*Indian Journal of Biological Sciences, 24 : 1-12, 2018 : ISSN No. 0972-8503*

# EVALUATION OF LICHEN DIVERSITY ON LIANAS IN SELECTED SACRED GROVES OF WEST MIDNAPORE DISTRICT, WEST BENGAL

**Uday Kumar Sen***
Ecology & Taxonomy Laboratory, Department of Botany & Forestry
Vidyasagar University, Midnapore - 721102
West Bengal, India

ABSTRACT ■ The sacred groves are fairly well studied for the anthropological, ecological, botanical, zoological and conservation perspectives. However, there are a few publications on lichens of sacred groves. The lichens have long been considered sensitive indicators for monitoring environmental state. The present study documents 80 species of lichens representing 43 genera of 19 families in twenty one selected sacred groves of West Midnapore district, West Bengal. *Combretum decandrum* Jacq. exhibited the maximum diversity of lichens in form of 45 species. This work is likely to foster further studies on lichen-diversity in other regions of West Bengal for a better understanding of the associated biodiversity and environment.

**Key words:** Conservation, Diversity, Liana, Lichen, Sacred grove

## INTRODUCTION

Lichens are interesting symbiotic association of green and non-green thallophytes, which thrive in a variety of habitats, being most abundant in subtropical and temperate climates. These require high levels of humidity for better growth and can grow easily on soil, bark and leaf of the plant, and on rocks. Growth-forms of lichen have many characteristic features. They are thalloid, attached to substratum in three forms: crustose, foliose and fruticose. Primarily lichens are symbiotic associations of fungi and algae. The major fungal component belongs to ascomycetes, for which most of the lichens are known as ascolichens (Ahmadjian, 1993). Lichens with cyanobacterial symbionts contribute significantly to forest nitrogen fixation (Bergman et al., 1992). Besides many other uses including folk uses, lichens are also used as pollution monitors and in dating of rocks.

Lianas are woody climbers rooted in the soil which use other plants, especially trees, as support for growth away from the ground (Holbrook and Putz, 1996). It is mostly assumed that the particular advantage of this habit is to allow these plants to escape from deep shade and to reach the upper canopy of forests. This implies that their seeds would germinate in the shade and seedlings initially would grow upwards and develop in the shade. In the tropical south West Bengal, lush growth of lianas, however, is mostly found in

* **Corresponding author** : e-mail: uudaysen@gmail.com

undisturbed forests especially the sacred groves. Lianas in fact can slow down successions in the reinvasion of gaps, in that they suppress climax species, and thus, support the growth of pioneer species (Schnitzer et al., 2000). Growth of saplings of trees is not only inhibited by lianas via competition for light, but also below ground via competition in the rooting medium (Schnitzer et al., 2005). Perhaps, by clasping other plants they are just saving investment in thick stems which would provide independent support for their biomass.

Shoots of lianas wind around branches of a support or form coils, which are then modified by their secondary thickening, so that the wood with a thick bark develops in the form of bands forming rope or cable like structures which are resistant to torsion.

Sacred groves, the tribal community-based repositories of plant diversity, are fragments of landscape with distinctive ecological features to afford protection to biodiversity on the basis of sacredness or religious practice or faith (Bhakat et al., 2008). The groves are distributed uniformly in West Midnapore district, West Bengal, India, in the form of densely wooded natural patches, mainly of angiosperm flora with perennial water resources in vicinity. As 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, bryophyta, pteridophyta and angiosperms (Nayaka and Upreti, 2004; Singh et al., 2012).

The general floristic composition and physiognomy of the vegetation of sacred groves are typically as the semi-evergreen forests (FSI, 2015). The vegetation in undisturbed groves is luxuriant and comprises several stories of trees mixed with shrubs, lianas and herbs (Sen and Bhakat, 2012). 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 economic values (Upreti et al., 2005; Kumar, 2009).

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 (Nayaka et al., 2013). The sacred grove provides a wide range of substrates for the growth of lichens, and hence, total 80 species of lichens belongs to corticolous category.

## STUDY AREA

The West Midnapore district is located in the southern part of West Bengal, India. It is bounded by Bankura and Hooghly districts in the northern side, Howrah district in the northeastern side and East Midnapore district in the southeastern side. The western boundary is merged with Jhargram district of West Bengal (Fig. 1).

### *Location and Topography*

The West Midnapore district exhibits regional diversity in terms of physiographic, agro-climatic characteristics and social composition etc. Geo-morphologically, the district is subdivided 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 southeast 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 southeast of the district (Anon, 2011).

***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 - 1500 mm, 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 lianas from twenty one selected sacred groves (area more than 1 hectare). Intensive sampling of lichens was carried out from January, 2015 to February, 2017. Lichens were collected along with substratum using a 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, sun-dried and deposited for preservation. Later, the species of lichens were studied using light compound binocular microscope and identified up to species level with the help of standard techniques such as spot tests, UV-light and Thin Layer Chromatography (TLC) (Elix and Ernst-Russel, 1993; Orange et al., 2001) and relevant literature including keys and technical monographs (Huneck and Yoshimura, 1996; Rout et al., 2010; Singh and Sinha, 2010; Vinayaka et al., 2010; Singh and Kumar, 2012).

