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Bark algal flora of Khultabad region in Aurangabad district of Maharashtra, India

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Abstract
Bark of trees provides humus and suitable substratum for algal growth. Algae growing on barks are subaerial in habitat. They are also called epiphloeophytes. As algae inhibiting bark of tree are also known as corticolous. In present research work algae growing on barks of *Gliricidia sepium* (Jacg.) Kunth, *Alstonia scholaris* (L.) R. BR. and *Delonix regia* (Boj ex Hook) Raf. were observed from Khultabad region of Aurangabad district of Maharashtra. Collection of bark algal samples were made in the month of July and August 2022. A total of 31 species under 20 genera belonged to Chlorophyceae, Bacillariophyceae and Cyanophyceae were identified and recorded. Cyanophycean algae dominated bark algal flora. *Chlorella valgaris, Myxosarcina burmensis, Phormidium abronema, Microcoleus accutissimus, Nostoc microscopicum, Nostoc punctiformae* and *Tolypothrix campylonemoides* were found dominant. Maximum number of algal taxa were found on the bark of *Gliricidia sepium* and *Alstonia scholaris.* Blue green alga *Tolypothrix campylonemoides* found specifically abundant on the bark of *Alstonia scholaris*. Present study is significant in diversity study of subaerial algae of selected study area.

Keywords: Bark algae, subaerial habitat and Khultabad

Introduction

Bark is a protective corky tissue on outside of stem of tree which protects the plant from insect and attacks of pathogens. It harbours number of microbes, insects, worms, lichens and algae. Bark provides humus and suitable substratum for algal growth. Algae growing on the bark are subaerial in habitat and called as epiphloeophytes. As these algae inhabiting bark of trees are also known as corticolous. They receive moisture either solely from the atmosphere or fairly steady source of water seeping through the moss mats. Algal propagules brought through wind and rain water flowing through the bark colonizes on bark with the help of favourable climatic conditions. For the development of bark algae particular climatic conditions are required such as high relative humidity, high and evenly distributed rainfall, low temperature and low to high photon irriadiance. Bark properties such texture, fissuring, dust deposition regulate the composition of bark algal flora.

Julia Snow (1899) [26] collected bark algal samples and observed abundance of *Pleurococcus.* Islam (1960) [12] recorded that very heavy rainfall and prevailing humidity provides ideal conditions for growth of subaerial algae. Marion (1969) [20] conducted survey on bark algae of different trees located in Charleston-Illineis and reported widely distribution of *Protococcus, Nanochloris, Stichococcus* and *Ulothrix*. Cox and Hightower (1972) [7], Wylie and Schlichting (1973) [27] and Handa and Nakeno (1998) [11] worked extensively on corticolous algae. Katharina *et al*. (2008) [15] systematically studied role of bark algae in monitoring airborne pollutants such as ozone and particulate matter. Neustupu and Skaloud (2008 and 2010) [22, 23] and Neustupu and Anna (2013) [24] extensively studied diversity and distribution of bark algae from tropical region. Lemes *et al*. (2008 and 2012) [18, 19] collected corticolous cyanobacteria and green algae from forests of Brazil. Sarim *et al*. (2011) [25] recorded 40 taxa of bark algae from Pakistan. Alwi *et al*. (2015) [1] studied effects of bark pH on diversity and density of bark algal composition. They observed that alkaline pH of bark help in the alteration of microalgal composition.

In India except few reports not much more attention has been paid towards bark algae. Bruhl and Biswas (1923) [5] studied bark algae from Kerla. Kamat and Harankhedkar (1976) [14] and Ashtekar (1980) [3] reported bark algae from Nagpur and Aurangabad Maharashtra. Biswas (1984) [4] studied role of aerophilous algae in producing colour effect on bark of tree. Kumar and Paliwad (2006) [17] observed distributional pattern of cyanobacteria on bark of different trees. Mikter *et al*. (2006) [21] worked on bark algal flora of some selected trees of Arunachal Pradesh. Chandra and Krishnamurthy (2006) [6] reported species of diatoms from tree trunk. Ghosh (2013) [9] reviewed work on bark algal flora. Kharkongor and Ramanujan (2014) [16] recorded 85 taxa of algae from tree barks of closed undisturbed sacred groves, mixed plantation and open disturbed forest of Meghalaya. Ambika and Krishnamurthy (2019) [2] studied diversity of algae and cyanobacteria on tree barks of tropical forest. Recently Jadhav (2022) [13] worked on bark algae of Daultabad region of Aurangabad district in Maharashtra. He observed dominance of *Chlorella vulgaris, Chlorococcum huicola, Pinularia sp. Aphanothece nidulans, Myxosarcina bumensis, Phormidium molle* and *Lyngbya major.*

In present research work algae growing on barks of *Gliricidia sepium* (Jacg.) kunth., *Alstonia scholaris* (L) R.BR. and *Delonix regia* (Bojex Hook) Raf. Were observed from khultabad region of Aurangabad district in Maharashtra.

