ABSTRACT

The present study entitled "Limnological Study of the Urpod Beel, Goalpara, Assam with special reference to Planktonic Diversity" based on collection and their identification, numerical density, diversity indices and their correlation against different parameters have been established.

All the investigating data, analysis and interpretation of this work have been embodied in six chapters of the thesis.

Chapter I - Introduction

This chapter is the introductory part which includes general introduction on limnology and its concerned field.

Aim and objectives of the work is (1) Evaluation of the physico-chemical parameters of beel water and their influence upon the plankton and macrophyte diversity. (2) Study of planktonic diversity (a) Phytoplankton and (b) Zooplankton (3) Study of macrophytic diversity.

Chapter 2 - Review of Literature

This chapter deals with review of literatures related to this subject, consulted during the course of present investigation.

Chapter 3 – Material and Methods

Study Area: - The Urpod beel is a natural lake situated at Agia in the Goalpara district of Assam, located approximately 25° 33' to 26° 12' N latitude and 90 ° 7' to 91° 5' E longitude respectively, connected to the river Brahmaputra.

For collection of water samples and other studies, the whole beel was divided into five collection sites (S-1, S-2, S-3, S- 4 and S-5). The studies and collections were done in four climatic seasons namely pre-monsoon, monsoon, post -monsoon and winter.

Methods: -

The physico-chemical parameters included in the study are Water Temperature, Transparency, p^H, DO, BOD, Free CO_2, Total Alkalinity, Total Hardness, Ca, Mg, Cl, Bicarbonate, Total Dissolved Solids, Total Suspended Solids, Na, K, SO_4, NO_3, PO_4, N, Zn, Cu, Cr and Cd. For analysis of physico-chemical parameters of the beel water the standard method adopted by APHA (2012) is followed.

For plankton study, sample collections are done by filtering a volume of 50 litre surface water through a plankton net No. 25 of bolting silk with mesh size 40 micron and were preserved in 5% formalin in 100 ml sterilized bottles (Edmonson 1963, Sharma and Sharma, 2013).

The microscopic analysis of phytoplankton is done according to Sourins (1978). Identifications were done by following standard literature (Desikachary, 1959; Prescott, 1982; Bellinger and Sigee, 2010; Likens, 2010).

The microscopic analyses of zooplanktons are followed by Hosmani and Bharathi (1980) identified following standard literature (Tonapi, 1980; Needham and Needham, 1986; Battish, 1992; Sharma and Sharma, 2013).

For the quantitative analysis of plankton, a Sedgwick – Rafter (SR) plankton counting cell is used.

Macrophytes are identified by consulting standard key and literature (Kanjilal *et al.*, 1940; Baruah, 1992; Bor, 1940) and consulting the herbaria of Gauhati University Botany of Department.

Diversity indices studied in the present investigations are Simpson Index, Dominance Index, Shanon–Wienner Diversity Index, Berger-Parker Dominance Index, Margalef Index and Sorensen's Similarity Index.

To find out the degree of relationships between different groups of Plankton and Physico-chemical parameters of water Karl Pearson's coefficient of correlation (r) is calculated among all these variables. The level of significance in the correlations was tested by performing the t-test. All the relevant statistical analyses are done by using SPSS version 16.

Canonical Correspondence Analysis (CCA) is done by using Palaeontological Statistics (PAST) Software Version 3.06 to determine the relationship between plankton and physico-chemical parameters.

Chapter 4 – Results

Physico-chemical Analysis of Water:- Seasonal fluctuation of water temperature at the maximum of 26.92°C ± 2.07 during monsoon and the minimum 13.30°C ± 1.28 during winter was recorded during the study. The higher transparency level (57.7 ± 0.2 cm) during monsoon and the lower of (42.2 ± 0.17 cm) in winter season are noted. The beel water is found slightly alkaline to moderately acidic in nature. Maximum DO is recorded in winter and post-monsoon season and minimum is in pre-monsoon and monsoon season. No significant variation is found in the BOD value. In this observation, the Free CO_2 showed marginal seasonal variation with the lowest level (6.1 ± 0.2 mgl^{-1}) in monsoon and the highest (6.5 ± 0.19 mgl^{-1}) is in pre-monsoon. The seasonal fluctuation of total alkalinity showed the similar trend with that of Free CO_2. The minimum value of Bicarbonate is found in monsoon season (29.3 ± 0.12 mgl^{-1}) and the maximum (34.3 ± 0.12 mgl^{-1}) value is found in pre-monsoon season. Water of the Urpod beel is found to be soft to moderately soft (27.1 ± 0.16 – 35.6 ± 0.23 mgl^{-1}). During the study period maximum value of Ca is in the pre-monsoon and monsoon (18.52 ± 0.61 and 16.69 ± 0.90 mgl^{-1}). During the study period the results of Cl level in this beel is low (5.1 ± 0.34 – 7.5 ± 0.08 mgl^{-1}). TDS values of the beel water are found in the range of 12.5 ± 0.25 to 19.9 ± 0.13 mgl^{-1}. During the monsoon period, the beel water shows the maximum value of TSS (67.6 ± 0.16 mg/l) and maintains almost at this level in all the seasons. In the present findings the NO_3 value has been observed at range variation of 0.80 ± 0.44 to 0.98 ± 0.19 in winter and pre-monsoon seasons respectively. The maximum value of PO_4 (0.16 ± 0.01 mgl^{-1}) is recorded in pre-monsoon season. The amount of SO_4 as the highest quantity is found during pre-monsoon (6.4 mgl^{-1}) and the lowest during winter 4.5 mgl^{-1}. The amount of Na in the Urpod beel has been found without significant changes throughout the year. K has been recorded under the limited level (1.45 mgl^{-1} in winter) in the beel water. The beel water shows the presence of negligible quantity of the heavy metals like Cu, Cd and

