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Impact of physicochemical parameters on phytoplankton diversity and abundance in Lakhota Lake, Jamnagar, Gujarat, India

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Abstract
Planktons are the organisms that are basically, wanderers that moves for some short distances and are usually found at the epilimnion. The present work is aimed at understanding the variation in planktonic communities, health of ecosystem or disturbance, Eco-toxicity and sustainability. The water and plankton samples were collected from a Lakhota Lake of Jamnagar city, Gujarat, India for a period of two year from sept 2020 to oct 2021 between 6:00 A.M and 9:00 A.M. Most of the physicochemical parameters are very suitable for phytoplankton growth. The result showed that there were highly significant differences in Alkalinity, pH, BOD, DO, COD, TDS, TH, P, Nitrate, calcium, magnesium, colour and turbidity among seasons and between sites of lake during study period. Environmental factors positively correlated with phytoplankton which were analysed by CCA and correlation coefficient During study period 15 different species observed which can belong to Bacillariophyceae (07 species), Chlorophyceae (04 species) and Cyanophyceae (3 species) Euglenophycea (01 Species). Different diversity indices and saprobic index also show high diversity and moderate pollution in the study area.

Keywords: Phytoplankton, lakhota lake, physicochemical parameter, saprobic index and BO

Introduction

Planktons are the organisms that are basically, wanderers that moves for some short distances and are usually found at the epilimnion. They move with current of the water and can't flow to the opposite side of the current. The study of planktons is known as planktology. Sun *et al*., 2019 [18]. Phytoplanktons are autotrophic in nature as they consist of the pigment chlorophyll within them and hence, they produce the CO_2 their product by fixing up the solar energy by the process of photosynthesis. Animal components all concluded in planktons are known as zooplanktons. They are the throng of much diversely floating microscopic organisms with much less power of locomotion. Fang *et al*., 2012 [7]. Water is the most essential requirement of all the living organism. But now a days water is getting much polluted due to the anthropogenic activities such as dumping of industrial and chemical wastes into fresh water making a decrement of the available portable water Hossain *et al*., 2017 [10]. The present work is aimed at understanding the variation in planktonic communities, health of ecosystem or disturbance, Eco-toxicity and sustainability.

Materials and Methods

The water and plankton samples were collected from a Lakhota Lake of Jamnagar city, Gujarat, India for a period of two year from sept 2020 to oct 2021 between 6:00 A.M and 9:00 A.M. Rain water is the only source of water for this lake. The data were taken thrice in month and interpreted seasonally, like winter (December - February). Water sample collected by grab sample method and manual sampling (APHA Standard). Collect a 1-L sample for most physical and chemical analyses. Sample packed in crushed ice and store at 4 to 5 degrees Celsius. Water parameter like BOD, COD, DO, pH, Mg, Ca, Alkalinity, Total hardness, TDS, Colour, Total phosphorus, nitrate and turbidity analysed using APHA standard method. Plankton is counted using a binocular compound microscope with various eyepieces, such as 10X and 40X. Estimating the populations of each species allows for thorough assessments of planktonic communities. Diversity index is calculated using PAST software. Saprobic index is calculated using pantle and buck method.

