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Diversity and distribution of Lichens in Mattavara forest of Chikkamagaluru, Karnataka, India

Sharath KP[1], FTZ Jabeen[2]
[1] Department of PG, Studies in Botany, IDSG Govt. College, Chikkamagaluru, Karnataka, India
[3] Department of Botany, Government First Grade College, Tumakuru, Karnataka, India

Abstract
The present study involves the biodiversity and distribution of lichens in the Mattavara forest, Chikkamagaluru taluk and district of Karnataka state. This study was promulgated to get some idea about the diversity and distribution pattern of lichens as this area is poorly explored yet. The area exhibits a total 34 species of lichens belongs to 15 genera and 12 families. The foliose lichens showed marked dominance represented by 20 species followed by crustose lichens 10 species and fruticose lichens 4 species. Out of total 34 species among these 29 species are corticolous and remaining 5 species are saxicolous. The members of family Physiaceae exhibit their dominance followed by Parmaliaceae. *Pertusaria amara* Ach. Shows high density 3.83and Abundance 4.6, *Crysothrix candellaris* (L) J. R. Laundon. Least density 0.83. *Usnea undulata* shows least Abundance with 1 and frequency 33.3%, and about 13 species shows the 100% frequency. The present record of number of lichen species may be considered as good and the area may be regarded as lichen rich area.

Keywords: Lichens, diversity, Mattavara, dominance

Introduction
Lichens are the complex organisms involving in a symbiotic association between photobiant and mycobiant [1]. These obiquotes group dominating as much as 10% of the earth's surface, they are estimated about 20,000 species present throughout the world [2] and in India the estimated record is 2,303 species, which represents 14% of world lichen population [3]. Morphologically lichens are three major growth forms, crustose (crust like and closely attached to the substratum), foliose (leaf like and loosely attached to the substratum) and fruticose (shrubs like hanging or erect growing on substratum) [4]. On the basis of their substrate preference lichens are categorized as corticolus (bark inhabiting), saxicolous (rock inhabiting), terricolous (soil inhabiting), lichenicolous (lichen inhabiting), muscicolous (moss inhabiting) etc [5]. Lichens have adapted to all possible environmental habitats in the world. In Indian context, these are more prominent and diverse in mountainous ranges. Eastern Himalaya and Western Ghats are two main centers of diversity in India. The western Ghats region is also very rich in lichen flora like Angiosperms [6]. Lichenologically this region is richest zones in the country with abundance of many interesting taxa. However, Western Ghats remained under-explored and less studied compared to vascular plants [7].

In Karnataka, most of the lichenological explorations were undertaken, the Western Ghats region, which is composed of tropical and subtropical moist forests harbor many lichen Species [8], hence the present investigation was undertaken for a detailed enumeration of lichen communities, their growth form, micro habitats and host plant interaction in different regions of Mattavara forest belonging to Chikkamagalur district.

Material and Methods
Study area
The Mattavara forest is located in Chikkamagaluru district in the state of Karnataka and Chikkamagaluru is famous for Coffee and it is known as Coffee land of Karnataka, and it is situated South Western part of Karnataka and the district located between 12^0 54' 42" and 13^0 53' 53" north latitude and between 75^0 04' 046" and 76^0 21' 50" east latitude.

The study area Mattavara reserve forest has mixed deciduous to evergreen type of vegetation, it comprises a large extent of hilly terrain, and totally this forest is around 548 hectares, and forest area is divided into two blocks. The humidity very high during monsoon season, There is a rapid increase in temperature after February with the mean daily maximum temperature at 30.7^0 C and the mean daily minimum temperature 19^0 C.

The average rainfall in Chikkamagaluru district is 1925 mm. it varies from low of 595mm in Kadur Taluk to high of 2379 mm in mudigere and average rainfall of Mattavara is 600 mm. The underlying rock is granite with admixture of quartz and the soil is coarse, generally without humous layer.

