Epidendric Microalgae from the Periphyton Microhabitats of a Mangrove Ecosystem

Jisha S., Hari B., and Neethu A.

Abstract- Periphyton communities are considered solar-powered biogeochemical reactors and are assemblages of algae, heterotrophic microbes, and prokaryotes. The diversity and species composition of periphytic, epidendric microalgae from the submerged roots of a *Cocos nucifera* which was fringing on Paravur Lake was qualitatively and quantitatively estimated. The study site is a sheltered area in the lake which is bordered by patches of mangroves. Sampling was done during the period of February to June 2016. Physico-chemical parameters of water like temperature, salinity, turbidity, biological oxygen demand, dissolved oxygen, acidity, and alkalinity were estimated. Soil texture and soil pH were also assessed. 66 species of microalgae under 29 genera were collected and identified from coconut roots. Class Bacillariophyceae (86.38%) dominated among microalgae. Other representative classes were Coscinodiscophyceae (3.03%), Zygnematophyceae (4.54%), Cyanophyceae (4.54%), and Euglenophyceae (1.51%). Apart from microalgae, some faunal groups like bivalves, barnacles, crustaceans, crustacean larvae, and polychaete worms were also identified from the coconut root. The roots of coconut trees seem to be a reservoir of periphyton with great diversity which is somewhat comparable to mangrove pneumatophores which abode a large number of periphyton. Variations in the physicochemical parameters of water and soil and the diversity and number of periphyton are revealed. Based on the results, the ecological role of epidendric microalgae on the coconut tree root is discussed in detail.

Index Terms- Backwater, Bacillariophyceae, Coconut tree roots, Diversity, Kerala, Microalgae, Paravur Lake, Periphyton

1 INTRODUCTION

The term 'periphyton' (peri: round, phyton: plant) was suggested by Behning [1] and get disseminated through the initial efforts of several investigators [2, 3, 4]. Wetzel [5] explained it as a micro 'floral' community seen adhered to any immersed substrate. Stevenson [6] presented it for describing microorganisms (algae and bacteria) living attached to substrata. Periphyton includes a complex conglomeration of algae, cyanobacteria, micro-invertebrates, their secretions, and detritus seen attached to any submerged substrate. Based on the substratum with which it colonizes, various synonyms of periphyton are commonly used in periphyton ecology such as 'epiphyton' for attached aquatic plants, 'epipelon' for 'periphyton' of sediments/mud/silt, 'epixylon' for wood or tree, 'epilithon' or rock, 'epipsammon' for sand and 'epizoon' for animals. 'Epidendric' periphyton are attached to submerged tree limbs and roots or on other wood surfaces. Periphyton communities are major primary producers and stand next to phytoplankton in nutrient-rich aquatic environments [7]. Their importance in aquatic systems is not only limited as primary producers (energy source), but also affects nutrient transfer between the benthic and the pelagic zone [8]. Periphyton acts as self-purifiers by absorbing contaminants. Odum [9] provided a good account of the producer components of aquatic systems and found that diatoms are good indicators of water quality. The range of variation in species and community structure is due to the change in environment and this can be regarded as the ecological and environmental impact on the periphyton community. However, the magnitude of the impact may vary according to the habitat. Periphyton diversity and composition vary with the substratum. The correlation of water quality parameters gives immense scope to analyze the essentialities in the colonization of periphyton. The physical and chemical properties of soil affect the abundance of vegetation and soil microorganisms. This is a pioneering approach to the study of periphyton communities associated to the roots of *Cocos nucifera* from a mangrove ecosystem in Paravur Lake, Kerala. The present study focussed on identifying the periphytic, microalgae associated with roots of coconut, classification of periphyton based on their taxonomic position, quantitative estimation of periphyton, determining water quality as well as physico-chemical parameters of soil at the sampling sites.

2 MATERIALS AND METHODS

The study site is a backwater ecosystem with sheltered patches of mangroves in Paravur ($8^0$48`51.08" N) and ($76^0$40`2.14" E), Kerala, India. It is located along the coastal line in the district of Kollam. There are also well-marked effects of high tide and low tide. During low tide the completely immersed substratum that is rich in periphyton is exposed; this may affect the colonization and distribution of micro-floral species. During the period of high tide, the reverse process happens to immerse all available periphytic niches. Thus, the entire ecosystem is tolerant to wide fluctuations in a climate with added contribution from anthropogenic disturbances.

