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Diversity and Distribution Pattern of Rice Stem Periphyton in Water-Logged Rice Fields under Different Cropping Seasons in Barak Valley, Assam

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Abstract: Periphyton play a crucial role in productivity and nutrient cycling in the aquatic ecosystems. They are believed to be an important component of the rice-field ecosystems, and thus have the potential to support integrated aquaculture by acting as food material for cultured fishes. This necessitates a detailed study on their diversity and distribution patterns in the rice field ecosystems. The present study was carried out in 24 traditionally managed water-logged rice fields under four cropping seasons viz., Boro, Asra, Aush and Sali located in Barak Valley, Assam, northeast India. We characterized rice-stem periphyton communities under different rice-cropping seasons (RCSs). The study revealed conspicuous variations in abundance of rice-stem periphyton communities across different RCSs. The study highlights that the water-logged rice fields in the study area are rich in rice stem periphyton, and therefore have the potential for concurrent rice-fish culture. The study recommends on-farm experiments on the prospects of using water logging conditions in such rice fields for concurrent rice-fish culture.
Keywords: Water-logged rice fields, rice cropping season, rice stem periphyton

I. INTRODUCTION

Periphyton is a universally accepted expression for all organisms that are attached to a substrate including submerged part of rice stem. Therefore, the microscopic plant components of periphyton on submerged part of rice stem are mentioned here as rice stem phyto-periphyton and microscopic animal components of periphyton on submerged part of rice stem are mentioned here as rice stem zoo-periphyton. The phyto-periphyton contributes significantly to primary production [1] in any aquatic systems. A detailed nutrient budget has demonstrated that periphyton consumes a significant fraction of nutrients such as available carbon, nitrogen and phosphorus during their growth [2] and aid in macrophyte decomposition [3]. Periphyton of rice stems or rice stem periphyton is being used traditionally as rich aquatic feed for fishes throughout the countries like Cambodia, West Africa, Sri Lanka, India and Bangladesh [4].Grazing of periphyton by wild fish has also been reported [5], [6].A wide range of fish and benthic invertebrates including snails, chironomids, mayflies, oligochaetes and several groups of crustaceans include periphyton in their diet [7]. Above information reveals the importance of periphyton in aquatic systems including the water-logged rice fields. Barak Valley, Assam, North East India, located in the Indo-Burma biodiversity hot spot region, is geographically placed in a heavy rainfall zone , (rainfall >2000mm) and hence, experiences a longer aquatic phase in its rice fields and thus dominated by rain-fed water-logged rice fields. Rice ecology in Barak Valley is mainly rain fed. All the agricultural classes of rice are grown in different agro-ecological situations depending on specific locations i.e. rice is grown in all the seasons throughout the year viz., Rabi or summer /spring rice, locally called as ‘Borua’ or ‘Boro’(cropping period: December/January to April-May); Pre-kharif or autumn rice, locally called as ‘Aush’/‘Ahu’(cropping period: May to August) and Kharif or winter rice, locally called as ‘Shail’/ ‘Sali’(cropping period: July to November). Besides, semi-deep water rice, locally called as ‘Asra’(cropping period: April-May to November-December) are also grown in Barak Valley, Assam. Rice fields of all these agricultural classes undergo aquatic phase the duration of which varies from 2 to 4 months and these systems behave like seasonal wetlands. With regard to the periphytic communities particularly those present in the submerged portion of the rice stems in water-logged rice fields under different RCSs no studies have been done in Barak Valley, Assam. Therefore, looking into the gap in information the present study has been undertaken in Barak Valley, Assam.

II. METHODOLOGY

A. Study area

The present study was done in Karimganj district of Barak Valley, Assam for two consecutive years during different RCSs from January 2012 to September 2013. We selected two sites (Fig. 1) under each RCS. Within each site a total of three plots of approximately similar area (1946.67 ±79.82 m^2) were demarcated for sampling. Thus, a total of 24 representative plots were sampled for the present study.

B. Sampling Procedure

Monthly sampling was carried out during the respective aquatic phases of different RCSs i.e., January to April for *Boro*, June to September for *Asra*, June to August for *Aush*, and August to September for *Sali*. The study was done for two consecutive years during the rice growing season, from 2012 to 2013.

C. Data Analysis

For qualitative and quantitative estimation of rice stem periphytic communities, samples were collected randomly by gently scrapping from a known area of 10 numbers of cut submerged rice stems using a fine scalpel. The scrapped samples were then immediately preserved in glass vials using 2ml 4% formalin. All the samples of rice stem periphyton were later on brought to the laboratory for their identification. Identifications of rice stem periphyton at lowest possible taxonomic level were done using a binocular microscope (make: Olympus; model: B-2). Identification of rice stem phyto-periphyton and zoo-periphyton in rice field water were done at 10X and 40X magnifications following standard keys of ([8]-[21]). Quantitative analysis of both the rice stem phyto-periphyton and zoo-periphyton were done following Lackey's drop method[22]and was finally expressed as number of individual cm^{-2}.