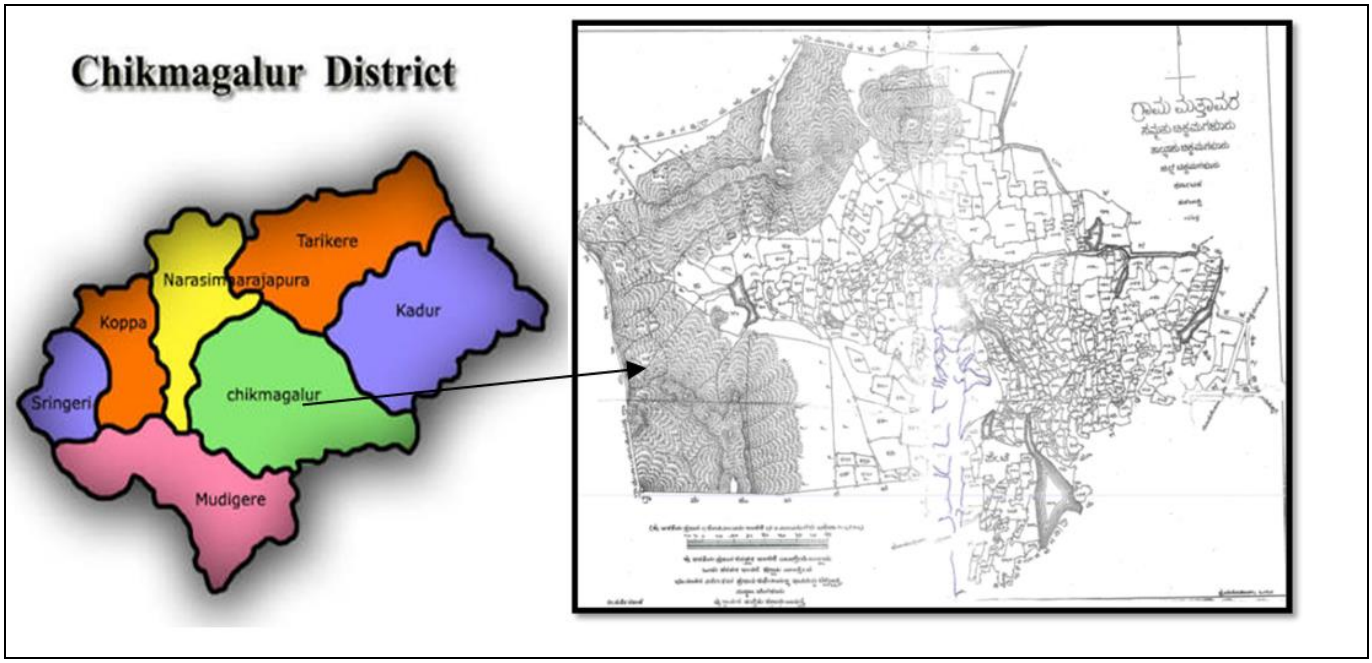


Fig 1: Showing the Chikmagalur District map and mattavara forest Map

Field survey: Survey work was carried out between April 2016 to February 2017 to make complete record of different habitats of species and their occurrence. A total of 6 quadrates each measuring 50×10 m were laid down in at different sites. In each quadrate all substrate were thoroughly searched and recorded the species (Table-1). The pH of the substrate like soil, bark, rock was recorded the host tree species were also identified. Bark sample were dried out in sunlight to reduce moisture content.

Table 1: Quadrates laid down in Mattavara forest at different sites

Sl. No.	Name of the species	Quadrates Laid Down						Total number of quadrate Studied	Total Number of Individuals Of Species	Total Number of quadrates of occurrence	Density	Abundance	Frequency in %
		1	2	3	4	5	6						
1.	*Caloplaca aractina* (Fr) Hayren.	2	1	1	-	2	1	6	7	5	0.85	1.4	83.3
2.	*Caloplaca microthallina (Wedd). Zahlbr.*	2	2	2	1	-	2	6	10	5	1.66	2	83.3
3.	*Candellaria concolor(*Dickson)Stein.	1	1	-	3	1	2	6	8	5	1.33	1.6	83.3
4.	*Cryptothecia striata* G.Thor.	1	3	1	1	-	2	6	8	5	1.33	1.6	83.3
5.	*Crysothrix candellaris*(L) J.R.Laundon.	-	2	2	-	1	-	6	5	3	0.83	1.6	50
6.	*Dirinaria aegialita (*Fee)D.D.Aswasthi.	1	2	3	5	1	4	6	16	6	2.66	2.66	100
7.	*Dirinaria applanata (*Sw) Vain.	1	1	2	-	1	1	6	6	5	1	1.2	83.3
8.	*Dirinaria confluens(*Fr) Awas.	2	2	3	3	2	1	6	13	6	2.16	2.16	100
9.	*Dirineria picta* (Sw.) Clem. & Shear	-	4	-	1	2	2	6	9	3	1.5	3	50
10.	*Graphis scripta (*L) Ach.	5	2	1	1	2	1	6	12	6	2	2	100
11.	*Heterodermia diadamata* (Taylor) D. D. Awasthi.	3	1	2	2	1	1	6	10	6	1.6	1.6	100
12.	*Heterodermia echinata* (Taylor)W.L.	2	1	2	3	1	1	6	10	6	1.6	1.6	100
13.	*Heterodermia incana(Stirt)*D.D Awasthi.	3	3	5	1	2	1	6	15	6	2.5	2.5	100
14.	*Heterodermia japonica (*L) Ach.	-	7	-	3	4	1	6	15	4	2.5	3.7	66.6
15.	*Heterodermia leucomelos* (L.) Poelt	3	2	6	-	6	3	6	20	5	3.3	4	83.3
16.	*Heterodermia speciosa (*Wulfen)Trevis.	1	3	2	7	2	2	6	17	6	2.83	2.8	100
17.	*Lecanora compertris* (Schaerer)Hue.	1	2	8	1	-	2	6	14	5	2.33	2.8	83.3
18.	*Lecanora chlarotera* Nyl.	1	2	1	1	4	3	6	12	6	2	2	100

