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Study of Dynamics of Phytoplanktons and Water Quality of Hadinaru Lake, Mysuru

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Abstract: ***Phytoplanktons which are present in a variety of aquatic habitats were studied with respect to their species diversity and distribution, studies on phytoplankton and water quality of Hadinaru lake , Nanjanagudu, Mysore, Karnataka were undertaken for 5 months of 2022 (April 2022 to August 2022). . The water samples were analyzed to physical and chemical parameters by following the standard methods of APHA (2005) and Trivedi and Goel (1984). The quantitative analysis of phytoplankton was done by Lackey's drop method modified by saxena (1987). Diversity indices have been discussed by using PASTA Software Program. Among the total 52 species recorded during the study, 25 were from Bacillariophyceae, 8 from Chlorophyceae, 8 from Cyanophyceae. 4 from Desmidiaceae 3 from Euglenophyceae and 2 from Charophyta. Bacillariophyceae was the most dominant group followed by Chlorophyceae, Cyanophyceae, Desmidiaceae. Euglenophyceae and Charophyta. The result of physico- chemical and biological parameters along with statistical method and biodiversity indices indicated that the Hadinaru lake is threatened ecologically due to various anthropogenic activities which lead organic pollution and eutrophication status of the lake. Statistical program Bray – Curtis similarity index explained, the cluster of EC, Total hardness and Total alkalinity is highly correlated with the clusters of phytoplanktons. Shannon and Weiner index showed that the lake was heavily polluted in the month of April due to increased temperature.***

Keywords: Phytoplankton, Physico-chemical parameters, Bray - Curtis Similarity Index, Principal component analysis.

I. INTRODUCTION

Water is the prime source for all the life forms on the earth. Although earth is covered by more than 75% of water, only 3% of water on earth is fresh water and only 0.3% is surface water [1].

Life on earth depends on fresh water. Fresh water is an important resource, necessary for the survival of most terrestrial organisms & is required by humans for drinking, agriculture and many other purposes. Fresh waters refers to bodies of water such as ponds, lakes, rivers and streams containing low concentration of dissolved salts and other total dissolved salts. Fresh waters are perhaps the most vulnerable habitats and are most likely to be changed by the activities of man. Fresh water, an essential resource is becoming increasingly scarce in many parts of the world due to severe impairment of water quality.

Limnology is the branch of science which deals with biological productivity of inland waters and with all the causal influences which determine it. Under the term inland waters are included all kinds or types of water- running or standing: fresh, Marine, or other physico-chemical composition, which are wholly or almost completely included within the land masses. Causal influences involves those various factors- physical, chemical, biological, meteorological, etc. which determine the character and quantity of biological production [2]. The phytoplankton community is mainly represented by algal representatives including both prokaryotes and eukaryotic genera. Plankton populations are mostly represented by members of Cyanobacteria, Chlorophyta, Dinophyta, Euglenophyta, Haptophyta, Chrysophyta, Cryptophyta and Bacillariophyta.

The physico- chemical characteristics of water plays an important role in algal biodiversity and population dynamics of planktons [3]. The phytoplankton have been an interesting group for investigation because of their very primitive nature and a worldwide distribution, which is due to their capability to exist under most varied environmental conditions [4].

Present study refers to the study of water quality of Hadinaru lake of Mysore which was assessed using both phytoplanktons and physico-chemical parameters from April 2022 to August 2022.

Objectives: Investigations are undertaken in the selected Hadinaru lake of Mysore district with the following objectives.

1) To study the relationship between physico- chemical parameters with phytoplankton population.
2) Evaluation of phytoplankton diversity of Hadinaru lake.

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II. MATERIALS AND METHODS

A. Topography of Hadinaru Lake

Hadinaru lake is also called as Doddalake. It is located at 12° 02' 02" North longitudes 76° 41'38* East latitude at an altitude of 653.35 meters HMSL. It is situated 33 kms away from Mysore city. Lake is located in Nanjangudu taluk, which is 11 kms away from Nanjangudu town. It has an independent catchment area of 8.57 sq.km, with water spread area of 10.10 hectares having a live capacity of 54.43 MCFT.

Fig 1: Views of Hadinaru lake

B. Physico-chemical parameters

Surface water samples were collected every month in different spots of a lake for a period of five months from Hadinaru lake in Mysore district and 14 physico- chemical parameters have been analyzed by standard methods given in APHA (2005) and Trivedy and and Goel (1997) [5] , [6].

Table 1: Physical water quality parameters along with methods and units

Parameter	Method	Units
pH	pH digital meter	-
Water temperature	Digital thermometer	°C
Electric conductivity	Conductivity meter	µS

Table 2: Chemical water quality parameters along with methods and units

Parameter	Method
Carbon di oxide (mg/L)	Titrimetric method (APHA, 2005)
Dissolved oxygen (mg/L)	Winkler's iodiometric method
Total hardness (mg/L)	EDTA titrimetric method (APHA, 2005)
Calcium (mg/L)	EDTA titrimetric method (APHA, 2005)
Magnesium (mg/L)	Calculation method (APHA, 2005)
Chloride (mg/L)	Argentometric method (APHA, 2005)
Total alkalinity (mg/L)	Titration method (APHA, 2005)
Bio-chemical oxygen demand (mg/L)	5- day BOD test (Trivedy and Goel, 1997)
Chemical oxygen demand (mg/L)	Potassium dichromate reflux method(APHA, 2005)
Total dissolved solids (mg/L)	Evaporation method (Trivedy and Goel, 1997)
Salinity (mg/L)	Titrimetric method (Trivedy and Goel, 1997)

C. Statistical analysis

To get a precise explanation on physico- chemical parameters and phytoplankton population various statistical analysis was performed. All data obtained were subjected to multivariate analysis. The statistical analysis was carried out by using following methods [8].