**RESULTS AND DISCUSSIONS**

The lichen flora on lianas of the sacred groves studied was of tropical type (Table 1). Among the liana-species *Combretum decandrum* was found to provide suitable habitat for rich growth of lichens (45 species). The other lichen-accommodating lianas were *Acacia torta*, *Bauhinia vahlii* and *Derris scandens* (13 species each); *Hiptage benghalensis* (10 species); *Aganosma heynei* and *Vallaris solanacea* (8 species each); *Capparis zeylanica* (3 species); *Ventilago denticulata* and *Ziziphus oenopolia* (2 species each) (Table 3; Fig. 2).

The study revealed the occurrence of 19 families of lichens represented by 43 genera and 80 species. Graphidaceae (24 species) was the most dominant family, followed successively by Arthoniaceae and Trypetheliaceae (10 species each); Pyrenulaceae (9 species); Ramalinaceae (4 species); Lecanoraceae, Parmeliaceae and Physciaceae (3 species each); Letrouitiaceae, Pertusariaceae and Thelotremataceae (2 species each) (Table 2; Fig. 3). Another set of eight families contains a single species, each namely Arthopyreniaceae, Chrysothricaceae, Collemataceae, Haematommataceae, Lecideaceae, Monoblastiaceae, Roccellaceae and Teloschistaceae (Table 2). Among the various growth forms crustose were the

**Table 1.** Occurrence of lichens in selected lianas of West Midnapore district, West Bengal, India.

| Sl. No. | Lichen Species | Family | Habit | Habitat | Substratum/Host plant (Table 3) |
|---|---|---|---|---|---|
| 1. | *Anisomeridium terminatum* (Nyl.) R. C. Harris | Monoblastiaceae | Cr. | C | Cz |
| 2. | *Anthracothecium thwaitesii* (Leight.) Müll. Arg. | Pyrenulaceae | Cr. | C | Hb |
| 3. | *Arthonia translucens* Stirt. | Arthoniaceae | Cr. | C | Hb |
| 4. | *Arthonia medusula* (Pers.) Nyl. | Arthoniaceae | Cr. | C | Vd/Zo |
| 5. | *Arthothelium albescens* Patw. & Makhija | Arthoniaceae | Cr. | C | Bv/Cd |
| 6. | *Arthothelium pycnocarpoides* Müll. Arg. | Arthoniaceae | Cr. | C | Hb |
| 7. | *Bacidia alutacea* (Kremp.) Zahlbr. | Ramalinaceae | Cr. | C | Vd/Zo |
| 8. | *Bacidia convexula* (Müll. Arg.) Zahlbr. | Ramalinaceae | Cr. | C | At/Bv/Ds |
| 9. | *Bacidia phaeolomoides* (Müll. Arg.) Zahlbr. | Ramalinaceae | Cr. | C | Cd |
| 10. | *Bacidiospora psorina* (Nyl. ex Hue) Kalb | Ramalinaceae | Cr. | C | At/Ds |
| 11. | *Bathelium benguelense* Müll. Arg. | Trypetheliaceae | Cr. | C | Hb |
| 12. | *Bathelium madreporiforme* (Eschw.) Trevis. | Trypetheliaceae | Cr. | C | Cd/Hb |
| 13. | *Bulbothrix isidiza* (Nyl.) Hale | Parmeliaceae | Fo. | C | Cd |
| 14. | *Caloplaca bassiae* (Ach.) Zahlbr. | Teloschistaceae | Cr. | C | Cd |
| 15. | *Chapsa pseudophlyctis* (Nyl.) Frisch | Graphidaceae | Cr. | C | Cd |
| 16. | *Chrysothrix candelaris* (L.) J. R. Laundon | Chrysothricaceae | Cr. | C | At/Bv/Ds |
| 17. | *Cryptothecia bengalensis* Jagadeesh, G. P. Sinha & Kr. P. Singh | Arthoniaceae | Cr. | C | Cd |
| 18. | *Cryptothecia effusa* (Mull. Arg.) R. Sant. | Arthoniaceae | Cr. | C | Ah/Vs |
| 19. | *Cryptothecia involuta* Stirt. | Arthoniaceae | Cr. | C | Cd |
| 20. | *Cryptothecia subtecta* Stirt. | Arthoniaceae | Cr. | C | Cd |
| 21. | *Diorygma megasporum* Kalb, Staiger & Elix | Graphidaceae | Cr. | C | Cd |
| 22. | *Dyplolabia afzelii* A. Massal. | Graphidaceae | Cr. | C | At/Bv/Ds |
| 23. | *Glyphis cicatricosa* Ach. | Graphidaceae | Cr. | C | At/Bv/Ds |
| 24. | *Glyphis scyphulifera* (Ach.) Staiger | Graphidaceae | Cr. | C | Cd |
| 25. | *Graphina platycarpa* (Eschw.) Zahlbr. | Graphidaceae | Cr. | C | Cd |
| 26. | *Graphis acharii* F'ee | Graphidaceae | Cr. | C | At/Bv/Ds |
| 27. | *Graphis caesiella* Vainio | Graphidaceae | Cr. | C | Hb |
| 28. | *Graphis distincta* Makhija & Adaw. | Graphidaceae | Cr. | C | Ah/Vs |
| 29. | *Graphis filiformis* Adaw. & Makhiza | Graphidaceae | Cr. | C | Cd |
| 30. | *Graphis glaucescens* Fee. | Graphidaceae | Cr. | C | Hb |