Diversity indices of rice stem periphyton in the water-logged rice fields under different RCSs were analyzed using the Shannon-Wiener Diversity index (H´) [23], Buzas and Gibson's evenness index (e^H/S) [24]and Berger-Parker dominance index (d) [25].

D. Statistical analysis

Kruskal-Wallis test for variations in density of phyto-periphyton and zoo-periphyton communities on rice stems in water-logged rice fields amongst different RCSs was carried out to find out significant variation in the distribution of major rice stem phyto-periphyton classes and zoo-periphyton groups of the water-logged rice field across all the RCSs. All statistical analyses were done using and SPSS version 20 [26].

III. RESULTS

Table1 depicted distribution and taxonomic richness of rice stem phyto-periphyton in water-logged rice fields under different RCSs during the study period. A total of 41 taxa of phyto-periphyton were observed under *Boro*. The richness pattern of different classes of phyto-periphyton depicted the following trend:

Bacillariophyceae (17) >Chlorophyceae (13)> Cyanophyceae (8) >Euglenophyceae (3)

A total of 55 taxa of phyto-periphyton were observed under *Asra*. The richness pattern of different classes of phyto-periphyton depicted the following trend:

Bacillariophyceae(21)=Chlorophyceae(21)>Cyanophyceae(7)>Euglenophyceae(3)>Zygnemophyceae (2) = Xanthophyceae (1);a total of 48 taxa of phyto-periphyton were observed under *Aush*. The richness pattern of different classes of phyto-periphyton depicted the following trend:

Bacillariophyceae (25)>Chlorophyceae (14)>Cyanophyceae (5)>Euglenophyceae> (3) Zygnemophyceae (1);

a total of 31 taxa of phyto-periphyton were observed under *Sali*. The richness pattern of different classes of phyto-periphyton depicted the following trend:

Bacillariophyceae (13) =Chlorophyceae (13)>Cyanophyceae (3)>Euglenophyceae (1) = Zygnemophyceae (1) .

Table 2 depicted distributions and taxonomic richness of rice stem zoo-periphyton in water-logged rice fields under different RCSs during the study periodA total of 8 taxa of zoo-periphyton were observed under *Boro*. The taxonomic richness pattern of different classes of zoo-periphyton registered the following trend:

Protozoa (3) > Cladocera (2)> Rotifera (1) =Copepoda (1) =Ostracoda (1);

a total of 14 taxa of zoo-periphyton were observed under *Asra*. The richness pattern of different classes of zoo-periphyton registered the following trend:

Rotifera (5) > Cladocera (4)> Protozoa (3) >Copepoda (1) =Ostracoda (1);

a total of 14 taxa of zoo-periphyton were observed under Aush. The richness pattern of different classes of zoo-periphyton depicted the following trend:

Rotifera (5) > Cladocera (3) = Protozoa (3) >Ostracoda (2)>Copepoda (1);

a total of 9 taxa of zoo-periphyton were observed under Sali. The richness pattern of different classes of zoo-periphyton depicted the following trend:

Rotifera (3) > Cladocera (2) = Copepoda (2)>Protozoa (1) =Ostracoda (1).

RCS-wise taxonomic richness of phyto-periphyton and zoo-periphyton depicted following trend:

For phyto-periphyton: Asra> Aush>Boro>Sali, and

For zoo-periphyton: Asra= Aush>Sali>Boro

Figure 2 represents the relative abundance of rice stem phyto-periphyton classes (A) and zoo-periphyton groups (B) in water-logged rice fields under different RCSs. Relative abundance of Bacillariophyceae was more in Asra followed by Aush, Boro and Sali. Relative abundance of Chlorophyceae and Cyanophyceae was more in Sali followed by Boro, Aush and Asra. Relative abundance of Euglenophyceae was more in Aush followed by Sali, Boro and Asra.