1) PCA by PASTA Software
2) Bray- Curtis Similarity index by PASTA Software
3) Biodiversity indices by PASTA Software

D. Phytoplankton analysis

Phytoplankton was collected by filtering 5 liters of water sample with the help of plankton net of mesh size 63 µm and 30cm diameter. The final volume of filtered sample was 25ml. The sample was transferred to 50ml sterile plastic bottle and labelled mentioning the time, date and place of sampling. The collected sample was preserved by using 2ml of 2-4% formaldehyde and 2 drops of Lugol's iodine solution. The preserved samples were taken to the laboratory for further assessment.

Phytoplankton count was done by Lackey's Drop Method (1939) as mentioned in APHA (1985) which was modified by Saxena (1987). In Lackey's drop method, the coverslip was placed over one drop of water sample in the slide, permanent slide is done by using DPX and whole coverslip were examined under Labomed trinocular microscope (LX400) with image transferor (DCM 35 USB 2.0) and photographs was captured by the software minisee and species identification was done by using standard monographs like Sudipta Kumar Das and Siba Prasad Adhikary [7], research articles and research personnel. After that organisms were counted in each drop [8]. This procedure was repeated three times for each samples and number of organism was measured as organism per liter. Formula used for the calculation of plankton as Org/L is

Formula used for the calculation of phytoplankton as units/L is

$$\text{Phytoplankton Unit/L} = \frac{N \times C \times 1000}{V}$$

N = No. of phytoplankton counted in 0.1ml concentrate.
C = total volume of concentrate in ml.
V = total volume of water filtered through net

III. RESULT AND DISCUSSION

A. Physico-Chemical Parameters

The water was analysed for its physical and chemical properties and the results have been discussed in the following sections [5] , [6] and presented in Table 3 which shows the values obtained in all samples collected from April 2022 to August 2022.

1) *Temperature*: It is one of the critical physical parameter which controls most the biological activities in the aquatic environment. The water temperature of lake during study period ranges from 25°C to 28°C.
2) *Electrical conductivity:* Electric conductivity is a parameter used to as certain the purity of water and is the measure of capability of water to transmit electric current. The Electric conductance ranges from 721µS to 928µS. A minimum value of 721µS was recorded in May and maximum of 928µS in August. It has been mentioned that increase in EC is due to dissolved salts content.
3) *pH*: pH is a term used universally to express the intensity of the acid or alkaline condition of a solution. The pH value ranges from 7.59 to 8.62. The minimum value of 7.4 was recorded in July and maximum of 8.62 in June. It has been mentioned that the increase in pH value appears to be associated with increased use of alkaline detergents in residential areas & alkaline material from wastewater is from agricultural areas.
4) *Total dissolved solids:* Total dissolved solids represent the amount of soluble inorganic substance in water. Total dissolved solids observed in the lake ranges from 6 mg/L to 19 mg/L. Minimum value of 6 mg/L was recorded in April and maximum of 19 mg/L in July. The entry of sewage, urban runoff, industrial wastewater influence the increase in the concentration of Total dissolved solids.
5) *Total Alkalinity*: Total alkalinity is the measure of capacity of water to neutralize a strong acid. The minimum value 387 mg/L was recorded in May and maximum value of 505 mg/L in July. The alkalinity in the waters is generally imparted by the salts of carbonates and bicarbonates, phosphates, nitrates, borates, silicates, etc, together with the hydroxyl ions in free state. The high value of total alkalinity in the lake may be due to cattle bathing and laundering of clothes.
6) *Salinity*: Salinity of the water is its capacity to neutralize a strong base to a fixed pH. It is caused by the presence of strong mineral acids, weak acids and hydrolysing salts of strong acids. Salinity low which ranges from 0 mg/L to 10mg/L.

7) *Free CO2:* Free Carbon-di-oxide (CO2) recorded in Hadinaru lake ranges from 0 mg/L to 13.2 mg/L and it is found tobe maximum in the month of July.
8) *Dissolved oxygen:* Dissolved oxygen values ranges from 4 mg/L to 12.56 mg/L. The minimum value of 4 mg/L was recorded in August and maximum value 12.56 mg/L in July. The increase in DO is influenced by the moderate temperature. Lower DO indicates the pollution of the lake by algae are unwanted things in lake.
9) *Biochemical oxygen demand (BOD):* Biochemical oxygen demand (BOD) refers to the oxygen used by the micro-organisms in aerobic oxidation of organic matter, therefore with the increase in the amount of organic matter in the water BOD increases. BOD values ranges from 0 mg/L to 5.67 mg/L. A minimum value of 0 mg/L was observed in August and maximum of 5.67 mg/L in July. Higher contents of organic load as well as high proliferation of microorganism are the causative factors for maximum BOD levels.
10) *Chemical Oxygen Demand (COD):* Chemical oxygen demand (COD) is commonly used to indirectly measure the amount of organic compounds in water. This makes COD as a useful indicator of organic pollution in surface water. COD values ranges from 72 mg/L to 98 mg/L. A minimum of 72 mg/L was observed in June and maximum of 98 mg/L in July. Higher value of COD pointing to deterioration of water quality was likely caused by the discharge of municipal waste water.
11) *Total Hardness*: The regular addition of large quantities of sewage and detergent into the lake from nearby residential localities is responsible for higher level of hardness. Hardness ranges from 161.5 mg/L as $CaCO_3$ to 290 mg/l as $CaCO_3$.The minimum of 161.5 mg/L as $CaCO_3$ was recorded in April and maximum of 290 mg/l as $CaCO_3$ in July. The hardness will be more where the concentration of calcium and magnesium is more.
12) *Calcium*: Hardness is caused by compounds of calcium and magnesium, and by a variety of other metals. Calcium ranges from 11.02 mg/L to 39.75 mg/L. The minimum of 11.02 mg/L was recorded in April and maximum of 39.75mg/L in July.
13) *Magnesium*: Hardness is caused by compounds of calcium and magnesium, and by a variety of other metals. Magnesium ranges from 36.6 mg/L to 62.35 mg/L. The minimum of magnesium 36.6 mg/L was recorded in April and maximum of 62.35 mg/L in August.
14) *Chloride*: Chloride is not utilized directly or indirectly for aquatic plant growth and hence its existence in the aquatic system is regarded as pollution. Chloride ranges from 34.80 mg/L to 50.41 mg/L in the lake. A Minimum of 34.80 mg/L was observed in July and maximum value of 50.41 mg/L in August. High chloride concentration in the lake water may be due to high rate of evaporation or due to organic waste of animal origin.

