Jurnal Ilmu Kehutanan
https://jurnal.ugm.ac.id/v3/jik/
ISSN: 2477-3751 (online); 0126-4451 (print)

Using the Diversity of Lichens in Maribu Forest Area, West Sentani District, Jayapura Regency as a Baseline Data on Environmental Changes

Penggunaan Keanekaragaman Lumut Lumut di Kawasan Hutan Maribu, Distrik Sentani Barat, Kabupaten Jayapura sebagai Data Dasar Perubahan Lingkungan

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RESEARCH ARTICLE DOI:

DOI: 10.22146/jik.v18i1.7850

MANUSCRIPT:
Submitted : 29 April 2023
Revised : 30 January 2024
Accepted : 22 February 2024

KEYWORD
bioindicator, diversity, lichens, Maribu Village, Jayapura Regency.

ABSTRACT

Lichens are thallophytes, capable of absorbing water, nutrients, and chemical compounds in the air, which led to their application as bio-indicators of air quality. Therefore, this research aimed to determine the abundance and diversity of lichens in the Maribu Village, West Sentani District, Jayapura Regency. This research used the exploration method by tracing the observation paths for vegetation and the presence of lichens. This research established three observation stations with three observation plots of 5 m × 5 m in each station. The obtained samples were identified in the Biology Laboratory of FMIPA Cenderawasih University. This research identified 14 tree species belonging to 12 families and 22 species of lichens belonging to 10 families in the observation plots. *Phlyctis argena* (39 colonies) and *Cryptothecia striata* (32 colonies) had the highest colony and fell in the 'very common' category, with the diversity index value (H') of 2.79, which was in the medium category status. The results became the first recorded data in the lowland areas of Papua and could become a baseline for further research.

KATA KUNCI
bioindikator, keragaman, liken; Kampung Maribu, Kabupaten Jayapura.

INTISARI

Liken merupakan tumbuhan thalophyta, dapat menyerap air, unsur hara, dan senyawa kimia di udara sehingga dijadikan sebagai bioindikator kualitas udara. Penelitian ini bertujuan untuk mengetahui kelimpahan dan keanekaragaman liken di kawasan kampung Maribu, Distrik Sentani Barat Kabupaten Jayapura. Metode yang digunakan adalah metode eksplorasi yaitu menelusuri jalur pengamatan mewakili vegetasi dan keberadaan liken. Untuk mempermudah pengamatan, tiga stasiun pengamatan ditentukan dengan masing-masing dibuat 3 petak pengamatan berukuran 5 m x 5 m. Sampel liken yang ditemukan diidentifikasi di laboratorium Biologi FMIPA Universitas Cenderawasih. Hasil penelitian diketahui terdapat 14 jenis pohon yang termasuk 12 famili di dalam plot pengamatan. Hasil identifikasi liken menunjukkan terdapat 22 jenis yang termasuk dalam 10 famili. Jenis dengan jumlah koloni tertinggi yaitu Phlyctis argena (39 koloni) dan Cryptothecia striata (32 koloni) dengan status melimpah dan kelimpahan liken dalam kategori sangat umum, sedangkan nilai indeks keanekaragaman (H') 2,79 termasuk dalam status kategori sedang. Hasil penelitian ini merupakan catatan pertama di kawasan dataran rendah di Papua, sehingga dapat dijadikan sebagai data awal dalam kajian dan pengembangan penelitian lain.

Introduction

Indonesia is a mega biodiversity country due to the vast and rich natural forests (Oldekop et al. 2020) on large and small islands (Suharno et al. 2021). Forests play crucial economic and ecological roles for humans (Sunderlin et al. 2005; Oldekop et al. 2020). According to the Forest Resources Assessment (FRA), forests cover 30.8% of the global land (FAO & UNEP 2020), or approximately 4.06 billion ha. However, forest distribution is not even (Suharno et al. 2023). Moreover, forest ecosystems produce goods or products and environmental services for humans, other living organisms, and nature (Ubaidillah 2022).