Relative abundance of Cladocera was more in Asra followed by Boro, Sali and Aush. Relative abundance of Protozoa was more in Boro followed by Aush, Asra and Sali. Relative abundance of Ostracoda was more in Boro followed by Asra, Aush and Sali and relative abundance of Copepoda was more in Sali followed by Asra, Aush and Boro. Relative abundance of Rotifera was more in Sali followed by Aush and Asra. Rotifera was absent in Boro.Kruskal-Wallis test for variations in density of phyto-periphyton and zoo-periphyton communities on rice stems in water-logged rice fields amongst different RCSs is presented in Table 3. It shows that in water-logged rice fields amongst different RCSs there were very significant variations in phyto-periphyton classes belonging to Chlorophyceae, Cyanophyceae and Zygnemophyceae. Significant variations were observed for Bacillariophyceae and Euglenophyceae. There were also significant variations in zoo-periphyton groups belonging to Protozoa, Rotifera and Cladocera. Figure 3 revealed the diversity indicesof rice stem phyto-periphyton classes (A) and zoo- periphyton groups (B) in water-logged rice fields under different RCSs. For rice-stem phyto- periphyton, Shannon–Wiener Diversity Index was more in Aush followed by Boro, Asra and Sali. Berger-Parker Dominance Index was more in Sali followed by Asra, Aush and Boro. Buzas and Gibson's Evenness Index was more in Sali followed by Aush, Boro andAsra. For rice stem zoo-periphyton, Shannon–Wiener Diversity Index was more in Aush followed by Asra, Sali and Boro. Berger-Parker Dominance Index was more in Asra followed by Sali Aush and Boro. Buzas and Gibson's Evenness Index was more in Sali followed by Boro, Aush and Asra.

IV. DISCUSSION

Taxa richness of rice stem phyto-periphyton (Table 1) was highest in Asra (55) followed by Aush (48), Boro (41) and Sali (31). Greater taxa richness of rice stem phyto-periphyton in Asra is due to longer duration of its cropping season and total aquatic phase (June to September), which also encountered maximum seasonal changes resulting in diverse habitat conditions and greater residence time for the rice stem phyto-periphyton communities. Besides availability of more substrate area on Asra rice cultivar also might have facilitated greater occurrence of rice stem phyto-periphyton communities under Asra cropping. On the other hand, in Sali due to its short aquatic phase (August to September), time for establishment of rice stem phyto-periphyton communities is less resulting in less richness of such communities. Cropping cycle wise taxonomic richness pattern of different classes of rice stem phyto-periphyton depicted the following trend.

For Boro: Bacillariophyceae (17)>Chlorophyceae (13)>Cyanophyceae (8)>Euglenophyceae (3)

For Asra: Bacillariophyceae (21) =Chlorophyceae (21)>Cyanophyceae (7)>Euglenophyceae (3)>Zygnemophyceae (2)> Xanthophyceae (1)

For Aush: Bacillariophyceae (25)>Chlorophyceae (14)>Cyanophyceae (5)>Euglenophyceae> (3) Zygnemophyceae (1)

For Sali: Bacillariophyceae (13) =Chlorophyceae (13)>Cyanophyceae (3)>Euglenophyceae (1) =Zygnemophyceae (1).

In all the RCSs taxonomic richness of rice stem periphytic algae was highest for Bacillariophyceae followed by Chlorophyceae. This is perhaps due to more availability of silicate [27]in such systems and also because of the fact that rice plants are very good silicon accumulators [28]which serve as favorable substrate for Bacillariophyceae to grow and proliferate. The preference of Bacillariophyceae for attachment on rice stem could also be due to its additional nature of attachment [29] which helped some taxa to remain attached to rice stems and to become dominant during all the rice growing seasons. Moreover, Bacillariophyceae prefer to exhibit periphytic life on organic substrates over planktonic life [30].Morphological and physiological nature of rice stem might have also influenced the development of attached algae, as the submerged rice had the ability to secrete mucilage to form stalks or mucilaginous matrices, allowing attachment to substrates [31]. Seasonal changes of periphyton in natural system are affected by seasonal changes in the vegetation upon which it grows[32]. Rice vegetation is a rapidly changing system [33]and therefore the rice stem greatly influences succession pattern of periphyton on it. Generic diversity of periphyton on rice stem increased with time[34]as is seen in case of Asra thus indicating that there might be some relationship between the life cycle of substrate and periphyton diversity. The physical growth or change in chemical organization of rice plant might have a correlation to explain such change. Presence of grazer also increases the heterogeneity and primary productivity of periphytic algal groups in water-logged rice fields[35].

Taxonomic richness of zoo-periphyton (Table 4) was equal in Asra (14) and Aush (14) followed by Sali (9) and Boro (8). Cropping cycle-wise taxonomic richness pattern of different groups of rice stem zoo-periphyton (Table 2) registered the following trend.