| Sl. No. | Lichen Species | Family | Habit | Habitat | Substratum/Host plant (Table 3) |
|---|---|---|---|---|---|
| 31. | *Graphis japonica* (Müll. Arg.) A.W. Archer & Lücking | Graphidaceae | Cr. | C | At/Bv/Ds |
| 32. | *Graphis librata* C. Knight | Graphidaceae | Cr. | C | Cd |
| 33. | *Graphis perticosa* (Kremp.) A.W. Archer | Graphidaceae | Cr. | C | Cd |
| 34. | *Graphis pinicola* Zahlbr. | Graphidaceae | Cr. | C | At/Bv/Ds |
| 35. | *Graphis scripta* (L.) Ach. | Graphidaceae | Cr. | C | Cd |
| 36. | *Graphis streblocarpa* (Bel) Nyl. | Graphidaceae | Cr. | C | Ah/Vs |
| 37. | *Graphis subasahinae* Nagarkar & Patw. | Graphidaceae | Cr. | C | At/Bv/Ds |
| 38. | *Graphis chlorotica* A. Massal. | Graphidaceae | Cr. | C | Hb |
| 39. | *Haematomma wattii* (Stirt.) Zahlbr. | Haematommataceae | Cr. | C | Cd |
| 40. | *Herpothallon isidiatum* Jagadeesh & G.P. Sinha | Arthoniaceae | Cr. | C | Ah/Vs |
| 41. | *Heterodermia obscurata* (Nyl.) Trevis. | Physciaceae | Fo. | C | Ah/Vs |
| 42. | *Heterodermia pseudospeciosa* (Kurok.) W. L. Culb. | Physciaceae | Fo. | C | Cd |
| 43. | *Laurera cumingii* (Mont.) Zahlbr. | Trypetheliaceae | Cr. | C | At/Bv/Ds |
| 44. | *Laurera keralensis* Upreti & Ajay Singh | Trypetheliaceae | Cr. | C | Cz |
| 45. | *Lecanora cinereofusca* H. Magn. | Lecanoraceae | Cr. | C | Cd |
| 46. | *Lecanora iseana* Rasanen | Lecanoraceae | Cr. | C | Ah/Vs |
| 47. | *Lecidea granifera* (Nyl.) Zahlbr. | Lecideaceae | Cr. | C | Cd |
| 48. | *Leiorreuma exaltatum* (Mont. & v.d. Bosch) Staiger | Graphidaceae | Cr. | C | Cd |
| 49. | *Leptogium austroamericanum* (Malme) C.W.Dodge | Collemataceae | Fo. | C | Cd |
| 50. | *Letrouitia leprolyta* (Nyl.) Hafellner | Letrouitiaceae | Cr. | C | Ah/Vs |
| 51. | *Letrouitia transgressa* (Malme) Hafellner & Bellem. | Letrouitiaceae | Cr. | C | Cd |
| 52. | *Mycomicrothelia conothele* (Nyl.) Hawksw. | Arthopyreniaceae | Cr. | C | Cd |
| 53. | *Myelochroa xantholepis* (Mont. & Bosch) Elix & Hale | Parmeliaceae | Fo. | C | Cd |
| 54. | *Myriotrema norstictideum* (Patw. & Nagarkar) D.D.Awasthi | Thelotremataceae | Cr. | C | Cd |
| 55. | *Opegrapha rufescens* Pers. | Roccellaceae | Cr. | C | Cd |
| 56. | *Pallidogramme chrysenteron* (Mont.) Staiger, Kalb & Lücking | Graphidaceae | Cr. | C | Cd |
| 57. | *Parmotrema andinum* (Mull. Arg.) Hale | Parmeliaceae | Fo. | C | Cd |
| 58. | *Pertusaria melastomella* Nyl. | Pertusariaceae | Cr. | C | Cd |
| 59. | *Pertusaria quassiae* (Fée) Nyl. | Pertusariaceae | Cr. | C | Cd |

