European Journal of Applied Sciences 2 (3): 94-97, 2010
ISSN 2079-2077

Nanoplankton Colonization on Artificial Substrate in a Large Perennial Freshwater Pond of West Bengal, India

[1]Utpal Singha Roy and [2]S.K. Mukhopadhyay

[1]Durgapur Government College, JN Avenue, Durgapur-713214, West Bengal, India
[2]Hooghly Mohsin College, Chinsurah-712101, West Bengal, India

Abstract: Colonization pattern of nanoplankton was studied over a period of four months in a perennial freshwater pond at Chinsurah, west Bengal, India. Sterilized polyurethane foam (PUF) units were immersed individually at about 15 cm below the water surface and harvested periodically for nano-phytoplankton and micro-rotiferan community. Colonization pattern of both the communities were dynamic in nature with Chlorophyceae being the dominant nano-phytoplanktonic group while, *Philodina roseola* was recorded as the dominant micro-rotiferan species. Diversity, richness, dominance, similarity indices and succession rate varied widely for both the communities. The community maturation time recorded for nano-phytoplanktonic community and rotiferan community were 21 and 60, days respectively. The present investigation provided an opportunity to understand nanoplankton colonization, growth and succession pattern in tropical freshwater ponds. Moreover, it provided a chance to learn complex community interactions that takes long time in nature in a simplified time efficient manner.

Key words: Nanoplankton · Rotifera · Succession Rate · Phytoplankton · Artificial Substrate

INTRODUCTION

Colonization pattern of micro-invertebrates on artificial substrates that include rocks, bricks, glass and plastic plates, wood blocks and polyurethane foam units are recorded [1, 2]. Fresh water ponds contain variety of nanoplankters some of which colonize in artificial substrates immersed at different depths [3, 4]. Study of such colonizing pattern gives an insight into the interactions occurring among nanoplanktonic communities in a small space and over a short time that will take many years for larger organisms. The present study was undertaken to observe the pattern and rate of colonization by fresh water micro-rotiferans and unicellular phytoplankton in submerged blocks of polyurethane foam from a freshwater pond of West Bengal, India. Nanoplankters play a crucial role in releasing of micronutrients in aquatic systems and most probably both ecocyding and ecoenergetics of any lentic water body is governed by the activities of planktonic organisms [5]. However, the small size of these organisms and the speed with which different events take place within the structural framework of their population and community are simultaneously advantageous and challenging for researchers.

The present study investigated the colonization pattern and succession rate of fresh water micro-rotiferans and unicellular phytoplankton that has not been studied in Indian fresh waters.

MATERIALS AND METHODS

A clean 6300 m^2 pond at Chinsurah (22.55° N long, 88.27° E; Alt. 9.75m), West Bengal, India, was selected for the present study. Water of the pond was colorless during the study period (February 2004 - July 2004). Domestic sewer drains did not open into it while, it was free of water hyacinth and other submerged or marginal weeds. A set up was made by using bamboo sticks and nylon strings to submerge four-polyurethane foam units of (10x5x3.5) cm at about 15 cm below the water surface. The first set-up was done in the month of February 2004 and sampling was carried out at weekly intervals. Each time a single PUF block was taken out to look for the

Corresponding Author: Utpal Singha Roy, Department of Zoology, Durgapur Government College, JN Avenue, Durgapur - 713214, West Bengal, India, E-mail: srutpal@gmail.com

colonization of nano-phytoplankton after an interval of 7 days. The sampling was done in the morning between 9:00 am and 10:00 am. The fluid from the PUF block was squeezed into a wide mouthed collecting bottle, using a rubber-glove. The bottles containing nano-phytoplankton were immediately taken to the laboratory and examined at once after concentrating the water. A second similar type of set up was done in the month of March 2004 and sampling was carried out a month after. Each time a single PU block was taken out to look for the colonization of micro-rotiferans after an interval of 30 days. Narcotisation (adding 5 drops of 5% formalin in 50 ml sample volume) and preservation (in 70 parts 70% alcohol + 25parts distilled water + 5 parts 5% formalin) were done for rotiferan samples before being observed under microscope fitted with mechanical stage [6].

All the organisms were counted in a Sedgwick Rafter counting cell and were measured using Erma (Japan) stage and ocular micrometers. Their figures were drawn by mirror-type Camera Lucida under appropriate magnifications (10x10 and 10x40) that helped in determining the size of the individuals. The index of dominance was calculated by Simpson's equation, general diversity was calculated according to Shannon and Weiner, index of species richness was done after Margalef's equation, while index of species evenness was measured after Pielou. Sorensen's species similarity index was applied to measure the index of similarity and the summed difference succession rate index was done after Lewis [7].

