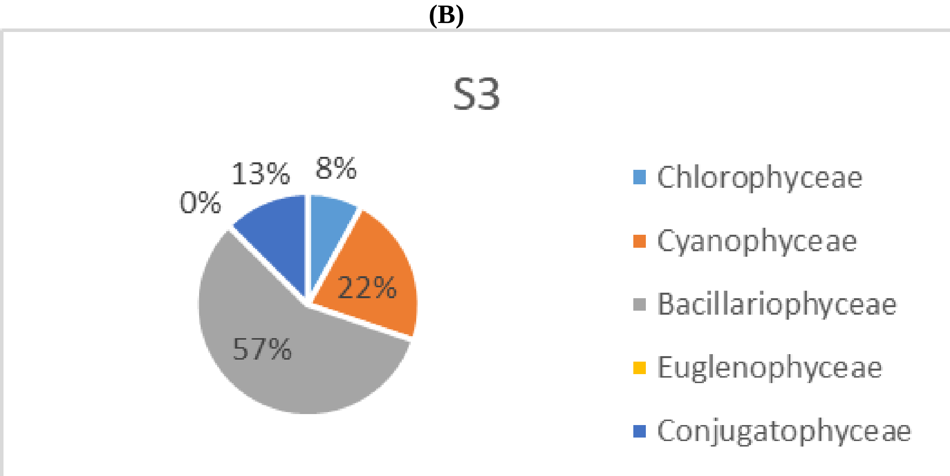

(C)

Figure 1: (A)/(B)/(C): Percentage Composition of Phytoplankton reported in the study sites.

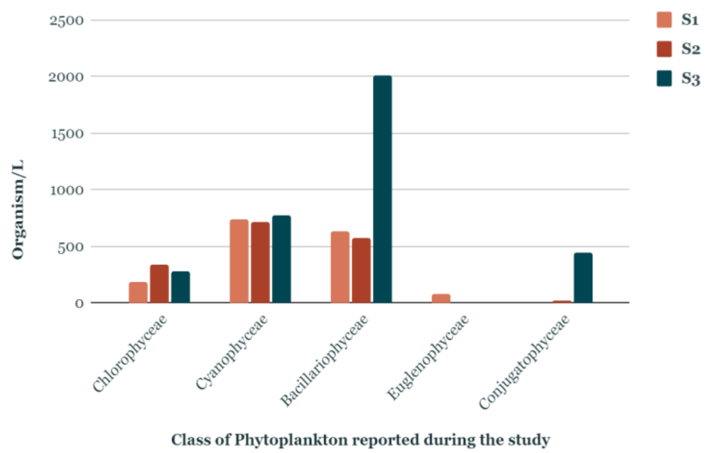

Figure 2: Phytoplankton abundance in Rejali pond (S_1), Bhokta pond (S_2), and Kichinn pond (S_3).

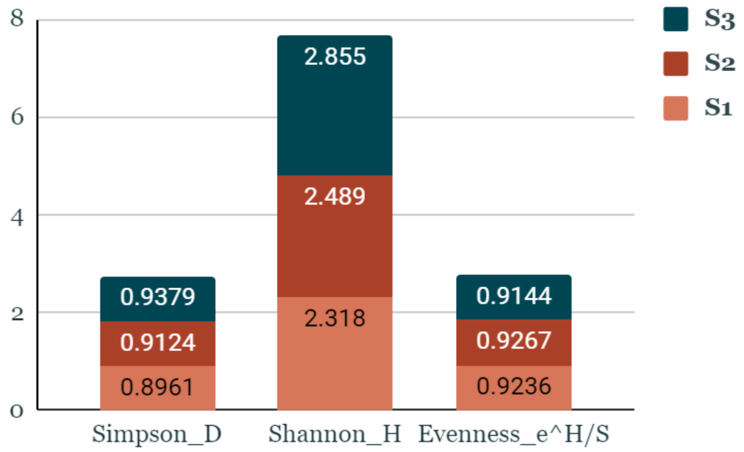

Figure 3: Variation of different diversity indices of Phytoplankton during July 2020 to June 2021.

Table 2: Diversity of Phytoplankton and their distribution at S_1, S_2, and S_3 during July 2020 to June 2021.

