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Short Communication: Species diversity of corticolous lichens in the arboretum of Padjadjaran University, Jatinangor, Indonesia

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Abstract. *Kusmoro J, Mayawatie B, Budiono R, Noer IS, Permatasari RE, Nurwahidah A, Satriawati R, Arum D, Saragih DE, Widya R, Jatnika MF, Makarim A, Partasasmita R. 2019. Short Communication: Species diversity of corticolous lichens in the arboretum of Padjadjaran University, Jatinangor, Indonesia. Biodiversitas 20: 1606-1616.* The lichen flora of tropical areas is still much under explored, Java in general and the Arboretum in West Java in particular, are no exceptions. The Arboretum of the main campus of Padjadjaran University, Jatinangor, Sumedang, West Java, Indonesia is representative of a typical man-made lowland tropical rain forest ecosystem in Java. It is planted with peculiar and rare species of plants, such as *Antidesma bunius, Syzygium cumini, Durio zibethinus, Caesalpinia pulcherrima, Tectona grandis, Albizzia falcataria, Swietenia mahagoni, Alstonia scholaris*, *Jatropha multifida*, *Sterculia foetida*, *Diospyrus blancoi, Hura crepitans* and *Rauvolfia serpentina.* We explored the lichen flora of this Arboretum using species of corticolous macrolichens as indicator taxa. Lichen survey was performed by exploring the different zones, such as zones for rare species, industrial plants, medicinal plants and fruit plants. Lichen diversity on 23 trees spread in 12 ha area was documented based on morphological and anatomical features, and also chemical tests. A total of 68 species of lichens, distributed in 38 genera and 12 families, were enumerated during the study. The crustose and foliose forms contributed 62% (42 species) and 37% (25 species) of the total species, respectively. Graphidaceae with 28 species and Parmeliaceae with 15 species were the dominant families, which together constituted more than 50% of the lichen populations. *Graphis librata* and *Parmeliopsis* sp. were the dominant and co-dominant species and *Drinaria picta* was another common species.

Keywords: Arboretum, corticolous lichens, species diversity

INTRODUCTION

Lichens are a highly diverse group of mutualistic organisms consisting of a fungal (the mycobiont) and a photosynthetic algal partner (the photobiont) living in a symbiotic association with each other to form a discrete structure (the thallus). The lichen thallus is a relatively stable and well-balanced system that has distinct structure and morphology that is often species-specific. The photobiont contains chlorophyll and may be either a member of the chlorophyta (green algae) in about 90% or a cyanobacterium (blue-green algae) in about 10% of the total lichens (Rogers 1992). In the lichen association, the photobiont provides the energy for maintaining life and growth of the structure, while the mycobiont offers protection to the photobiont by reducing the light intensity to which the photobiont is exposed and is also thought to enhance water uptake (Nash 2008).

Lichens constitute a significant portion of forest biodiversity worldwide (McCune 2000; Debolt et al. 2007), forming a cover of about 8% of the earth's terrestrial surface (Purvis 2000; Brodo et al. 2001). Globally, there are an estimated 14,000 species of lichens (Brodo et al. 2001). While lichens are generally believed to be more diverse in cool temperate climates, studies indicate that lichen diversity in the tropics may equal or even surpass that found in non-tropical areas (Lücking 1999). Tropical montane forests are typically characterized by a high diversity of epiphytes, both of higher plants and lichens (Gradstein et al. 1996; Komposch and Hafellner 2000; Lücking and Matzer 2001). However, little is known about their diversity in the tropical areas due to limited studies and lack of inventory data for most such areas. Consequently, large areas, especially the paleo tropics, remain mostly under-explored making it difficult to make accurate estimates of lichen diversity (Lücking 1999; Lücking and Matzer 2001; Feuerer and Hawksworth 2006; Caceres et al. 2008a; Lücking et al. 2009).

Our current knowledge of lichens in Indonesia is among the poorest in the world and studies in lichen diversity and its ecology are rare. Alexander Zahlbruckner has released "lichen flora of Java" in 1943. Noer (1989) attributed the

limited studies of lichens in Kamojang, Gunung Salak and Darajat Geothermal field of West Java to the lack of lichen expertise in the region and reference materials, and also to the fact that most botanists in Indonesia prefer to work on vascular plants. Recent studies in the tropical regions are revealing a much higher diversity than previously envisaged (Caceres et al. 2008a,b). In a recent publication of one hundred new species of lichenized fungi, Lumbsch et al. (2011) placed the estimates of the undescribed lichens at about 10,000 species, most of which are likely to be found in the tropical areas of the world. For complete global lichen diversity, more focus should therefore be placed on the tropical regions, especially on the primary forests (Sipman and Aptroot 2001).

Corticolous lichens grow epiphytically on the bark of trees and shrubs, forming one of the most striking characteristics of tropical montane forests (Gradstein et al. 2003). They play an important role in water balance and nutrient cycle in these forests; their value is exemplified by their usefulness as ecological indicators of climate and forest type (Brodo et al. 2001; Gradstein et al. 2003; Aptroot and van Herk 2007). As such, describing and analyzing these communities is a research priority for conservation of biodiversity and a prerequisite for sustainable management of tropical montane forests (Holz and Gradstein 2005).

This study is aimed at enhancing our current knowledge on the diversity of lichens in the tropics by assessing the distribution of the corticolous lichens along an altitudinal gradient in Arboretum of Padjadjaran University, Jatinangor, Indonesia. The lichen diversity data thus obtained will constitute an important baseline information for future use in biomonitoring studies.