Diaz et al. (2015) categorized ecosystem services into provisioning, regulating, cultural, and supporting. Forests provide ecosystem services, including known and yet-to-be-discovered plant species. In this context, lichens, also known as crustose lichens, have received less attention (Suharno et al. 2021). The diversity of these plants is estimated to be around 18,000 (Suharno et al. 2021) or even 20,000 species (Bhagarathi et al. 2022), distributed in various regions worldwide (Suharno et al. 2021, Bhagarathi et al. 2022). Lichens are formed from an association between fungi and algae, living epiphytically on trees, soil, rocky surfaces, coastlines, or high mountains. Currently, lichens are widely used as one of the parameters in monitoring environmental health conditions (Kuldeep & Prodyut 2015; Will-Wolf et al. 2017; Khastini et al. 2018). Previous research also reported the application for evaluating air quality and climate change and as an effective early warning system for detecting heavy metals and radioactive materials accumulation in terrestrial ecosystems (Aptroot & van Herk 2007; Cababan et al. 2020).

Research on lichens in Indonesia remains limited, although investigations have been conducted in several urban areas (Kusmoro et al. 2018). One of the areas explored in Papua is the Baliem Valley in Wamena (Suharno et al. 2020). The forests of Papua, including those in Jayapura, are still in good condition. History shows that besides being an indicator of air pollution, lichens could become natural dyes, food sources, medicinal herbs, sources of perfume ingredients, and even mummy preservation. Most lichens are used for environmental health biomonitoring and as a source of secondary meta-bolites in cancer treatment (Suharno et al. 2021). Some lichens are sensitive to air pollution. Hence, changes in composition in an area can occur rapidly. Further intensive research is needed to explore the benefits of these plants.

Maribu Village, West Sentani District, Jayapura Regency, has a pristine forest area that is planned to become a local tourist destination. This small village covers an area of 44.85 km² (BPS 2020) at an elevation ranging from 347.2 to 795.8 masl with some parts falling in the buffer zone of the Cyclops Mountains Nature Reserve, facilitating the growth of lichens. Aside from investigations on the diversity and use of lichens, research in urban areas mainly focuses on biodiversity associated with air pollution issues (Hardini et al. 2018; Khastini et al. 2018; Mafaza et al. 2019). Lichens are among the best indicator species capable of absorbing many chemicals from rainwater and air pollution. This sensitivity to pollutants leads to the application in monitoring environmental health (Mafaza et al. 2019; Lawal et al. 2023). Therefore, this research aimed to determine the diversity, distribution, abundance, and diversity status of lichens in the Maribu forest area, West Sentani District, Jayapura Regency.

Methods

Time and Location

This research was conducted from November 2021 to May 2022 in the forest area of Maribu Village, West Sentani District, Jayapura Regency, Papua Province (Figure 1). The research established three observation stations, each containing three plots. Station I was located in S: 02°30.553'', E: 140°22.937'' with an elevation of about 345–360 masl, while Station II was in S: 02°29.542'', E: 140°22.874'' with an elevation of 375–385 masl. Additionally, Station III was located in S: 02°29.567'', E: 140°22.367'' with an elevation of 793–798 masl. The research sites ranged from 347.2 to 795.8 masl, with temperatures between 24-31°C, humidity of 80-94%, and light intensity around 1523-2830 lux.

Data Collection

Data required in this research were related to biotic and abiotic conditions. Biotic factors included