Division	Class	Order	Family	Species
Charophyta	Conjugatophyceae	Desmidiales	Desmidiaceae	*Staurastrum* sp.
			Closteriaceae	*Closterium* sp.
Chlorophyta	Chlorophyceae	Sphaeropleales	Microsporaceae	*Microspora* sp.
		Chaetophorales	Chaetophoraceae	*Chaetophora* sp.
				Homidium sp.
Ochrophyta	Bacillariophyceae	Bacillariales	Bacillariaceae	*Bacillaria* sp.
				Nitzschia sp.
		Cymbellales	Cymbellaceae	*Cymbella* sp.
		Fragilariales	Fragilariaceae	*Diatoma* sp.
				Fragilaria sp.
		Melosirales	Melosiraceae	*Melosira* sp.
		Naviculales	Naviculaceae	*Navicula* sp.
			Pinnulariaceae	*Pinnularia* sp.
		Tabellariales	Tabellariaceae	*Tabellaria* sp.
		Fragilariales	Fragilariaceae	*Synedra* sp.
Phylum	**Class**	**Order**	**Family**	**Species**
Cyanobacteria	Cyanophyceae	Nostocales	Nostocaceae	*Nostoc* sp.
				Anabaena sp.
			Oscillatoriaceae	*Spirulina* sp.
				Oscillatoria sp.
		Chroococcales	Chroococcaceae	*Microcystis* sp.
Euglenophycota	Euglenophyceae	Euglenales	Euglenaceae	*Euglena* sp.

CONCLUSION

Waste discharge causes an increase in chemical concentrations, changing the physicochemical and biological characteristics of the lentic environment. According to the results of the current study, the $S_{1,}$ S_2, and S_3 ponds supported a decent number of phytoplankton species. The pond ecosystem, which supports a wide range of algae species in general, is where diversity measures are the most useful. When compared, S_3 exhibited the greatest diversity of phytoplankton species, according to the diversity indices calculated during this study period. The phytoplankton species and their assemblage served as bioindicators that provided information about the pollution levels in the studied lakes. As a result, the ponds taken under investigation contain both the beneficial species and the pollution indicator species. Also, environmental monitoring makes use of the fact that communities under stress or exposure to pollution exhibit a change in the overall species abundance. This means that the ponds' wastewater, which is rich in nutrients, not only enhances the variety and richness of phytoplankton in these ponds but also may help the pisciculture techniques, which will undoubtedly boost the local economy. Comprehensively, this study has established a baseline of knowledge on the current biotic and abiotic conditions of the three abandoned ponds, and the findings indicate that these ponds can be maintained for the practice of fish culture and can be enhanced for plankton and fish survival.