For Boro: Protozoa (3) > Cladocera (2)> Rotifera (1) =Copepoda (1) =Ostracoda (1)

For Asra: Rotifera (5) > Cladocera (4)> Protozoa (3) >Copepoda (1) =Ostracoda (1)

For Aush: Rotifera (5) > Cladocera (3) = Protozoa (3) Ostracoda (2)>Copepoda (1)

For Sali: Rotifera (3) > Cladocera (2) = Copepoda (2)>Protozoa (1) =Ostracoda (1)

Amongst all the RCSs taxonomic richness of rice stem zoo-periphyton was more in Asra and Aush whereas it was lowest in Boro. This may be attributed to the variation in environmental variables in the different RCSs. In all the RCSs taxonomic richness of Rotifera was highest followed by Cladocera except in Boro where taxonomic richness of Protozoa was highest. This may be attributed to the variation in environmental variables and food availability for the rice-stem zoo-periphyton under different RCSs. Amongst the diverse zoo-periphytic groups, Cladocera was present in all RCSs. Rotifera was also was present in all RCSs except Boro. Occurrence of Cladocera in all RCSs indicates their preference and need for rice stem periphytic mode of life compared to other groups. Favorable environmental factors in terms of greater organic matter contents as feeding materials for the rotifers and some of their physiological specialization viz., less specialized feeding, parthenogenetic reproduction and high fecundity etc. also favored rotiferan richness [36]on the rice stems in water-logged rice field.

Kruskal-Wallis test for variations in density of phyto-periphyton and zoo-periphyton communities on rice stems in water-logged rice fields amongst different RCSs(Table 3) shows that amongst different RCSs there were very significant variations inthe abundance of different phyto-periphyton classes and in zoo-periphyton groups reflecting highly dynamic nature of the water-logged rice fields and also heterogenic nature of rice stem under different RCSs.

Highest relative abundance of Bacillariophyceae in Asra is due to its location in low lying river bank area which facilitates silicate accumulation and silica rich environment favorable for Bacillariophyceae. On the other hand, in Sali due to its short aquatic phase time for establishment of rice stem phyto-periphyton communities is less resulting in less abundance of Bacillariophyceae. Relative abundance of both Chlorophyceae and Cyanophyceae was more in Sali followed by Boro, Aush and Asra. Relative abundance of Euglenophyceae was more in Aush followed by Sali, Boro and Asra. Xanthophyceaewas observed only in Asra and Zygnemophyceae was absent in Boro and Aush (Figure 2A). All these indicate the variation in micro-climatic conditions on rice stems under different RCSs. All the zoo-periphyton groups showed poor relative abundance in all RCSs. This might be due to the fact that microscopic animal group present in water logged rice fields of the study area do not have to adopt periphytic mode to avoid high WT or in search of various other requirements essential for their survival as because they have unique ability of vertical migration to avoid high surface temperature and also to make other adjustments with the habitat condition. Variation in relative abundance of different phyto-periphytonclasses and zoo- periphyton groups under different RCSs can be attributed to variations in micro climatic condition in the rice fields as well as on the rice stems (Figure 2 B).The value of Shannon-Wiener diversity index of phyto-periphyton was highest in Aush and lowest in Sali. This was perhaps due to greater habitat heterogeneity in rice fields under Aush cropping which compels planktonic life forms to opt periphytic mode resulting in an increase in the diversity of rice stem phyto-periphyton classes. Lowest value of diversity index for phyto-periphyton in Sali might be because of its short aquatic phase, more use of agro-chemical which might have discouraged periphytic mode of life. Berger-Parker dominance index of phyto-periphyton was highest in Sali which also had lowest Shannon-Wiener diversity index. Greater dominance index in Sali was perhaps due to less duration of aquatic phase, and greater input of chemicals which have created favorable habitat condition for some selective phyto-periphyton under Sali. Lowest Berger-Parker dominance index in Boro might be because of greater seasonal variation leading to greater habitat heterogeneity which discouraged any particular group to dominate and thus more diversity and less dominance. Buzas and Gibson's evenness index was greater in *Sali* and lowest in *Asra.* This may be attributed to the fact that less variation in seasonal parameters might have contributed to less variation in microclimate in water-logged rice field under Sali resulting in less variation in habitat condition leading high evenness index. Minimum evenness index for phyto-periphyton in Asra was perhaps due to long duration of aquatic phase during the cropping season which resulted in significant micro-environmental variations that might have restricted the phyto-periphyton taxa to flourish evenly under Asra(Figure 3 A). The value of Shannon–Wiener Diversity Index of zoo- periphyton was highest in Aush and lowest in Boro. This was perhaps due to greater habitat heterogeneity in rice fields under Aush cropping which compels planktonic life form to opt periphytic mode resulting in an increase in the diversity of rice stem zoo- periphyton. Lowest value of diversity index for zoo-periphyton in Boro might be because of low

WT and great seasonal variation. Highest Berger-Parker Dominance Index of rice stem zoo- periphyton in Asra was perhaps due to more seasonal variation, high WD etc. which might have allowed only few taxa of rice stem zoo- periphyton to withstand fluctuation of the environment leading to high dominance. Again, poor dominance zoo-periphyton in Boro might be because of low WT and variation in WD which discourage dominance of any particular group. Highest value of Buzas and Gibson's Evenness Index in Sali was perhaps due tohigh WT, low WD and less variation in seasonal parameters contributing to high evenness index in Sali. Reason for minimum evenness index for zoo-periphyton in Asra was perhaps due to its longer duration of aquatic phase which resulted in significant micro-environmental variations that might have encouraged zoo-periphyton taxa to flourish evenly under Asra(Figure 3B).