According to Kershaw (1985), environmental conditions such as climate, substrate, light and moisture play important roles in the distribution of lichen. Lichen species with similar distribution models tend to have similar ecological requirements. Monitoring programs by lichen research that are more specific to environmental monitoring are needed to ensure that the moss ecosystems are conserved and managed sustainably to maintain their environmental benefits in the ecosystems. Unfortunately, in the case of Arboretum of Padjadjaran University main campus, Jatinangor, Sumedang, West Java, Indonesia there are no studies regarding lichen diversity and distribution that are necessary to catch the attention of the concerned public agency in the government. Assessment of these organisms is the effective tool to provide information for efficient environmental monitoring.

MATERIALS AND METHODS

Study area

The Padjadjaran University (Unpad) main campus, Jatinangor is lying in the foot of Mount Geulis and Mount Manglayang, at an elevation of 720-820 m. The coordinates are 107°77'20" E; 6°93’252” S, located in the direction of Bandung city with a straight distance of 22.75 km. Administratively, it is a part of the Hegarmanah Village, Jatinangor sub-district, Sumedang district, West Java Province, Indonesia.

The study site arboretum is located at an altitude of 723-750 meters above sea level, in coordinates of 107°46’14.13”-107°46’28.80”E and 6°55’34.41”-6°55’54.92” S. The total area Arboretum of campus is 12.5 ha. The present study was carried out from June 2018 to November 2018, in selected locations. The location map of the study is presented as Figure 1.

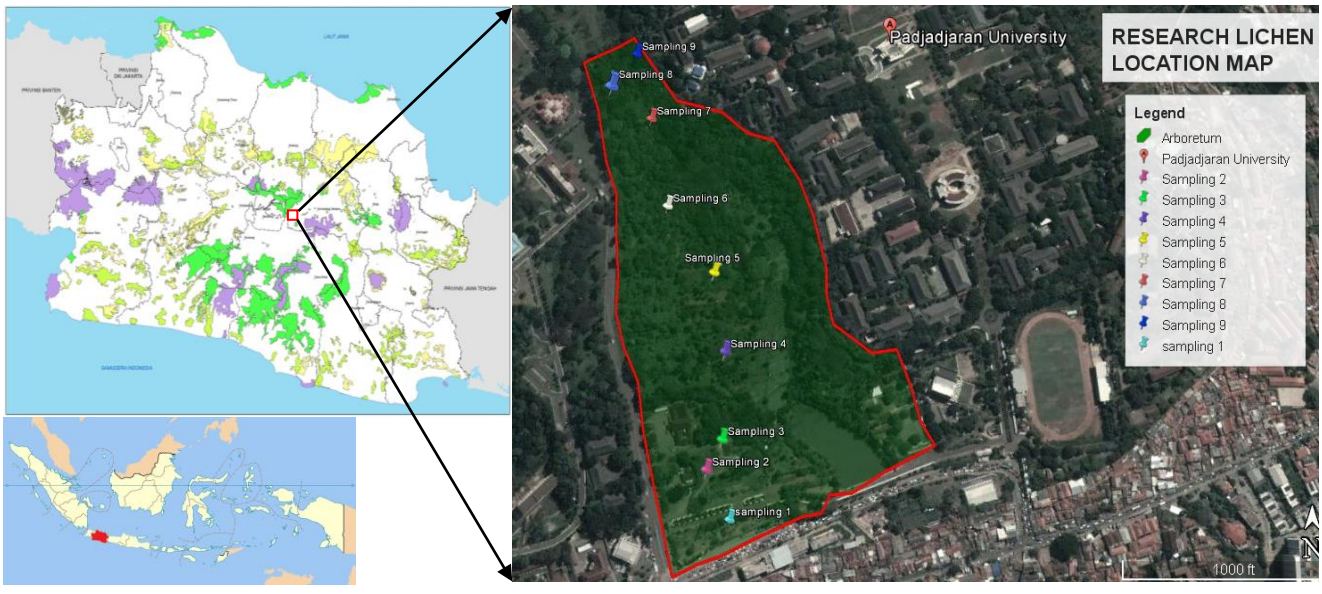


Figure 1. Locations of lichen study in the arboretum of Padjadjaran University, main campus, Jatinangor, Indonesia

A **B** **C** **D**

Figure 2. Different zones of the arboretum: A. Rare species Zone, B. Village ecosystem zone, C. Industrial plants zone, D. Identity plants zone

The Unpad campus at Jatinangor has a campus forest that is cultivated whose ecosystem is similar to native forests. The campus forest area is 62.59 ha of which an area of 24.45 ha is an arboretum. The arboretum is divided into several zones planted with various types of plants in accordance with taxonomic criteria, village ecosystem zones and regional identity categories of West Java Province. The zones of arboretum includes fruit plant zone, industrial plant zone, medicinal plant zone, rare plant zone and zone of symbollic plants of the districts (*jatidiri* plants) of West Java (Figure 2).

