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ASSESSMENT OF LICHENS IN SELECTED SACRED GROVES OF WEST MIDNAPORE DISTRICT, WEST BENGAL, INDIA

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Abstract

Sacred groves are traditionally protected relic forest patches surviving on socio-religious grounds. It harbors valuable regional biodiversity with vital ecosystem and are under anthropogenic threats. Sacred groves are fairly well-studied for socio-cultural and ecological aspects, and evaluation of higher flora and fauna and their conservation. However, there are no or scarce studies on cryptogams available on sacred groves. The lichens have long been recognized as biologically sensitive indicators of environmental conditions. The present study reveals the occurrence of 129 species of lichens, represented by 52 genera and 25 families in ten selected sacred groves. Shorea robusta exhibited the maximum diversity of lichens by 74 species. Since this is the first study of lichens in the district there is ample scope for further studies in South Bengal region. This study will help to understand the diversity of lichens better and give the correct status of the biodiversity of West Bengal.

Keywords: *Lichens; Diversity; Sacred Grove; West Midnapore; West Bengal; India.*

Introduction

Lichens are polyphyletic in origin, and a unique group of non-vascular cryptogams composed of two quite different organisms, a fungus and an alga, forming a self-supporting combination. The fungal component is called the mycobiont and the algal component is known as the photobiont. These two live in intimate association appeared to be a single plant. They are the dominant life forms on the earth, constitute about 8% of the earth's surface. The fungal component forms the bulk of the lichen thallus, and hyphae form a close network resembling a tissue–like mass with the algal cells. The fungi obtain their food either saprophytically from dead organic matter or eats by parasitic mode of actions from the living bodies of host organisms [1].

Algae synthesize their own food from carbon dioxide and water. Food materials from the alga diffuse out and are absorbed by the fungus. However, the reproductive organs are entirely fungal in nature [2].

There are two types of photobionts - a green and a blue-green alga. In most of the lichens, the main photobiont is a green alga. In some of the foliose lichens, blue-green alga acts as the primary photobiont. Blue-green algal symbiosis mainly found in leguminous trees which

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shows their primitiveness, and there had been a shift from blue-green alga to green alga, as the latter being more efficient in photosynthesis [3].

Morphologically, the thallus of lichens shows variations in its structure such as crustose, squamolose, foliose and fruiticose forms. If the thallus is partially or superficially or completely developed within the substrate like rocks or bark, the fructification (ascocarp) is partially or fully visible. Generally, lichens stores green algae as the photobiotic component, and ascomycetes fungi as a mycobiont, which acts as modified vegetative or asexual propagules [4].

On the basis of substratum, lichens are classified as corticolous (on bark of trees), saxicolous (on rocks), terricolous (on soil) and follicolous (on leaf surfaces) [5]. Lichen is a highly diverse group and because of its universal distribution, they play very significant roles in the pioneer but when we compare with other group of plants they receive little scientific attention [6].

Sacred groves, the tribal community- based repositories of plant diversity, are fragments of landscape with distinctive ecological features; afford protection on the basis of sacredness or religious practice or faith [7]. The groves are distributed uniformly in West Midnapore district, West Bengal, India, in the form of densely wooded natural patches, mainly angiospermic flora with perennial water resources in its vicinity. As being a unique ecosystem, it helps in soil and water conservation, preserving the biological wealth. They are the treasure house of many cryptogamic and phanerogamic plants such as algae, fungi, lichen, bryophyte, pteridophyta and angiosperms [8, 9].

The general floristic composition and physiognomy of vegetation of sacred groves are typically as the semi-evergreen forest [10]. The vegetation in undisturbed groves is luxuriant and comprises several stories of trees mixed with shrubs, lianas and herbs [11]. The soil is rich in humus, and covered with thick litter. Such types of groves create micro-climatic conditions, encouraging luxuriant growth of moisture-loving lichens including other growth forms, of immense ecological and economical values [12, 13].

The distribution of lichens (as in other cryptogams) is largely influenced by microclimatic factors such as topography, land cover and water. In sacred groves, four major ecological factors that produce several microclimatic niches for the growth of lichens are substrate, vegetation, climate and altitude [14]. The sacred grove provides a wide range of substrates for the growth of lichens, and hence, of the total 129 species of lichens, 116 are corticolous, 11 are saxicolous and 2 are follicolous.