Cr and the concentration of Zn in the beel water is found in bellow the permissible level (0.26 mgl^{-1}).

Phytoplankton Diversity: - The phytoplankton community of the beel all together comprised of 61 species under 41 genera, 18 families, 8 orders and 5 different classes namely Cyanophyceae, Chlorophyceae, Bacillariophycea, Xanthophyceae and Euglanophyceae during the course of investigation. The class Chlorophyceae comprises of 30 species belonging to 20 genera 8 families under 3 orders. Class Cyanophyceae is comprised of 15 species belonging to 10 genera 4 families, and 2 orders. The class Bacillariophyceae follows Cyanophyceae with 10 species, 8 genera belongs to 4 families under one order. Class Euglanophyceae is comprised of 4 species, 2 genera belong to one family and one order. Xanthophyceae is also constituted by 2 species, one genus under one family and one order.

The seasonal trend of abundance in terms of numerical density of Chlorophyceae has been observed as monsoon > pre-monsoon > winter > post-monsoon in the first year and as pre-monsoon > monsoon > winter > post-monsoon in second year of observation. The highest growth of Chlorophyceae is contributed by *Volvox aureus, Micrasterias foliacea, Closterium calosporum, Ankistrodesmus falcatus* and *Tetraedron pusillum.* The seasonal trend of Cyanophyceae is observed as monsoon > winter >pre-monsoon > post-monsoon in the first year and it was as pre-monsoon > monsoon > winter > post-monsoon in the second year of the observation. The dominant species are *Anabaena orientalis, A. fertilissima, Nostoc mascorum* and *Microcystis aeruginosa.* The seasonal trend of Bacillariophyceae has been assessed as monsoon > pre-monsoon > winter > post-monsoon in the first year and as pre-monsoon > monsoon > post-monsoon > winter in second year of observation. The highest growth of Bacillariophyceae is attributed by *Navicula rhynchocephala* and *Nitzschia* sp. The seasonal trend for Xanthophyceae has presented as pre-monsoon > monsoon > winter > post-monsoon and as pre-monsoon > winter > monsoon > post-monsoon in first and second year of observation respectively. The seasonal trend for Euglenophyceae has been arranged as pre-monsoon > monsoon > winter > post-monsoon for both first and second year of observation.

Zooplankton Diversity: - The zooplankton community of the beel all together comprised of 44 species under 29 genera, 20 families, 7 orders and 5 different classes namely Protozoa (8 species), Rotifera (13 species), Copepoda (7 species), Cladocera (14 species) and Ostracoda (2 species) during the course of investigation.

Variation of zooplankton abundance that occurred in different seasons is in the following trend:

Monsoon – Cladocera >Rotifera > Protozoa > Copepoda >Ostracoda

Pre-monsoon – Cladocera >Rotifera > Protozoa > Copepoda >Ostracoda

Post-monsoon –Rotifera > Cladocera > Protozoa > Copepoda > Ostracoda

Winter – Cladocera >Rotifera > Protozoa > Copepoda

The highest growth of Protozoa is contributed by *Arcella discoid, A. vulgaris, Difflugia corona* and *Centropyxis minuta.* Protozoa shows significant positive correlation with Cladocera and total zooplankton in pre-monsoon season. Protozoa is significantly correlated with total zooplankton in monsoon season. The highest growth of Rotifera is contributed by *Lecane lunaris, Horaella brehmi, Testudinella patina* and *Trichocera procellus.* The highest growth of Copepoda is contributed by *Mesocyclops leuckarti* (male & female) and *Cyclopoid copepoidite.* The highest growth of Cladocera is contributed by *Acroperus harpae, Macrothrix spinosa, M. triseralis* and *Alona ractengula.* Cladocera has been significantly correlated with total zooplankton in pre-monsoon season. Cladocera shows the significant positive correlation with total zooplankton in monsoon season and post-monsoon season. Cladocera is also significantly correlated with total zooplankton in winter season.