Table 3: Monthly variation in the Physico-chemical parameters from April 2022 to August 2022

Sl No	Parameter	April	May	June	July	August
1	Air temperature	28	28	26	27	25
2	pH	7.6	8.1	8.6	7.4	7.5
3	EC	747	721	794	809	928
4	TDS	6	7	10	19	18
5	Total alkalinity	406	387	416	505	450
6	Salinity	10	10	10	0	0
7	Free CO2	0	0	0	13.2	8.8
8	DO	6.8	8.9	10	12.56	4
9	BOD	3.2	0.83	1.9	5.67	0
10	COD	83.2	84.8	72	98	96
11	Total Hardness	162	220	250	290	286
12	Calcium	11	14	12	39.75	30.46
13	Magnesium	36.6	50.2	58	61.06	62.35
14	Chloride	37.7	35.5	36.38	34.80	50.41

All values are expressed in mg/L except pH, WT (°C) and EC (µS).

B. Analysis of Phytoplankton Population

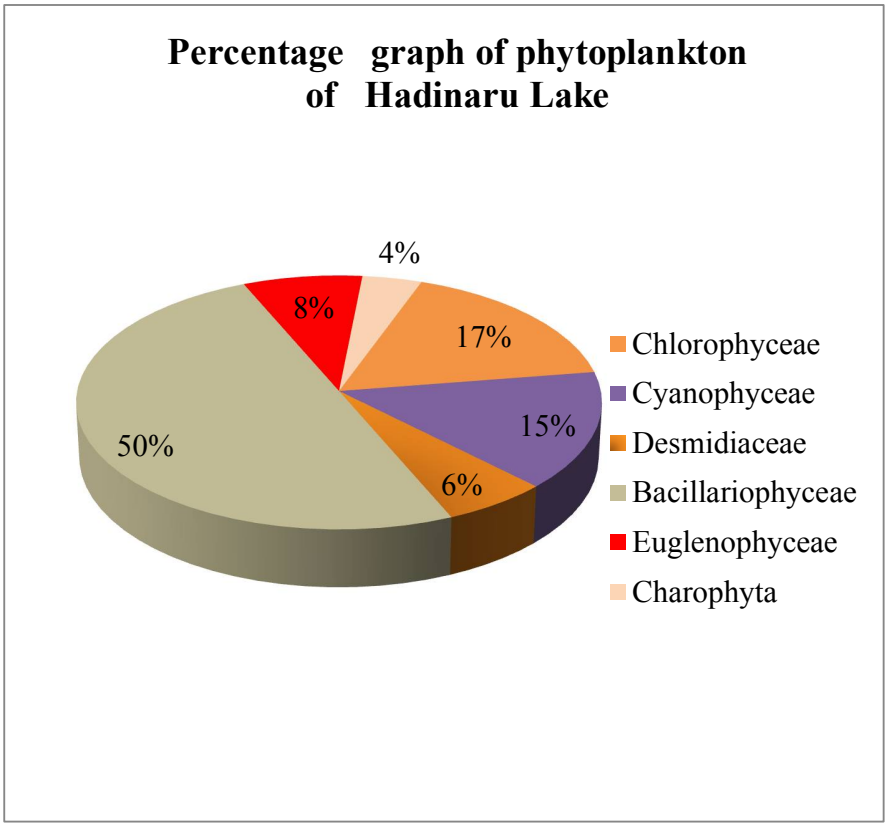
The phytoplankton community is a heterogenous group of tiny plants adapted to float in the sea and fresh waters. The analysis of phytoplankton population was done in selected Hadinaru lake in Mysuru district. Phytoplankton population analysis was done by using standard methods and identification was done by consulting taxonomic guides and monographs [5], [6] , [7].

In the present study total of 52 species of phytoplanktons were identified in the Hadinaru lake of Mysuru district during the period April-2022 to August-2022 represented in the fig 7 Bacillariophyceae was high (50%) followed by Chlorophyceae (17%) and Cyanophyceae (15%). Desmidiaceae (8%), Euglenophyceae (6%) and Charophyta (4%) were very poorly represented. Among all the phytoplankton, *Gomphonema augur*(23800 O/L) was found in large number followed by *Pinnularia gibba* (21000 O/L), *Gomphonema constrictum* (16800 O/L) and *Merismpedia tenuissima* (15400 O/L).

Table 4: Phytoplanktons of Hadinaru Lake from April 2022-August 2022

Names of Phytoplankton	*April*	*May*	*June*	*July*	*August*	*O/L*
Chlorophyceae						
Oedogonium sp.	2800	4200	2800	1400	1400	12600
Scendesmus quadrispina	1400	5600	2800	2800	0	12600
Desmodesmus abundans	1400	2800	0	0	0	4200
Amtodesmus dimorphous	0	0	1400	1400	0	2800
Tetraedron regulare	1400	1400	0	0	0	2800
Hariotina reticulatum	0	0	1400	1400	1400	4200
Tetradesmus major	0	0	0	1400	1400	2800
Parallela transversalis	0	0	1400	1400	1400	4200
Oedogonium sp.	2800	4200	1400	1400	1400	11200
Cyanophyceae						
Phormidium sp.	0	4200	4200	1400	1400	11200
Planktothrix isothrix	1400	1400	0	0	0	2800
Komvophoron constrictum	0	0	0	1400	1400	2800
Merismopedia tenuissima	0	5600	2800	4200	2800	15400
Calothrix geitonos	0	0	0	1400	0	1400
Microchaete sp.	0	0	2800	4200	2800	9800
Arthrospira khannae	0	0	0	1400	1400	2800
Phormidium crassior	0	0	0	4200	4200	8400
Desmidiaceae						
Cosmarium regnelli	0	0	0	1400	1400	2800
Cosmarium bitrapezoideum	0	0	1400	1400	1400	4200
Cosmarium trilobulatum	0	0	1400	0	0	1400
Staurastrum bloklandiae	0	0	0	1400	0	1400
Bacillariophyceae						
Navicula gottlandica,	5600	4200	0	0	0	9800
Gomphonema augur	7000	8400	5600	1400	1400	23800
Gomphonema constrictum	5600	7000	0	2800	1400	16800
Gomphonema sp.	2800	4200	0	1400	1400	9800
Gomphonema grunowii	1400	0	2800	0	0	4200
Gomphoneis exigua	0	0	1400	0	0	1400
Gomphonema montanum	2800	4200	2800	0	0	9800
Gomphonema tabellaria	1400	1400	0	0	0	2800
Gomphonema elegans	0	0	1400	0	0	1400
Gomphonema parvulum	0	0	4200	1400	0	5600
Gomphonema parvulum	0	0	0	1400	0	1400