Study Area

West Midnapore district lies between 22° 57' 10" to 21° 36' 35" N latitude and 88° 12' 40" to 86° 33' 50" E longitude, located in the southern part of West Bengal, India. It is bounded by Bankura district from the northern side and East Midnapore district from the south-eastern side. The southern boundary of the district is merged with Balasore and Mayurbhanj districts of Orissa, and the western boundary is merged with Singbhum, and east district of Jharkhand (Fig. 1).

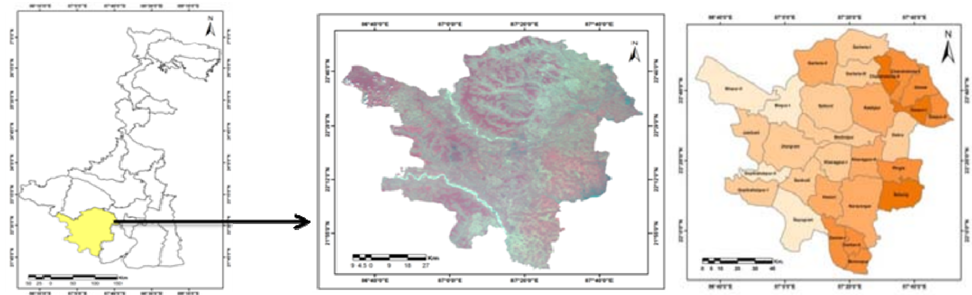

Fig. 1. Satellite and map view of West Medinipur district.

The human population of the district is 5943300 (density 640/km^2), with 18.05% schedule castes and 14.87% schedule tribes population. Geographically, the area is 9295.28km^2, which is further divided into four sub-divisions, 29 blocks and 8 municipalities.

Location and Topography

West Midnapore district represents regional diversity in terms of physiographic, agro-climatic characteristics and social composition etc. Geo-morphologically, the district is sub-divided into three parts, *viz.* Chhotonagpur flanks with hills, mounds and rolling lands in the westernmost part, Rahr plain with lateritic uplands in the middle part and Alluvial plain of the east with recent deposits. It is hilly towards the north-west, represents low basins in the south-east and east. It has drought-affected dry areas in the west, but highly wet flood-affected in the east. Dense semi-evergreen forest in the west is replaced by semi-aquatic vegetations of marshy lands in the east. It has barren lateritic, non-arable lands in the west and north-west, which gradually changes with highly productive alluvial soil areas in the central and eastern part of the district. It is the abode of tribes and primitive tribes (Bhumij, Kheria, Lodha, Mahali, Munda and Santal) in the western blocks, while most of the area is inhabited by almost all castes of the society, representing the diverse culture across blocks.

Extremely rugged topography is seen in the western part of the district and rolling topography is experienced consisting of lateritic areas. These rolling plains gradually merge into flat alluvial and deltaic plains to the east and south east of the district [15].

Climate and Soil

The climate of the region is tropical; the terrain is characterized by hard rock uplands, lateritic areas, and flat alluvial and deltaic plains with fairly fertile soil. The area experiences an annual rainfall of 1400 - 1500mm, but is highly erratic for the last few years. The mean temperature of the area is between maximum of 44°C during peak summer and minimum 10°C during the coldest days of winter.

Methodology

Different species of lichens were opportunistically collected from ten different species of dicotyledonous trees from ten selected sacred groves of an (area more than 5 acres) and from rocks at ten different localities. Intensive sampling of lichens was carried out from January, 2010 to February, 2012. Lichens were collected along with substratum using sharp knife. The specimens were procured very precisely without damaging the thallus. Various species of lichen were also encountered through collection of fallen branches and twigs on the ground. The specimens were cleaned carefully by removing debris, sundried and deposited in the laboratory herbaria. Later, the species of lichens were identified upto species level using light compound binolcular microscope and also identified with the help of standard techniques such as spot tests, UV-light and Thin Layer Chromatography (TLC) [16-17]. The identification of each species of lichen was done using relevant keys, published literature and technical monographs [18-22].

Results and Discussions

The lichen flora of the studied sacred groves was of tropical type, confined mostly on trees including few species grown on rocky substrate (Table 1). The few individuals of *Shorea robusta* was found to provide suitable habitat for rich growth of lichens (74 species). The other tree species harbouring lichens were *Pongamia pinnata* (11 species); *Schleichera oleosa* (8 species); *Wrightia antidysenterica* (7 species); *Albizia lebbeck*, *Butea monosperma*, *Diospyros melanoxylon* and *Mangifera indica* (3 species each), and *Bombax ceiba*, and *Sapindus trifoliatus* (2 species each) (Table 2, Fig. 2).