Triplicate sampling was conducted on monthly basis from February to June 2016. For the quantitative estimation, roots of *Cocos nucifera* which were fringed on the backwaters were cut at a length of 10 cm using a sharp knife and collected. Periphytons were scraped off using a soft brush and preserved in formalin. Quantitative estimations were carried out using a plankton counting chamber and the drop count method was followed for qualitative estimations. Water quality was estimated using standard methods [10]. Soil parameters were also analyzed [9,11].

3 RESULTS AND DISCUSSION

The atmospheric temperature ranged from 29 to 34 ^{0}C, while the water temperature ranged from 27 to 28 ^{0}C. The average pH of the water was 7.5. Salinity ranged between 16 and 29 ppt. Turbidity values showed remarkable fluctuation

ranging from 11 NTU to 61 NTU. The mean dissolved oxygen and BOD values of water samples were 5.3 mgL^{-1} and of 2.45 mgL^{-1} respectively. The acidity of water ranged from 7.04 to 12.32 mgL^{-1}. The mean total alkalinity was 1026.67 mgL^{-1} and the methyl orange alkalinity was zero during the sampling period. Mean soil pH and moisture contents were 6 and 8% respectively. The soil texture analysis revealed that the soil samples were silty loam in composition.

The roots of *Cocos nucifera* serve as an ideal substratum for periphytic microalgae. A checklist of epidendric microalgae associated with the periphyton communities on roots of *Cocos nucifera* from a mangrove ecosystem in Paravur Lake, Kerala is presented in Table 1. A total of 66 microalgae were identified from the periphyton communities on the roots of *Cocos nucifera.* Quantitative, as well as qualitative estimation, revealed the dominance of class Bacillariophyceae (86.38%) with 66 species in 29 genera. Other representative classes included were Coscinodiscophyceae (3.03%), Zygnematophyceae (4.54%), Cyanophyceae (4.54%), and Euglenophyceae (1.51%). Along with microfloral communities, some faunal groups were also identified from the periphyton community. These include bivalves, barnacle nauplius, crustaceans (Calanus), and polychaete worms. The roots of coconut were quantitatively rich in microalgae. A total of 23 species were quantitatively estimated during six-month collections and the number of some species showed the least values in the last collection probably due to the advent of monsoon showers. *Fragilaria* sp., *Cymbella* sp., *Navicula* sp., *Cocconeis* sp., *Nitzschia* sp. dominated in almost all collections. *Euglena* sp., *Melosira* sp., *Coscinodiscus* sp., *Synedra* sp., *Surirella* sp., *Phormidium* sp., *Lyngbya* sp. etc. were presented in limited quantity (Table.2). Janhavi [12] studied the algal samples collected from freshwaters and mangrove sites near Achara and Dhamapur forests, district Sindhudurg across the Western Coast of Maharashtra. Microalgae *Oscillatoria* sp., *Lyngbya* sp., *Scenedesmus* sp., *Chlorella* sp., *Anabaena* sp., *Arthrospira* sp. *Selenastrum* sp. and *Synechocystis* sp. were identified in their studies. In the present study also many of the above-said species were reported. Selvakumar [13] conducted a survey on cyanobacterial association with mangrove plants in the Muthupet estuary during the month of December, (2010). A total of 17 cyanobacterial strains were recorded by them in association with the mangrove vegetation. In the present study, only a limited number of cyanobacterial species was recorded when compared to the results of Selvakumar [13]. However, in the present study, more Bacillariophyceae species were recorded probably due to the unpolluted sampling site which is indicated by lower BOD values. Nasser and Sureshkumar [14] delineated the interaction between micro-algal species richness and environmental variables in Peringalkuthu Reservoir of Western Ghats, Kerala. 94 species of microalgae belonged to 42 genera under the classes Chlorophyceae, Desmidiacee, Bacillariophyceae, Cyanophyceae, and Euglenophyceae were recorded from the samples in their studies. Almost similar species (66 in number) were recorded in the present study from the roots of *Cocos nucifera* (Table 1). Aarati [15] observed that Aachira Creek, habitat in North Goa District supported the luxurious growth of marine algae and seagrasses and was the safest environment in which the flora present is attached to the soil, mangrove roots, and stem or trunk bases throughout the year. They showed that the abundance of algal species was highest in the pre-monsoon and post-monsoon periods. Similarly, in the present study also an abundance of periphyton was noted during the pre-monsoon with a gradual decline with the onset of monsoon. Roots of *Cocos nucifera* as a substratum for periphyton serve a very high ecological role and they stand almost equal to the potential of mangrove roots. They support the luxurious growth of both micro-floral and faunal communities.

