



Diversity and distribution of lichen biota in Angul district of Odisha, India with 77 new additions for the state

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Abstract

An exhaustive study was undertaken to explore and document the lichen mycota of ecologically fascinating and biodiversity rich Angul district located in central part of Odisha. The results of the present survey revealed the occurrence of 174 species of lichens from 15 localities in the study area. It is interesting to note that out of the total species of lichen collected, 77 species were found to be new records for the state or not reported earlier. Among the different growth forms, the crustose lichens were represented with the maximum diversity with 122 species followed by 41 species of foliose, 6 species of squamulose, 4 species of leprose and a single species representing the fruticose form. Besides, the corticolous lichens were recorded with maximum diversity with 135 species followed by 39 saxicolous species. Further taxonomic studies revealed that family Caliciaceae was the dominant one represented by 21 species followed by Graphidaceae with 19, Parmeliaceae with 15, Lecanoraceae with 11, Ramalinaceae with 10 and Physciaceae and Arthoniaceae each with 9, Teloschistaceae with 8 and Verrucariaceae with 7 species. Among the genus *Bacidia* and *Graphis* having largest number of species i.e. 10 followed by *Lecanora* and *Parmotrema* 9, *Pertusaria* 6, *Amandinea*, *Dirinaria*, *Diorygma*, *Heterodermia*, *Caloplaca*, *Peltula* and *Pyxine* harboured 5 species each respectively. Observations on tree substrata of all the lichen species collected indicated that the tree of *Shorea* could harbour 23 different lichen species followed by *Mangifera* with 19, *Anacardium* with 12 *Madhuca* with 8, and *Diospyros* with 7 numbers of lichens. The study also revealed that 2 endemic lichen species are also present in the region namely *Caloplaca orissensis* (Räsänen) D.D. Awasthi and *Pertusaria indica* Preeti Srivast. & D.D. Awasthi. Within the district the Pallahada and Panchadhara forest range are endowed with huge lichen diversity.

Keywords: biodiversity, endemic, mycota, pallahada, panchadhara

Introduction

Lichens are the pioneer colonizer of xeric succession and a marvelous example of symbiotic association having a composite thallus comprising of two components such as a phycobiont or photobiont and a mycobiont. The consortium between the two has been fruitful to such an extent that a number of fungi have adapted the symbiotic relationship thereby forming numerous species of the planet. This advantageous relationship in lichens is not only an arbitrary blend of any fungal and algal species, however it is the indication of an amazingly specific procedure that has evolved through eras and has created in enormous ways. There are about 120,000 known species of fungi present in the world [1]. Out of these total amount of fungi, about 20,000 species are lichenized fungi which is almost one sixth (20%) of all fungi [2] and Indian subcontinent bears 2714 (13.57%) species belonging to 324 genera and 78 families [3]. Due to intricacy and diversity in microhabitats, different types of tropical forests usually bear a rich diversity of lichenized fungi. Although they are too tiny and unobtrusive, mainly in the lowland forest system, they may be helpful for essential part change in the forest ecosystem [4]. A significant estimation says that 50% of the Indian lichen communities are presently undiscovered [5]. In India, regionally the total numbers of lichens are not available, and few areas like some parts of Western Ghats, Eastern Ghats are approximately described [6,7]. Among these regions, Odisha is sporadically explored where 252 lichens are already reported from six different districts [8]. A genus

namely *Thecaria* Fee was recorded new for Eastern Ghat from Gajapati district of Odisha [9]. Again seven new macrolichen species were added as new records for Odisha from Mahendragiri region [10]. Further a study was conducted by Nayak *et al* [11] on lichens growth on Sun Temple of Konark in Odisha, where the added two new species namely *Peltula euploca* (Ach.) Poelt and *Trapelia coarctata* (Sm.) Choisy. Further Bajpai *et al*. [12] described one new species *Cryptothecia odishensis* from Jharsuguda district. Recently a compilation on monumental lichens from Odisha was done by Behera *et al*. [13] where he recorded 31 species among which two genus are new to Odisha namely *Endocarpon* and *Phylliscum* and two new species *Bacidia arnoldiana* (Körb.) V. Wirth & Vězda and *Peltula patellata* (Bagl.) Swinsc. & Korg. After that again ten lichen species were added for lichen biota of Odisha from Angul district [14]. In view of the meager works undertaken in this region to explore this significant biota, the present work was carried out with an objective to describe the micro- and macrolichen diversity and their distribution within the different forest divisions of the Angul district in Odisha.

Materials and Methods

Study area

Angul, a centrally located district of Odisha occupies a geographical area of 6232 square kilometres and lies between 20° 31' N and 21° 40' N Latitude, 84° 15' E and 85° 23' E Longitude (Fig. 1). The forest areas include the

reserve forests, demarcated protected forests, un-demarcated protected forests and forests under revenue records. The total forest area constitutes 37% of the total geographical area of the district. *Shorea robusta* Gaertn. f. (Sal) is the predominating species in all the forest divisions followed by *Diospyros melanoxylon* Roxb., *Tectona grandis* L.,

Terminalia sp. and *Buchanania lanzan* Spreng. The Angul forest range mainly consists of two vegetation types progressively from lower to higher altitudes (east to west) namely dry deciduous forest (DDF), moist deciduous forest (MDF) [15].