Result and Discussion

Most of the physicochemical parameters are very suitable for phytoplankton growth. The result showed that there were highly significant differences in Alkalinity, pH, BOD, DO, COD, TDS, TH, P, Nitrate, calcium, magnesium, colour and turbidity among seasons and between sites of lake during year oct-2020 to sep-2021Higher Alkalinity 53.6 ± 0.37 mg/L was recorded during in May (Summer season) and a low Alkalinity 32.6 ± 0.17 mg/L during August (Rainy season) at station A of lake. While Higher Alkalinity 50.3 ± 0.15 mg/L was recorded during in April (Summer season) and a low Alkalinity 44.7 ± 0.20 mg/L during July (Rainy season) at station B of lake. Higher BOD 22.3 ± 0.05 mg/L was recorded during in June (Summer season) and a low BOD 14.0 ± 0.11 mg/L during Jan (Winter season) at station A of lake. While in station B Higher BOD 5.8 ± 0.15 mg/L was recorded during in June (Summer season) and a low BOD 2.7 ± 0.05 mg/L during Dec (Winter season). Higher COD 97.6 ± 1.1 mg/L was recorded during in Aug (Rainy season) and a low COD 40.6 ± 1.1 mg/L during May (Summer season) at station A of lake. While in station B Higher COD 18.6 ± 0.05 mg/L was recorded during in July (Rainy season) and a low COD 13.06 ± 0.05 mg/L during Apr (Summer season). Higher Calcium 57.6 ± 0.5 mg/L was recorded during in Aug (Rainy season) and a low Calcium 34.6 ± 0.5 mg/L during Apr (Summer season) at station A of lake. While in station B Higher Calcium 28.6 ± 0.5 mg/L was recorded during in Aug (Rainy season) and a low Calcium 11.6 ± 0.5 mg/L during Apr (Summer season). Higher colour 13.2 ± 0.01 mg/L was recorded during in Aug (Rainy season) and a low Colour 10.01 ± 0.07 mg/L during Apr (Summer season) at station A of lake. While in station B Higher Colour 7.21 ± 0.01 mg/L was recorded during in

Aug (Rainy season) and a low Colour 5.72 ± 0.01 mg/L during Apr (Summer season). Higher DO 7.16 ± 0.15 mg/L was recorded during in Feb (Winter season) and a low DO 4.03 ± 0.05 mg/L during Aug (Rainy season) at station A of lake. While in station B Higher DO 11.1 ± 0.05 mg/L was recorded during in Feb (Winter season) and a low DO 7.03 ± 0.05 mg/L during Aug (Rainy season). Higher Mg 32.3 ± 0.5 mg/L was recorded during in Aug (Rainy season) and a low Mg 14.6 ± 1.1 mg/L during Apr (Summer season) at station A of lake. While in station B Higher Mg 16.3 ± 0.5 mg/L was recorded during in Aug (Rainy season) and a low Mg 7.6 ± 1.5 mg/L during Apr (Summer season). Higher Nitrate 64.8 ± 0.20 mg/L was recorded during in Sep (Rainy season) and a low Nitrate 45.4 ± 0.25 mg/L during May (Summer season) at station A of lake. While in station B Higher Nitrate 25.3 ± 0.20 mg/L was recorded during in Sep (Rainy season) and a low Nitrate 45.4 ± 0.25 mg/L during May (Summer season). Higher Turbidity 8.1 ± 0.0 mg/L was recorded during in Aug (Rainy season) and a low Turbidity 5.3 ± 0.11 mg/L during Feb (Winter season) at station A of lake. While in station B Higher turbidity 5.2 ± 0.05 mg/L was recorded during in July (Rainy season) and a low Turbidity 3.4 ± 0.00 mg/L during Jan (Winter season). Higher pH 8.2 ± 0.05 mg/L was recorded during in May (Summer season) and a low pH 6.1 ± 0.11 mg/L during Jul (Rainy season) at station A of lake. While in station B Higher pH 8.3 ± 0.05 mg/L was recorded during in Apr (Summer season) and a low pH 7.0 ± 0.11 mg/L during Aug (Rainy season). Higher TDS 623.6 ± 1.5mg/L was recorded during in Sep (Rainy season) and a low TDS 490 ± 1.5 mg/L during Apr (Summer season) at station A of lake. While in station B Higher TDS 471 ± 0.00 mg/L was recorded during in Sep (Rainy season) and a low TDS 370 ± 0.05 mg/L during Apr (Summer season). Higher Total hardness 276±3.0 mg/L was recorded during in Aug (Rainy season) and a low Total hardness 146.6 ± 5.6 mg/L during Apr (Summer season) at station A of lake. While in station B Higher Total hardness 138.3 ±3.5 mg/L was recorded during in Aug (Rainy season) and a low Total hardness 60.3 ± 5.8 mg/L during Apr (Summer season). Higher Phosphorus 0.18 ± 0.032 mg/L was recorded during in Sep (Rainy season) and a low Phosphorus 0.08 ± 0.0 mg/L during Mar (Summer season) at station A of lake. While in station B Higher Phosphorus 0.061± 0.0 mg/L was recorded during in Sep (Rainy season) and a low Phosphorus 0.025 ± 0.0 mg/L during Feb (Summer season). During year 2021-2022 there is also variation in physicochemical parameters among different season. Fifteen species of phytoplankton were recorded in the lakhota lake during year 2020-2022 represented by Four major groups, Bacillariophyceae (07 species), Chlorophyceae (04 species) and Cyanophyceae (3 species) Euglenophycea (01 Species)**.** Phytoplankton species observed during research period were *Pediastrum sp.*, *Chlorella sp.*, *Zygnema sp.*, *Spirogyra sp.*, *Gloeocapsa sp.*, *Osillatoria sp.*, *Anabaena sp.*, *Cocconeis sp.*, *Synedra sp.*, *Phytoconis sp.*, *Diatoma sp.*, *Cymbella sp.*, *Nitzshia sp.*, *Skeletonema sp.* and *Euglinoids sp* among them *Pediastrum sp.*, *Chlorella sp.*, *Zygnema sp.* and *Spirogyra sp.*, belongs to Chlorophyceae while *Gloeocapsa sp.*, *Osillatoria sp.* and *Anabaena sp.*, belongs to Cynophyceae and *Cocconeis sp.*, *Synedra sp.*, *Phytoconis sp.*, *Diatoma sp.*, *Cymbella sp.*, *Nitzshia sp.* and *Skeletonema sp.* belongs to Bacillariophyceae. Only one species *Euglinoids sp* belongs to Euglenophycea. Total Phytoplankton density 8427 Org/L was observed at station A while total Phytoplankton density 4728 Org/L was observed at station B during year 2020-2021. Maximum density was observed during February month (Winter season) while minimum density was observed during august month (Rainy season) at station A. It starts declining from March onwards and attains lowest ebb during August (monsoon months). Again, phytoplankton showed an increase in their density in post monsoon season and attains peak in winter season. Bacillariophyceae was the most dominant of all the groups of phytoplanktons in both the station. In station A Bacillariophyceae Contribute 45% (3815 Org/L) which is followed by Chlorophyceae 27% (2274 Org/L), Cynophyceae 22% (1856 Org/L), Euglenophyceae 6% (482 Org/L). In station B Bacillariophyceae Contribute 43% (2035 Org/L) which is followed by Chlorophyceae 29% (1382 Org/L), Cynophyceae 23% (1090 Org/L), Euglenophyceae 5% (221 Org/L). In station B Maximum density of Chlorophyceae was observed during March month (summer season) and minimum density was observed during August month (Rainy season). Cynophyceae was maximum during April Month (summer Season) and minimum during August month (Rainy season). Bacillariophyceae maximum during January Month (Winter Season) and minimum during August month (Rainy season). Maximum density of Euglenophyceae was observed during February month (winter season) and minimum during September month (Rainy season).