Table 1. Occurrance of lichens in selected sacred groves of West Midnapore district, West Bengal, India.

Sr. No.	Lichen Species	Family	Habit	Habit	Substratum/Host plant
1.	*Anisomeridium terminatum* (Nyl.) R. C. Harris	*Monoblastiaceae*	Cr.	C	*Mangifera indica* L. **(Anacardiaceae)**
2.	**Anthracothecium thwaitesii** (Leight.) Müll. Arg.	*Pyrenulaceae*	Cr.	C	*Schleichera oleosa* (Lour.) Merr. **(Sapindaceae)**
3.	*Arthonia translucens* Stirt.	*Arthoniaceae*	Cr.	C	*Schleichera oleosa* (Lour.) Merr. **(Sapindaceae)**
4.	*Arthonia tumidula* Leight.	*Arthoniaceae*	Cr.	C	*Diospyros melanoxylon* Roxb. (**Ebenaceae**)
5.	*Arthonia medusula* (Pers.) Nyl.	*Arthoniaceae*	Cr.	C	*Diospyros melanoxylon* Roxb. (**Ebenaceae**)
6.	*Arthothelium albescens* Patw. & Makhija	*Arthoniaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
7.	*Arthothelium confertum* (A.L. Sm.) Makhija & Patw.	*Arthoniaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
8.	*Arthothelium erumpens* Müll. Arg.	*Arthoniaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
9.	*Arthothelium pycnocarpoides* Müll. Arg.	*Arthoniaceae*	Cr.	C	*Sapindus trifoliatus* L. **(Sapindaceae)**
10.	*Bacidia alutacea* (Kremp.) Zahlbr.	*Ramalinaceae*	Cr.	C	*Diospyros melanoxylon* Roxb. **(Ebenaceae)**
11.	*Bacidia convexula* (Müll. Arg.) Zahlbr.	*Ramalinaceae*	Cr.	C	*Pongamia pinnata* (L.) Pierre **(Fabaceae)**
12.	*Bacidia medialis* (Tuck. ex Nyl.) B. de Lesd.	*Ramalinaceae*	Cr.	C	*Pongamia pinnata* (L.) Pierre **(Fabaceae)**
13.	*Bacidia millegrana* (Taylor) Zahlbr.	*Ramalinaceae*	Cr.	C	*Schleichera oleosa* (Lour.) Merr. **(Sapindaceae)**
14.	*Bacidia phaeolomoides* (Müll. Arg.) Zahlbr.	*Ramalinaceae*	Cr.	C	*Shorea robusta Gaertn.* **(Dipterocarpaceae)**
15.	*Bacidiospora psorina* (Nyl. ex Hue) Kalb	*Ramalinaceae*	Cr.	C	*Albizia lebbeck* (L.) Benth. **(Fabaceae)**
16.	*Bathelium benguelense* Müll. Arg.	*Trypetheliaceae*	Cr.	C	*Schleichera oleosa* (Lour.) Merr. **(Sapindaceae)**
17.	*Bathelium madreporiforme* (Eschw.) Trevis.	*Trypetheliaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
18.	*Bathelium tuberculosum* (Makhija & Patw.) R. C. Harris	*Trypetheliaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
19.	*Bulbothrix isidiza* (Nyl.) Hale	*Parmeliaceae*	Fo.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
20.	*Byssoloma tricholomum* (Mont.) Zahlbr.	*Pilocarpaceae*	Cr.	F	
21.	*Caloplaca bassiae* (Ach.) Zahlbr.	*Teloschistaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
22.	*Caloplaca herbidella* (Hue) H. Magn.	*Teloschistaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
23.	*Caloplaca indurata* V. Wirth & Vezda	*Teloschistaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
24.	*Caloplaca vitellinula* (Nyl.) H.Olivier	*Teloschistaceae*	Cr.	S	
25.	*Caloplaca aurantia* (Pers.) Hellb.	*Teloschistaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
26.	*Chapsa pseudophlyctis* (Nyl.) Frisch	*Graphidaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
27.	*Chrysothrix candelaris* (L.) J. R. Laundon	*Chrysothricaceae*	Cr.	C	*Pongamia pinnata* (L.) Pierre **(Fabaceae)**
28.	*Cryptothecia bengalensis* Jagadeesh, G. P. Sinha & Kr. P. Singh	*Arthoniaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
29.	*Cryptothecia effusa* (Mull. Arg.) R. Sant.	*Arthoniaceae*	Cr.	C	*Wrightia antidysenterica* (L.) R.Br. **(Apocynaceae)**
30.	*Cryptothecia involuta* Stirt.	*Arthoniaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
31.	*Cryptothecia multipunctata* Jagadeesh, G. P. Sinha & Kr. P. Singh	*Arthoniaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
32.	*Cryptothecia subtecta* Stirt.	*Arthoniaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
33.	*Diorygma hieroglyphicum* (Pers.) Staiger & Kalb	*Graphidaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
34.	*Diorygma junghuhnii* (Mont. & Bosch) Kalb, Staiger & Elix	*Graphidaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
35.	*Diorygma megasporum* Kalb, Staiger & Elix	*Graphidaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
36.	*Diorygma pruinosum* (Eschw.) Kalb, Staiger & Elix	*Graphidaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