var. micropus						
Nitzschia holsatica	0	0	1400	1400	0	2800
Nitzschia sigmoidea	1400	4200	1400	2800	0	9800
Nitzschia sp.	0	0	2800	2800	0	5600
Nitzschia acicularis	1400	1400	1400	1400	0	5600
Synedra gracilis	4200	1400	1400	0	0	7000
Cymbella lanceolata	1400	2800	1400	0	0	5600
Cymbella sp.	1400	4200	1400	0	0	7000
Sellaphora pupula	1400	1400	0	0	0	2800
Gyrosigma sp.	1400	2800	1400	1400	0	7000
Pinnularia gibba	4200	7000	5600	2800	1400	21000
Ulnaria ulna	1400	4200	2800	1400	1400	11200
Ulnaria oxyshynchus	1400	1400	0	0	0	2800
Aulacoseira islandica	1400	2800	1400	1400	0	7000
Fragillaria sp.	0	0	1400	0	0	1400
Euglenophyceae						
Euglena splendens	0	0	1400	0	0	1400
Lepocinclis ovum	1400	2800	0	0	0	4200
Euglena virdis	0	0	1400	0	0	1400
Charophyta						
Klebsormidium sp.	0	0	0	1400	1400	2800
Klebsormidium sp.	0	0	0	1400	0	1400



Graph 1: Percentage graph of phytoplankton of Hadinaru Lake

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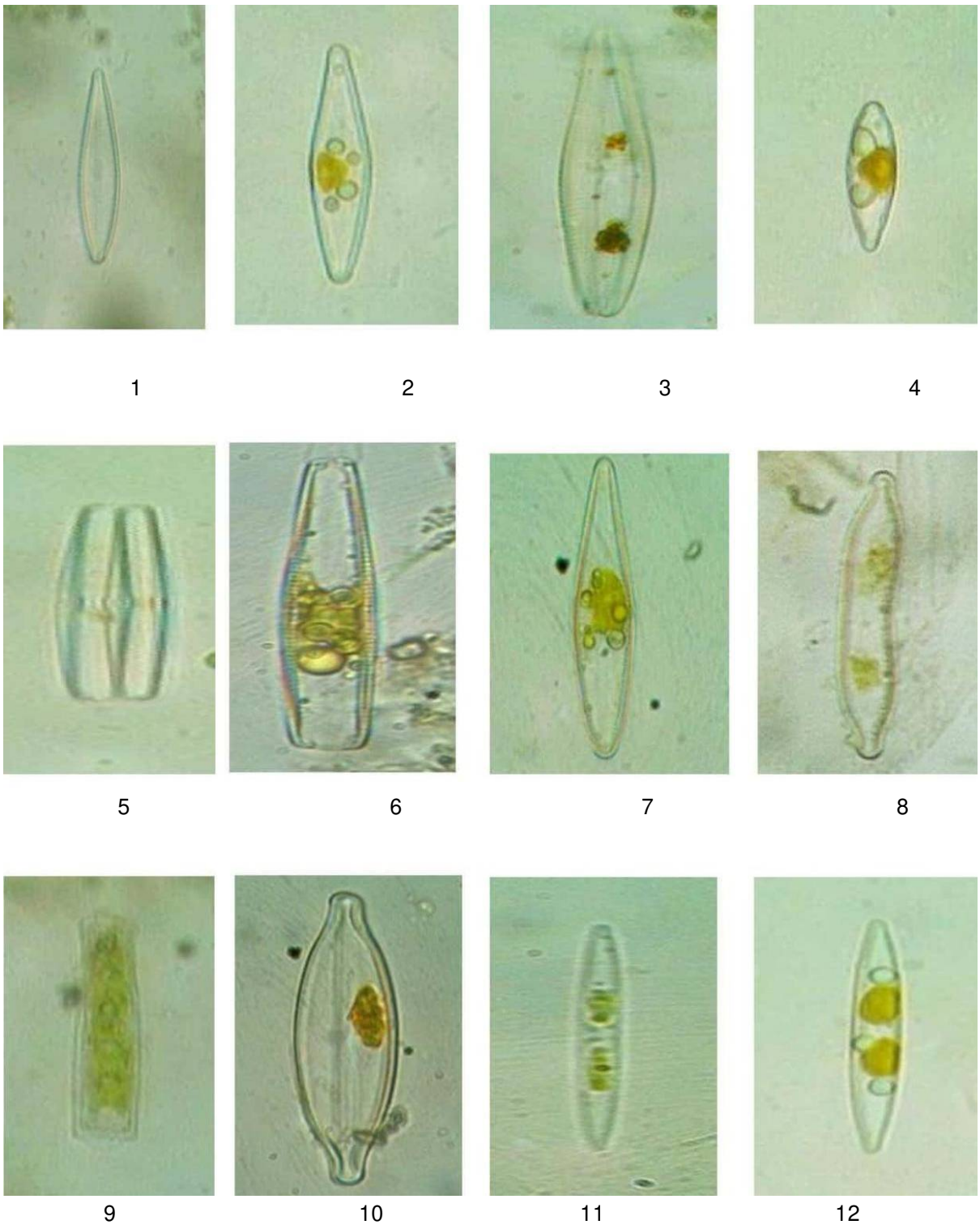