V. CONCLUSION

Overall, the study revealed that water logged rice fields are rich in rice stem periphytic communities which can serve as natural live food for fish, if stocked in such systems. The study further revealed that water logged rice fields under *Sali*, may not be suitable for concurrent rice-fish culture because of poor abundance of periphyton communities compared to other RCSs. However, for further confirmation of the observation the study recommends on-farm experimental trials in the study area in this regard.

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REFERENCES

[1] B.Moss, Ecology of Freshwaters: Man and Medium, Past to Future, 2nd ed., Oxford, Blackwell Scientific Publ. London, UK, 1998.
[2] C. H. Williams, "Studies on the Ability of a Potamogetonpectinatus Community to Remove Dissolved Nitrogen and Phosphorus Compounds from Lake Water", Journal of Applied Ecology, vol.18 (2), pp. 619-637, 1981.
[3] T. W. Federle and J. R. Vestal, "Evidence of microbial succession on decaying leaf litter in an arctic lake", Canadian Journal of Microbiology, vol. 28(6), pp. 686-695, 1982
[4] S. K. Saikia and D. N. Das, "Potentiality of periphyton-based aqua culture technology in rice-fish environment",Journal of Scientific Research, vol. 1(3), pp. 624-634, 2009.
[5] L.A. Hansson, "The influence of a periphyticbiolayer on phosphorous exchange between substrate and water",
[6] L. Greenwood, T. A. Clason, R. L. Lowe, and S. E. Belanger, "Examination of endopelic and epilithic algal community structure employing scanning electron microscopy", Freshwater Biology, vol. 41, pp. 821–828, 1999.
[7] J. I. Jones, B. Moss and J. O. Young, Ed., Interactions between periphyton, nonmolluscan invertebrates, and fish in standingfreshwaters. The structuring role of submerged macrophytes in lakes. (E. Jeppesen, M. Søndergaard, M Søndergaardand K.
[8] J. V. Ward and G. C. Whipple, Fresh water Biology, 2nd edn., Wiley, New York, 1959J. G. Needham and P. R. Needham, A Guide to the Study of Freshwater Biology, 5th ed., Holden-Day Inc. San Francisco, Callifornia, 1972.
[9] K. Biswas, Common fresh and brackish water algal flora of India and Burma, Botanical Survey of India, vol. XV, Periodical ExpertsBook Agency, India, 1980.
[10] P. Michael, Ecological Methods for Field and Laboratory investigations, Tata McGraw Hill Publishing Company Limited, New Delhi, 1984.
[11] A. Pentecost, Introduction to freshwater algae, Richmond Publishing Corporation, England, 1984
[12] R. G. Michael, B. K. Sharma, IndianCladocera (Crustacea: Branchiopoda: Cladocera). Fauna of India and adjacent countries series,Zoological Survey of India, Calcutta, 1988.
[13] R. Santhanam, P. Velayutham, G. Jegatheesan, A Manual of Freshwater Ecology (An Aspect of Fishery Environment), Daya Publishing House, Delhi, 1989.
[14] N. Anand, Hand book of blue-green algae (of rice fields of South India), Bishen Singh Mahendra Pal Singh, Dehra Dun, India, 1989
[15] N. Anand, Indian freshwater microalgae, Bishen Singh Mahendra Pal Singh, Dehra Dun, India, 1998
[16] S.K. Battish, Freshwater zooplankton of India, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, India, 1992
[17] A. K. Tripathi and S. N. Pandey, Water pollution, Ashish Publishing House, New Delhi, India, 1995
[18] B. N. Prasad and Y. Singh, Algal indicators of water pollution. Bishen Singh Mahendra Pal Singh, Dehra Dun, India, 1996
[19] K. S. Bilgramiand L. C. Saha, A Text Book of Algae, CBS Publishers and Distributors, New Delhi, 2004.
[20] APHA: Standard Methods for examination of water and wastewater, 22nd ed., APHA, AWWA, WPCF, Washington DC, USA, 2012.
[21] J. B. Lackey, "The Manipulation and Counting of River Plankton and Changes in Some Organisms Due to Formalin Preservation", Public health reports, vol. 53, pp. 2080-2093, 1938.
[22] C. E. Shannon, W. Wiener, The mathematical theory of communication, University of Illinois Press, Urbana, IL: University of Illinois Press, 1949.
[23] D.A.T. Harper, Numerical Palaeobiology, John Wiley & Sons, New York, 1999.
[24] W. H.Berger, F.L. Parker, "Diversity of planktonic Foraminifera in deep sea sediments", Science, vol. 168, pp. 1345–1347, 1970. N. Nie,
[25] C. Hull andD. Bent, IBM statistical package for the social sciences (SPSS Version 20). Computer Software.Chicago, IL: SPSS, 2011