19.	*Leptogium burnetiae* C.W.Dodge.	2	1	6	3	6	4	6	22	6	3.66	3.66	100
20.	*Leptogium cochleatum* (Dicks)P.M.Jorg and P.James.	3	2	7	5	3	1	6	21	6	3.5	3.5	100
21.	*Parmotrema austrosinense* (Zahlbr.)hale.	-	2	3	-	2	1	6	8	5	1.33	1.6	93.3
22.	*Parmotrema cristiferum (Taylor)Hale*.	3	4	5	7	2	1	6	22	6	3.66	3.66	100
23.	*Parmotrema perlatum* (Huds.)M.Choisy	2	2	3	1	5	1	6	14	6	2.33	2.33	100
24.	*Parmotrema praesorediosum* (Nyl)Hale.	1	6	7	1	4	1	6	20	6	3.33	3.33	100
25.	*Parmotrema reticulatum* (Tayler)M.Choisy.	2	3	8	1	7	-	6	21	5	3.5	4.2	83.3
26.	*Parmotrema tinctorum* (Despr.Ex Nyl.)Hale.	2	1	3	1	-	1	6	8	5	1.33	1.6	83.3
27.	*Pertusaria amara* Ach.	5	1	6	5	6	-	6	23	5	3.83	4.6	83.3
28.	*Phyllospora spp.*	4	7	1	-	2	1	6	15	5	2.5	3	83.3
29.	*Pyxine sorediata* (Ach)Mont.	2	3	4	5	-	-	6	14	4	2.33	3.5	66.6
30.	*Pyxine subcinerea* Stirt.Trans and Proc.	5	-	3	2	2	8	6	20	5	3.33	4	83.3
31.	*Ramalina hossei* Vain.	2	-	-	1	-	1	6	4	3	1.5	1.33	50
32.	*Ramalina farinacea*(Swartz) Mot.	2	1	3	8	2	-	6	16	5	2.66	3.2	83.3
33.	*Usnea ghattensis G*.awasthi	-	1	-	-	-	3	6	4	3	0.66	1.33	50
34.	*Usnea undulata* Stirt.	-	-	1	-	1	-	6	2	2	0.33	1	33.3

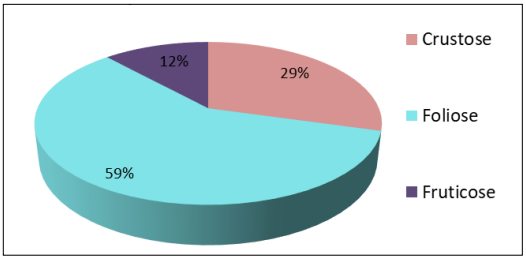
Collection and identification

The representative lichen specimen collected along with their substratum irrespectively of their growth form. Only the lichens that were loosely attached to substratum was scraped out and collected. The corticolous lichens growing on tree stem only superficial bark was removed with the help of chisel by knife In order to avoid the damage of the trees. In case of saxicolous lichens smaller pieces of the rock substrate was collected.

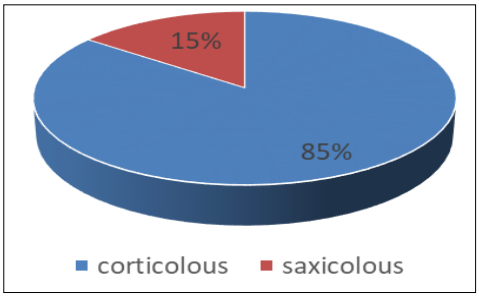
The collected specimens were sun dried and the lichen herbarium packets made with thick brown handmade acid free paper and these herbarium were deposited in the Depatrment of P.G. studies in Botany, I.D.S.G. Govt. College, Chikkamagaluru. The process of identification was done by using standard manual (Awasthi, 1988, 2007) and also on the basis morphology, anatomy and chemical tests. The external morphology was studied under discection microscope. The anatomical studies of the thallus and apothecia were studied by taking T.S and L.S. of thallus and hypothecium. The colour of the medulla, hypothecium, ascus and shape and size of the asci, ascospores and conidia were measured. Chemical test of the specimens includes colour spot tests such as K, C, KC, I and Pd test and thin layer chromatography (TLC) was done.