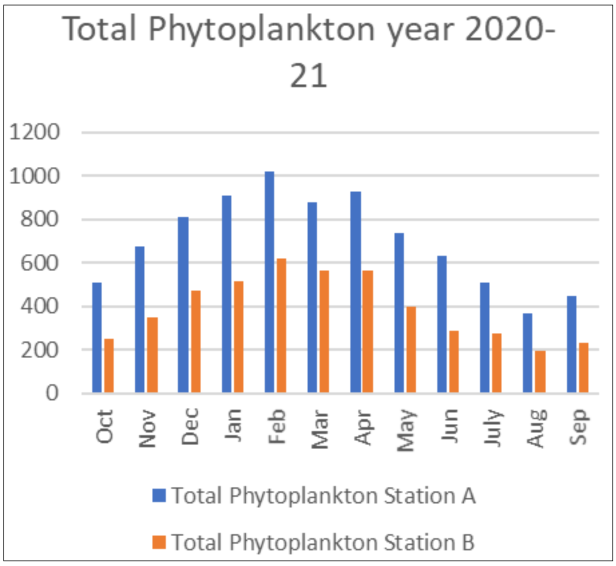

Chart 1: Monthly variation of Total Phytoplankton of lakhota lake water, Jamnagar from September 2020 to October 2021