RESULTS

The community structure of different nanoplanktonic groups in the artificial substratum varied widely during the study period. Abundance of different nanophytoplanktonic groups colonized on the artificial substrate in the pond under investigation during study period is given in Table 1. Chlorophyceae was noted to be the most dominant group throughout the study period comprising highest number of species. Bacillariophyceae and Euglenophyceae both were present in the first sample, but disappeared thereafter while, abundance of Cyanophyceae flourished during the later part of the study period. Index of dominance is a good parameter to comment on community structures (Table 3), where the dominance of a single group of taxon indicates the influence of environmental stresses.

Table 1: Periodic changes of different phytoplanktonic groups at an interval of 7 days covering a total span of 28 days colonized in the artificial substrate. Number outside the bracket indicates total number of individuals per 0.1 cc while numbers inside the bracket indicates the actual number of species encountered in each group.

	Week			
Phytoplankton classes	First	Second	Third	Fourth
Chlorophyceae	18 (5)	72 (9)	24 (8)	38 (6)
Xanthophyceae	2 (2)	2 (1)	4 (1)	3 (2)
Bacillariophyceae	1 (1)	-	-	-
Cyanophyceae	-	15 (3)	9 (3)	3 (2)
Euglenophyceae	2 (1)	-	-	-

Table 2: Periodic changes of different micro-Rotifera (individuals per 0.1 cc) at an interval of 30 days covering a total span of 120 days colonized in the artificial substrate.

	Month			
Rotifer species	1	2	3	4
Brachionus quadridentatus	7	-	-	-
Brachionus falcatus	7	-	-	-
Brachionus caudatus	-	4	-	-
Keratella tropica	5	-	-	-
Notholca sp.	-	1	1	1
Lepadella patella	-	4	-	-
Lecane bulla	-	-	1	4
Lecane closterocerca	-	1	1	-
Lecane leontina	-	-	-	4
Choochiloides nathans	-	-	7	13
Filinia opoliensis	5	-	-	-
Philodina citrina	-	6	-	-
Philodina roseola	-	19	47	10

Table 3: Analysis of community structure for nano-phytoplankton.

	Week			
Variables	1	2	3	4
Total number of species	9	13	12	10
Total importance value (nos. cc^{-1})	23	89	37	44
Index of dominance	0.63	0.68	0.49	0.76
Index of species richness	2.55	2.90	3.32	2.64
Succession rate index	-	0.0897	0.1383	0.034

Table 4: Analysis of community structure for micro-Rotifera.

	Month			
Variables	1	2	3	4
Total number of species	4	6	5	5
Total importance value (nos. cc^{-1})	24	35	57	32
Index of dominance	0.26	0.35	0.70	0.29
General diversity index	1.37	1.33	1.96	1.36
Index of species richness	0.94	1.41	0.99	1.15
Index of species evenness	0.99	0.37	1.22	0.84
Index of similarity	_	0.0	0.54	0.80
Succession rate index	_	0.003	0.173	0.002

The result obtained from study of rotiferan community is given in Table 2 and 4. Thirteen rotiferan species population were observed to colonize the artificial substrate within a span of 120 days. Out of 13 rotiferan species, 10 were loricate forms of the genera *Brachionus, Filinia, Keratella, Lepadella, Lecane and Notholca.* Though only 2 illoricate genera *Conchiloides and Philodina* having 3 species population were observed to colonize the artificial substratum, their population size was much denser than that of their loricate counterparts. *Brachionus quadridentatus, Brachionus falcatus, keratella tropica and Filinia opoliensis* were encountered in the first sample and had never appeared again. On the other hand, as time progressed (second month onwards) it was seen that the sessile forms or the forms having limited locomotion started to flourish; these were *Philodina roseola, Philodina citrina, Conochiloides nathans*. Though two other loricate species *Lecane* (*Monostyla*) *closterocerca and Notholca* sp. were also present in all the samples their population size was comparatively small.

In the present study, the highest single rotiferan species dominance was observed to appear after 60 days of colonization indicating the rotiferan community maturation period. Shannon Index increased from first batch of 1.372 to third batch of 1.962. Second third and fourth batch of samples were observed to harbor community with diverse species population. Community similarity index shows that the community that was present after first month of incubation was absolutely dissimilar with that of the second month. Between second and third month samples similarity index was 0.545 and it increased to 0.80 between the third and fourth batches of samples. The Succession Rate Index is a parameter that reflects the rate of compositional change per unit time [7]. Though Succession Rate Index gives a little information about the nature of change in community, an increase in it indicates the maturity of the concerned community and in the present study community maturation time recorded for nano-phytoplanktonic community and rotiferan community were 21 days and 60, respectively.