REFERENCES

1. Ress SE. The historical and cultural importance of ponds and small lakes in Wales, UK. Aqu Cons Mar Freshwat Ecosyst, 1997; 7: 133-139.
2. Narayan R, Saxena KK, Chauhan S. Limnological investigations of Texi temple pond in district Etawah (U.P.). J Environ Biol, 2007; 28: 155-157.
3. Bishnoi M, Malik R: Ground water quality in environmentally degraded localities of panipat city. India J Environ Biol, 2008; 29: 881-886.
4. Isaiarasu L, Mohandoss A. Hydrobiological survey in ponds around Sivakasi. The Proceeding of National Symposium on Environment Biology, St. Xavier's College, Palayamkottai, India; 1998; P. 212.
5. Kamat S, Sima V. Hydrobiological studies of two temple ponds in Ponda Taluka Goa. Ecol Environ Cons, 2000; 6: 361-362.
6. Shiddamallayya N, Pratima M. Impact of domestic sewage of fresh water body. J Environ Biol, 2008; 29: 303-308.
7. Tas B, Gonulol B. An ecologic and taxonomic study on phytoplankton of a shallow lake. Turk J Environ Biol, 2007; 28: 439–445.
8. Saravanakumar A, Sesh SJ, Thivakaran GA, Rajkumar M. Benthic macrofaunal assemblage in the arid zone mangroves of Gulf of Kuchchh-Gujarat. J Ocean Univ China, 2008; 6: 33–39.
9. Schmidt LJ. Polynyas, CO_2, and diatoms in the Southern Ocean. In: NASA earth observatory, 2000.
10. Ponmanickam P, Rajagopal T, Rajan MK, Achiraman S, Palanivelu K. Assessment of drinking water quality of Vembakottai reservoir, Virudhunagar district, Tamil Nadu. J Exp Zool India, 2007; 10(2): 485–488.
11. Shekhar RT, Kiran BR, Puttaiah ET, Shivaraj Y, Mahadevan KM. Phytoplankton as index of water quality with reference to industrial pollution. J Environ Biol, 2008; 29: 233–236.
12. Pal S, Mondal P, Bhar S, Chattopadhyay B, Mukhopadhyay SK. Oxidative response of wetland macrophytes in response to contaminants of abiotic components of East Kolkata wetland ecosystem. J Limnol Rev, 2014; 14(2): 101–108.
13. APHA (2005). American Public Health Association, Standard Methods for the Examination of Water and WasteWater. American Public Health Association, Washington, DC.
14. Prescott GW. Algae of the western great lakes area, vol 2. W.M.C. Brown Company Publishers, Dubuque Lowa, P. 660, 1962.
15. Needham JG, Needham PR. A guide to the freshwater biology. 5th ed., Holden day Inc. San. Fransisco, Calif; Pp 108, 1966.
16. Adoni A, Joshi DG, Gosh K, Chourasia SK, Vaishya AK, Yadav M,Verma HG: Work book on limnology. Pratibha Publisher, Sagar: 1985, pp. 1-166.
17. Agarker MS, Goswami HK, Kaushik S, Mishra SM, Bajpai AK, Sharma US: Biology, conservation and management of Bhojtal wetland, Upper lake ecosystem in Bhopal. Bionature, 1994; 14: 250-273.
18. Das D, Pal S, Keshri JP. Environmental determinants of phyto-plankton assemblages of a lentic water body of Burdwan, West Bengal, India. Int J Curr Res Rev, 2015; 7(4): 1–7
19. Chouyyok W, Wiacek RJ, Pattamakomsan K, Sangvanich T, Grudzien RM, Fryxell GE, Yantasee W. Phosphate removal by anion binding on functionalized nanoporous sorbents. Environ Sci Technol, 2010; 44(8): 3073–3078
20. López-Flores R, Quintana XD, Romaní AM, Bañeras L, Ruiz-Rueda O, Compte J, Green AJ, Egozcue JJ. A compositional analysis approach to phytoplankton composition in coastal mediterranean wetlands: influence of salinity and nutrient availability. Estuar Coast Shelf Sci, 2014; 136: 72–81.
21. Gaikwad SR, Ingle KN, Thorat SR. Study of zooplankton pattern and resting egg diversity of recently dried water bodies in north Maharashtra region. J. Environ. Biol., 2008; 29: 353-356.
22. Miller RL, Bradford WL, Peters NE. Specific conductance: theo-retical considerations and application to analytical quality control. US Geo Sur Water Sup, 1988; 2311.
23. ISI. Indian standard methods for sampling and testing (physical and chemical) for water used in industry, Indian standard Institute, Manak Bhawan, New Delhi, 1974.