Material and methods

Monsoon season is the favourable season for the growth of bark algae. During monsoon season because of consistent and high rainfall, algal growth was occurred on barks of trees of khultabad region in Aurangabad district of Maharashtra. Mainly algal growth was observed on barks of *Gliricida sepium* (Jacg.) kunth., *Alstonia scholaris* (L) R.BR. and *Delonix regia* (Bojex Hook) Raf. Collection of bark algal samples were made in the month of July and August 2022. Bark algal samples measuring 1 cm^2 were collected by gently scraping the bark with the help of 1.5 meter above the ground. Care was taken to ensure that there was no cross-contamination between samples by sterilizing the scalpel with alcohol after each sample collection. Total 36 samples were collected throughout the period of study. Samples were collected in collection bottles separately and brought to the laboratory for further taxonomic investigation. Collected bark algal samples were observed under research microscope and identified by referring to the standard literature on algae.

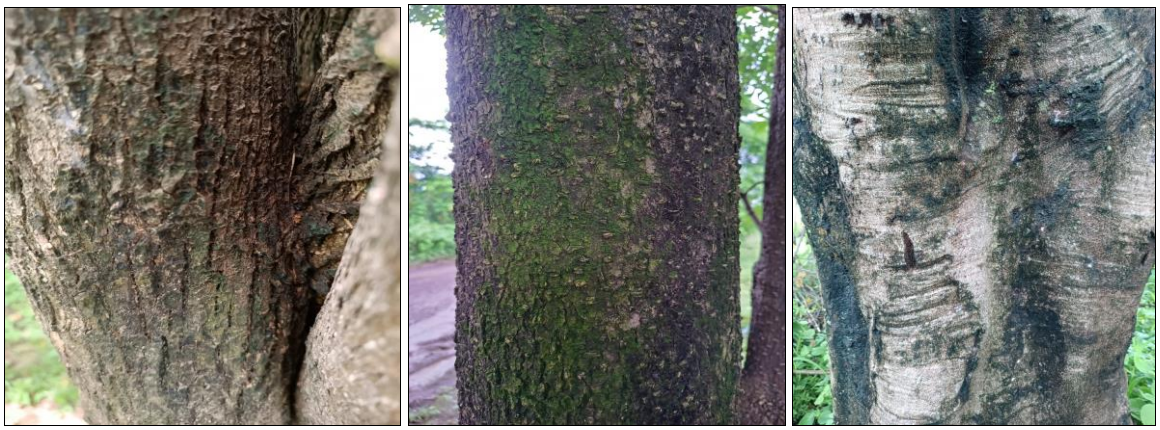
Results and discussion

A total of 31 species under 20 genera belonged to Chlorophyceae, Bacillariophyceae and Cyanophyceae were identified and recorded. Cyanophycean algae were found dominant which is followed by Chlorophyceae and Bacillariophyceae (Table 1 and 2). Wylie and Schlichting (1973) [27], Kamat and Harankhedkar (1976) [14], Mikter *et al*. (2006) [21], Neustupu and Skaloud (2008) [22], Kharkongor and Ramanujan (2014) [16] and Jadhav 2022 [13] also recorded dominance of Cyanophycean algae in bark algal flora. In present study *Chlorella vulgaris, Myxosarcina burmensis, Phormidium abronema, Microcoleuss acutissmus, Nostoc microscopicum, Nostoc punctiformae* and *Tolypothrix campylonemoides* were found dominant. Marion (1969) [20] recorded dominance of *Protococcus, Nanochloris, Stichococcus* and *Ulothrix.* Abundance of *Oscillatoria, Phormidium, Lyngbya* and *Microcoleus* was observed by Ashtekar (1980) [3]. Katharina *et al*. (2008) [15] recorded dominance of *Apatococcous lobatus, Chlorella elliposidea, Chlorella valgaris, Chlorella saccharophila* and *Demococcus endolithicus.* Jadhav (2022) [13] in his extensive study on bark algae reported dominance of *Chlorella valgaris, Chlorococcum humicola, Pinnularia sp. Aphanothece nidulans, Myxosarcina bumensis, Phormidium molle* and *Lyngbya major*.