In general, the study area has man made forest formations dominated by plant species, such as tahiti chestnut (*Inocarpus fagifer*), chinquapin (*Castanopsis argentea*), sea mango (*Cerbera manghas*), rasamala (*Altingia excelsa*), bignay (*Antidesma bunius*), schleichera (*Schleicera oleosa*), calabash (*Crescentia cujete*), jambolan (*Syzygium cumini*), rukem (*Flacourtia rukam*), canistel (*Pouteria campheciana*), elemi (*Canarium commune*), african tuliptree (*Spathodea campanulata*), jamaica cherry (*Muntingia calabura*), monkey pod tree (*Samanea saman*), bamboo (*Schizostachyum blumei*), *Litsea fulva*, common red stem fig (*Ficus variegata*), poison fish tree (*Barringtonia asiatica*), cerlang (*Pterospermum javanicum*), white cheese wood (*Alstonia scholaris*), kiteja (*Neolitsea javanica*), Indian snake root (*Rauvolfia serpentina*), *Cinnamomum sintoc*, velvet apple (*Diospyros blancoi*) and *Alyxia reinwardtii*.

Climate

The region has tropical, warm and humid climate with two principle seasons - dry and wet season. Dry season is severe, extending from April to August while wet season starts from early September extending up to May. The temperature is 29.7 to30.9°C on wet season and humidity is high throughout the year, with an average of 87% during morning and 70 % during evening. Rainfall averages between 600 and 1000 mm per annum, and light intensity ranges from 3300 to 43200 lux.

Dominant wind direction and d wind speed based on secondary data windrose BMKG Banung class I can be conclude that the dominant wind direction is from west to east. The wind speed is 1-4 knots with a percentage of 4%.

Collection and identification of lichens

Documentation of diversity of lichens was carried out by land survey method by exploring an area of 12.35 ha starting from the ecosystem near the check dam through the zone of industrial plants, zone of rare species, village ecosystem zone, identity plants zone, and then return to garden plants in check dam area.

In each zone, 4-5 trees with a minimum of 30 cm diameter at breast height (DBH) were randomly selected for sampling lichens. The corticolous lichen specimens observed on the selected trees were collected with the help of a chisel and hammer, along with recording of ecological notes, which includes the host tree type and altitude. The collected specimens were investigated morphologically, anatomically and chemically for further identification (Kumar 2009b). The specimens were placed on a hard card sheet and packed in a lichen herbarium packet (17cm x10cm) with details of the locality, and preserved in the herbarium of the Department of Biology, Faculty of Mathematics and Natural Science, University of Padjadjaran, Jatinangor, Sumedang, West Java, Indonesia (Obermayer 2002).

Morphological features were studied under stereo microscope (Olympus CX22) with 10x to 45x magnifications and anatomical features were studied under light microscope XSZ-107BN with 40x to 400x magnifications, using optilab microscope camera. Thin hand-cut sections of thalli and ascomata mounted in water were observed.

Thalline spot test was applied for identifying lichen species that have a color reaction using 10% solution of Potassium hydroxide and 4% solution of Sodium hypochlorite or chlorine. Microcrystal test was performed by using crystallizing reagents: GE (glycerine-acetic acid), GAW (glycerine alcoholwater), GAoT (glycerine alcohol o-toluidin) and GAAn (glycerine alcohol aniline) (Hale 1974; Huneck and Yoshimura 1996).

The species of collected lichens were identified by comparing them with the characteristics given in Schumm and Aptroot (2010), Zahlbrukner (1843), and Lucking et al. (2009).

RESULTS AND DISCUSSIONS

Species diversity of lichens

Species richness is the number of species found in each substrate in the area observed (Odum 1993). The results of the study indicated that lichen diversity of the Arboretum (Unpad) of Jatinangor campus consisted of 68 species, belonging to 38 genera and 12 families (Tabel 1). Mostly they are belonging to the group Ascomycetes. The crustose and foliose forms contributed 62 % (42 species) and 37% (25 species) of total species, respectively. Graphidaceae with 28 species and Parmeliaceae with 15 species were the dominant families, which together constituted more than 50% of total lichen populations. *Graphis librata* and *Parmeliopsis* sp. were the dominant and codominant species. *Drinaria picta* was another frequently encountered species.

Eight species of trees were found in the study locations which were preferred by lichens as their habitat. They were common guajava (*Psidium guajava*), chinese petai (*Leucaena leucocephala*), neem tree (*Azadirachta indica*), surian (*Toona sureni*), mahogany (*Swietenia mahagoni*), narra (*Pterocarpus indicus*), kapok (*Ceiba petandra*), and avocado (*Persea americana*).

The results of the literature search revealed that the Graphidaceae tribe has more than 1000 recorded species globally and most of them were growing in tropical rainforests or subtropical forests.-Generally, lichens of the Graphidaceae tribe prefers tree bark as the substrate/place to grow than rock or soil (Staiger 2005). A special feature of this tribe is the white to grayish colored crustose thallus with elongated fruiting body (lirellae). The best known species is *Graphis librata* which was found in trees that grow in the green lane of the study area.

Graphis is a genus of lichenized fungi in the family Graphidaceae. According to the Krik et al. (2008), this widespread genus contains 386 species. Graphidaceae is one of the most prevailing group in lichen communities, though its classification is not well developed.