37.	*Diorygma radiatum* (D.D. Awasthi & S.R. Singh) Kr.P. Singh & Swarnalatha	*Graphidaceae*	Cr.	S	
38.	*Diploschistes muscorum* (Scop.) R. Sant.	*Thelotremataceae*	Cr.	S	
	Dyplolabia afzelii A. Massal.	*Graphidaceae*	Cr.	C	*Butea monosperma* (Lam.) Taub. **(Fabaceae)**
40.	*Glyphis cicatricosa* Ach.	*Graphidaceae*	Cr.	C	*Pongamia pinnata* (L.) Pierre **(Fabaceae)**
41.	*Glyphis duriuscula* Stirt.	*Graphidaceae*	Cr.	C	*Bombax ceiba* L.**(Malvaceae)**
42.	*Glyphis scyphulifera* (Ach.) Staiger	*Graphidaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
43.	*Graphina platycarpa* (Eschw.) Zahlbr.	*Graphidaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
44.	*Graphis acharii* Fée	*Graphidaceae*	Cr.	C	*Butea monosperma* (Lam.) Taub. **(Fabaceae)**
45.	*Graphis albidofarinacea* Adaw. & Makhija	*Graphidaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
46.	**Graphis albissima** Mull.Arg.	*Graphidaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
47.	*Graphis caesiella* Vainio	*Graphidaceae*	Cr.	C	*Schleichera oleosa* (Lour.) Merr. **(Sapindaceae)**
48.	**Graphis distincta** Makhija & Adaw.	*Graphidaceae*	Cr.	C	*Wrightia antidysenterica* (L.) R.Br. **(Apocynaceae)**
49.	*Graphis filiformis* Adaw. & Makhiza	*Graphidaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
50.	**Graphis furcata** Fée.	*Graphidaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
51.	**Graphis glaucescens** Fee.	*Graphidaceae*	Cr.	C	*Schleichera oleosa* (Lour.) Merr. **(Sapindaceae)**
52.	**Graphis handelii** Zahlbr.	*Graphidaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
53.	*Graphis hiascens* (Fée) A.W. Archer	*Graphidaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
54.	**Graphis japonica** (Müll. Arg.) A.W. Archer & Lücking	*Graphidaceae*	Cr.	C	*Pongamia pinnata* (L.) Pierre **(Fabaceae)**
55.	*Graphis librata* C. Knight	*Graphidaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
56.	*Graphis perticosa* (Kremp.) A.W. Archer	*Graphidaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
57.	*Graphis pinicola* Zahlbr.	*Graphidaceae*	Cr.	C	*Pongamia pinnata* (L.) Pierre **(Fabaceae)**
58.	**Graphis pyrrhocheiloides** Zahlbr.	*Graphidaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
59.	**Graphis scripta** (L.) Ach.	*Graphidaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
60.	**Graphis streblocarpa** (Bél.) Nyl.	*Graphidaceae*	Cr.	C	*Wrightia antidysenterica* (L.) R.Br. **(Apocynaceae)**
61.	**Graphis subasahinae** Nagarkar & Patw.	*Graphidaceae*	Cr.	C	*Albizia lebbeck* (L.) Benth. **(Fabaceae)**
62.	*Graphis tenella* Ach.	*Graphidaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
63.	*Graphis chlorotica* A. Massal.	*Graphidaceae*	Cr.	C	*Schleichera oleosa* (Lour.) Merr. **(Sapindaceae)**
64.	*Graphis cincta* (Pers.) Aptroot	*Graphidaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
65.	*Graphis insulana* (Müll. Arg.) Lücking & Sipman	*Graphidaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
66.	*Haematomma wattii* (Stirt.) Zahlbr.	*Haematommataceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
67.	*Herpothallon isidiatum* Jagadeesh & G.P. Sinha	*Arthoniaceae*	Cr.	C	*Wrightia antidysenterica* (L.) R.Br. **(Apocynaceae)**
68.	*Heterodermia albidiflava* (Kurok.) D.D. Awasthi	*Physciaceae*	Fo.	C	*Pongamia pinnata* (L.) Pierre **(Fabaceae)**
69.	*Heterodermia diademata* (Taylor) D. D. Awasthi	*Physciaceae*	Fo.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
70.	*Heterodermia obscurata* (Nyl.) Trevis.	*Physciaceae*	Fo.	C	*Pongamia pinnata* (L.) Pierre **(Fabaceae)**
71.	*Heterodermia pseudospeciosa* (Kurok.) W. L. Culb.	*Physciaceae*	Fo.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
72.	*Laurera aurentiaca* Makhija & Patw.	*Trypetheliaceae*	Cr.	C	*Bombax ceiba L.***(Malvaceae)**
73.	*Laurera cumingii* (Mont.) Zahlbr.	*Trypetheliaceae*	Cr.	C	*Butea monosperma* (Lam.) Taub. **(Fabaceae)**
74.	*Laurera keralensis* Upreti & Ajay Singh	*Trypetheliaceae*	Cr.	C	*Mangifera indica* L. **(Anacardiaceae)**
75.	*Laurera kundarensis* Upreti & Ajay Singh	*Trypetheliaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
76.	*Laurera vezdae* Makhija & Patw.	*Trypetheliaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**