Plate 1: 1)Navicula gottlandica, 2) Gomphonema augur, 3) G. constrictum, 4) G. species 5) G. grunowii 6) Gomphoneis exigua, 7) Gomphonema montanum, 8) Grunowia tabellaria, 9) Gomphonema elegans, 10) Navicula sp., 11) Nitzschia holsatica, 12) Nitzschia sigmoidea

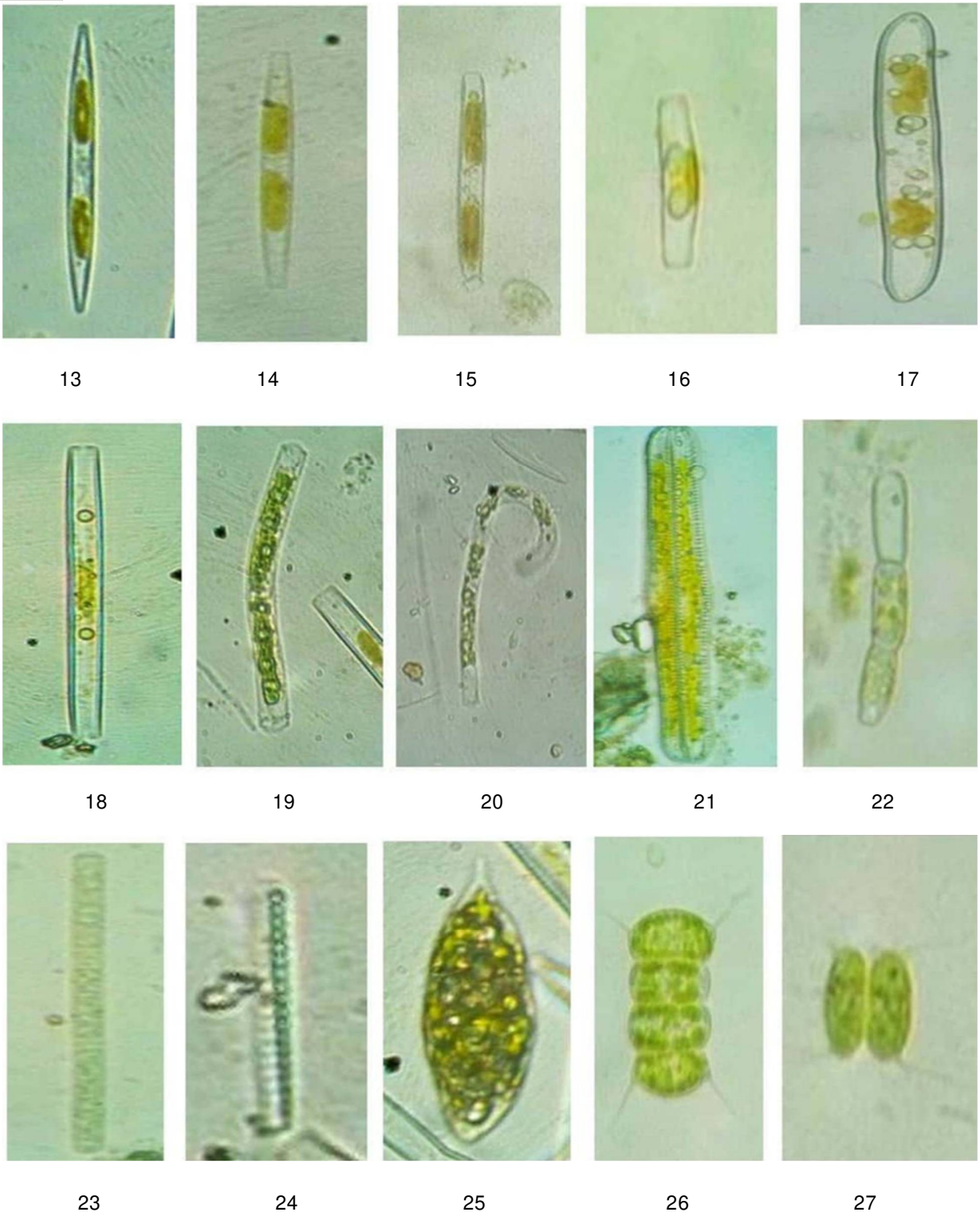


Plate 2: 13) Synedra gracilis, 14) Cymbella lanceolata , 15) Cymbella sp., 16) Sellaphora pupula, 17) Gyrosigma sp., 18) Nitzschia sps.,19) Phormidium sp., 20) Klebsormidium, 21)Pinnularia gibba, 22) Oedogonium species, 23)Planktothrix isothrix, 24)Komvophoron constrictum, 25)Euglena splendens, 26) Scendesmus quadrispina, 27) Desmodesmus abundans.