Six species of Graphidaceae which are very often found in the arboretum are: *Graphis* sp 2, *Acanthothecis claulifera, Glyphis scyphulifera, Graphis librata, Platygramme discurren*s and *Thecaria quassilicola*. The total species diversity of this genera in the arboretum area consists of 12 species, and is almost the same as that found in the geothermal area of Kamojang, West Java (Kusmoro et al. 2018), but is far more diverse than Thailand. Only 32 species of *Graphis* have been reported from the entire Thailand (Pitakpong et al. 2016). *Graphis* has a higher probability of distribution at medium altitude than in high and low regions in Thailand, while arboretum at Jatinangor is located at an altitude of about 700 m asl. Changes in environmental conditions can affect their growth. If habitat of *Graphis* is lost or changed, its populations may disappear completely. These findings are important for effective lichen conservation in the arboretum (Unpad) of Jatinangor Campus. At present, climate change may be the major cause for the loss of lichens from the study area.

Graphidaceae spreads mainly in tropical and subtropical regions. *Graphis* is the largest tropical crustoce mrolinene genus, a group that has been ignored but contributes a large part of the diversity of tropical lichen biota (Rivas Plata et al. 2012). In Thailand, the genus *Graphis* generally grows in the forest.

Crustose lichens have morphological properties in the form of crust and they do not require much water, which allows these lichens to grow easily. The current study results showed that diversity of crustose lichens was more than foliose lichens. Lichens of crustose type are considered more tolerant to air pollution because they have relatively simpler thallus structure compared to other lichen types (McCune 2006).

The type of lichens often found in the arboretum are *Parmotrema tinctorum, Graphis emersa, Cryptothecia, Lecanora helva* and *Phaeographis* sp. These type of likhens are able to tolerate conditions of pollution (State et al. 2010; Vicol 2016; Richardson 1992). Collema types of lichens are found near the Dam check and ditch, which is an indicator of the presence of moist areas.

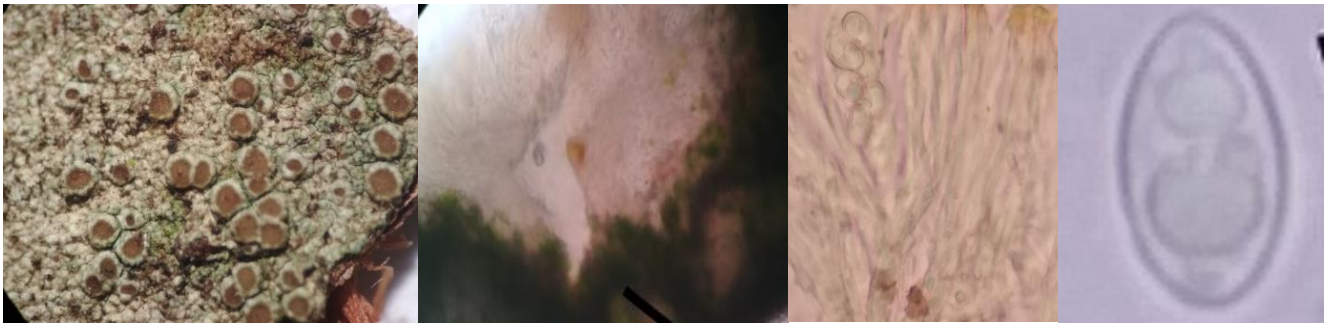
Some of the important lichens found in the study area are shown in Figures 3-12, with brief descriptions. Members of Lecanoraceae with gray-yellow thallus and apothecia appearing to be clear. Spores single (Figure 3). It is a member of Arthoniaceae. This type of lichen has a green crustose thalus and a bright red lirellae. Spores consist of 4-5 transverse septa (Figure 4). A member of Caliciaceae. It has a transverse septae of apothecia, is black, rather wide. Color of thalus is grayish green (Figure 5). It is a member of Parmeliaceae and has a foliose thalus. Grayish color on upper surface and brown lower surface. Found in Mahoni uganda trees (Figure 6). It is a member of Parmeliaceae. There is wrinkling in the middle of the thallus and lot of soredia on the edges of the lobe that is located in the middle of the thallus (Figure 7). It is a member of Parmeliaceae which has a green thalus with a lobe bent inward on the upper surface of the thallus, and rhizin on the lower surface (Figure 8). Thallus is diffuse, rather thick, powdery (leprose) crust, pale to greenish blue-grey, with a white medulla, granules commonly with a weft of projecting cottony hyphae; apothecia unknown. Trebouxia is the phycobiont. Found on trunks of duren, kemiri, kamboja, sukun, and jati, especially where sheltered from direct rain, widespread and evidently common (Figure 9). Thallus thin, leprose and granular-sorediate, sometimes diffuse, bright yellow; apothecia apparently unknown, minute, with orange but yellow-pruinose discs. Found on tree bark of Suren, palem raja and jati putih. Phytobiont: *Trebouxia* and *Trentepohlia* (Figure 10). Thallus green, medulla is white, isidia is not found in this species. *Trentepohloid* is the photobiont. Secondary metabolites consist of atranorin. Found on flamboyant trees (*Delonix regia*), suren (*Toona* sp.), beringin (*Ficus benjamina*) and duren (*Chrysophyllum cainito*) (Figure 11). Thallus grayish green with a fairly smooth texture. Lirellae is black, elongated but small, rather slender, flat, hollow, and has white margins. The apothecia incision is blackish brown. Spores consist of 8-transverse septa with 9 locules. Secondary metabolites consist of atranorin. Found on mindi trees (*Melia azedarach*) (Figure 12).