4 CONCLUSIONS

Periphyton affects ecosystem processes in many ways. They act as the architects of the food web, indicators of ecological stability and ecological degradation, self-purifiers, gauges of the degree of pollution (especially certain diatoms), index of water quality, creators of soil, builders of homes to microbiota, and symbols of current and historical ecosystem health. The roots of *Cocos nucifera* serve as an ideal substratum for periphytic microalgae. A total of 66 microalgae were identified from the periphyton communities on the roots of *Cocos nucifera* from a mangrove ecosystem in Paravur Lake, Kerala. Quantitative, as well as qualitative estimation, revealed the dominance of class Bacillariophyceae (86.38%) with 66 species in 29 genera. The diversity of the periphyton community in the roots of *Cocos nucifera* was comparable to that of mangrove roots. Many faunal groups colonize on these roots and hence these are ideal substratum with maximum diversity.

5 ACKNOWLEDGMENTS

The authors are grateful to The Principal, Sree Narayana College, Kollam for providing the facility for carrying out the study. The authors are also acknowledging the research facility provided by DST-FIST.

6 REFERENCES

[1] A.L. Behning, "Periphyton. Zur Erforschung der am Flussboden der Wolga Iebenden Organismen;" *Monogr. Biol.Wolga. Statt.,* vol. 1, pp.1-398. 1924.

[2] W.B. Cooke, "Colonization of Artificial Bare Areas by Microorganisms," *Bot. Rev.,* vol. 22, no.9, pp. 613-638. 1956.

[3] A. Sladeckova, "Limnological Investigation Methods for Periphyton (Aufwuchs) community," *Bot. Rev.*, vol. 28, no. 2, pp. 287-350, 1962.

[4] E. Pieczynska, "Periphyton in the Trophic Structure of Fresh Water Ecosystem," *P. Arch. Hydrobiol.*, vol. 17, pp.141-147. 1970.

[5] R.G. Wetzel, "Primary Productivity of Periphyton," *Nature*, vol. 197, no. 4871, pp. 1026-1027. 1963.

[6] R.J. Stevenson, "The Stimulation and Drag of Current". *Algal Ecology: Freshwater benthic ecosystems,* R.J. Stevenson,

M.L. Bothwell, and R.L. Lowe, eds., Academic Press, New York, USA, pp. 321-340. 1996.

[7] S.K. Saikia, S. Nandi and S. Majumder, "A Review on the Role of Nutrients in the Development and Organization of Periphyton," *Journal of Research in Biology,* vol. 3, no.1, pp. 780-788. 2013.

[8] S.K. Saikia, "Review on Periphyton as Mediators of Nutrient Transfer in Aquatic Ecosystem," *Ecol. Balkanica*, vol.3, no.2, pp. 65-78. 2011.

[9] E.P. Odum, "Fundamentals of Ecology," Sarded., W.B. Sunders, Philadelphia, pp.750. 1997.

[10] APHA, "Standard Methods for Examination of Water and Waste Water (17thEdn.)," American Public Health Association, Washington, D.C. 1989.

[11] P.S. Verma, and V.K. Agarwal, "Environmental Biology," Chand and company Ltd. New Delhi, pp. 591. 2002.

[12] A.K. Janhavi and V.D. Sanjay, "Biodiversity of Microalgal Species Identified from Western Ghats of Maharashtra as a Potential Source for Development of Bio-products". Proc. of UGC Sponsored National-Level Seminar: Dynamics of Mangrove Ecosystem, ISBN 978-81-92489-3-7, pp. 32. 2013.

[13] G. Selvakumar, and M. Sundararaman," Mangrove Associated Cyanobacterial Species in Muthupet Estuary," *Seaweed Res. Utiln*., vol. 1&2, pp.19-22. 2001.

[14] M.K.M. Nasser, and S. Sureshkumar, "Interaction between Microalgal Species Richness and Environmental Variables in Peringalkuthu Reservoir, Western Ghats, Kerala," *Journal of Environmental Biology*, vol. 34, pp. 1001-1005. 2012.

[15] P. J. Aarati, R., Nayak and S.G. Yeragi, "Associate Algal Flora in the Mangrove Habitat of Achara Creek." Proc. of UGC Sponsored National-Level Seminar: Dynamics of Mangrove Ecosystem, ISBN 978-81-92489-3-7, pp.16. 2013.

S. Jisha and B. Hari are currently working as Associate Professors, Post Graduate and Research Department of Zoology, Sree Narayana College, Kollam, Kerala., affiliated to University of Kerala, India. E-mail: jishasooriya@mail.com, hariprashobh@gmail.com.