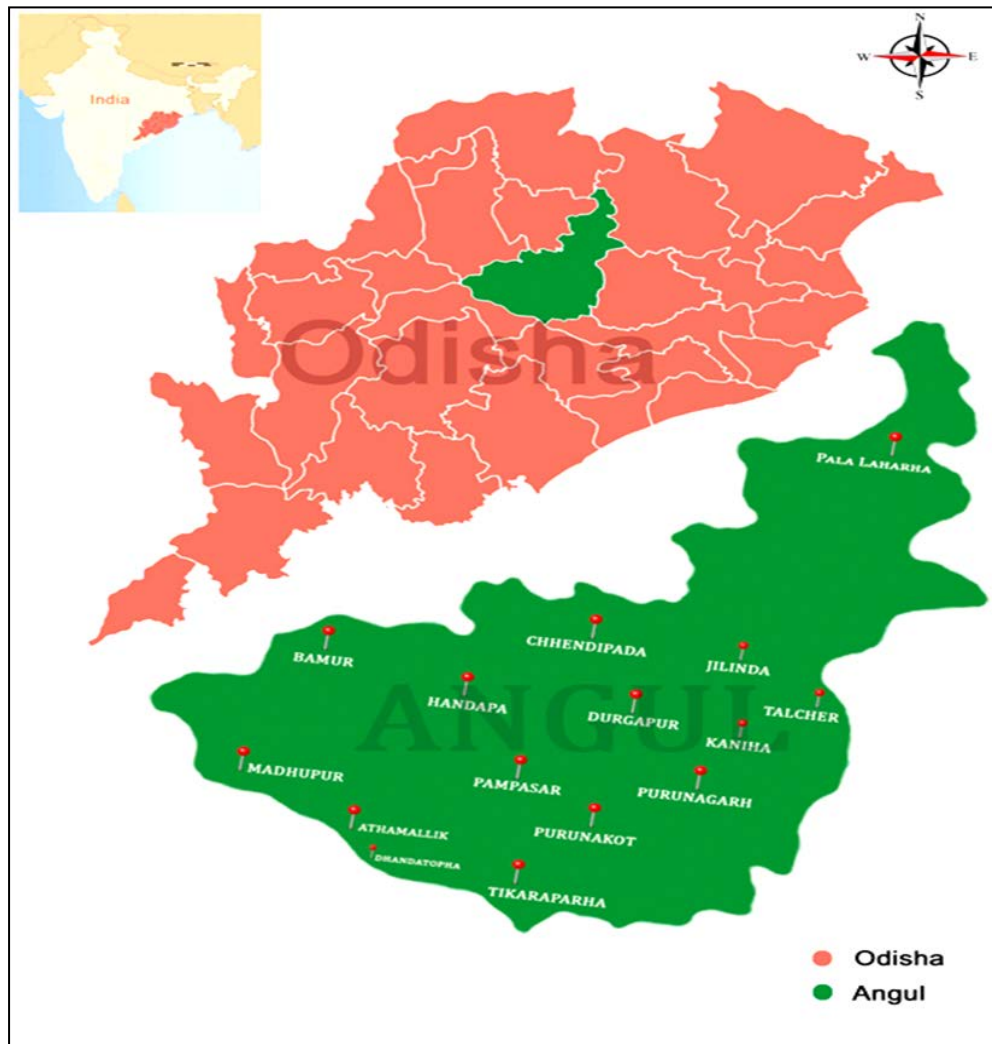


Fig 1: Map showing different localities surveyed from Angul district, Odisha

Methodology

Extensive survey of the study area at regular intervals during 2016 September - 2019 December could make it possible to collect 1027 lichen samples from different forest divisions comprising of 15 localities namely Chhendipada, Durgapur, Kaniha, Purunagarh, Talcher, Athmallik, Bamur, Dhandatopha, Handapa, Madhapur, Tikarpara, Jilinda, Pampasar, Purunakote and Pallahada. Survey was conducted by the authors basing on all the possible lichen growing substrates like barks, fallen twigs, rocks, leaves and soil. An accession number was given to each specimen before they were brought to the laboratory for further studies. Finally the samples were desiccated and preserved in the Lichenological Laboratory, NBRI, Lucknow and Department of Botany, Utkal University, Bhubaneswar. The analysis of external feature of lichen thallus was done under a stereo zoom microscope. Thin sections of ascomata and thallus were mounted in distilled water, lactophenol cotton blue, 5% potassium hydroxide and Lugol's iodine solution and discerned under a Leica DM 2500 compound microscope. The spot tests on the cortex, medulla and ascomatal tissue were done using the standard reagents K

(5% KOH), C [aqueous solution of $\text{Ca}(\text{ClO})_2$], and P (0.5g of $\text{C}_6\text{H}_8\text{N}_2$ dissolved in 5 ml of $\text{C}_2\text{H}_5\text{OH}$). Thin layer chromatography was performed in solvent system C (toluene: acetic acid; 85:15 ml) for identification of secondary metabolites by following a definite method [16]. Identification of taxa was done by following the relevant literature [17-29]. The nomenclature of lichen was updated following indexfungorum.org and classification mentioned by Wijayawardene *et al.* [30] was followed to arrange the species within families. For all lichen species their distribution, growth form and substratum were observed.