Sr. No.	Lichen Species	Family	Habit	Habit	Substratum/Host plant
77.	*Lecanora cinereofusca* H.Magn.	*Lecanoraceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
78.	*Lecanora iseana* Räsänen	*Lecanoraceae*	Cr.	C	*Wrightia antidysenterica* (L.) R.Br. **(Apocynaceae)**
79.	*Lecidea granifera* (Nyl.) Zahlbr.	*Lecideaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
80.	*Lecidea lapicida* (Ach.) Ach.	*Lecideaceae*	Cr.	S	
81.	*Lecidea plana* (J. Lahm) Nyl.	*Lecideaceae*	Cr.	S	
82.	*Lecidella enteroleucella* (Nyl.) Hertel	*Lecanoraceae*	Cr.	S	
83.	*Leiorreuma exaltatum* (Mont. & v.d. Bosch) Staiger	*Graphidaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
84.	*Leptogium austroamericanum* (Malme) C.W.Dodge	*Collemataceae*	Fo.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
85.	*Letrouitia domingensis* (Pers.) Hafellner & Bellem.	*Letrouitiaceae*	Cr.	C	*Pongamia pinnata* (L.) Pierre **(Fabaceae)**
86.	*Letrouitia leprolyta* (Nyl.) Hafellner	*Letrouitiaceae*	Cr.	C	*Wrightia antidysenterica* (L.) R.Br. **(Apocynaceae)**
87.	*Letrouitia transgressa* (Malme) Hafellner & Bellem.	*Letrouitiaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
88.	*Miriquidica deusta* (Stenh.) Hertel & Rambold	*Lecanoraceae*	Cr.	S	
89.	*Mycomicrothelia conothele* (Nyl.) Hawksw.	*Arthopyreniaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
90.	*Myelochroa xantholepis* (Mont. & Bosch) Elix & Hale	*Parmeliaceae*	Fo.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
91.	*Myriotrema norstictideum* (Patw. & Nagarkar) D.D.Awasthi	*Thelotremataceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
92.	*Opegrapha rufescens* Pers.	*Roccellaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
93.	*Pallidogramme chrysenteron* (Mont.) Staiger, Kalb & Lücking	*Graphidaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
94.	*Parmotrema andinum* (Müll.Arg.) Hale	*Parmeliaceae*	Fo.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
95.	*Parmotrema ravum* (Krog & Swinscow) Sérus	*Parmeliaceae*	Fo.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
96.	*Parmotrema tinctorum* (Despr. ex Nyl.) Hale	*Parmeliaceae*	Fo.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
97.	*Pertusaria kodaikanalensis* M. Choisy	*Pertusariaceae*	Cr.	S	
98.	**Pertusaria melastomella** Nyl.	*Pertusariaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
99.	*Pertusaria multipuncta* (Turner) Nyl.	*Pertusariaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
100.	*Pertusaria quassiae* (Fée) Nyl.	*Pertusariaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
101.	*Phaeographis brasiliensis* (A. Massal.) Kalb & Matthes-Leicht	*Graphidaceae*	Cr.	C	*Schleichera oleosa* (Lour.) Merr. **(Sapindaceae)**
102.	*Platythecium grammitis* (Fée) Staiger	*Graphidaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