| Sl. No. | Lichen Species | Family | Habit | Habitat | Substratum/Host plant (Table 3) |
|---|---|---|---|---|---|
| 60. | *Phaeographis brasiliensis* (A. Massal.) Kalb & Matthes-Leicht | Graphidaceae | Cr. | C | Hb |
| 61. | *Platythecium grammitis* (Fée) Staiger | Graphidaceae | Cr. | C | Cd |
| 62. | *Polymeridium proponens* (Nyl.) R.C. Harris | Trypetheliaceae | Cr. | C | Cd |
| 63. | *Pyrenula acutalis* R.C. Harris | Pyrenulaceae | Cr. | C | Cd |
| 64. | *Pyrenula anomala* (Ach.) Vain. | Pyrenulaceae | Cr. | C | Cd |
| 65. | *Pyrenula introducta* (Stirt.) Zahlbr. | Pyrenulaceae | Cr. | C | At/Bv/Ds |
| 66. | *Pyrenula leucotrypa* (Nyl.) Upreti | Pyrenulaceae | Cr. | C | Cd |
| 67. | *Pyrenula nitens* (Fée) Fée | Pyrenulaceae | Cr. | C | Cd |
| 68. | *Pyrenula sublaevigata* (Patw. & Makhija) Upreti | Pyrenulaceae | Cr. | C | Cd |
| 69. | *Pyrenula subnitida* Müll. Arg. | Pyrenulaceae | Cr. | C | At/Bv/Ds |
| 70. | *Pyrenula thelomorpha* Tuck. | Pyrenulaceae | Cr. | C | Ah/Vs |
| 71. | *Pyxine coccifera* (Fée) Nyl. | Physciaceae | Fo. | C | Cd |
| 72. | *Ramboldia russula* (Ach.) Kalb, Lumbsch & Elix | Lecanoraceae | Cr. | C | Cd |
| 73. | *Reimnitzia sentensis* (Tuck.) Kalb. | Thelotremataceae | Cr. | C | Cd |
| 74. | *Sarcographa tricosa* (Ach.) Müll. Arg. | Graphidaceae | Cr. | C | At/Bv/Ds |
| 75. | *Trypethelium eluteriae* Spreng. | Trypetheliaceae | Cr. | C | Cz |
| 76. | *Trypethelium endosulphureum* Makhija & Patw. | Trypetheliaceae | Cr. | C | Cd |
| 77. | *Trypethelium platystomum* Mont. | Trypetheliaceae | Cr. | C | Hb |
| 78. | *Trypethelium pupula* (Ach.) R.C. Harris | Trypetheliaceae | Cr. | C | Cd |
| 79. | *Trypethelium tropicum* (Ach.) Müll. Arg. | Trypetheliaceae | Cr. | C | Cd |
| 80. | *Tylophoron protrudens* Nyl. | Arthoniaceae | Cr. | C | Cd |

**Abbreviations: C**-Corticolus, **Cr**-Crustose, **Fo**-Foliose

dominant (73 species; 91%) than foliose (7 species; 9%) (Fig. 4). On the basis of substratum, the studied all lichens on the lianas of the sacred groves was found to prefer corticolous (80 species of bark) habitat (Table 1).

The 14 dominant plant genera with descending species number (=2) are *Graphis* (13 species), *Pyrenula* (8 species), *Trypethelium* (5 species), *Cryptothecia* (4 species), *Bacidia* (3 species), and 9 genera *Arthonia*, *Arthothelium*, *Glyphis*, *Lecanora*, *Letrouitia*, *Pertusaria*, *Heterodermia*, *Bathelium*, *Laurera* contain 2 species each. Remaining 29 genera contain single species each (Table 2; Fig. 5).

The rich lichen flora on a particular liana is dependent on a wide range of interrelated factors. The microclimate exhibited by various parts of encountering liana species, including the mature substratum, determines the lichen growth on a liana. The age, smoothness, roughness, and spongy nature of bark, along

**Table 2.** Enumeration of family, genus and species of lichen.

| Family | Genus | Species | |
|---|---|---|---|
| | | Genus-wise | Total |
| Arthoniaceae Reichenb. ex Reichenb. | *Arthonia* | 2 | 10 |
| | *Arthothelium* | 2 | |
| | *Cryptothecia* | 4 | |
| | *Herpothallon* | 1 | |
| | *Tylophoron* | 1 | |
| Arthopyreniaceae W. Watson | *Mycomicrothelia* | 1 | 1 |
| Chrysothricaceae Zahlbr. | *Chrysothrix* | 1 | 1 |
| Collemataceae Zenker | *Leptogium* | 1 | 1 |
| Graphidaceae Dumort. | *Chapsa* | 1 | 24 |
| | *Diorygma* | 1 | |
| | *Dyplolabia* | 1 | |
| | *Glyphis* | 2 | |
| | *Graphina* | 1 | |
| | *Graphis* | 13 | |
| | *Leiorreuma* | 1 | |
| | *Pallidogramme* | 1 | |
| | *Phaeographis* | 1 | |
| | *Platythecium* | 1 | |
| | *Sarcographa* | 1 | |
| Haematommataceae Hafellner | *Haematomma* | 1 | 1 |
| Lecideaceae Chevall. | *Lecidea* | 1 | 1 |
| Lecanoraceae Korb. | *Lecanora* | 2 | 3 |
| | *Ramboldia* | 1 | |
| Letrouitiaceae Bellem. & Hafellner | *Letrouitia* | 2 | 2 |
| Monoblastiaceae W. Watson | *Anisomeridium* | 1 | 1 |
| Parmeliaceae Zenker | *Bulbothrix* | 1 | 3 |
| | *Parmotrema* | 1 | |
| | *Myelochroa* | 1 | |
| Pertusariaceae Korb. ex Korb. | *Pertusaria* | 2 | 2 |
| Physciaceae Zahlbr. | *Heterodermia* | 2 | 3 |
| | *Pyxine* | 1 | |
| Pyrenulaceae Rabenh. | *Anthracothecium* | 1 | 9 |
| | *Pyrenula* | 8 | |
| Ramalinaceae C. Agardh | *Bacidia* | 3 | 4 |
| | *Bacidiospora* | 1 | |
| Roccellaceae Chevall. | *Opegrapha* | 1 | 1 |
| Teloschistaceae Zahlbr. | *Caloplaca* | 1 | 1 |
| Thelotremataceae (Nyl.) Stizenb. | *Myriotrema* | 1 | 2 |
| | *Reimnitzia* | 1 | |
| Trypetheliaceae Zenker | *Bathelium* | 2 | 10 |
| | *Laurera* | 2 | |
| | *Polymeridium* | 1 | |
| | *Trypethelium* | 5 | |
| **Total 19** | **43** | **80** | **80** |