[26] Y. S. Lukaw, J. L. C. Ladu, D. D. Kenyi, "Seasonal Influence of Physicochemical Variables on Phytoplankton Abundance in Jebel Aulia Reservoir in Khartoum –Sudan". Nature and Science, vol. 10 (11), pp. 168-175, 2012.
[27] N.Yamajiand M. J. Feng, "Spatial Distribution and Temporal Variation of the Rice Silicon Transporter Lsi1", Plant Physiology, vol.
[28] A. A. Van Dam, M. C. M. Beveridge, M. E. Azim, M. C. J. Verdegem, "The potential of fish production based on periphyton" Review of Fish Biology and Fisheries, vol. 12, pp. 1-31, 2002.
[29] T. Bere, "Benthic diatom community structure and habitat preferences along an urban pollution gradient in the Monjolinho River, São Carlos, SP, Brazil", ActaLimnologicaBrasiliensia, vol. 22(1), pp.80-92, 2010.
[30] F. E. Round, Diatoms in River water monitoring studies. Journal of Applied Phycology, vol. 3, pp. 129-145, 1991.
[31] A.J. Horne and Golderman, Limnology, 2nd ed., McGraw-Hill Book Company, 1994
[32] C. H. Fernando, "Rice field ecology and fish culture-an overview", Hydrobiologia, vol. 259, pp. 91-113, 1993
[33] S. K., Saikia, S., Roy, J. Mukherjee, Ed., The Upside of Grazer-Periphyton Interactions: A Review. Zooplankton and Phytoplankton: Types, Characteristics and Ecology (GiriKattel), Nova Science Pubishers Inc., UK. 2011.
[34] S. K. Saikia and D. N. Das, "Diversity and productivity (Chlorophyll-a and Biomass) of periphyton on natural and artificial substrateswetland ecosystem", Journal of Wetlands Ecology, vol. 5, pp. 1-9, 2011.
[35] E.V. Sampaio, O. Rocha, T. Matsumura-Tundisi and J. G. Tundisi, "Composition and abundance of Zooplankton in the limnetic zone of seven reservoirs of the Paranapanema River, Brazil",Brazilian Journal of Biology, vol. 62, pp. 525-545, 2002.

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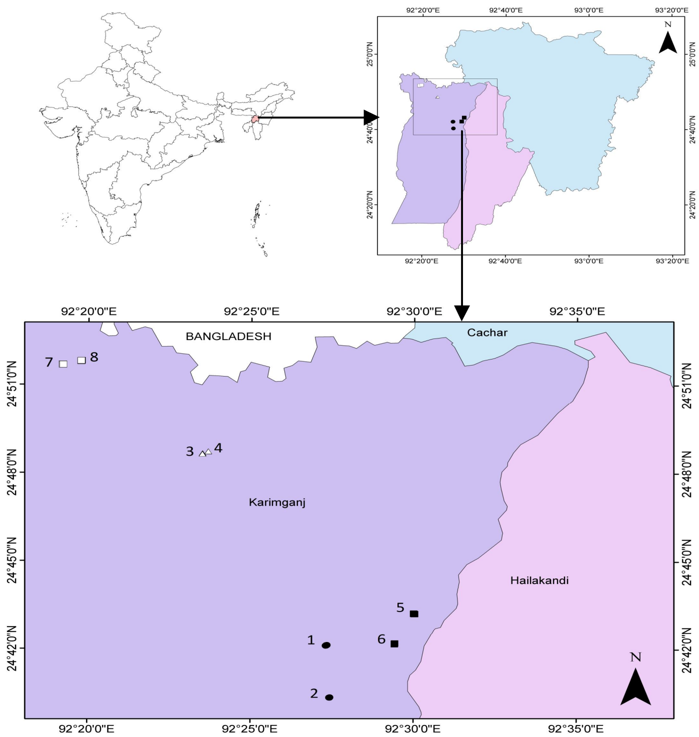

Fig.1Map showing the study area and sampling stations in water-logged rice fields under different RCSs
Boro: Stations 1 and 2, *Asra*: Stations 3 and 4, *Aush*: Stations 5 and 6, *Sali*: Stations 7 and 8.