Results and Discussion

The data presented in Table 1 on different growth forms of the lichen samples collected revealed that the crustose lichens showed the maximum diversity representing 122 species followed by 41 species belonging to foliose, 6 species of squamulose, 4 species of leprose and a single species of fruticose form (Fig. 2; Fig.3). The data also revealed that the corticolous species had the maximum diversity represented by 135 species followed by 39 saxicolous species (Fig. 4). Families wise distribution of

members revealed that Caliciaceae was the dominant one represented by 21 species followed by Graphidaceae with 19, Parmeliaceae with 15, Lecanoraceae with 11, Ramalinaceae with 10 and Physciaceae and Arthoniaceae each with 9, Teloschistaceae with 8 and Verrucariaceae with 7 species (Fig. 5). Among the genus *Bacidia* and *Graphis* having largest number of species i.e.10 followed by *Lecanora* and *Parmotrema* 9, *Pertusaria* 6 *Amandinea*, *Dirinaria*, *Diorygma*, *Heterodermia*, *Caloplaca* and *Peltula*, *Pyxine* harboured 5 species each respectively (Fig. 2). Observations on tree substrata of all the lichen species collected indicated that the tree of *Shorea* could harbour 23 different lichen species followed by *Mangifera* with 19, *Anacardium* with 12, *Madhuca* with 8, and *Diospyros* with 7 numbers of lichens (Fig. 6). Two endemic lichen species namely *Caloplaca orissensis* (Räsänen) D.D. Awasthi and *Pertusaria indica* Preeti Srivast. & D.D. Awasthi are also recorded. Out of 174 species 77 species are recorded for the first time from the state namely *Alyxoria varia* (Pers.) Ertz & Tehler., *Amandinea coniops* (Wahlenb. in Ach.) Choisy ex Scheidegger & Mayrh., *Amandinea endochroa* (Malme) Marbach, *Amandinea punctata* (Hoffm.) Coppins & Scheid. *Amandinea montana* (H. Magn.) Marbach, *Amandinea subduplicata* (Vain.) Marbach, *Anisomeridium bifforme* (Borrer) R.C. Harris, *Anisomeridium tamarindi* (Fée) R.C. Harris, *Arthonia radiata* (Pers.) Ach., *Arthopyrenia grisea* (Schleich. ex Schaer.) Korber, *Arthopyrenia minor* R.C. Harris, *Arthothelium abnorme* (Ach.) Müll.-Arg., *Bacidia atlantica* (Müll.Arg.) Zahlbr., *Bacidia rubella* (Hoffm.) Massal *Bacidia spadicea* (Ach.) Zahlbr., *Baculifera curtisii* (Tuck.) Marbach, *Bathelium madreporiforme* (Eschw.) Trevisan, *Buellia aethalea* (Ach.) Th., *Buellia disciformis* (Fr.) Mudd, *Bulbothrix meizospora* (Nyl.) Hale, *Canoparmelia ecaperata* (Müll. Arg.) Elix & Hale, *C. eruptens* (Kurok.) Elix & Hale, *C. texana* (Tuck.) Elix & Hale, *Chapsa alborosella* (Nyl.) A. Frisch, *Cococarpia erythroxyli* (Spreng.) Swinscow & Krog, *Cratiria obscurior* (Stirt.) Marbach & Kalb, *Dimelaena tenuis* (Mill. Arg) H. Mayrhofer & Wippel, *Dirinaria picta* (Sw.) Schaer. ex Clem., *Collema nigrescens* Degel, *C. pulcellum* var. *subnigrescens* (Müll. Arg.) Degel., *C. subflaccidum* Degel, *Diploschistes rampoddensis* (Nyl.) Zahlbr., *Diorygma rufosporum* (Patw. & C.R. Kulk.) B.O. Sharma & Makhija, *D. soozanum* (Zahlbr.) M. Nakan. & Kashiw., *Endocarpon pallidum* Ach., *E. pusillum* Hedw., *Fissurina comparimuralis* Staiger, *Graphis lineola* Ach., *G. proserpens* Vain. *G. pseudoserpens* Chaves & Licking, *Haematomma puniceum* (Sm. ex Ach.) Massal, *Herpothallon granulare* (Sipman) Aptroot & Lücking, *H. philippinum* (Vainio) Aptroot & Lücking, *Heterodermia isidiophora* (Nyl.) D.D. Awasthi, *H. flabellata* (Fee) D.D. Awasthi, *Lecanora achroa* Nyl., *Lecanora alba* Lumbsch, *Lecanora inerjecta* Müll. Arg., *Lecanora leprosa* Fée, *Lepraria incana* (L.) Ach., *L. membranacea* (Dicks) Vain., *Leprocaulon coriense* (Hue) Lendemer & Hodkinson, *Omphalodina pseudistera* Nyl., *Parmotrema saccatilobum* (Taylor) Hale, *P. mesotropum* (Müll.Arg.) Hale, *Peltula placodizans* (Zahlbr.) Wetmore, *P. obscurans* (Nyl.) Gyeln., *P. tortusa* (Nees) Wetmore, *Pertusaria indica* Preeti Srivast. & D.D. Awasthi, *P. punctata* Nyl., *P. submultipuncta* Nyl., *Phaeographis endophaeiza* (Stirt.) Zahlbr., *Pseudoschismatomma rufescens* (Pers.) Ertz & Tehler, *Physcia caesia* (Hoffm.) Fürnr. *P. dimidata* (Arn.) Nyl., *Pyrenula nitida* (Weigel) Ach., *Pyxine petricola* Nyl., *P. reticulata* (Vain.) Vain., *Ramboldia subnexa* (Stirt.) Kantvilas & Elix, *Sarcographa labyrinthica* (Ach.) Müell.-Arg., *Scythioria phlogina* (Ach.) S.Y. Kondr., Kärn.,