Maximum number of algal taxa were found on the bark of *Gliricida maculata* which followed by *Alstonia scholaris* and *Delonix regia* (Table 3) the bark properties of bark regulate composition of bark algal flora. Bark algae are micro-habitats developed on various tree barks. The pH of bark surface is one of the most important factors affecting community structure of corticolous organisms (Neustua and Anna 2013). [22] Abundance of cyanobacteria is strongly related to increase in bark pH. Green Algae as compared to other algal groups normally grow better at a higher pH of bark. Alwi *et al*. (2015) [1] observed that alkaline pH of bark alters microalgal composition of bark. Bark algae highly sensitive to the pollution and temperature fluctuations. In moist tropical climate algae commonly grows on bark of trees but some species are also able to grow on trees in temperate subtropical climate. In Marathwada region of Maharashtra climate is dry but in rainy season occurrence of algae on barks of is found in rare form as compared to moist tropical climate. Study of bark algae is significant to understand diversity of subaerial algae of particular geographical area.

Conclusion

31 taxa of bark algae were recorded, Cyanophycean algae were found dominant. *Chlorella valgaris, Myxosarcina burmensis, Phormidium abronema, Microcoleus accutissimus, Nostoc microscopicum, Nostoc punctiformae* and *Tolypothrix campylonemoides* were found dominant. In moist tropical forest bark algae are commonly found. In India except few report rare attention work has been paid towards bark algae. Present research work highlights the occurrence of bark algae in Marathwada region in Maharashtra. In Marathwada region overall climate is dry but rainy season algae occurs on bark of trees and it is a interesting phenomenon. Study of bark algae is significant to understand to diversity subaerial algae of particular geographical area.



a b c

Fig 1: Algae growing on barks of a-*Gliricidia sepium*, b- *Alstonia scholaris* and c- *Delonix regia*

Table 1: Algal taxa growing on bark of trees

Sr.No.	Name of Algal taxa	*Gliricidia maculata*	*Alstonia scholaris*	*Delonix regia*
I	**Chlorophyceae**			
1	*Gloeocystis gigas* (Kuetz) Lagerheim	-	+	-
2	*Gloeocystis major* gernekex Lemmerann	+	-	+

3	*Ulothrix subconstricta* G.S. West	-	+	-
4	*Oedogonium sp*.	+	-	-
5	*Trebouxia humicola* (Treboux) West et Fritsch	-	-	+
6	*Chlorella vulgaris* Beyerinck	+	-	-
II	**Bacillariophyceae**			
7	*Pinnularia sp.*	+	+	-
III	**Cyanophyceae**			
8	*Chroococcus minutus* (Kutz.) Nag.	+	-	-
9	*Chroococcus minor* (Kutz.) Nag.	+	-	-
10	*Aphanocapsa pulchera* (Kutz.) Rabenh.	-	-	+
11	*Aphanothece nidulans* Richter, P.	-	+	-
12	*Myxosarcina burmensis* Skuja	+	+	-
13	*Xenococcus acervatus* Setchell et Gardner	-	-	+
14	*Osillatoria princeps* Vauchar ex Gomant	-	-	+
15	*Phormidium abronema* Skuja	+	-	-
16	*Phormidium jadinianum* Gomont	+	-	-
17	*Phormidium jenkelianum* Schnid,G	-	-	+
18	*Phormidium muscosum* Gardner	+	+	-
19	*Phormidium rubroteriecola* Gardner	-	+	-
20	*Phormidium subincrustatum* Fritsch et Rich	+	+	-
21	*Lyngbya hieronymusii* Lemm	-	-	+
22	*Lyngbya sp.*	-	+	-
23	*Microcoleus acutissmus* Gardner	+	-	-
24	*Microcoleus lacustris*(Rabenn.)Farlow	-	-	+
25	*Nostoc commune* Vaucher ex Born. Et. Flah	+	-	-
26	*Nostoc microscopicum* Carm.ex Born et. Flah	+	-	-
27	*Nostoc punctiformae*(Kutz.) Hariot	+	-	-
28	*Plectonema gracillimum* (Zopf) Hansgirg	+	-	-
29	*Scytonema schmidtii* J.De.Toni	+	-	-
30	*Tolypothrix campylonemoides* Ghose	-	+	-
31	*Calothrix sp.*	+	-	-

Table 2: Total number of algal genera and species recorded from bark of trees

Sr. No.	Class	Genera	Species
1	Chlorophyceae	05	06
2	Bacillariophyceae	01	01
3	Cyanophyceae	14	24
Total		20	31

Table 3: Treewise algal observed on bark of trees

Sr. No.	Tree	Chlorophyceae	Bacillariophyceae	Cyanophyceae	Total
1	*Glirilicidia maculata*	03	01	14	18
2	*Alstonia scholaris*	03	01	08	12
3	*Delonix regia*	01	00	06	07

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