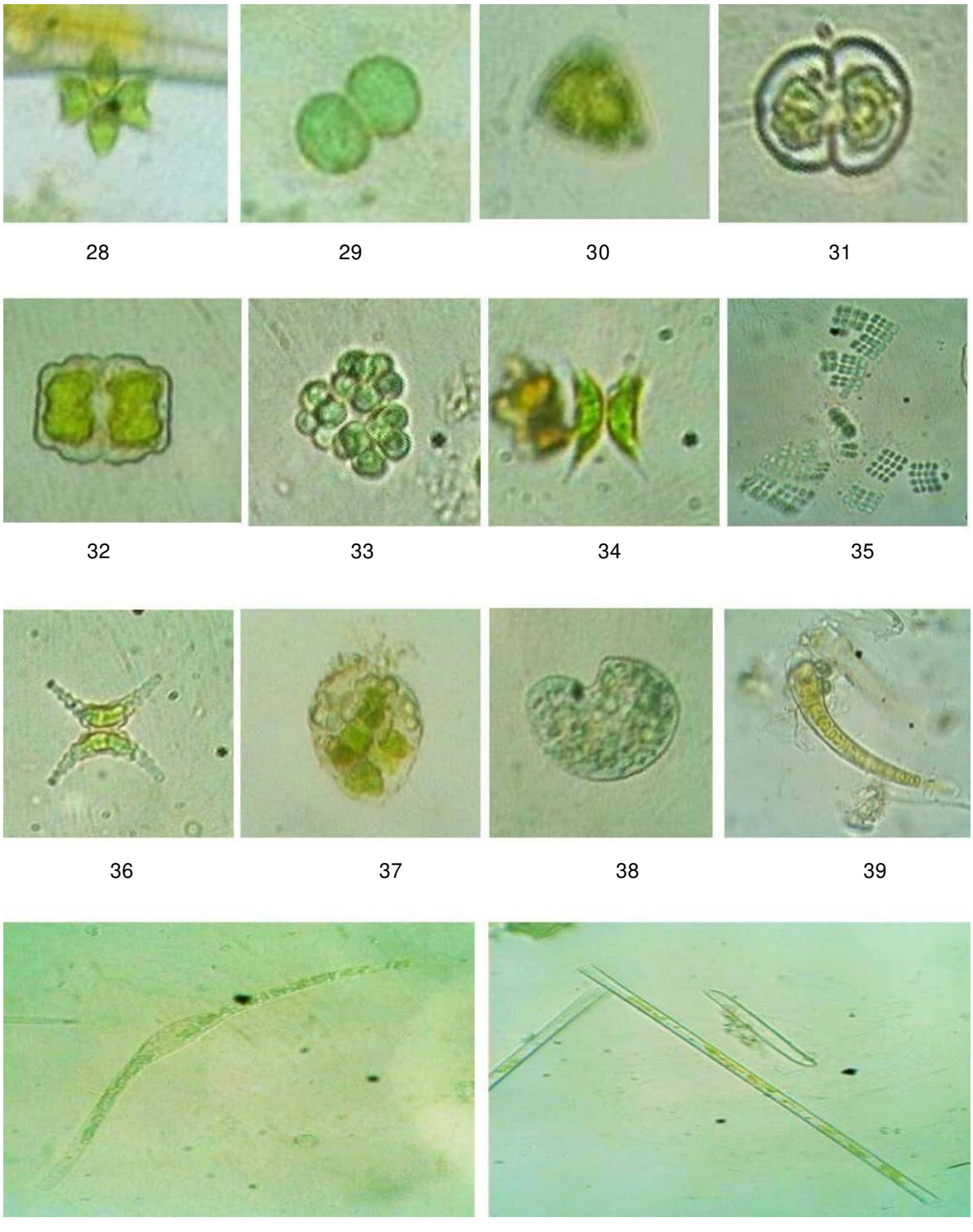
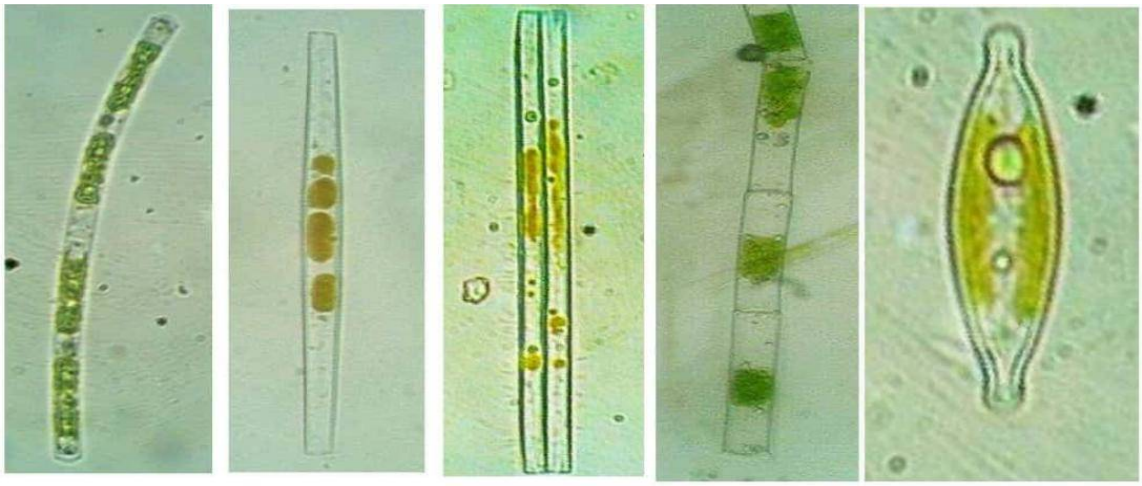
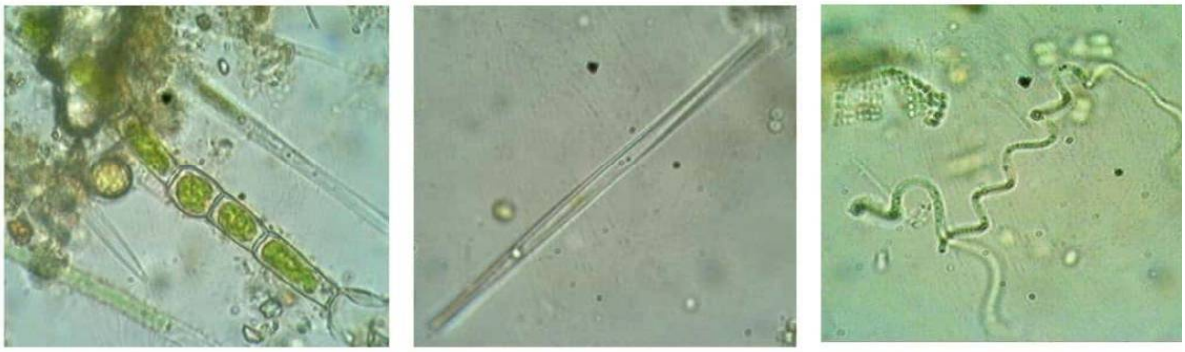


Plate 3 : 28) Amtodesmus dimorphous, 29) Cosmarium regnelli, 30) Tetraedron regulare 31)Cosmarium bitrapezoideum,32) C. trilobulatum, 33) Hariotina reticulatum, 34) Tetradesmus major, 35) Merismopedia tenuissima, 36) Staurastrum bloklandiae, 37) Lepocinclis ovum, 38) Euglena virdis, 39) Calothrix geitonos, 40) Parallela transversalis, 41) Ulnaria ulna.