Table 1. Lichen diversity in Arboretum of Padjadjaran University, Jatinangor, Indonesia

Species	Family	Plants where lichens grow (habitat)	Reproduction	Lichenic acid	Growth form
Acanthothecis sp.	Graphidaceae	*Switenia mahagoni, Ficus variegata*	Lirallae	Atranorin	Crustose
Amandinea melaxanthella (Nyl) Marbach	Caliciaceae	*Persea americana, Artocarpus heterophyllus, Maesopsis eminii*	Apothecia	Atranorin	Crustose
Anomalographis madeirensis (*Tav.*) *Kalb.*	Graphidaceae	*Artocarpus heterophyllus*	Lirellae	Atranorin	Crustose
Arthonia antillarum (DC.) Walf	Arthoniaceae	*Pinus merkusii, Gmelina arborea, Persea americana, Annona muricata*	Apothecia	Chlooatranorin, atranorin, gyrophoric	Crustose
Arthonia sp.	Arthoniaceae	*Leucaena leucocephala*	Apothecia	-	Crustose
Buellia subdisciformis (Leighton) Jatta	Caliciaceae	*Persea americana, Switenia mahagoni*	Apothecia	Atranorin	Crustose
Carbacanthographis candidate (Nyl.) Staiger & Kalb	Graphidaceae	*Euphoria longan, Persea americana, Parkia speciosa, Artocarpus heterophyllus*	Lirallae	Atranorin	Crustose
Carbacanthographis marcescens (Fée) Staiger & Kalb	Graphidaceae	*Manilkara zapota*	Lirellae	Atranorin	Crustose
Chapsa leprieurii (Mont.)	Graphidaceae	*Durio zibethinus*	Lirellae	Atranorin	Crustose
Collema nigrescens (Huds.) DC	Collemataceae	*Gmelina arborea,*	Isidia	-	Foliose
Cryptothecia sp. 1	Arthoniaceae	*Delonix regia, Toona sureni , Ficus variegata, Chrysophyllum cainito*	-	Atranorin	Leprose
Diorygma hieroglyphicum (Pers.) Staiger & Kalb	Graphidaceae	*Switenia mahagoni*			Crustose
Dirinaria applanata (Fée) D.D.Awasthi .	Caliciaceae	*Chrysophyllum cainito, Persea americana , Morinda citrifolia, Roystonea regia, Ceiba petandra, Acacia mangium*	Apothecia, soredia	Atranorin, barbatic, isousnic	Foliose
Dirinaria sp.	Caliciaceae	*Leucaena leucocephala*	Soredia	-	Foliose
Dyplolabia afzelii (Ach) A. Massal	Graphidaceae	*Switenia mahagoni*	Lirallae	Atranorin	Crustose
Glyphis scyphulifera (Ach.) Staiger	Graphidaceae	*Persea americana*	Lirallae	Atranorin	Crustose
Glyphis substriatula (Nyl.) Staiger.	Graphidaceae	*Manilkara zapota*	Lirellae	Atranorin	Crustose
Graphis sp.1	Graphidaceae	*Leucaena leucocephala, Roystonea regia*	Lirallae	Atranorin	Crustose
Graphis sp. 2	Graphidaceae	*Leucaena leucocephala, Corypha utan*	Lirallae	-	Crustose
Graphis sp.3	Graphidaceae	*Toona sureni, Wodyetia bifurcata*	Lirallae	Salazinic	Crustose
Graphis sp.4	Graphidaceae	*Switenia mahagoni*	Lirallae	-	Crustose
Graphis duplicata Ach.	Graphidaceae	*Persea americana*	Lirallae	Atranorin	Crustose
Graphis elongata Zenker	Graphidaceae	*Persea americana*	Lirallae	Atranorin	Crustose
Graphis emersa Mull. Arg.	Graphidaceae	*Melia azedarach*	Lirallae	Atranorin	Crustose
Graphis insulana (Mull. Arg) Luking	Graphidaceae	*Switenia mahagoni, Artocarpus heterophyllus*	Lirallae	Atranorin	Crustose
Graphis intricata Fée	Graphidaceae	*Switenia mahagoni, Euphoria longan, Ceiba petandra*	Lirallae	Atranorin	Crustose
Graphis librata C. Knight	Graphidaceae	*Corypha utan, Delonix regia*	Lirallae	Atranorin	Crustose
Graphis longispora D.D. Awasthi & S.R. Singh	Graphidaceae	*Mangifera indica*	Lirallae	Atranorin	Crustose
Graphis urandrae Vain.	Graphidaceae	*Mangifera indica*	Lirallae	-	Crustose