**Table 3.** Total number of lichen species hosted by each liana.

| Sl. No. | Name of the liana species | Abbreviation | Family | No. of species hosted |
|---|---|---|---|---|
| 1. | *Acacia torta* (Roxb.) Craib | At | Fabaceae | 13 |
| 2. | *Aganosma heynei* (Spreng.) I.M. Turner | Ah | Apocynaceae | 08 |
| 3. | *Bauhinia vahlii* Wight & Arn. | Bv | Fabaceae | 13 |
| 4. | *Capparis zeylanica* L. | Cz | Capparaceae | 03 |
| 5. | *Combretum decandrum* Jacq. | Cd | Combretaceae | 45 |
| 6. | *Derris scandens* (Roxb.) Benth. | Ds | Fabaceae | 13 |
| 7. | *Hiptage benghalensis* (L.) Kurz | Hb | Malpighiaceae | 10 |
| 8. | *Vallaris solanacea* (Roth) Kuntze | Vs | Apocynaceae | 08 |
| 9. | *Ventilago denticulata* Willd. | Vd | Rhamnaceae | 02 |
| 10. | *Ziziphus oenopolia* (L.) Mill. | Zo | Rhamnaceae | 02 |

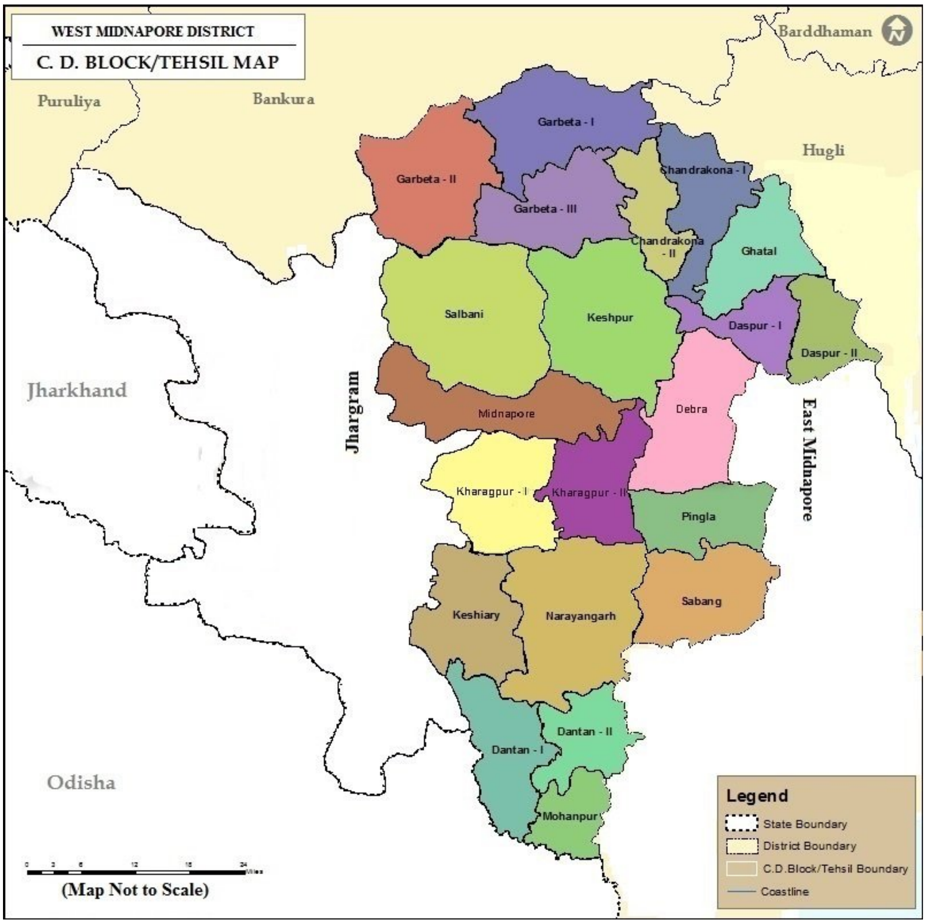


**Fig. 1:** Location map of West Midnapore district.

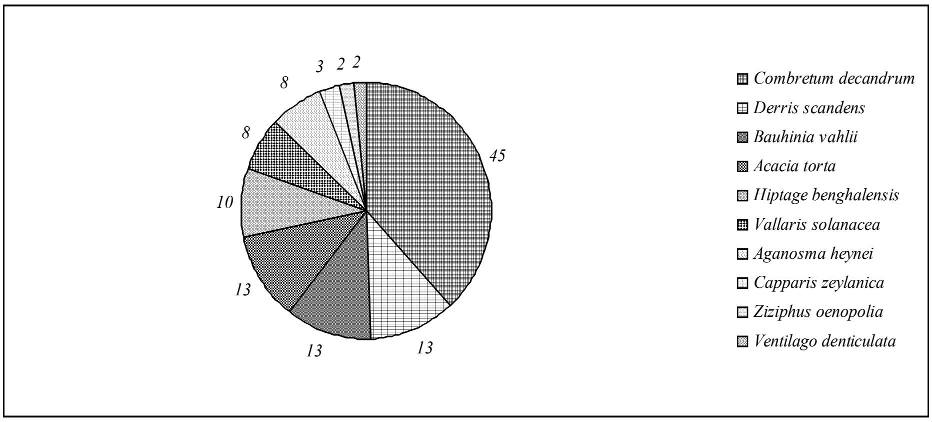


**Fig. 2:** Total number of lichen species hosted by each liana.

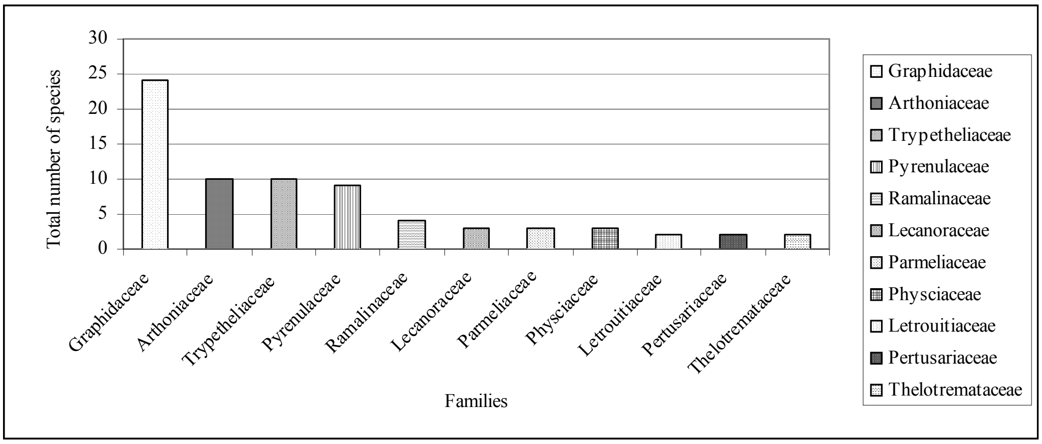


**Fig. 3:** Dominant lichen families with descending number of species (=2 species).

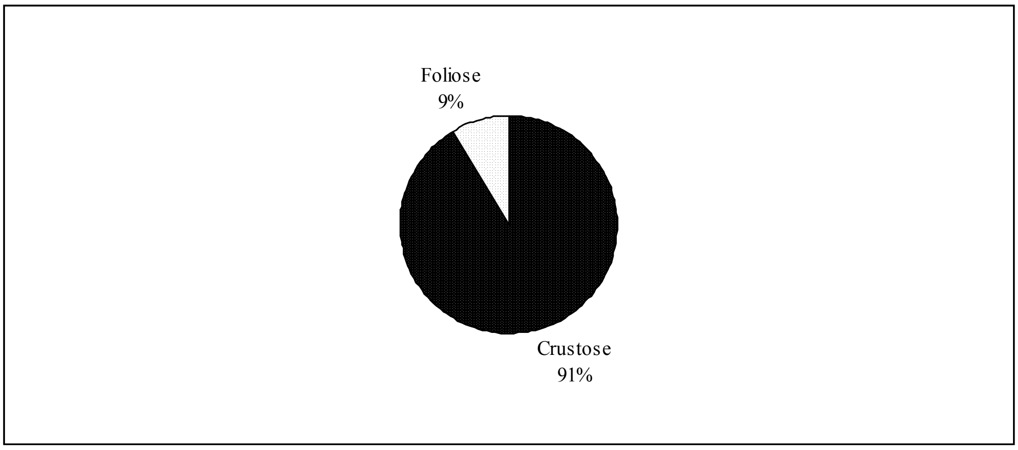


**Fig. 4:** Different growth forms of lianas.

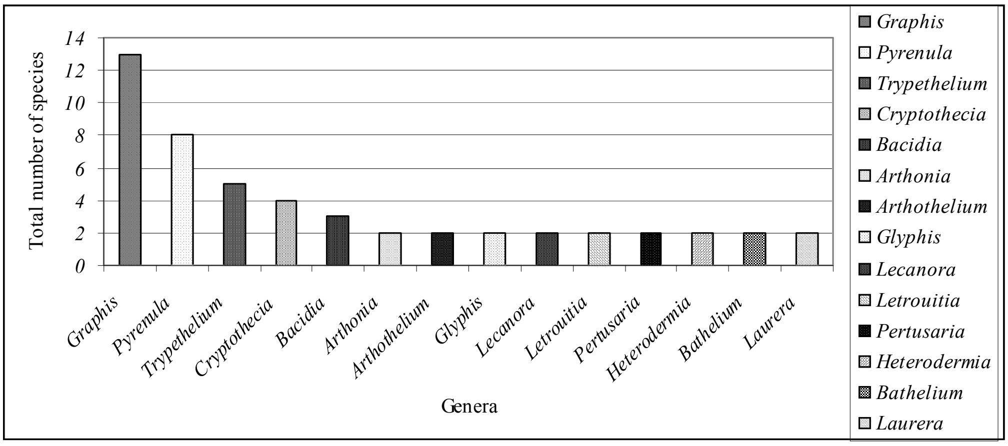


**Fig. 5:** Dominant lichen genera with descending number of species (=2 species).

with pH, nutrient status, buffer capacity and water holding capacity of soil are other important factors affecting the growth of lichens on the lianas (Satya et al., 2005). The reason for rich lichen flora harbored by *Combretum decandrum* could be due to the variation of the bark-quality in different parts of the liana.

Over the past three decades, nearly all arguments about the conservation of nature on this planet have involved the issue of biological diversity and the ways to preserve it (Margules and Pressey, 2000). Lichens have not remained immune from such inquiries, and several studies testify to the contemporary importance of conservation of lichens and their habitats (Wolseley, 1995). Ganderton et al. (2005) state "in terms of biogeography, conservation can be seen as one more element in the dynamic interactions between species and their natural environment". Such an interaction tends to maintain a desired range of taxa and habitats often against prevailing ecological and environmental changes. Many aspects of our environment are changing locally or globally as a result of human activities. These include temperature, carbon dioxide, rainfall, UV radiation, ozone, acidification and nitrification and changes in them are likely to have direct effects on lichen communities (Galloway, 1993). Conservation strategies, such as selection of protected areas, now need to take into account changes in environmental factors and human-induced events, such as rapid climate change that may shift the environmental conditions of a protected area in a way that may no longer support the taxa or ecosystems the protected area attempts to conserve (Mackey et al., 2008). Lichens over their long evolutionary history have seen many catastrophic changes in the planet's terrestrial environments and are probably much better placed with their unique symbiotic systems to survive and see some future anthropogenic mass extinction episodes.

**Threats and Conservation**

Lichens being very sensitive to the environmental changes may in response show changes in their diversity, abundance, morphology, physiology, accumulation of pollutants etc. The main threats that apply to biodiversity in general are also true for lichens, e.g. habitat fragmentation, degradation and loss, overexploitation, air pollution and climate change (Scheidegger and Werth, 2009). The rapid urbanization, agriculture, tourism and small scale industrialization in remote areas have been leading to the fast extinction of the forest vegetation as well as the lichens (Negi, 2003). Overgrazing by animals also leads to extinction of lichens. There has been a sharp increase in the demand of non-timber forest produces from the forests and hence, the