Results and Discussion

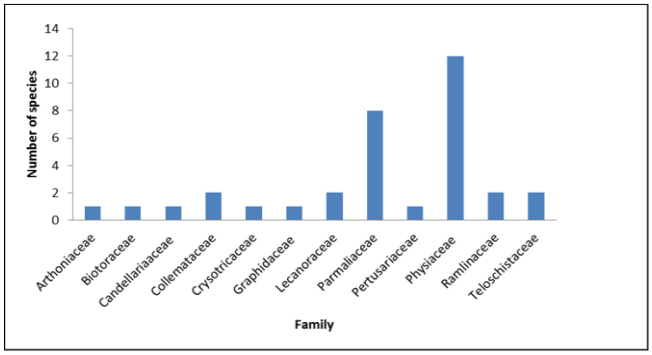
In the present study 34 lichens species were identified belongs to 15 genera and 12 families. The foliose lichen shows the marked dominance represented by 20 species followed by crustose lichens with 10 species and fruticose lichens with 4 species (Graph -1). Deciduous forest have highest intensity and open canapy which is suitable for crustose and foliose lichens (Negi and Gadgil,1996; Balaji and Hariharan, 2004).



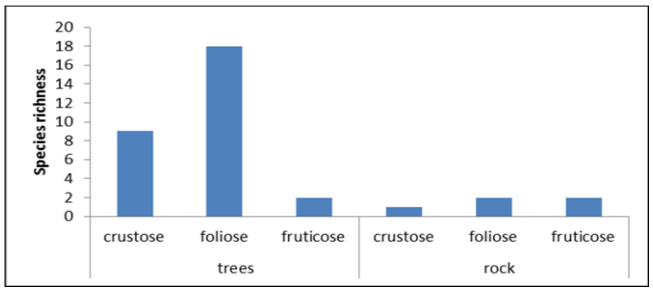
Graph 1: Growth forms of Lichens



Graph 2: Substrate of lichens



Graph-3: Representation of different lichen families in Mattavara forest



Graph 4: lichens recorded in different substratum

Among the total 34 species 29 species are corticolous and remaining 5 species are saxicolous (Graph-2). The members of family Physiaceae exhibit their dominance with 12 species and followed by Parmaliaceae with 8 species. Collemataceae, Teloschistaceae, Lecanoraceae and Ramlinaceae with 2 species. Arthoniaceae Biotoraceae, Crysotricaceae Pertusariaceae, Graphidaceae and Candellariaceae with 1 species (Graph-3.). Occurrence of more than 34 species only form Mattavara forest indicates a rich diversity of lichens and their assemblages do vary depending upon host plants. Moreover majority of lichen species are found to favour wood, this brings out importance of woody habitats in promoting lichens species diversity.

Pertusaria amara Ach. Shows high density 3.83 and Abundance 4.6, *Crysothrix candellaris* (L) J.R.Laundon. Least density 0.83. *Usnea undulata* shows least Abundance with 1 and frequency 33.3%, and about 13 species shows the 100% frequency (Table – 1)

Most of them are macrolichens because of semideciduous region. The important macrolichens grow in this region are *Parmotrema* and *Heterodermia* with 6 species of each genus, and *Dirinaria* with 4 species, *Ramalina*, *Pertusaria* and *Usnea* with 2 species each.