Table 2. Diversity of selected epidendric microalgae (cells L^{-1}) associated with the periphyton communities on roots of *Cocos nucifera* from a mangrove ecosystem in Paravur Lake, Kerala

Sl.No.	Microflora	January 2016	February 2016	March 2016	April 2016	May 2016	June 2016
1	*Fragilaria* sp.	233333	166667	866667	0	0	0
2	*Pluerosigma* sp.	286667	286667	280000	100000	326667	400000
3	*Cymbella* sp.	700000	440000	460000	286667	246667	273333
4	*Navicula* sp.	686667	846667	566667	586667	333333	426667
5	*Closterium* sp.	100000	0	0	0	0	0
6	*Frustulia* sp.	93333	186667	0	20000	73333	60000
7	*Achnanthidium* sp.	166667	0	0	20000	100000	0
8	*Oscillatoria* sp.	53333	333333	33333	13333	106667	140000
9	*Gyrosigma* sp.	60000	53333	0	86667	106667	0
10	*Amphora* sp.	173333	113333	153333	40000	113333	113333
11	*Cocconeis* sp.	26667	460000	680000	533333	473333	233333
12	*Cyclotella* sp.	73333	206667	53333	0	0	0
13	*Nitzschia* sp.	193333	420000	540000	773333	373333	126667
14	*Achnanthes* sp.	80000	226667	233333	306667	246667	153333
15	*Diatomella* sp.	20000	0	0	0	0	0
16	*Euglena* sp.	20000	53333	13333	60000	6667	66667
17	*Melosira* sp.	53333	0	0	0	0	0
18	*Coscinodisus* sp.	26667	0	0	0	0	46667
19	*Pinnularia* sp.	133333	380000	200000	246667	300000	280000
20	*Diplonies* sp.	0	133333	20000	0	20000	0
21	*Synedra* sp.	0	73333	0	0	0	0
22	*Surirella* sp.	0	0	73333	0	0	0
23	*Phormidium* sp.	0	0	13333	0	0	0

Table 1. Checklist of epidendric microalgae associated with the periphyton communities on roots of *Cocos nucifera* from a mangrove ecosystem in Paravur Lake, Kerala

Sl. No.	Micro algae	Sl. No.	Micro algae
1	*Achnanthes exigua*	34	*Frustulia* sp.
2	*Achnanthes inflata*	35	*Gomphonema* sp.
3	*Achnanthes* sp.	36	*Gyrosigma parvulum*
4	*Achnanthidium lanceolatum*	37	*Gyrosigma* sp.
5	*Achnanthidium minutissimum*	38	*Lyngbya* sp.
6	*Achnanthidium* sp.	39	*Navicula exigua*
7	*Amphora elliptica*	40	*Navicula gregaria*
8	*Amphora laevis*	41	*Navicula lanceolata*
9	*Amphora lineolata*	42	*Navicula pupula*
10	*Amphora* sp.	43	*Navicula radiosa*
11	*Cocconeis placentula*	44	*Navicula* sp.
12	*Coconeis pediculus*	45	*Navicula transitans*
13	*Coscinodiscu sgranii*	46	*Netrium digitus*
14	*Coscinodiscus* sp.	47	*Netrium* sp.
15	*Cosmarium* sp.	48	*Nitzschia acicularis*
16	*Cyclotella* sp.	49	*Nitzschia acuta*
17	*Cyclotella meneghiniana*	50	*Nitzschia gracilis*
18	*Cymbella affinis*	51	*Nitzschia obtusa*
19	*Cymbella kappi*	52	*Nitzschia palea*
20	*Cymbellam inuta*	53	*Nitzschia pellucida*
21	*Cymbella* sp.	54	*Nitzschia reversa*
22	*Cymbella turgid*	55	*Nitzschia sigma*
23	*Diatoma mesodon*	56	*Nitzschia* sp.
24	*Diatom atenius*	57	*Oscillatoria* sp.
25	*Diatomella* sp.	58	*Phormidium* sp.
26	*Diploneis elliptica*	59	*Pinnularia conica*
27	*Diploneis* sp.	60	*Pinnularia nodosa*
28	*Encyonema* sp.	61	*Pinnularia* sp.
29	*Euglena acus*	62	*Pleurosigma elongatum*
30	*Eunotia* sp.	63	*Pleurosigma* sp.
31	*Fragilaria capucina*	64	*Rhopalodia* sp.
32	*Fragilaria* sp.	65	*Surirella* sp.
33	*Frustulaia vulgaris*	66	*Synedra* sp.