Elix, Thell & Hur, *Staurothele clopima* (Wahlenb.) Th. Fr., *Tephromela khatiensis* (Räsänen) Lumbsch, *Thelotrema subtile* Tuck, *Trapelia coarctata* (Sm.) Choisy, *T. placodioides* Coppins & P. James. *Verrucaria margacea* (Wahlenb.) Wahlenb. and *Verrucaria pinguicula* (Nyl.) Massal., *Xanthoparmelia congensis* (J. Steiner) Hale. The results of the present study also indicated that of all the taxonomically identified lichen species, 76% were found to be colonized on bark (corticolous), followed by 22% lichens on rock (saxicolous), while a single lichen species was recorded to be grown both on bark and rock substratum. The bark inhabiting lichens were reported to show luxuriant growth in both moist deciduous forest and dry deciduous forest (47% each) followed by the scrub forest (43%). Similarly rock populating lichens were found growing in maximum numbers in moist deciduous forest (4 species) followed by dry deciduous forest with 3 species and scrub forest 1 species. *Parmotrema praesorediosum* was found colonizing both on bark as well as on rock in the dry deciduous forest. Microscopic observation on photobiont could reveal that 85% of lichens studied were having *Trebouxia*, 9.27% with *Trentepohlia* and 5.29% lichens had cyanobacterial association. Lichen genera having cyanobacterial species were identified as *Collema* & *Leptogium* and with *Trentepohlia* as algal partner represented through the genera *Opegrapha*, *Pyrenula* and *Graphis*. It was also seen that lichen diversity with *Trebouxia* as photobiont were dominant in all types of forests where as cyanolichens were recorded maximum in the moist deciduous forest. Lichen taxa with cyanobacteria were more commonly observed in the moist forests. Species of *Collema* and *Leptogium* were found in dry deciduous forest as well as moist deciduous forest and *Leptogium cyanescens* was found in all forest types. It is interesting to observe that lichen communities in the moist deciduous forest and mixed deciduous forest are dependent on moisture and shade-acclimatized, whereas such communities of the dry deciduous forest are habituated with xerophytic conditions and are also photophilous in nature [31]. This pattern of distribution can be attributed to the sensitivity of the lichen photobiont to drought or high temperatures, which determine the survival of a lichen thallus and the *Trebouxia* containing lichens, are known to survive better in the open and dry conditions prevailing in the dry deciduous forest [32]. More number of shade tolerant and moisture-dependent *Nostoc*-containing lichens were observed in moist deciduous forest type. The adaptations to tropical and shaded moist conditions are due to the presence of cyanobacteria and *Trentepohlia* as photobionts [33].

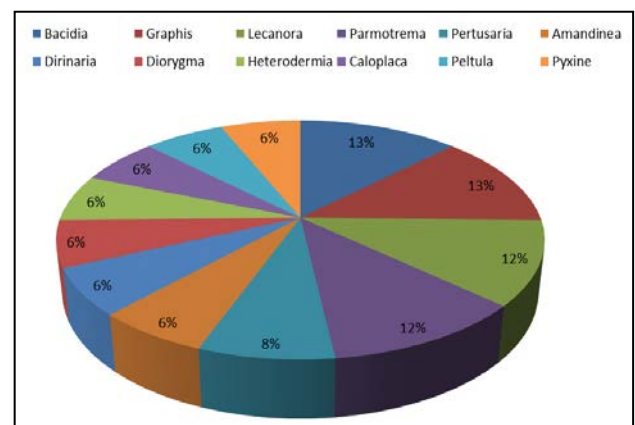


Fig 2: Pie chart showing the dominant genera of lichens in Angul district of Odisha