Macrophytic Diversity: - All together 82 numbers of macrophytic species belonging to 60 different genera and 33 families are recorded. Out of 82 species 4 species are from Pteridophytes belonging to 4 families and others are Angiosperms. Among the Angiosperms 38 species are Dicotyledons under 18 families and 40 species are from Monocotyledons under 11 families.

Among the observed Macrophytes, 20 species are belonging to Marshy amphibious (MA), 15 species are Floating aquatic (FA), 20 species are Submerged

aquatic (SA), 21species are Emergent aquatic (EA) and 6 species are found as Free floating (FF).

Based on IVI value *Azolla pinnata, Salvinia natans, Ipomoea aquatic, Echhornia crassipes, Lemna perpusilla, Marsilea quadrifolia, Hygroryza aristata, Hydrila verticillata, Centela asiatica, Alternanthera sessilis, Polygonum hydropiper, Euryale ferox, Sagittaria sagittifolia,* have been recorded as the dominant species of the beel irrespective of sites and seasons .

Correlation analysis has been performed among the studied physico-chemical parameters of water to find out the interrelationships among them and the planktonic groups.

Chapter 5 – Discussion

Seasonal fluctuation of water temperature is found at the maximum during monsoon and the minimum in winter during the study. The lower transparency in winter is due to low level of water, heavy siltation and increase of organic matter as well to fishing activity against one high level of water due to influx of rain water in monsoon. The beel water is found slightly alkaline to moderately acidic in nature which exhibits an identical trend with the natural floodplain wetlands of Assam. Maximum DO is recorded in winter and post-monsoon season and minimum is in pre-monsoon and monsoon season. No significant variation is found in the BOD value. In monsoon season the level of CO_2 is found low, the presence of algal bloom in the monsoon season may be the reason for low level of CO_2 in the beel. Water of the Urpod beel is found to be soft to moderately soft during the study period. Increase of Ca in the beel might be due to the input of sewage, drainage water and fertilizers from nearby rice field during pre-monsoon and monsoon. Chloride has been reported as a chemical indicator for pollution and thereby it could well be inferred that Urpod beel remained fresh to its possible level. During the study period the results of Cl level in this beel is low.TDS values of the beel water are found in the range of permissible limit which is the indicative of the unpolluted water body. The most important inorganic nitrogen compound in water is NO_3. In the present findings the NO_3 value has been observed within the desirable limit. The high level of SO_4 in the study period

possibly as a result of the breakdown of leaves of vegetation, specifically the macrophytes. The beel water showed the presence of negligible quantity of the heavy metals like Cu, Cd and Cr and the concentration of Zn in the beel water is found in bellow the permissible level.

The seasonal observation of phytoplankton population during the period of investigation reveals that among the five classes, Chlorophyceae has been observed as most dominant followed by Cyanophyceae, Bacillariophyceae, Euglanophyceae and Xanthophyceae.

In phytoplankton *Volvox aureus*, *Micrasterias foliacea, Ankistrodesmus falcatus, Anabaena orientalis, Microcystis*, *Navicula rhynchocephala*, *Nitzschia* sp. are found the most abundant species in the study year.

The presence and dominance of zooplankton species play a vital role in functioning of freshwater ecosystem and the seasonal changes in zooplankton species are clearly related to the water quality and biologically regime of the aquatic environments. In zooplankton *Arcella discoides*, *Arcella vulgaris, Testudinella patina, Mesocyclops leuckarti* (male and female), *Acroperus harpae, Macrothrix spinosa* are the dominant species during the study period. Among the zooplankton in context to the present study, the Cladocera are found to be the dominant group in terms of species diversity and abundance during the period of investigation.

Zooplankton is a good indicator of changes in water quality because it is strongly affected by environmental conditions and responds quickly to changes in environmental quality. In the study period, summer population of total zooplankton falls during the monsoon due to a dilution effect. The population rises to a higher level in the winter as a result of favourable environmental conditions, including temperature, dissolved oxygen and the availability of abundant food in the form of bacteria, nano-plankton and suspended detritus.

Chapter 6 – Summary and Conclusion

This chapter deals with the overall summary and conclusion of the work.

From the investigation it may be concluded that the Urpod beel is one of the rich biodiversity areas within the wetland ecosystem of Assam. Low chloride level in

the beel shows the less anthropogenic influence in the lake water which increases the amount of Dissolve oxygen. It is a rich planktonic diversity region which is evident from the present findings. Numerical abundance of planktons reveals that phytoplanktons are most dominant than that of zooplanktons. During the summer, large parts of the beels are covered by aquatic vegetation like water hyacinth, aquatic grasses, water lilies and other submerged, emergent and floating vegetation.

The beel plays an important role in maintaining the environmental quality of the areas and its vicinity and also of the Goalpara town. So it is essential to conserve the beel for the future generation.

Bibliography

It deals with the list of consulted references.