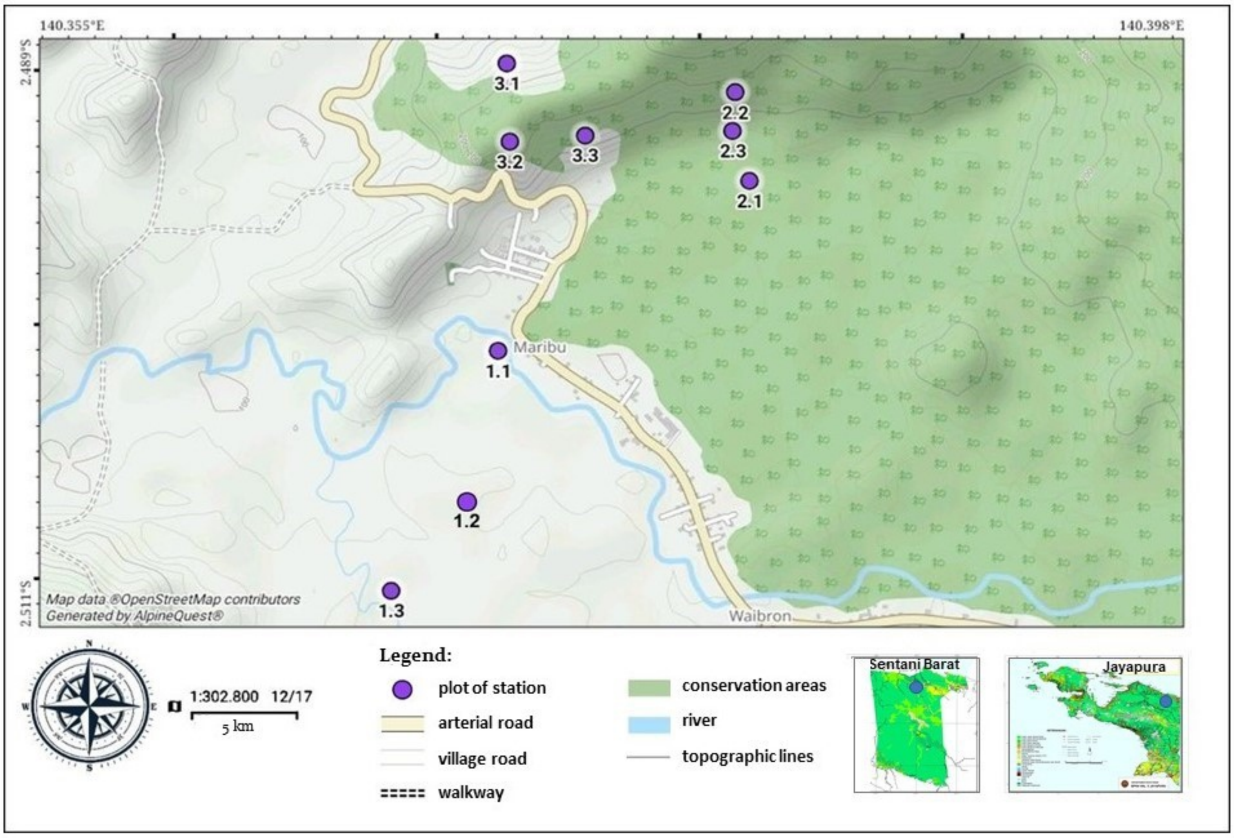

Figure 1. Research location in Maribu Village forest area, West Sentani District, Jayapura Regency, with observation plots of Station I (1.1 – 1.3), Station II (2.1 – 2.3), and Station III (3.1 – 3.3).

the types of host plants as substrates for the growth habitat of lichens, while observed abiotic factor data consisted of temperature (using a thermometer), humidity (hygrometer), and light intensity (lux meter). The tree species were identified at the family level in each plot. Tree species identification required herbarium specimens and further identification in the Biology Laboratory of Cenderawasih University using reference books by van Steenis et al. (2008) and Womersley (1978).

The data collection used a purposive sampling method, which intentionally selected observation points known to have lichens and considered to represent the community and local forest conditions. Three sampling plots were determined for each station, with a size of 5 m x 5 m, resulting in nine observation plots. Five tree species were selected in each plot to observe lichens, with a distance of 100-500 m. The coordinates and types of lichens were recorded, documented, and identified. Identification was carried out in the Biology Laboratory of Cenderawasih University using books including those from Suharno et al. (2021).

The abundance status of lichens was measured according to the USDA 2004 standards (Suharno et al. 2021). The classification based on the number of colonies included *rare* (code 1) = <3 individuals/colonies, *scarce* (code 2) = 4–10 individuals/colonies, *common* (code 3) = 10–40 individuals/colonies, very common (code 4) = >40 individuals/colonies, and *abundant* (code 5) = >50% of the available substrate was covered with lichens.

Data Analysis

Research data were analyzed qualitatively and quantitatively. Qualitative data analysis entailed determining the types of trees on which lichens grew by including the family and scientific name in tables and figures. Each species obtained was also described based on the morphological characteristics. The diversity index (H') calculation used the Shannon–Wiener formula (Odum 1971) and employed Microsoft Excel software:

$$H' = -\sum (ni/N) \ln (ni/N) \text{ or } H' = -\sum (pi) \ln (pi)$$

where: H' = species diversity index; N = total individuals (colonies) of all species; ni = number of individuals (colonies) of each species; pi = proportion of total individuals (colonies) of all species belonging to number of individuals (colonies) of each species; ln = natural logarithm. The classification of species diversity status (Fachrul 2007): H' <1 = the level of species diversity is low; 1 < H'≤ 3 = medium level of species diversity; H' >3 = high level of species diversity.