103.	*Polymeridium proponens* (Nyl.) R.C. Harris	*Trypetheliaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
104.	*Pseudopyrenula subnudata* Müll. Arg.	*Trypetheliaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
105.	*Pseudopyrenula subvelata* (Nyl.) Müll. Arg.	*Trypetheliaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
106.	*Pyrenula acutalis* R.C. Harris	*Pyrenulaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
107.	*Pyrenula anomala* (Ach.) Vain.	*Pyrenulaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
108.	*Pyrenula citriformis* R.C. Harris	*Pyrenulaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
109.	*Pyrenula introducta* (Stirt.) Zahlbr.	*Pyrenulaceae*	Cr.	C	*Pongamia pinnata* (L.) Pierre **(Fabaceae)**
110.	*Pyrenula leucotrypa* (Nyl.) Upreti	*Pyrenulaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
111.	*Pyrenula mamillana* (Ach.) Trevis.	*Pyrenulaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
112.	*Pyrenula nitens* (Fée) Fée	*Pyrenulaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
113.	*Pyrenula sublaevigata* (Patw. & Makhija) Upreti	*Pyrenulaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
114.	*Pyrenula subnitida* Müll. Arg.	*Pyrenulaceae*	Cr.	C	*Pongamia pinnata* (L.) Pierre **(Fabaceae)**
115.	*Pyrenula thelomorpha* Tuck.	*Pyrenulaceae*	Cr.	C	*Wrightia antidysenterica* (L.) R.Br. **(Apocynaceae)**
116.	*Pyxine coccifera* (Fée) Nyl.	*Physciaceae*	Fo.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
117.	*Ramboldia russula* (Ach.) Kalb, Lumbsch & Elix	*Lecanoraceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
118.	*Reimnitzia sentensis* (Tuck.) Kalb.	*Thelotremataceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
119.	*Rinodina oxydata* (A. Massal.) A. Massal.	*Physciaceae*	Cr.	S	
120.	*Sarcographa tricosa* (Ach.) Müll. Arg.	*Graphidaceae*	Cr.	C	*Albizia lebbeck* (L.) Benth. **(Fabaceae)**
121.	*Staurothele drummondii* (Tuck.) Tuck.	*Verrucariaceae*	Cr.	S	
122.	*Strigula complanata* (Fée) Mont.	*Strigulaceae*	Cr.	F	
123.	**Trypethelium eluteriae** Spreng.	*Trypetheliaceae*	Cr.	C	*Mangifera indica* L. **(Anacardiaceae)**
124.	*Trypethelium endosulphureum* Makhija & Patw.	*Trypetheliaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
125.	*Trypethelium platystomum* Mont.	*Trypetheliaceae*	Cr.	C	*Sapindus trifoliatus* L. **(Sapindaceae)**
126.	*Trypethelium pupula* (Ach.) R.C. Harris	*Trypetheliaceae*	Cr.	C	*Shorea robusta Gaertn.* **(Dipterocarpaceae)**
127.	*Trypethelium tropicum* (Ach.) Müll. Arg.	*Trypetheliaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
128.	*Tylophoron protrudens* Nyl.	*Arthoniaceae*	Cr.	C	*Shorea robusta* Gaertn. **(Dipterocarpaceae)**
129.	*Verrucaria rupestris* Schrader	*Verrucariaceae*	Cr.	S	