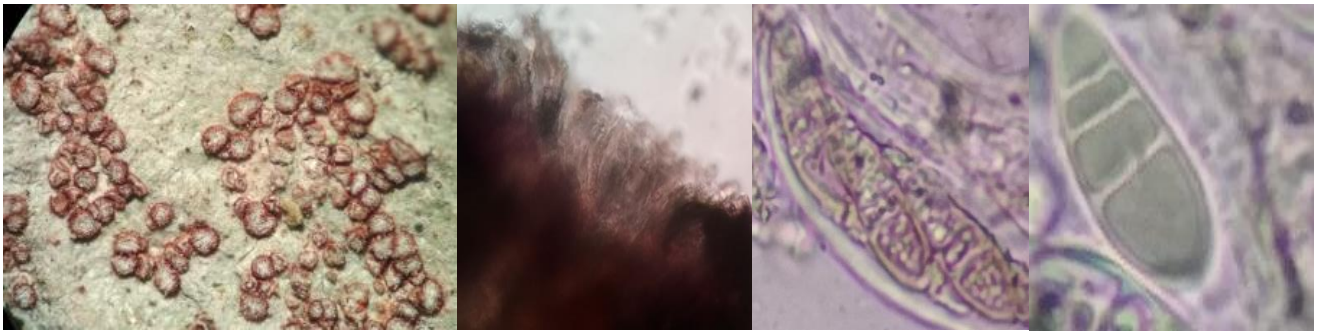
Hemithecium implicatum (Fee) Staiger	Graphidaceae	*Persea americana, Plumeria* sp., *Delonix regia, Khaya antotheca, Ceiba petandra*	Lirallae	Atranorin	Crustose
Heterodermia obscurata Nyl.	Parmeliaceae	*Persea americana*	-	Atranorin, alectoronic, hypoprotocetraric	Foliose
Lecanora sp.1	Lecanoraceae	*Roystonea regia, Leucaena leucocephala*	Apothecia	Atranorin	Crustose
Lecanora sp.2	Lecanoraceae	*Roystonea regia, Leucaena leucocephala*	Apothecia	Atranorin	Crustose
Lecanora helva Stizenb	Lecanoraceae	*Honduras Mahogany, Morinda citrifolia, Persea americana*	Apothecia	Atranorin	Crustose
Lepraria candelaris (L.) Fr., Nov. Sched. Critic. Lich	Stereocaulaceae	*Toona sureni, Roystonea regia, Gmelina arborea*	-	-	Leprose
Lepraria incana (L.) Ach.	Stereocaulaceae	*Durio zibethinus, Aleurites moluccanus, Plumeria* sp., *Artocarpus communis, Durio zibethinus, Tectona grandis*	-	-	Leprose
Leptogium cyanescens (Rabenh.) Korb	Collemataceae	*Switenia mahagoni*	-	-	Foliose
Melanotrema meiospermum (Nyl.) Frisch	Thelotremataceae	*Melia azedarach,Ceiba petandra*	Apothecia	Atranorin	Crustose
Ochloroea sp.	Lecanoraceae	*Toona sureni*	Apothecia	-	Crustose
Opegrapha paraxanthodes Nyl.	Roccellaceae	*Artocarpus heterophyllus*	Lirellae	Atranorin, gyrophoric	Crustose
Parmelia sp.1	Parmeliaceae	*Toona sureni, Switenia mahagoni, Leucaena leucocephala*	Soredia	-	Foliose
Parmelia sp. 2	Parmeliaceae	*Switenia mahagoni*	Soredia	-	Foliose
Parmeliopsis sp.	Parmeliaceae	*Persea americana*	Soredia	Atranorin, physodic, hypoprotocetraric, miriquidic, haemathamnolic	Foliose
Parmotrema sp.1	Parmeliaceae	*Khaya antotheca*	Soredia	-	Foliose
Parmotrema gardneri (C.W. Dodge) Serus	Parmeliaceae	*Toona sureni*	-	-	Foliose
Parmotrema perforatum (Wulfen) A.Massal.	Parmeliaceae	*Mangifera indica*	-	Atranorin, caperatic, isousnic	Foliose
Parmotrema sorediata Müll. Arg.	Parmeliaceae	*Acacia mangium, Switenia mahagoni*	Soredia	Atranorin, usnat	Foliose
Parmotrema sp.1	Parmeliaceae	*Acacia mangium, Switenia mahagoni, Ceiba petandra, Roystonea regia*	Soredia	Miriquidic, chloroatranorin, psoromic, retigeric, pseudoplacodiolic, didymic	Foliose
Parmotrema sp.2	Parmeliaceae	*Acacia mangium, Switenia mahagoni, Ceiba petandra, Roystonea regia*	Soredia	Anziaic, diffractaic, nephroarctin isousnic, psoromic, porphyrilic, didymic, norstictic	Foliose
Parmotrema sp.3	Parmeliaceae	*Switenia mahagoni, Acacia mangium*	Soredia	Atranorin, barbatic	Foliose
Parmotrema sp.4	Parmeliaceae	*Pterocarpus indicus, Switenia mahagoni, Acacia mangium, Persea americana*	Soredia	Atranorin, barbatic, isousnic, usnat	Foliose
Parmotrema sp.5	Parmeliaceae	*Khaya antotheca, Cocos nucifera*	Soredia	Atranorin, nephroarctin, friedelin, merochlorophaeic,	Foliose