TABLE I
Distribution and taxonomic richness of rice stem phyto-periphyton in water-logged rice fields under different rice cropping seasons

Phyto-periphyton classes	Phyto-periphyton taxa	Rice cropping seasons			
		Boro	Asra	Aush	Sali
Bacillariophyceae	Achnanthes sp.	+	+	+	+
	Amphora sp.	+	+	+	+
	Asterionella sp.	-	-	+	-
	Cymbella sp.	+	+	+	+
	Diatoma sp.1	-	+	+	-
	Encyonemasp.	+	+	+	+
	Epithemia sp.	+	+	+	-
	Eunotiasp.1	+	+	+	-
	Fragilaria sp.	+	+	+	-
	Frustulia sp.	-	+	+	+
	Gomphonemasp.	-	+	+	+
	Gyrosigma sp.	-	-	+	-
	Hantzschia sp.	+	+	-	-
	Melosira sp.	-	+	+	-
	Naviculasp.1	+	+	+	-
	Naviculasp.2	-	-	+	-
	Naviculasp.3	+	-	+	[illegible]
	Naviculasp.4	-	-	+	-
	Naviculasp.5	+	+	-	+

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	Naviculasp.6	+	+	-	-
	Nitzschiasp.2	-	-	+	+
	Nitzchiasp.3	+	+	+	-
	Pinnularia sp.	+	+	+	+
	Pleurosigma sp.	-	-	+	-
	Rhopalodiasp.	+	+	+	+
	Stauroneis sp.	-	+	-	+
	Surirella sp.	+	+	+	+
	Synedrasp.	+	+	+	-
	Tabellariasp.	-	-	+	+
	Total taxa: 29	17	21	25	13
Chlorophyceae	Ankistrodesmus sp.	+	+	+	-
	Asterococcus sp.	-	+	-	-
	Chlamydomonas sp.	+	-	+	-
	Chlorococcum sp.	-	+	-	-
	Closteriumsp.1	+	+	+	-
	Closteriumsp.2	-	+	+	+
	Closteriumsp.3	-	+	-	+
	Closteriumsp.4	-	-	-	+
	Closterium sp.6	-	+	+	-
	Cosmariam sp.2	+	+	+	+
	Desmidiumsp.	+	+	+	+
	Docidium sp.	-	+	-	-
	Euastrumsp.	+	+	+	+
	Gonatozygon sp.	-	+	-	+
	Microsporasp.	+	+	-	+
	Oedogonium sp.	-	+	-	+
	Pediastrum sp.	+	+	+	-
	Penium sp.	-	-	+	+
	Protococcus sp.	-	+	-	-
	Scenedesmussp.	-	+	+	-
	Selenastrum sp.	+	-	-	-
	Sphaerozosma sp.	-	+	-	-
	Spirogyra sp.	+	+	+	+
	Staurastrum sp.	+	+	+	+
	Ulothrix sp.	+	+	+	+
	Zygnema sp.	+	-	-	-
	Total taxa: 26	13	21	14	13
Cyanophyceae	Anabaena sp.	+	+	+	-
	Aphanizomenon sp.	-	+	-	-
	Aphanocapsasp	-	+	-	
	Lyngbya sp.	+	-	+	-
	Merismopedia sp.	+	-	-	-
	Microcoleus sp.	+	+	-	+
	Microcystissp.	+	+	-	-
	Nostoc sp.	+	-	-	-
	Oscillatoria sp.	+	+	+	+

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	Phormidium sp.	+	+	+	+
	Spirulinasp.	-	-	+	-
	Total taxa: 11	8	7	5	3
Euglenophyceae	Euglena sp.	+	+	+	+
	Phacus sp.	+	+	+	-
	Trachelomonas sp.	+	+	+	-
	Total taxa: 3	3	3	3	1
Xanthophyceae	Tribonema sp.	-	+	-	-
	Total taxa: 1	-	1	-	-
Zygnemophyceae	Micrasteriassp.	-	+	-	-
	Triploceras sp.	-	+	+	+
	Total taxa: 2	-	2	1	1
Grand total class: 6		4	6	5	5
Grand total taxa: 72		41	55	48	31

'+' indicates present and '-'indicates absence of the taxa concerned

TABLE II

Distribution and taxonomic richness of rice stem zoo-periphyton in water-logged rice fields under different rice cropping seasons