irrational harvesting of lichens has become a serious hazard to biodiversity. Lichens are slow growing organisms, and thus, if once removed from their habitat, they will take several years to reestablish or ultimately disappear. Air pollution is yet another major threat to the lichens as they are sensitive to different levels of pollution (Upreti et al., 2005; Sen, 2014). Conservation of their habitat 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.

## CONCLUSION

Sacred groves are religiously protected areas that 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 non timber forest products, fuel wood collection, decrease in the religious faiths along with a fall in the commitment of the present generation towards such natural sacred areas, and lastly, the heavy burden of developmental interventions that are prepared to undertake. Microclimatic conditions of sacred groves play an important role in the ecology of lichens. 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 is evident that sacred grove abodes a good number of lichens which are getting impoverished due to various factors. The 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.

## ACKNOWLEDGMENT

The author would like to express his gratitude to the local people whose support was impressive during the collection period of lichens.

## REFERENCES

Ahmadjian, V. **1993**. *The lichen symbiosis*. John Wiley and Sons, New York. pp. 1-250.

Anon, **2011**. *District human development report*, Paschim Medinipur. Development and Planning Department. Government of West Bengal. India.

Bergman, B., Rai, A. N., Johansson, C. and Söderbäck, E. **1992**. Cyanobacterial-plant symbioses. *Symbiosis*. **14**: 61–81.

Bhakat, R. K., Sen, U. K. and Pandit, P. K. **2008**. Role of a sacred grove in conservation of plants. *Indian Forester*. **134**(7): 866-874.

Elix, J. A. and Ernst-Russel, K. D. **1993**. *Catalogue of standardized Thin Layer Chromatographic data and biosynthetic relationships for lichen substances*. Australian National University, Canberra.