Table 2: List of lichens species of Mattavara forest

Sl. No.	Species Names	Family	Growth Forms	Host species	pH
1	*Caloplaca aractina* (Fr)Hayren.	Teloschistaceae	Crustose	*Acacia auriculiformis*	6.2
2	*Caloplaca Microthallina(Wedd).Zahlbr.*	Teloschistaceae	Crustose	*Randia dumentorium*	5.8
3	*Candellaria concolor(*Dickson)Stein.	Candelariaceae	Crustose	*Delonix regia* (Boj.ex Hook) Raf.	6.5
4	*Cryptothecia striata* G.Thor.	Arthoniaceae	Crustose	*Duranta repens* L.	6
5	*Crysothrix candellaris*(L) J.R.Laundon.	Crysothricaeae	Crustose	*Syzygium cumini* (L) Skeels	6.5
6	*Dirinaria aegialita (*Fee)D.D.Aswasthi.	Physciaceae	Foliose	*Dalbergia latifolia*	7
7	*Dirinaria applanata(*Sw) Vain.	Physciaceae	Foliose	*Terminalia elliptica* Wild.	6.2
8	*Dirinaria confluens(*Fr) Awas.	Physciaceae	Foliose	*Acacia auriculiformis*	6.2
9	*Dirineria picta* (Sw.)Clem. & Shear.	Physciaceae	Foliose	*Kydia calycina*	6
10	*Graphis scripta(*L)Ach.	Graphidaceae	Crustose	*Pongamia pinnata*	7.2
11	*Heterodermia diadamata(*Taylor)D.D.Awasthi.	Physciaceae	Foliose	*Santalum album*	6.3
12	*Heterodermia echinata(*Taylor)W.L.	Physciaceae	Foliose	*Acacia concinna*	6.7
13	*Heterodermia incana(Stirt)*D.D Awasthi.	Physciaceae	Foliose	*Acacia concinna*	6.7
14	*Heterodermia japonica (*L)Ach.	Physciaceae	Foliose	*Cassine glauca*	7.2
15	*Heterodermia leucomelos* (L.) Poelt	Physciaceae	Foliose	*Cassine glauca*	7.2
16	*Heterodermia Speciosa (*Wulfen)Trevis.	Physciaceae	Foliose	*Santalum album*	6.3
17	*Lecanora compertris*(Schaerer)Hue.	Lecanoraceae	Crustose	*Pterocarpus marsupium* Roxb.	6
18	*Lecanora chlarotera* Nyl.	Lecanoraceae	Crustose	*Gemelia arboria* Roxb	6.5
19	*Leptogium burnetiae* C.W.Dodge.	Collemataceae	Foliose	*Syzygium cumini* (L.) Skeels	5.8
20	*Leptogium cochleatum*(Dicks)P.M.Jorg and P.James.	Collemataceae	Foliose	*Sapindus trifoliatus* Linn.	6.3
21	*Parmotrema austrosinense(*Zahlbr.)hale.	Parmeliaceae	Foliose	*Ficus bengalansis*	7
22	*Parmotrema cristiferum(Taylor)Hale*.	Parmeliaceae	Foliose	*Santalum album*	6.3
23	*Parmotrema perlatum* (Huds.)M.Choisy	Parmeliaceae	Foliose	*Dalbergia latifolia*	6.8
24	*Parmotrema praesorediosum (*Nyl)Hale.	Parmeliaceae	Foliose	Rock	7.5
25	*Parmotrema reticulatum(*Tayler)M.Choisy.	Parmeliaceae	Folios	Rock	8
26	*Parmotrema tinctorum* (Despr.Ex Nyl.)Hale.	Parmeliaceae	Foliose	*Ficus bengalansis*	7
27	*Pertusaria amara* Ach.	Pertusariaceae	Crustose	Rock	8
28	*Phyllospora spp.*	Biotoraceae	Crustose	*Caryota urens* L.	6
29	*Pyxine sorediata (*Ach)Mont.	Physciaceae	Foliose	*Xylia xylocarpa*	6.2
30	*Pyxine subcinerea* Stirt.Trans and Proc.	Physciaceae	Foliose	*Randia dumentorium*	6.2
31	*Ramalina hossei* Vain.	Ramalinaceae	Fruticose	*Delonix regia* (Boj.ex Hook) Raf.	8
32	*Ramalinafarinacea(*Swartz) Mot.	Ramalinaceae	Fruticose	*Cassine glauca*	7.2
33	*Usnea ghattensis G.*awasthi.	Parmeliaceae	Fruticose	Rock	8
34	*Usnea undulata* Stirt.	Parmeliaceae	Fruticose	Rock	8

Conclusion

The diversity of lichen flora has undergone a substantial decrease in the last five decades. Among the numerous anthropogenic activities, overexploitation and selective removal of economically essential lichens have become major threats to the lichen flora of the country. The present record of number of lichen species may be considered as good and the area may be regarded as lichen rich area. An extensive and intensive exploration of unexplored zones will definitely add many additional lichen taxa to the lichen biota of the state. Conservation of their habitat is most important to avoid the extinction of lichens. It can be done by developing schemes for *insitu* and *exsitu* conservation. This study provides the basic information about the lichen diversity in Mattavara forest, Chikkamagalur which will be helpful for further bio-monitoring studies.

Plate 1: Images of Lchens

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