Parmotrema tinctorum (Despr. Ex Nyl) Hale	Parmeliaceae	*Khaya antotheca, Alstonia scholaris*	Isidia	Gyrophoric, crypto-chloropaeic, alectoronic, atranorin, norstictic, caperatic, nephroarctin	Foliose
Phaeographis dendritica	Graphidaceae	*Melia azedarach*	Lirellae	Atranorin	Crustose
Phaeographis lobata (Eschw.) Müll.Arg.	Graphidaceae	*Leucaena leucocephala*	Lirallae	-	Crustose
Phaeographis sp.1	Graphidaceae	*Psidium guajava, Switenia mahagoni*	Lirallae	Atranorin	Crustose
Phaeographis sp.2	Graphidaceae	*Leucaena leucocephala*	Lirallae	-	Crustose
Physcia dimidiata (Arn.) Nyl	Physciaceae	*Switenia mahagoni*	Soredia	Atranorin, physodic	Foliose
Physcia sp.1	Physciaceae	*Pinus merkusii, Khaya antothec, Saribus rotundifolius*	Soredia	Miriquidic, chloroatranorin	Foliose
Physcia sp.2	Physciaceae	*Pinus merkusii, Khaya antotheca, Gmelina arborea*	Soredia	Schizopeltic, physodic, usnat, retigeric, ursolic, leucotylin	Foliose
Platygramme caesiopruinosa	Graphidaceae	*Euphoria longan, Polyalthia longifolia*	Lirellae	Atranorin	Crustose
Porpidia irigina	Lecidaceae	*Aleurites moluccanus*	Apothecia	Atranorin	Crustose
Porpidia sp.	Lecideaceae	*Toona sureni*	Apothecia	-	Crustose
Pyxine sp.1	Physciaceae	*Pterocarpus indicus, Switenia mahagoni*	Apothecia	-	Foliose
Pyxine sp.2	Physciaceae	*Gmelina arborea, Leucaena leucocephala, Toona sureni*	Soredia	Chloroatranorin, sphaeroporin	Foliose
Thecaria quassilicola Fee	Graphidaceae	*Gmelina arborea, Euphoria longan*	Lirallae	Atranorin	Crustose
Trypethelium sp.1	Trypetheliaceae	*Pterocarpus indicus, Leucaena leucocephala, Annona muricata*	Apothecia	Gyrophoric, atranorin	Crustose
Trypethelium eluteriae Spreng.	Arthoniaceae	*Ceiba petandra, Annona muricata, Tectona grandis*	Apothecia	Gyrophoric, atranorin	Crustose



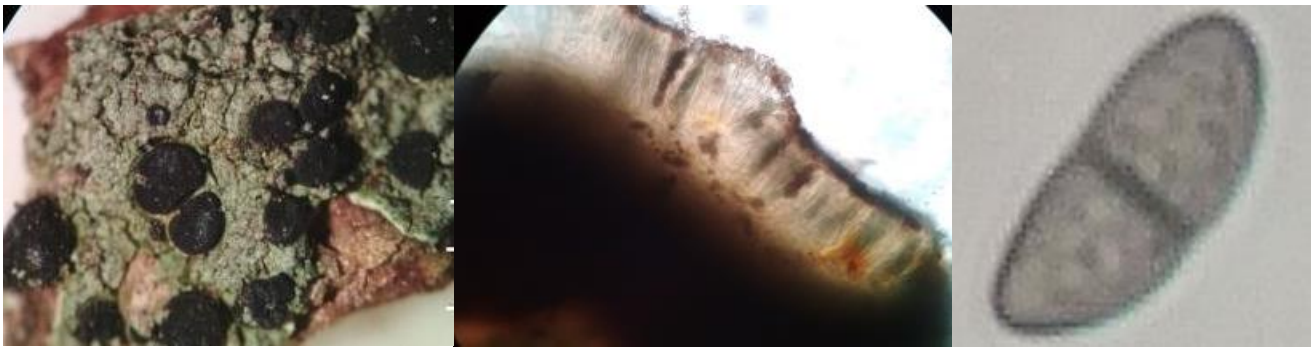
A **B** **C** **D**

Figure 3. *Lecanora helva* Stizenb.: A. Morphological appearance, B. Apothecia Section, C. Ascus, D. Spore



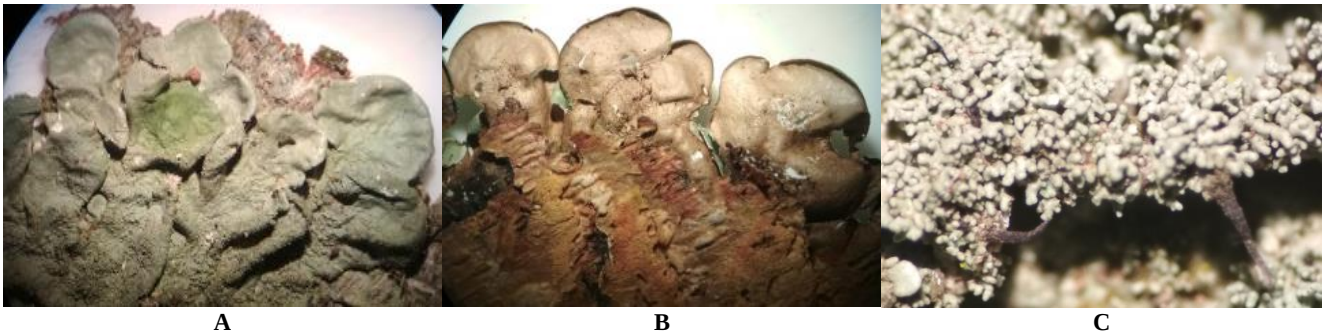
A **B** **C** **D**

Figure 4. *Arthonia antillarum* (DC.) Walf.: A. Morphological appearance, B. Apothecia Section, C. Ascus, D. Spore



A **B** **C**

Figure 5. *Amandinea melaxanthella* (Nyl) Marbach: A. Morphological appearance, B. Apothecia section, C. Spore



A **B** **C**

Figure 6. *Parmotrema tinctorum* (Despr. Ex Nyl) Hale. A. Upper surface appearance, B. Lower surface, C. Isidia

A **B** **C**

Figure 7. *Parmotrema praesorediosum* (Nyl) Hale: A. Upper surface, B. Lower surface, C. Isidia