Karl Pearson's coefficient of correlation used to observe significant relationship between physiochemical factor and phytoplankton and zooplankton. From the correlation matrix showed that phytoplankton positively correlated with pH (0.87), DO (0.83), Nitrate (0.80), Phosphorus (0.79), Turbidity (0.95), TDS (0.75), Alkalinity (0.76) while negatively correlated with BOD (-0.70), COD (-0.79), Total hardness (-0.91), Calcium (-0.92), Mg (-0.89) and colour (-0.92) in station A during 2020-2021. From the correlation matrix showed that phytoplankton positively correlated with pH (0.61), DO (0.96), Nitrate (0.60), Phosphorus (0.96), Turbidity (0.72), TDS (0.88), Alkalinity (0.82) while negatively correlated with BOD (-0.33), COD (-0.88), Total hardness (-0.84), Calcium (-0.85), Mg (-0.83) and colour (-0.90) in station B during 2020-2021.

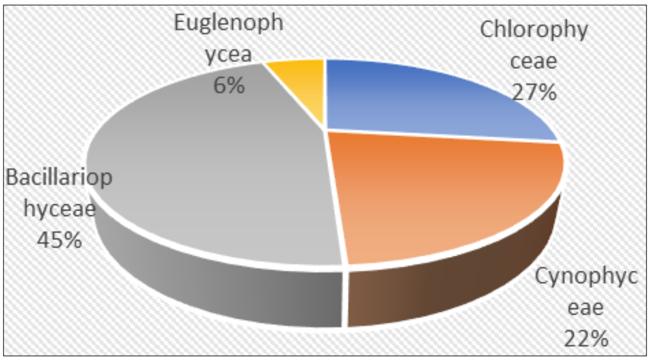

Chart 2: Percentage contribution of different classes of Phytoplankton at station A of lakhota lake water, Jamnagar

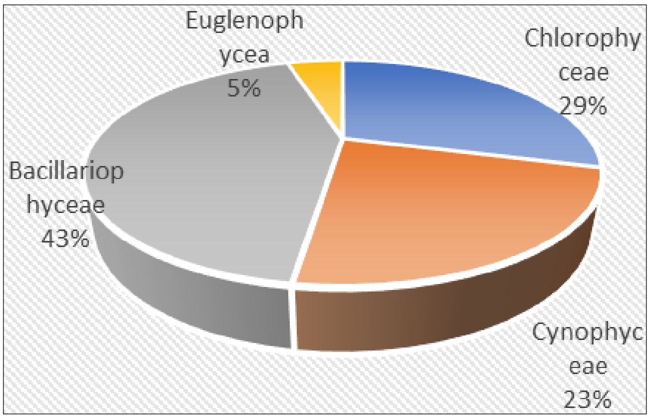

Chart 3: Percentage contribution of different classes of Phytoplankton at station B of lakhota lake water, Jamnagar

13 phytoplankton and 4 taxa of phytoplankton selected for CCA. In station A Axis 1 explained 61.67% of the variation in phytoplankton abundance with eigenvalue of 0.001597 while Axis 2 explained 31.33% of the variation in phytoplankton abundance with eigenvalue of 0.0008113. In station B Axis 1 explained 61.93% of the variation in phytoplankton abundance with eigenvalue of 0.01152 while Axis 2 explained 31.64% of the variation in phytoplankton abundance with eigenvalue of 0.00588. During 2020-2021 Saprobic index of phytoplankton at station A which show moderate (Degree of pollution) -Beta-mesosaprobic. While at station B show very slight- oligosaprobic.

Conclusion

During research work total 15 phytoplankton species observed in both the station of lake among that Bacillariophyceae (07 species), Chlorophyceae (04 species) and Cyanophyceae (3 species) Euglenophycea (01 Species). 13 different environmental factors analysed using Karl Pearson correlation and CCA analysis where it shows variation during different seasons. Among them pH, DO, Nitrate, Phosphorus, Turbidity, TDS, Alkalinity were positively correlated with phytoplankton while BOD, COD, Total hardness, Calcium, Mg and colour negatively correlated with phytoplankton in station A and B during 2020-2021. Different diversity index analysed for the diversity of phytoplankton which shows that high abundance occurs within study area. Saprobic index also calculated based on pollution indicator species which shows station A show moderate pollution while station B show very slight degree of pollution. Proper management of the lake required for the health of the ecosystem

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