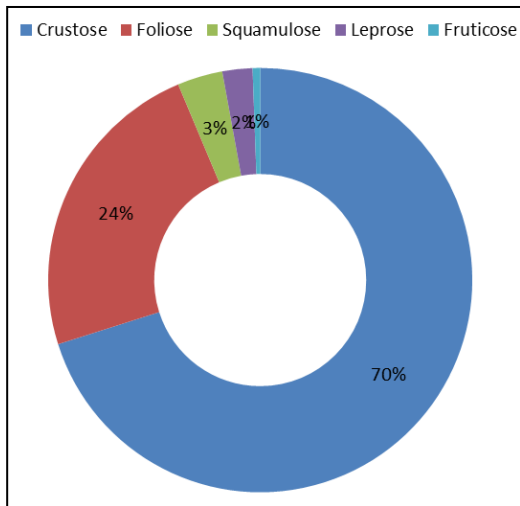


Fig 3: Proportion of various growth forms represented in Angul district

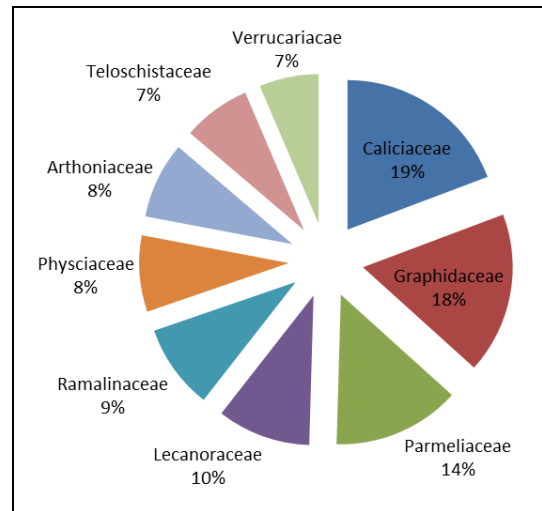


Fig. 5: Representation of different dominant lichen families in Angul district

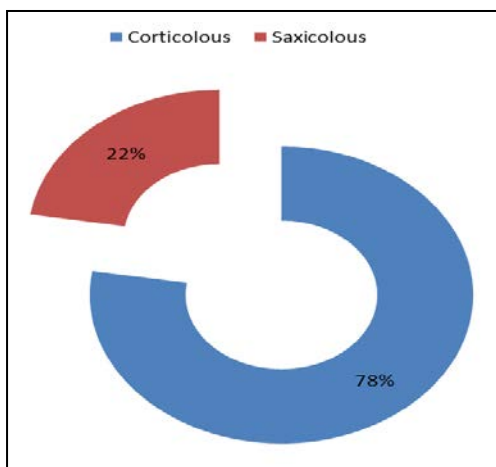


Fig 4: Habitat preference of lichens in Angul district

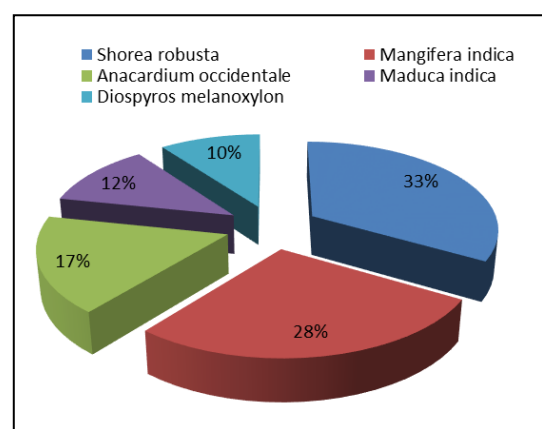


Fig. 6: Representation of dominant host species in the forests of Angul district

Table 1: Diversity and distribution of lichen species in Angul district of Odisha

Sl. No.	Scientific Name	GF	Herbarium No.	Host	Study sites														
					1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Arthoniaceae																			
1.	<i>Arthonia radiata</i> (Pers.) Ach.	Cr	BOTU-075	<i>Madhuca indica</i>	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.	<i>Arthothelium abnorme</i> (Ach.) Müll.Arg.	Cr	BOTU -077	<i>Syzygium cumini</i>	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-
3.	<i>Cryptothecia lunulata</i> (Zahlbr.) Makhija & Patw.	Cr	BOTU- 065 & 043	<i>Mangifera indica</i>	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-
4.	<i>C. multipunctata</i> Jagad. Ram, G. P. Sinha & Kr. P. Singh	Cr	BOTU-055	<i>Madhuca indica</i>	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
5.	<i>C. scripta</i> G. Thor	Cr	BOTU-034 & 048	<i>Mangifera indica</i> and many others	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-
6.	<i>C. striata</i> Thor.	Cr	BOTU- 031	<i>Mangifera indica</i> and many others	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7.	<i>Herpothallon granulare</i> (Sipman) Aptroot & Lücking	Cr	BOTU-146	<i>Diospyros melanoxylon</i>	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8.	<i>H. isidiatum</i> Jagadeesh Ram & G. P. Sinha	Cr	BOTU-114 & 128	<i>Mangifera indica</i>	-	-	-	+	-	-	-	-	-	+	-	-	-	-	-
9.	<i>H. philippinum</i> (Vain.) Aptroot & Lücking.	Cr	BOTU-105	<i>Mangifera indica</i>	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2. Arthopyreniaceae																			
10.	<i>Arthopyrenia grisea</i> (Schleich. ex Schaer.) Korber	Cr	BOTU-022 & 028	<i>Madhuca indica</i>	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-
11.	<i>A. minor</i> R.C. Harris	Cr	BOTU-062 & 053	<i>Mangifera indica</i>	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-
3. Brigantiaaceae																			
12.	<i>Brigantiaea leucoxantha</i> (Spreng.) R. Sant. & Hafellner	Cr	BOTU-021 & 034	<i>Milium velutina</i>	+	-	-	-	-	-	-	-	-	-	+	-	-	-	-
13.	<i>Letrouitia domingensis</i> Hafellner & Bellem	Cr	BOTU-136 & 213	<i>Pongamia pinnata</i>	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-
14.	<i>L. leprolyta</i> (Nyl.) Hafellner	Cr	BOTU-041 & 059	<i>Holarrhena pubescens</i>	-	-	-	-	+	+	+	-	-	-	-	-	-	-	-
15.	<i>L. transgressa</i> (Malme) Hafellner & Bellem	Cr	BOTU-130 & 202	<i>Anogeissus acuminata</i>	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-
4. Caliciaceae																			
16.	<i>Amandinea coniops</i> (Wahlenb. in Ach.) Choisy ex	Cr	BOTU-033 & 076	Rock	+	-	-	-	-	-	-	-	-	+	-	-	-	-	-