DISCUSSION

Spatial heterogeneity of aquatic micro-invertebrates associated with natural substrates like stones and macrophytes is greatly reduced when artificial substrates are used to measure the pattern of community colonization [8]. PUF blocks have been reported as excellent artificial substrates for aquatic invertebrate colonization [9] and it is also evidenced in the present study.

Colonization of periphytons on artificial substrates have been hypothesized as a dynamic process whereas species number generally increases with time and then equilibrates following the MacArthur-Wilson equilibrium model [10, 11]. Nanoplankton colonization pattern on PUF blocks in the present study also tend to follow this assumption. From the results it is evident as the time progressed, the pioneer species were replaced and only a few species that established in the artificial substrate started to flourish which presumably resulted from internal factors such as competition and predation pressure that altogether shapeup the final community to reach an equilibrium state. However, as far as succession is concerned, it is always emphasized that as the community matures and the handling of received energy becomes more economic, species (taxon) diversity decreases, while individual importance value increases which in turn thrusts the dominance value towards 1.0.

In the present investigation gradual increase in the indices of dominance between 14 to 21 days indicated that the nano-phytoplanktonic community colonization matures after 21 days on an artificial substrate.

So far as micro-rotiferan community is concerned in the present study initial free living pelagic forms with higher growth rates were gradually replaced by more sedentary species with lower growth rate. Variations in species dominance, diversity, evenness, richness of the micro-rotiferan community was interesting. Shannon-Wiener species diversity index (H'), mainly based on the proportional species abundance reached to its maximum value during late phase (3rd month) of micro-rotiferan colonization. Pielou's index of evenness (J) was also maximum in the months when highest H' value was noted. Simpson's dominance index (D_{SIMP}), which is also based on proportional abundance like H', showed similar values to those for H'. Margalef's richness index (D_{MARG}), which considers both abundance and species numbers, also attests the situation as the maximum values were associated with the period of peak aggregation while minimum values were evident in the early colonization phase. This finding needs confirmation by a series of replication through yearlong studies in different freshwater situations. Thus it can be concluded that studies made on nanoplankton colonization on artificial substrate not only reveals the growth pattern and succession rate but also gives an excellent opportunity to learn complex community interactions in a more simplified manner.

ACKNOWLEDGEMENTS

Authors thankfully acknowledge the infrastructural support extended by the Director of Public Instruction, Government of West Bengal, India.

REFERENCES

1. Aloi, J.E., 1990. A critical review of recent freshwater periphyton field methods. Can. J. Fish. Aquat. Sci., 47: 656-70.
2. Kepner, R.L. Jr. and R.A. Jr. Wharton, 1998. Mc Murdo. Dry valleys LTER: Characterization of protozoan communities in lakes Hoare and Fryxell using artificial substrates. Antarct. J. U.S. -1996 Review Issue (NSF 98-28), 31: 201-202.
3. Cairns, J. Jr. W.H. Jr. Yongue and H. Jr. Boatin, 1973. The protozoan colonization of polyurethane foam units anchored in the benthic area of Douglas Lake, Michigan. Trans. Am. Micros. Soc., 92: 648-656.
4. Saliu, J.K. and U.R. Ufuoma Reubena Ovuorie, 2007. The artificial substrate preference of invertebrates in Ogbe Creek, Lagos, Nigeria. Life Sci. J., 4: 77-81.
5. Sommer, U., 1988. Phytoplankton succession in microcosm experiments under simultaneous grazing pressure and resource limitation. Limnol. Oceanogr., 33: 1037-1054.
6. Michael, R.G. and B.K. Sharma, 1988. Fauna of India and Adjacent Countries: Indian Cladocera (Crustacea: Branchiopoda: Cladocera). The Technical and General Press, India.
7. Lewis, W.M. Jr., 1978. Analysis of succession in a tropical phytoplankton community and a new measure of succession rate. Am. Nat., 112: 401-414.
8. Xu, H. G.S. Min, J.K. Choi, S.J. Kim, J.H. Jung and B.J. Lim, 2009. Periphytic ciliate colonization of an artificial substrate in Korean coastal waters. Protistol., 6: 55-65.
9. Stewart, P.M., J.R. Pratt, J. Jr. Cairns and R.L. Lowe, 1985. Diatom and protozoan species accrual on artificial habitats in lentic habitats. Trans. Am. Micros. Soc., 104: 369-377.
10. MacArthur, R.H. and E.O. Wilson, 1967. The theory of island biogeography. Monographs in population ecology, I. Princeton University Press, Princeton, N. J.,
11. Franco, C., G. Esteban and C. Tellez, 1998. Colonization and succession of ciliated protozoa associated with submerged leaves in a river. Limnologica, 28: 275-283.