Results and Discussions

Environmental Conditions

The Maribu Village was situated in lowland, with elevations ranging from 347.2 to 795.8 masl and temperatures ranging from 24-31°C. The area was relatively humid (80-94%), with light intensity around 1523-2830 lux. The humidity conditions were highly conducive to the growth of lichens. According to Hadiyati and Setyawati (2013), lichens could grow and photosynthesize effectively in this range, specifically at 85% humidity. Photosynthesis efficiency might be reduced at higher values above 85% by around 35-40%. The light intensity at the research location strongly supported growth. The minimum light intensity required by lichens for effective photosynthesis activity was 1,025 lux. Lichens were found in this area as organisms with a relatively wide range of environmental tolerances. Kamaluddin (2022) suggested that lichens could survive in low- and high-temperature conditions. Hadiyati and Setyawati (2013) also stated that the optimal temperature for growth was below 40°C, while a value of 45°C might damage chlorophyll and disrupt photosynthesis activity. Air temperature would affect the ability to absorb SO_2, with high temperatures increasing efficiency in absorbing pollutants for plants and lichens.

Host Plant and Lichen Species

The lichens host plants in the Maribu forest area comprised 14 species (Table 1). The dominant host plant was water guava (*Syzygium aqueum*), harboring six species, while *Hiptage benghalensis* and narra (*Pterocarpus indicus*) each hosted five species. According to Suharno et al. (2021), the presence of tree substrates greatly influenced the population of lichens. Vinayaka et al. (2011) also found that trees provided suitable substrates for the life of various lichen species. The linggua (*Pterocarpus indicus*) trees were found in three observation stations. Lichens adapting to this tree species would have an equal chance of being present in other locations. As Vinayaka et al. (2011) stated, host plants greatly influenced the distribution and density of lichens, but not every host tree species could be colonized. Air pollutant conditions and biotic and abiotic environmental factors significantly influenced the presence of lichens (Syarif & Efri 2018). The canopy density restricted the spread of epiphytic plants to the basal parts of the tree, with only a few species growing at the top. Sujalu et al. (2015) suggested that aside from environmental factors, the presence of epiphytes, including lichens living on trees, tended to be influenced by the conditions and physical characteristics of the tree bark and the density of the canopy.

Lichen Diversity and Thallus Types

The types of lichens found amounted to 22 species belonging to 15 genera and ten families (Table 2; Figure 2). Graphidaceae and Parmeliaceae each had five species, the highest among the others, while Collemataceae, Opegraphaceae, and Stereocaulaceae had the fewest. The total number of species in Maribu was lower compared to the observations by Suharno et al. (2020) in the Baliem Valley of Papua, where 37 species were found belonging to 24 genera and 11 families at altitudes between 1,655-2,179 masl with temperatures ranging from 18-26°C. Meanwhile, Vinayaka et al. (2011) found 36 species in Koppa, Western Ghats, India, at altitudes between 700-844 masl. In another research, Nurhidayani (2020) found 27 species in the Abdul Latief Grand Forest Park, Sinjai Borong Regency, which belonged to 18 families at altitudes of 437.9-1,779.4 masl. As Suharno et al. (2021) suggested, the higher the altitude of an area, the greater the diversity of lichens found.