42 43 44 45 46



47 48 49

50 51 52

Bray - Curtis Similarity Index:

Plate 4 : 42) Microchaete sp., 43) Ulnaria oxyshynchus, 44) Ulanaria ulna, 45) Aulacoseira islandica, 46) Gomphonema parvulum var. micropus, 47) Oedogonium sp.,48) Nitzschia acicularis,49) Arthrospira khannae, 50) Phormidium crassior, 51) Klebsormidium sp., 52) Fragilaria sp.

The Bray- Curtis similarity index is the best tool in understanding the effect of abiotic and biotic components in the lake ecosystem. Based on the physico- chemical and phytoplankton population hierarchical cluster analysis with Bray- Curtis distance measure was performed. The level of significance is taken to be 0.48 and above. The outcome of Bray- Curtis cluster analysis for Hadinaru lake during the period from April 2022 to August 2022 is represented in figure 2 for physicochemical and phytoplankton respectively. In the current study the highly correlated clusters were those of EC, Total hardness and Total alkalinity. The biological parameters like Chlorophyceae, Cyanophyceae and Bacillariophyceae have became one cluster and Desmidiaceae, Charophyta have became another cluster, these two clusters have showed high significance with the physico-chemical cluster of EC, Total hardness and Total alkalinity.

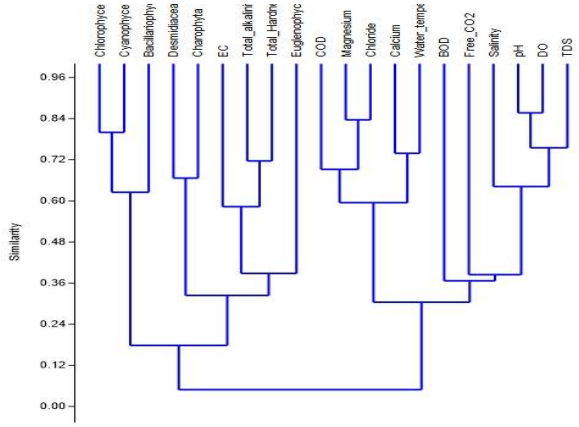


Fig 2: Bray-Curtis Similarity Index of Biological Parameters of Hadinaru lake (April 2022 to August 2022)

C. Principal Component Analysis

A statistical relationship between the composition of phytoplankton and the physico-chemical environment variables in the surface water was done by Principal Components Analysis (PCA) in the Multivariate Statistical Package PASTA Software. In the current study Cyanophyceae and Chlorophyceae showed positive correlation with EC but showed the negative correlation with other physico-chemical parameters. The EC and other physico-chemical parameter showed the positive correlation with Bacillariophyceae. This was shown in the figure 3.

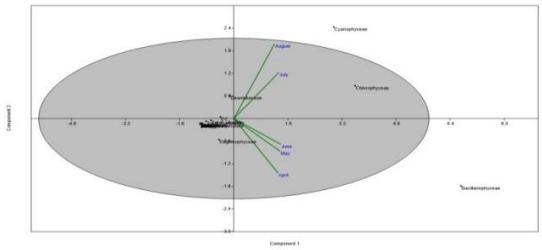


Fig 3: Principal Component Analysis of Physico-Chemical Parameters of Hadinaru lake (April 2022 to August 2022)

D. Biodiversity Indices

The diversity indices explain about the dominance, evenness and abundance of the species. Diversity indices like Simpson's, Shannon wiener, Pielou's evenness, Margalef's index, Fisher's alpha index and Berger-Parker index were discussed. To know the diversity of phytoplankton the data was subjected to PASTA software. The calculated diversity indices are shown in Table 5.

Simpson's diversity index

Simpson's index (D) is a measure of diversity, which takes into account both species richness, and an evenness of abundance among the species present. In essence it measures the probability that two individuals randomly selected from an area will belong to the same species. The formula for calculating D is presented as follows

$$D = \sum \frac{ni\ (ni-1)}{N\ (N-1)}$$

Where ni is the total number of organisms of each individual species
N is the total number of organisms of all species
D ranges from value 0 to 1. With this index, 0 represents the infinite diversity and 1 represents thereis no diversity which indicates that, bigger the value lower the diversity [9]. The index value ranged from 0.539 to 0.745. The minimum value recorded was 0.539 during April 2022 to a maximum value was 0.745 during July 2022. It shows species are not evenly distributed throughout the study.

E. Shannon Weiner Index

This index helps in determining pollution status of the water body. According Willham and Dorris (1966) stated that values of the index >3 indicates clean water, values <3 indicates moderate pollution and values <1 is considered as heavily polluted. Normal values range from 0 to 4. This index is a combination of species present and the evenness of the species [15]. It is represented as follows:

$$(H') = \sum_{R=1} p_i \, Ln \, p_i$$

Where p_i is the proportion of the i^{th} species and in natural logarithm. The value ranged from 0.986 to 1.449. The minimum value observed were 0.986 during April 2022 which indicates that the lake is heavily polluted during this month. Maximum value of 1.449 was recorded during July 2022. It implies the lake moderately polluted during the study.

F. Pielou's Evenness Index:

Pielou's Evenness Index (1975) measures the evenness of the species. The index is expressed as,

$$J = H' \log (S)$$

If H is the observed Shannon Weiner index, the maximum value this would take is log(S) where S is the total number of species in the habitat [13].The Pielou's index value ranges from 0.670 to 0.851. The minimum value observed during April and maximum value of 0.851 during July. It shows that species were not evenly distributed throughout the year.

G. Margalef's Index

The Margalef's index is also similar to Menhinick index, which also measures the richness of species in an ecosystem. It is calculated using the formula

$$D = \frac{S - 1}{Ln\,(N)}$$

It is calculated as the species number (S) minus 1 divided by the logarithm of the total number of individuals (N) [11]. In the present investigation, the Margalef's index values ranged from 0.299 to 0.404. The minimum value observed was 0.299 during April and maximum value of 0.404 during the month of August . The maximum richness of the species was found in august and minimum richness was found in April.