Zoo-periphyton groups	Zoo-periphyton taxa	Rice cropping seasons			
		Boro	Asra	Aush	Sali
Protozoa	Arcellasp.	+	+	+	-
	Centropyxissp.	-	+	+	-
	Difflugia sp.	+	+	+	-
	Euglypha sp.	+	-	-	-
	Trinemasp.	-	-	-	+
	Total taxa: 5	3	3	3	1
Cladocera	Bosminalongirostris	+	+	+	+
	ceriodaphnia sp.	-	-	+	-
	Chydorussp.	+	+	-	-
	Pleuroxussp.	-	+	-	-
	Simocephalus sp.	-	+	+	+
	Total taxa: 5	2	4	3	2
Copepoda	Bryocamtus sp.	-	-	-	+
	Diaptomussp.	-	-	-	+
	Mesocyclops sp.	+	+	+	-
	Total taxa: 3	1	1	1	[illegible]
Ostracoda	Cypridopsis sp.	-	-	+	-
	Cypris sp.	+	+	+	+
	Total taxa: 2	1	1	2	1
Rotifera	Asplanchna sp.	+	+	+	-
	Brachionus sp.	-	-	+	+
	Lecaneluna	-	+	+	+

Continued-----

	Lepadellasp	-	+	+	-
	Monostylasp.	-	+	-	-
	Mytilina sp.	-	+	-	-
	Polyarthrasp.	-	-	-	+
	Testudinellasp	-	-	+	-
	Total taxa: 8	1	5	5	3
Grand total group: 5		5	5	5	5
Grand total taxa: 23		8	14	14	9

'+' indicates present and '-'indicates absence of the taxa concerned

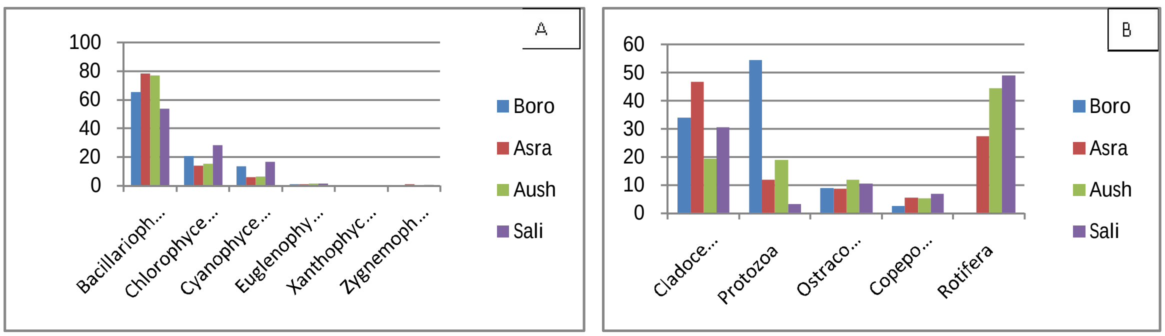

Fig.2Relative abundance of rice stem phyto-periphyton classes (A) and zoo- periphyton groups (B) in water-logged rice fields under different rice cropping seasons

TABLE IIII

Kruskal-Wallis test for variations in density of rice stem phyto-periphyton and zoo-periphyton communities on in water-logged rice fields amongst different rice cropping seasons

Parameters		Chi-Square
Phyto-periphyton classes	Bacillariophyceae	8.079*
	Chlorophyceae	22.933**
	Cyanophyceae	48.682**
	Euglenophyceae	7.952*
	Xanthophyceae	2.250
	Zygnemophyceae	55.327**
Zoo-periphyton groups	Protozoa	25.765**
	Cladocera	9.176*
	Copepoda	.596
	Ostracoda	4.424
	Rotifera	31.579**

Degree of freedom (n-1) = 3;** p<0.01; *p<0.05

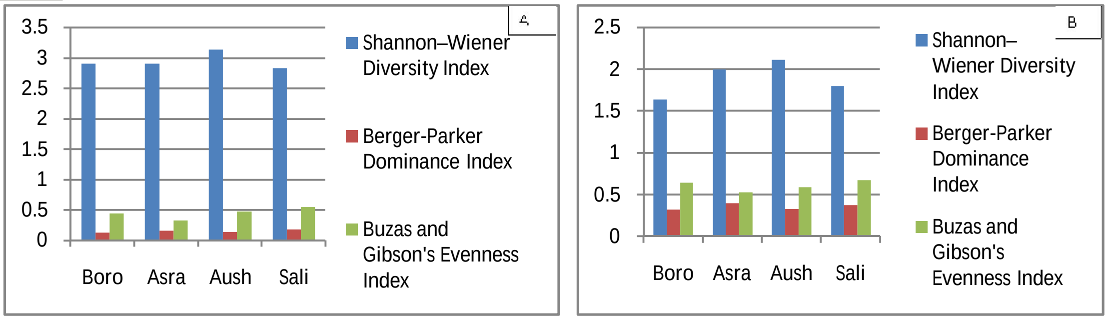

Fig. 3 Diversity indicesof rice stem phyto-periphyton (A) and zoo-periphyton (B) in water-logged rice fields under different rice cropping seasons