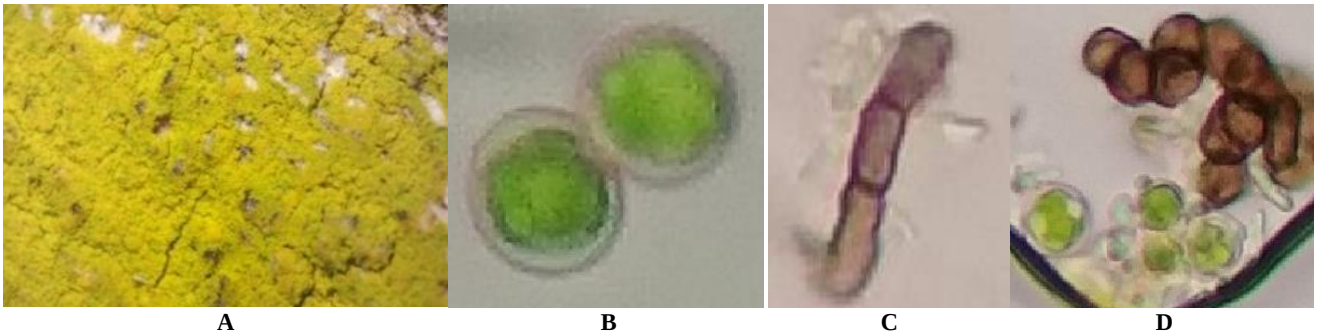
.

A **B**

Figure 8. *Heterodermia obscurata* Nyl.: A. Upper surface, B. Lower surface

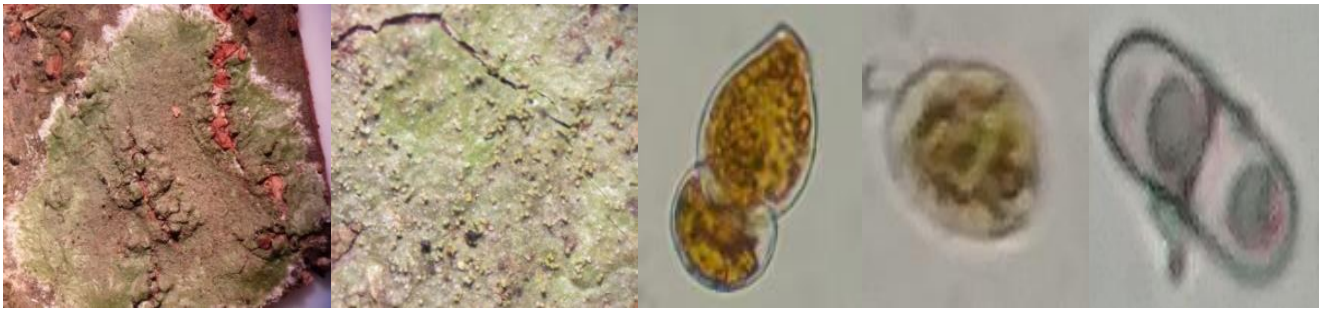
A **B** **C** **D**

Figure 9. *Lepraria incana* (L.) Ach.: A. Thallus on substrate, B. Morphological appearance, C. Powder, D. Algae



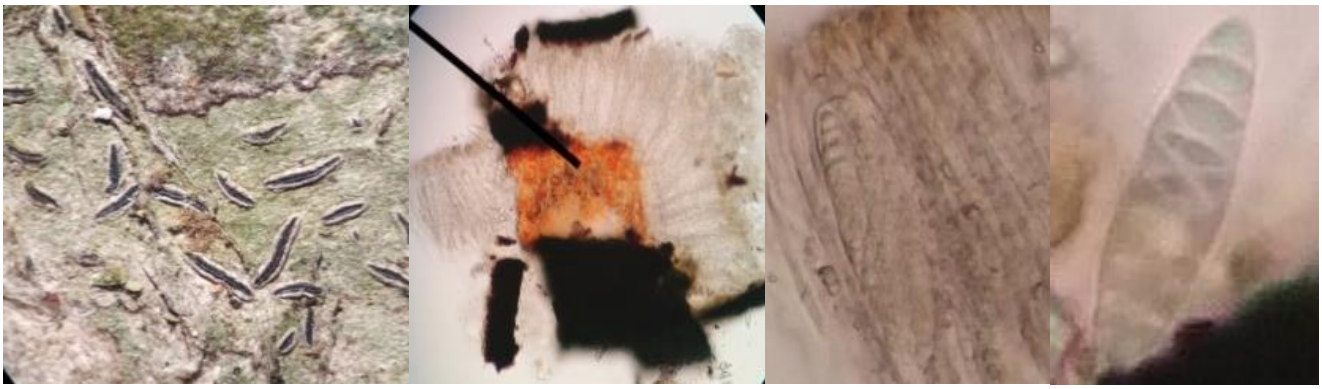
A **B** **C** **D**

Figure 10. *Lepraria candelaris* (L.) Fr., Nov. Sched. Critic.: A. Upper surface, B. *Trebouxia* sp. (photobiont), C. *Trentepohlia* sp. (photobiont), D. *Gleocapsa* sp. (photobiont)



A **B** **C** **D** **E**

Figure 11. *Cryptothecia* Stirt.: A. Thallus on substrate, B. Morphological appearance (powdery), C-D. Algae, E. Spore



A **B** **C** **D**

Figure 12. *Graphis emersa* Mull. Arg.: A. Morphological appearance, B. Apothecia section, C. Ascus, D. Spore

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