69.	<i>G. scripta</i> (L.) Ach.	Cr	BOTU-005, 056 & 161	<i>Areca catechu, Cocos nucifera, Plumeria rubra</i>	+ - - - + - - - - - - - - + - -
70.	<i>G. tenella</i> Ach.	Cr	BOTU-032 & 074	<i>Anacardium occidentale</i>	- + - - - - - - - - - - - - -
71.	<i>Phaeographis endophaeiza</i> (Stirt.) Zahlbr.	Cr	BOTU-049 & 102	<i>Anacardium occidentale</i>	- - - + - - - - - - - - - + -
72.	<i>Sarcographa labyrinthica</i> (Ach.) Müll.Arg.	Cr	BOTU-142 & 164	<i>Tectona grandis</i>	- - - - + - - - - - - - - + - -
73.	<i>Thecaria quassiiicola</i> Fée	Cr	BOTU-018 & 135	<i>Simarouba glauca</i>	- + - - - - - - - - - - - - -
12. Haematommataceae					
74.	<i>Haematomma puniceum</i> (Sm. ex Ach.) Massal.	Cr	BOTU-012 & 024	<i>Shorea robusta</i>	+ - - - - - - - - - - - - + - -
13. Lecanographaceae					
75.	<i>Alyxoria varia</i> (Pers.) Ertz & Tehler	Cr	BOTU-006 & 058	<i>Madhuca indica</i>	- + - - - - - + - - - - - - - -
14. Lecanoraceae					
76.	<i>Lecanora achroa</i> Nyl.	Cr	BOTU-162 & 243	<i>Acacia nilotica</i>	- - - - + - - - - - - - - + - -
77.	<i>L. alba</i> Lumbsch	Cr	BOTU-148 & 206	<i>Acacia leucophloea, Plumeria rubra</i>	+ - - - - - - + - - - - - - - -
78.	<i>L. argentata</i> (Ach.) Degel.	Cr	BOTU-119	<i>Polyalthia</i> sp.	+ - - - - - - - - - - - - - - -
79.	<i>L. fimbriata</i> H. Magn.	Cr	BOTU-345	<i>Shorea robusta</i>	+ - - - - - - - - - - - - - - -
80.	<i>L. helva</i> Stizenb.	Cr	BOTU-149 & 201	<i>Artocarpus heterophyllus, Syzygium</i> sp.	- - - - - - - + - - - - - + - - -
81.	<i>L. inerjecta</i> Müll..Arg.	Cr	BOTU-120 & 216	<i>Boswellia serrata</i>	+ - - - + - - - - - - - - - - -
82.	<i>L. leprosa</i> Fée	Cr	BOTU-109 & 167	<i>Madhuca indica</i>	+ - - - + - - - - - - - - - - -
83.	<i>L. perplexa</i> Brodo	Cr	BOTU-153 & 223	<i>Shorea robusta</i>	- - - - + - - - - - - - - + - -
84.	<i>L. tropica</i> Zahlbr.	Cr	BOTU-066 & 229	<i>Pongamia pinnata</i>	+ - - - + - - - - - - - - + - -
85.	<i>Lecidella enteroleucella</i> (Nyl.) Hertel	Cr	BOTU-016 & 168	<i>Albizzia lebbek, Diospyros</i> sp.	- - - - + - - - + - - - - - - -
86.	<i>Omphalodina pseudistera</i> (Nyl.) S.Y. Kondr., L. Lökös & Farkas	Cr	BOTU-127 & 110	<i>Litchi sinensis</i>	+ - - - + - - - - - - - - + - -
15. Lecideaceae					
87.	<i>Lecidea lapicida</i> (Ach.) Ach.	Cr	BOTU-003 & 068	Rock	+ + - - - - - - - - - - - - - -
88.	<i>Lecidea plana</i> (J. Lahm) Nyl.	Cr	BOTU-037 & 220	Rock	- - - - + + - - - - - - - - - -
16. Leprocaulaceae					
89.	<i>Leprocaulon coriense</i> (Hue) Lendemer & Hodgkinson	Le	BOTU-019, 046 & 039	Rock	+ - - - + - - - - - - - - + - -
17. Malmideaceae					
90.	<i>Malmidea granifera</i> (Ach.) Kalb, Rivas Plata & Lumbsch	Cr	BOTU-050 & 160	<i>Simarouba glauca</i>	+ - - - - - - - - - - - - + - -
18. Monoblastiaceae					
91.	<i>Anisomeridium bifforme</i> (Borrer) R.C. Harris	Cr	BOTU-151 & 208	<i>Mangifera indica</i>	+ - - - - - - - - - - - - + - -
92.	<i>A. tamarindi</i> (Fée) R.C. Harris	Cr	BOTU-029, 071 & 204	<i>Anacardium occidentale, Tamarindus indica</i>	+ - - - + - - - - - - - - + - -
93.	<i>A. terminatum</i> (Nyl.) R.C. Harris	Cr	BOTU-169 & 221	<i>Mangifera indica</i>	+ - - - + - - - - - - - - - - -
19. Ochrolechiaceae					
94.	<i>Ochrolechia africana</i> Vain.	Cr	BOTU-070	<i>Shorea robusta</i>	+ - - - - - - - - - - - - - - -
20. Opegraphaceae					
95.	<i>Opgerapha subvulgata</i> Nyl.	Cr	BOTU-343, 366 & 391	<i>Artocarpus heterophyllus</i>	+ - - - + - - - - - - - - + - -
21. Parmeliaceae					
96.	<i>Bulbothrix isidiza</i> (Nyl.) Hale	Fo	BOTU-373, 382 & 395	<i>Madhuca indica</i>	+ - - - + - - - - - - - - + - -
97.	<i>B. meizospora</i> (Nyl.) Hale	Fo	BOTU-030, 139 & 214	<i>Shorea robusta</i>	+ - - - + - - - - - - - - + - -
98.	<i>Canoparmelia ecaperata</i> (Müll. Arg.) Elix & Hale	Fo	BOTU-079	<i>Mangifera indica</i>	+ - - - - - - - - - - - - - - -
99.	<i>C. eruptens</i> (Kurok.) Elix & Hale	Fo	BOTU-255	<i>Simarouba glauca</i>	+ - - - - - - - - - - - - - - -
100.	<i>C. texana</i> (Tuck.) Elix & Hale	Fo	BOTU-224	<i>Cipadessa baccifera</i>	+ - - - - - - - - - - - - - - -
101.	<i>Parmotrema austrosinense</i> (Zahlbr.) Hale	Fo	BOTU-140 & 192	<i>Shorea robusta</i>	- - - - - - + + - - - - - - - -
102.	<i>P. crinitum</i> (Ach.) M. Choisy	Fo	BOTU-172, 158 & 195	<i>Shorea robusta</i>	+ - - - - - + - - - - - - + - -
103.	<i>P. cristiferum</i> (Taylor) Hale	Fo	BOTU-187, 218 & 242	<i>Shorea robusta</i>	+ + - - - - - - - - - - - + -
104.	<i>P. mesotropum</i> (Müll..Arg.) Hale	Fo	BOTU-185, 277 & 317	<i>Tectona grandis</i>	+ + - - - - + - - - - - - - - -
105.	<i>P. praesorediosum</i> (Nyl.) Hale	Fo	BOTU-139, 179 & 297	<i>Tectona grandis</i>	+ - - - + - - - - - - - - + - -
106.	<i>P. ravum</i> (Krog & Swinscow) Serus	Fo	BOTU-255	<i>Terminalia alata</i>	+ - - - - - - - - - - - - - - -
107.	<i>P. reticulatum</i> (Taylor) M. Choisy	Fo	BOTU-191, 262 & 303	<i>Shorea robusta</i>	+ - - - + - - - - - - - - + - -
108.	<i>P. saccatilobum</i> (Taylor) Hale	Fo	BOTU-179, 194 & 313	<i>Tectona grandis</i>	- + - - - - + - - - - - - + - -
109.	<i>P. tinctorum</i> (Despr. ex. Nyl.) Hale	Fo	BOTU-263, 247 & 306	<i>Shorea robusta</i>	+ - - - + - - - - - - - - + - -