Abbreviations: C-Corticolus, Cr-Crustose, F-Follicolus, Fo-Foliose, S-Saxicolous

Table 2. Lichen Species hosted by tree species.

Sr. No.	Family	Scientific Name	No. of Species hosted
1.	Anacardiaceae	*Mangifera indica* L.	3
2.	Apocynaceae	*Wrightia antidysenterica* (L.) R.Br.	7
3.	Dipterocarpaceae	*Shorea robusta* Gaertn.	74
4.	Ebenaceae	*Diospyros melanoxylon* Roxb.	3
5.	Fabaceae	*Albizia lebbeck* (L.) Benth.	3
		Butea monosperma (Lam.) Taub.	3
		Pongamia pinnata (L.) Pierre	11
7.	Malvaceae	*Bombax ceiba* L.	2
8.	Sapindaceae	*Sapindus trifoliatus* L.	2
1		*Schleichera oleosa* (Lour.) Merr.	8
	Total (7)	**10**	**116**

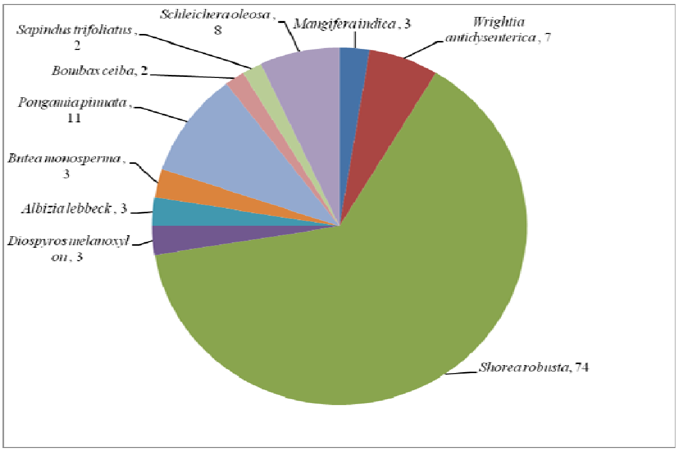

Fig. 2. Lichen species hosted by the plant.

The study revealed the occurrence of 22 families of lichens represented by 52 genera and 129 species. Graphidaceae (38 species) was the most dominant family, followed by Trypetheliaceae (16); Arthoniaceae (14); Pyrenulaceae (11); Physciaceae and Ramalinaceae (6 each); Lecanoraceae, Parmeliaceae, and Teloschistaceae (5 each); Pertusariaceae (4); Lecideaceae, Letrouitiaceae, and Thelotremataceae (3 each); Verrucariaceae (2); Arthopyreniaceae, Chrysothricaceae, Collemataceae, Haematommataceae, Monoblastiaceae, Pilocarpaceae, Roccellaceae, and Strigulaceae (1 each) (Table 3, Fig. 3). Among the various growth forms crustose was the dominant (118 species) than foliose (11 species). On the basis of substratum, the studied lichens of the sacred groves was found to prefer corticolous (116 species on bark) habitat, followed by saxicolous (11 on rock), and follicolous (2 on leaf) habitat.

The rich lichen flora on a particular tree is dependent on a wide range of interrelated factors. The microclimate exhibited by various parts of encountered tree species including the mature substratum, are two important factors in determining the lichen growth on a tree. The age, smoothness, roughness, and spongy nature of bark, along with pH, nutrient status, buffer capacity and water holding capacity of soil are other important factors affecting the growth of lichens on the trees. The reason for rich lichen flora harboured by *Shorea robusta* could be due to the variation of the tree bark at different parts of the tree [23].

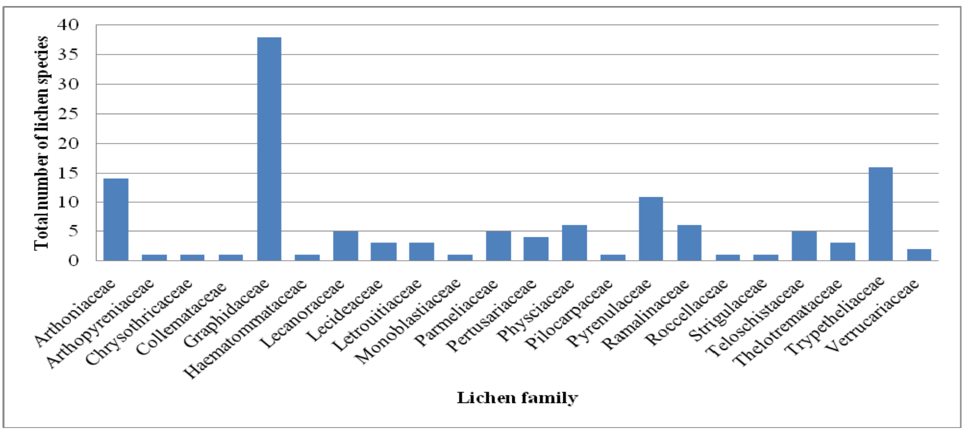

Fig. 3. Total number of lichen species with family.

Table 3. Enumeration of Family, Genus and Species of Lichens.