FSI, **2015**. *The state of forest report*, Forest Survey of India. Ministry of Environment and Forests. New Delhi, India.

Galloway, D. J. **1996**. Lichen biogeography. *Lichen biology*. **2**: 315-335.

Ganderton, P. S., Ganderton, P. and Coker, P. **2005**. *Environmental biogeography*. Pearson Education.

Holbrook, N. M. and Putz, F. E. **1996**. Physiology of tropical vines and hemiepiphytes: plants that climb up and plants that climb down. *In*: Stephen, S., Chazdon, R. L. and Smith, A. P. (Eds.). *Tropical forest plant ecophysiology*. Springer, US. pp. 363-394.

Huneck, S. and Yoshimura, I. **1996**. *Identification of lichen substances*. Springer, Tokyo. pp. 1-493.

Kumar, B. **2009**. Lichen resource use pattern and its socioeconomic status in temperate region of Garhwal Himalaya, India. *Nature and Science*. **7**(2): 101-106.

Mackey, B. G., Watson, J. E., Hope, G. and Gilmore, S. **2008**. Climate change, biodiversity conservation, and the role of protected areas: an Australian perspective. *Biodiversity*. **9**(3-4): 11-18.

Margules, C. R. and Pressey, R. L. **2000**. Systematic conservation planning. *Nature*. **405**(6783): 243.

Nayaka, S. and Upreti, D. K. **2004**. Scope for cryptogamic studies in sacred groves-a case study of lichens from Maharashtra. *Journal of Economic and Taxonomic Botany.* **28**(1): 209-212.

Nayaka, S., Reddy, A. M., Ponmurugan, P., Devi, A., Ayyappadasan, G. and Upreti, D. K. **2013**. Eastern Ghats' biodiversity reserves with unexplored lichen wealth. *Current Science*. **104**(7): 821-825.

Negi, H. R. **2003**. Lichens: a valuable bio-resource for environmental monitoring and sustainable development. *Resonance*. **8**(1): 51-58.

Orange, A., James, P. W. and White, F. J. **2001**. *Microchemical methods for the identification of lichens*. British Lichen Society, UK. pp. 1-101.

Rout, J., Das, P. and Upreti, D. K. **2010**. Epiphytic lichen diversity in a Reserve Forest in southern Assam, North East India. *Tropical Ecology*. **51**(2): 281-288.

Satya, D., Upreti, K. and Nayaka, S. **2005**. Shorea robusta – an excellent host tree for lichen growth in India. *Current Science*. **89**(4): 594-595.

Scheidegger, C. and Werth, S. **2009**. Conservation strategies for lichens: insights from population biology. *Fungal Biology Reviews*. **23**(3): 55-66.

Schnitzer, S. A., Dalling, J. W. and Carson, W. P. **2000**. The impact of lianas on tree regeneration in tropical forest canopy gaps: evidence for an alternative pathway of gap-phase regeneration. *Journal of Ecology*. **88**(4): 655-666.

Schnitzer, S. A., Kuzee, M. E. and Bongers, F. **2005**. Disentangling above and below ground competition between lianas and trees in a tropical forest. *Journal of Ecology*. **93**(6): 1115-1125.

Sen, U. K. **2014**. Assessment of lichens in selected sacred groves of West Midnapore district, West Bengal, India. *International Journal of Conservation Science*. **5**(1): 85-94.

Sen, U. K. and Bhakat, R. K. **2012**. Sacred grove and plant conservation: an insight from taxonomy and ecology. *In*: Maiti, G. G. and Mukherjee, S. K. (Eds.). *Mutidisciplinary approaches in angiosperm systamatics*. Department of Botany, University of Kalyani. West Bengal. India. pp. 610-621.

Singh, H., Husain, T., Agnihotri, P., Pande, P. C. and Iqbal, M. **2012**. Biodiversity conservation through traditional beliefs system: a case study from Kumaon Himalayas. India. *International Journal of Conservation Science*. **3**(1): 33-40.

Singh, K. P. and Kumar, K. **2012**. A note of the lichens from Simlipal Biosphere Reserve, Odisha, India. *Indian Journal of Forestry*. **35**(3): 383-390.

Singh, K. P. and Sinha, G. P. **2010**. *Indian lichens: an annotated checklist*. Botanical Survey of India, Ministry of Environment and Forest, Government of India, India. pp. 1-571.

Upreti, D. K. 2005. Loss of diversity in Indian lichen flora. *Environmental Conservation*. **22**(4): 362-363.

Upreti, D. K., Divakar, P. K. and Nayaka, S. **2005**. Commercial and ethnic use of lichens in India. *Economic Botany*. **59**(3): 269-273.

Vinayaka, K. S., Krishnamurthy, Y. L. and Nayaka, S. **2010**. Macrolichen flora of Bhadra Wildlife Sanctuary, Karnataka, India. *Annals of Forestry*. **11**: 26–32.

Wolseley, P. A. **1995**. A global perspective on the status of lichens and their conservation. *Mitteilungen der Eidgenössischen Forschungsanstalt für Wald, Schnee und Landschaft*. **70**: 11-27.