H. Fisher's Alpha Index:

The index is the alpha parameter [10]. The index of diversity that assumes that the abundance of species follows the log series distribution: $\alpha x \; \alpha x^2, \alpha x^3, \ldots . \alpha x$

In the present investigation, the Fisher's alpha values ranged from 0.358 to 0.470. The minimum value observed was 0.358 during May and maximum value of 0.470 during August . The maximum abundances of the species was found in august and minimum richness was found in May.

I. Berger - Parker Index:

The Berger–Parker diversity index has been used typically to assess the dominance of species in a community. It is represented as follows:

$$D = \frac{N_{max}}{N}$$

Where N_{max} is the number of individuals in the most abundant species and N is the total number of individuals in the sample [14].In the present investigation, the Berger–Parker values ranged from 0.300 to 0.625. The minimum value observed was 0.300 during July to a maximum value of 0.625 during April . It shows species were not evenly distributed throughout the year.

Table 5: Biodiversity indices of Hadinaru lake during April 2022 to August 2022

	April	May	June	July	August
Taxa_S	4	4	5	5	5
Individuals	22400	25200	28000	28000	19600
Dominance_D	0.4609	0.3889	0.34	0.255	0.2653
Simpson_1-D	0.5391	0.6111	0.66	0.745	0.7347
Shannon_H	0.9869	1.12	1.277	1.449	1.433
Evenness_e^H/S	0.6707	0.7662	0.7174	0.8518	0.838
Margalef	0.2995	0.296	0.3906	0.3906	0.4047
Menhinick	0.02673	0.0252	0.02988	0.02988	0.03571
Fisher_alpha	0.3626	0.3584	0.4532	0.4532	0.47
Berger-Parker	0.625	0.5556	0.5	0.3	0.3571

IV. CONCLUSION

The result of physico- chemical and biological parameters along with statistical method and biodiversity indices indicated that the lake in the present study is threatened ecologically due to various anthropogenic activities which lead organic pollution and eutrophication status of the lake. As wetlands are rich in life, reservoirs for sewage disposal, maintenance of local ground water levels and as a refuge for local and migratory wildlife, it's our responsibility to conserve the lakes in sustainable manner. Knowing the ecological status of the lake, will helpful for carrying out restoring practices of the same.

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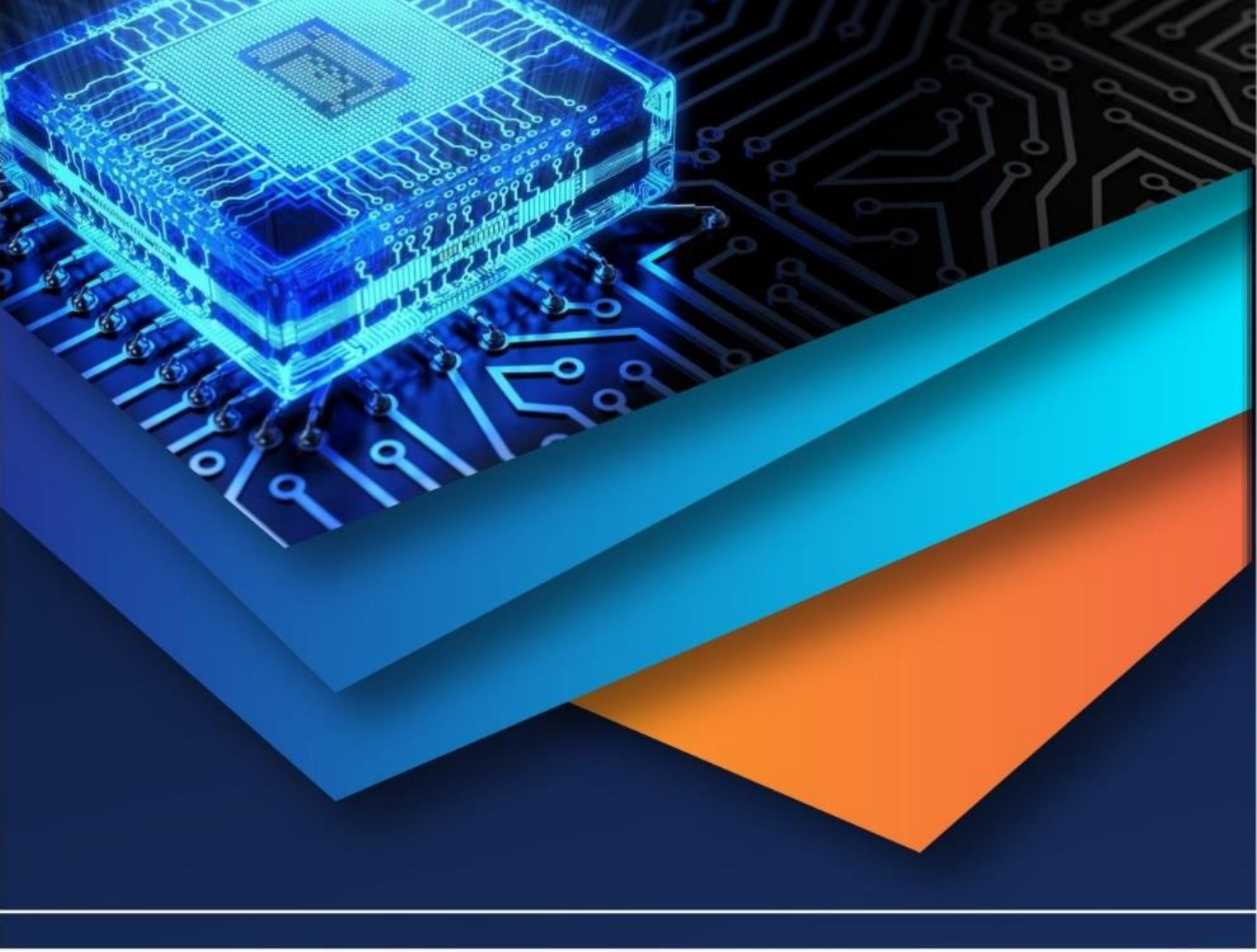

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