Sr. No.	Family	Genus	Species	
			Genus-wise	Total
1.	Arthoniaceae Reichenb. ex Reichenb.	*Arthonia*	3	
		Arthothelium	4	
		Cryptothecia	5	
		Herpothallon	1	
		Tylophoron	1	14
2.	Arthopyreniaceae W. Watson	*Mycomicrothelia*	1	1
3.	Chrysothricaceae Zahlbr.	*Chrysothrix*	1	1
4.	Collemataceae Zenker	*Leptogium*	1	1
5.	Graphidaceae Dumort.	*Chapsa*	1	
		Diorygma	5	
		Dyplolabia	1	
		Glyphis	3	
		Graphina	1	
		Graphis	22	
		Leiorreuma	1	
		Pallidogramme	1	
		Phaeographis	1	
		Platythecium	1	
		Sarcographa	1	38
6.	Haematommataceae Hafellner	*Haematomma*	1	1
7.	Lecanoraceae Körb.	*Lecanora*	2	
		Lecidella	1	
		Miriquidica	1	
		Ramboldia	1	5
8.	Lecideaceae Chevall.	*Lecidea*	3	3
9.	Letrouitiaceae Bellem. & Hafellner	*Letrouitia*	3	3
10.	Monoblastiaceae W. Watson	*Anisomeridium*	1	1
11.	Parmeliaceae Zenker	*Bulbothrix*	1	
		Myelochroa	1	
		Parmotrema	3	5
12.	Pertusariaceae Körb. ex Körb.	*Pertusaria*	4	4
13.	Physciaceae Zahlbr.	*Heterodermia*	4	
		Pyxine	1	
		Rinodina	1	6
14.	Pilocarpaceae Zahlbr.	*Byssoloma*	1	1
15.	Pyrenulaceae Rabenh.	**Anthracothecium**	1	
		Pyrenula	10	11
16.	Ramalinaceae C. Agardh	*Bacidia*	5	
		Bacidiospora	1	6
17.	Roccellaceae Chevall.	*Opegrapha*	1	1
18.	Strigulaceae Zahlbr.	*Strigula*	1	1
19.	Teloschistaceae Zahlbr.	*Caloplaca*	5	5
20.	Thelotremataceae (Nyl.) Stizenb.	*Diploschistes*	1	
		Myriotrema	1	
		Reimnitzia	1	3
21.	Trypetheliaceae Zenker	*Bathelium*	3	
		Laurera	5	
		Polymeridium	1	
		Pseudopyrenula	2	
		Trypethelium	5	16
22.	Verrucariaceae Zenker	*Staurothele*	1	
		Verrucaria	1	2
	Total 22	**52**	**129**	**129**

Threats and Conservation

Lichens are very sensitive organisms and their response to the environmental changes may include changes in their diversity, abundance, morphology, physiology, accumulation of pollutants, etc. [24]. The main threats that apply to biodiversity in general are also true for lichens, e.g. habitat fragmentation, habit degradation and loss, overexploitation, air pollution and the change of climate [25]. The rapid urbanization, agriculture, tourism and small scale industrialization in remote areas lead to the fast extinction of the sacred groves as well as the lichens.

Lichens are slow growing organisms, and thus, if once removed from their habitat, they will take several years to re-establish or ultimately disappears [26]. Conservation of their habitats is very important to prevent the extinction of lichens. It can be done by developing strategies for *in-situ* and *ex-situ* conservation. The overexploitation of natural resources should be reduced and conservation areas must be prioritized. It is important to create awareness among people about the importance and conservation of lichens.

Conclusions

Sacred groves are religiously protected areas provide a comprehensive and rich ecological niche as repositories of genetic diversity. Moreover, it is felt that there are tremendous direct and indirect pressures at work on the groves threatening their existence. These threats can be related to increasing prospects of tourism, higher demands for NTFPs, fuel wood collection, decrease in the religious faiths along with fall in the commitment of the present generation towards such natural sacred areas, and lastly, the heavy burden of developmental interventions are prepared to undertake. Microclimatic conditions of sacred groves play an important role in the ecology of lichen. Availability of water, sunlight, moderate climate, unpolluted atmosphere, wind condition and type of substratum are the major factors responsible for the optimal growth of lichens. From the present study, it has become evident that sacred grove abodes a good number of lichen in its rich habitats which are getting depleted due to various factors. Little attention of administrators towards the deteriorating condition of holy places and the groves add another dimension. Such gene pool reserves can definitely serve as icons of *in situ* conservation under the prevailing times through a good mixture of scientific measures and awareness building efforts with the active involvement of the local community and the government.

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