110.	<i>Xanthoparmelia congensis</i> (J. Steiner) Hale	Fo	BOTU-170	<i>Shorea robusta</i>	+ - - - - - - - - - - - - - - -
22. Peltulaceae					
111.	<i>Peltula euploca</i> (Ach.) Poelt	Sq	BOTU-189 & 316	Rock	+ - - - - - - - - - - - - - - -
112.	<i>P. obscurans</i> (Nyl.) Gyeln.	Sq	BOTU-171 & 188	Rock	+ - - - - - - - - - - - - - - -
113.	<i>P. patellata</i> (Bagl.) Swinsc. & Korg	Sq	BOTU-267 & 295	Rock	+ - - - - - - - - - - - - - - -
114.	<i>P. placodizans</i> (Zahlbr.) Wetmore	Sq	BOTU-240 & 275	Rock	+ - - - - - - - - - - - - - - -
115.	<i>P. tortosa</i> (Nees) Wetmore	Fo	BOTU-178 & 257	Rock	+ - - - - - - - - - - - - - - -
23. Pertusariaceae					
116.	<i>Pertusaria indica</i> Preeti Srivast. & D.D. Awasthi	Cr	BOTU-309	Rock	+ - - - - - - - - - - - - - - -
117.	<i>P. leucosora</i> Nyl.	Cr	BOTU-173, 187 & 304	Rock	+ - - - - - - - - - - - - - - -
118.	<i>P. leucostoma</i> (Bernh.) Massal.	Cr	BOTU-198, 250 & 273	<i>Cordia</i> sp., <i>Cleistanthus collinus</i>	- + - - - - - - - - - - - - - -
119.	<i>P. pertusa</i> (Weigel) Tuck.	Cr	BOTU-180, 245 & 319	<i>Acacia nilotica</i> , <i>Leea indica</i>	- + - - - - - - - - - - - - - -
120.	<i>P. punctata</i> Nyl.	Cr	BOTU-253, 265 & 290	<i>Mangifera indica</i>	- - - - - - - - - - - - - - - -
121.	<i>P. submultipuncta</i> Nyl.	Cr	BOTU-279	Rock	+ - - - - - - - - - - - - - - -
122.	<i>P. quasissiae</i> (Fée) Nyl.	Cr	BOTU-182	<i>Senna siamea</i>	+ - - - - - - - - - - - - - - -
24. Physciaceae					
123.	<i>Heterodermia diademata</i> (Taylor) D.D. Awasthi	Fo	BOTU-183, 260 & 305	<i>Eleagnus colloga</i> , <i>Simarouba glauca</i> , <i>Cleistanthus collinus</i>	+ - - - - - - - - - - - - - - -
124.	<i>H. flabellata</i> (Fee) D.D. Awasthi	Fo	BOTU-175, 248 & 330	Rock	+ - - - - - - - - - - - - - - -
125.	<i>H. isidiophora</i> (Nyl.) D.D. Awasthi	Fo	BOTU-193, 261 & 315	<i>Leucaena leucocephala</i> , <i>Acacia</i> sp	+ - - - - - - - - - - - - - - -
126.	<i>H. obscurata</i> (Nyl.) Trevis.	Fo	BOTU-212, 256 & 308	<i>Shorea roustia</i> , <i>Artocarpus heterophyllus</i>	+ - - - - - - - - - - - - - - -
127.	<i>H. speciosa</i> (Wulfen.) Trevis	Fo	BOTU-271, 196 & 301	Rock	+ + - - - - - - - - - - - - - -
128.	<i>Physcia caesia</i> (Hoffm.) Fűrnr.	Fo	BOTU-197	<i>Mangifera indica</i>	- - - + - - - - - - - - - - - -
129.	<i>P. dimidata</i> (Arn.) Nyl.	Fo	BOTU-354, 383 & 396	Rock	+ - - - - - - - - - - - - - - -
130.	<i>Rinodina oxydata</i> (Massal.) Massal.	Cr	BOTU-174, 291 & 318	Rock	+ - - - - - - - - - - - - - - -
131.	<i>R. sophodes</i> (Ach.) Massal.	Cr	BOTU-199, 266 & 320	<i>Litchi chinensis</i> , <i>Acacia</i> sp.	+ - - - - - - - - - - - - - - -
25. Pyrenulaceae					