24. Xing W, Yin M, Lv Q, Hu Y, Liu C, Zhang J. Oxygen solubility, diffusion coefficient, and solution viscosity. Reduction Electrocatalysts, 2014; 1–31
25. Kaden D, Mandin A, Nielsen GD, Wolkoff P. Formaldehyde. In WHO Guidelines for Indoor Air Quality: Selected Pollutants, Geneva: World Health Organization: 2010; (pp. 1–3).
26. Ferrarese S, Apadula F, Bertiglia F, Cassardo C, Ferrero A, Fialdini L, Francone C, Heltai D, Lanza A, Longhetto A, Manfrin M, Richiardone R, Vannini C. Inspection of high-concentration CO_2 events at the Plateau Rosa Alpine station. Atmospheric Pollution Research, 2015; 6(3): 415–427.
27. Lawson TB. Fundamentals of aquaculture engineering. New York, Chapman and Hall, 1995.
28. Boyd CE. Water quality for pond aquaculture. Research and Development Series No.43. International center for Aquaculture and Aquatic Environments, Alabama Agricultural Experiment Station, Auburn University, Alabama, 1998.
29. Kelly LA. Release rates and biological availability of phosphorus released from sediments receiving aquaculture wastes. Hydrobiologia, 1993; 253(1-3): 367-372.
30. Yang XE, Wu X, Hao HL, He ZL. Mechanisms and assessment of water eutrophication. J Zheji Univ, Science B. 2008; 9(3): 197–209.
31. Chislock MF, Doster E, Zitomer RA, Wilson AE. Eutrophication: Causes, consequences, and controls in aquatic ecosystems. Nature Education Knowledge, 2013; 4(4): 1–10.
32. Mengel K. Potassium. In Barker A V and Pilbeam D J (eds). Hand book of plant nutrition. Tailor and Francis, New York. 2007; pp. 91-120.
33. Nandan SN, Aher NH. Algal community used for assessment of water quality of Haranbaree dam and Mosam river of Maharashtra. J Environ Biol. 2005; 26: 223-227.
34. Zargar S, Ghosh TK. Influence of cooling water discharges from Kaiga nuclear power plant on selected indices applied to plankton population of Kadra reservoir. J Environ Biol, 2006; 27: 91-98.
35. Atici T, Olcay O. Seasonal variation of phytoplankton and value of chlorophyll a in the Sariyar Dam Reservoir (Ankara, Turkey). Turk J Bot, 2006; 30: 349–357.
36. Okoth OE, Mucai M, Shivoga WA, Miller SN, Rasowo J, Ngugi CC. Spatial and seasonal variations in phytoplankton community structure in alkaline-saline Lake Nakuru, Kenya. Lakes Reserv Res Manag, 2009; 14(1): 57–69.
37. Palaniswamy R, Manoharan S, Mohan A. Characterisation of tropical reservoirs in Tamil Nadu, India in terms of plankton assemblage using multivariate analysis. Indian J Fish, 2015; 62(3): 1–13.
38. Lin CK. Phytoplankton Succession in a eutrophic lake with special reference to blue-green algae blooms. Hydrobiologia, 1972; 39 (3): 321-334.
39. Margalef R. Information theory in ecology- Gen. Sys., 1958; 3: 36- 71.
40. Pirzan AM, Pong-Masak PR. Relationship between phytoplankton diversity and water quality of Bauluang Island in Takalar Regency, South Sulawesi. Biodiversitas, 2008; 9: 217–221.
41. Wilham JL, Dorris TC. Biological Parameters of Water Quality Criteria. BioScie, 1968; 18(6): 447-481.
42. Shannon CE, Weiner VA. Mathematical Theory of Communication. University Press Illinois Urban, 1949; 101-107.
43. Pielou EC. Ecological Diversity. John Wiley and Sons New York, Pp: 165, 1975.
44. Fabricus DM, Maidana A, Gomez N, Sabater S. Distribution patterns of benthic diatoms in a Pampean River exposed to seasonal floods: The Cuarto River (Argentina). Biodiversity and Conservation, 2003; 12: 2443–2454.
45. Sarkar UK, Sharma J, Mahapatra BK. Review on the fish communities in the Indian reservoirs and enhancement of fisheries and aquatic environment. J Aquac Res Dev, 2015; 6: 297.
46. Sarkar UK, Sandhya KM, Mishal P, Karnatak G, Kumari L, Pannikar S, Palaniswamy P, Karthikeyan R, Mol M, Paul SS, Ramya TT, Rao VL, Khan DSK, Panda MFD, Das BK. Status, prospects, threats and the way forward for sustainable management and enhancement of the tropical Indian reservoir fsheries: an overview. Rev Fish Sci Aquac, 2017; 26(2): 155–174.
47. Reid AJ, Carlson AK, Creed IF, Eliason EJ, Gell PA, Johnson PTJ, Kidd KA, MacCormack TJ, Olden J D, Ormerod SJ, Smol JP, Taylor WW, Tockner K, Vermaire JC, Dudgeon D, Cooke SJ. Emerging threats and persistent conservation challenges for freshwater biodiversity. Biological Reviews, 2018; 94(3): 849–873.