132.	<i>Anthracotheecium thwaitesii</i> (Leight) Müll..Arg.	Cr	BOTU-251 & 293	<i>Tamarindus indica</i> , <i>Couroupita guianensis</i>	+ - - - - - - - - - - - - - - -
133.	<i>A. variolosium</i> (Pers.) Müll..Arg.	Cr	BOTU-177 & 270	<i>Pongamia pinnata</i>	- + - - - - - - - - - - - - - -
134.	<i>Pyrenula brunnea</i> Fée	Cr	BOTU-312	<i>Couroupita guianensis</i>	- + - - - - - - - - - - - - - -
135.	<i>P. mamillana</i> (Ach.) Trevis.	Cr	BOTU-274	<i>Simarouba glauca</i>	+ - - - - - - - - - - - - - - -
136.	<i>P. nitida</i> (Weigel) Ach.	Cr	BOTU-264	<i>Mangifera indica</i>	- - - + - - - - - - - - - - - -
26. Ramboldiaceae					
137.	<i>Ramboldia russula</i> (Ach.) Kalb., Lumbsch & Elix	Cr	BOTU-241 & 264	<i>Shorea robusta</i>	+ - - - - - - - - - - - - - - -
138.	<i>Ramboldia subnexa</i> (Stirt.) Kantvilas & Elix	Cr	BOTU-300	<i>Shorea robusta</i>	- - - - - - - - - - - - - - - -
27. Ramalinaceae					
139.	<i>Bacidia alutacea</i> (Krempelh) Zahlbr.	Cr	BOTU-184 & 254	<i>Syzygium cumini</i>	+ - - - - - - - - - - - - - - -
140.	<i>B. arnoldiana</i> (Körb.) V. Wirth & Vězda	Cr	BOTU-311 & 323	<i>Prosopis cineraria</i>	- + - - - - - - - - - - - - - -
141.	<i>B. atlantica</i> (Müll.Arg.) Zahlbr.	Cr	BOTU-355	<i>Mangifera indica</i>	- - - - - - - - - - - - - - - -
142.	<i>B. millegrana</i> (Taylor) Müll..Arg.	Cr	BOTU-246	<i>Artocarpus heterophyllus</i>	- - - - - - - - - - - - - - - -
143.	<i>B. phaeolomoides</i> (Müll..Arg.) Zahlbr.	Cr	BOTU-176, 180 & 322	<i>Chloroxylon swietiana</i> , <i>Tectona grandis</i> , <i>Anogeissus</i> sp.	+ + - - - - - - - - - - - - - -
144.	<i>B. psorina</i> (Nyl.) G. Pant & D.D. Awasthi	Cr	BOTU-276	<i>Artocarpus heterophyllus</i>	- - - - - - - - - - - - - - - -
145.	<i>B. rubella</i> (Hoffm.) Massal.	Cr	BOTU-334	<i>Anogeissus latifolia</i>	+ - - - - - - - - - - - - - - -
146.	<i>B. rufescens</i> (Müll..Arg.) Zahlbr.	Cr	BOTU-347	<i>Mangifera indica</i>	- - - - - - - - - - - - - - - -
147.	<i>B. spadicea</i> (Ach.) Zahlbr.	Cr	BOTU-294	<i>Diospyros malabarica</i>	- - - - - - - - - - - - - - - -
148.	<i>B. submedialis</i> (Nyl.) Zahlbr.	Cr	BOTU-176	<i>Madhuca indica</i>	- - - - - - - - - - - - - - - -
28. Roccellaceae					
149.	<i>Pseudoschismatomma rufescens</i> (Pers.) Ertz & Tehler	Cr	BOTU-329	<i>Boswellia serrata</i>	- - - - - - - - - - - - - - - -
150.	<i>Roccella montagnei</i> Bél.	Fr	BOTU-296, 339 & 357	<i>Roystonea regia</i>	+ - - - - - - - - - - - - - - -
29. Tephromelataceae					
151.	<i>Tephromela khatiensis</i> (Räsänen) Lumbsch,	Cr	BOTU-326	<i>Mangifera indica</i>	+ - - - - - - - - - - - - - - -
30. Teloschistaceae					
152.	<i>Brownliella cinnabarina</i> (Ach.) S.Y. Kondr.,	Cr	BOTU-302, 336 &	Rock	+ - - - - - - - - - - - - - - -

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