The results showed that lichens had two types of thallus, namely Crustose and Foliose. The majority had a crustose thallus type, comprising 16 species (72.7%), while the remaining six (27.3%) had a foliose thallus type. These results were similar to those of Sofyan (2017) and Madjeni et al. (2020), who only found two types of thallus, crustose and foliose, at

Table 1. Host plant and lichen species

Host plant		Lichen species
Families	Species	
Arecaceae	Coconut (*Cocos nucifera*)	*Lecidella alaechroma*
		Leecidella stigmatea
	Areca nut (*Areca catechu*)	*Graphis* sp.
Combretaceae	Ketapang (*Terminalia catappa*)	*Cryptothecia striata*
		Opegrapha sp.
		Phlyctis argena
Chrysobalanaceae	*Licania arborea*	*Physcia phaea*
		Cryptothecia striata
Cornaceae	*Nyssa sylvatica*	*Bacidia viridi farinosa*
		Phylictis sp.
Fabaceae	Linggua (*Pterocarpus indicus*)	*Cryptothecia striata*
		Collema subflaccidum
		Bacidia viridi farinosa
		Physcia sp.
		Sarcographa labyrinthica
Lauraceae	Avocado (*Persea americana*)	*Cryptothecia* sp.
		Lecidella alaechroma
Malpighiaceae	*Hiptage benghalensis*	*Cryptothecia striata*
		Diorygma poitaei
		Dylolabia afzelli
		Parmotrema sp.
		Sarcographa labyrinthica
Myrtaceae	Guava (*Syzygium aqueum*)	*Cryptothecia striata*
		Graphis subelegans
		Lecidella alaechroma
		Lepraria sp.
		Pyrenula concatervans
		Pyrenula pseudobufonia
Moraceae	Jackfruit (*Artocarpus heterophyllus*)	*Diorygma poitaei*
Pandanaceae	Pandan (*Pandanus* sp.)	*Cryptothecia striata*
		Parmelia sp.
		Parmelia sulcata
Rubiaceae	Noni (*Morinda citrifolia*)	*Physcia phaea*
Sapindaceae	Matoa (*Pometia pinnata*)	*Sarcographa labyrinthica*
	Rambutan (*Nephelium lappaceum*)	*Lepraria* sp.
		Lepraria alaeochroma
		Phlyctis argena
		Sarcographa labyrinthica

Figure 2. Several types of lichens in Maribu forest area; (a) *Parmotrema* sp.; (b) *Parmelia sulcata*; (c) *Phlyctis argena*; (d) *Lecidella elaeochroma*; (e) *Pyrenula concatervans*; (f) *Cryptothecia striata*.

Table 2. Lichens and thallus types

No.	Family	Genus	Species	Thallus type
1.	Arthoniaceae	*Cryptothecia*	*Cryptothecia striata*	C
			Cryptothecia sp.	C
			Bacidia viridi farinosa	C
			Graphis subelegans	C
			Graphis sp.	C
		Diorygma	*Diorygma poitaei*	C
		Sarcographa	*Sarcographa labyrinthica*	C
		Dyplolabia	*Dyplolabia afzelii*	C
2.	Lecanoraceae	*Lecidella*	*Lecidella alaeochroma*	C
			Lecidella stigmatea	C
3.	Opegraphaceae	*Opegrapha*	*Opegrapha* sp.	C
4.	Phlyctidaceae	*Phlyctis*	*Phlyctis argena*	C
			Phylictis sp.	C
5.	Pyrenulaceae	*Pyrenula*	*Pyrenula pseudobufonia*	C
			Pyrenula concatervans	C
6.	Stereocaulaceae	*Lepraria*	*Lepraria* sp.	C
7.	Collemataceae	*Collema*	*Collema Subflaccidum*	F
8.	Parmeliaceae	*Parmelia*	*Parmelia sulcata*	F
			Parmelia sp.	F
		Parmotrema	*Parmotrema sp.*	F
		Physcia	*Physcia phaea*	F
			Physcia sp.	F

Note: C=crustose; F= foliose

specific locations in lowland Indonesia. According to Muslim and Hasairin (2018), crustose lichens demonstrated slower growth than foliose. Crustose lichens were considered the most effective among other types, and certain species could survive when experiencing water scarcity and continue to live on the substrate.

Lichen Distribution

Ten species were found at observation Station I (345–360 masl), nine at Station II (375–385 masl), and ten at Station III (793–798 masl). Generally, lichens in this forest area with altitude below 1,000 masl had nearly equal diversity (Figure 3). *Phlyctis argena* was found at Stations I and II, *Cryptothecia striata* was found at Stations II and III, and *Lecidella alaeochroma* was recorded at all research stations. Microclimate, including light, humidity, topography, rainfall, and substrate, influenced the presence of these lichen species. Jannah (2018) stated that light became a crucial aspect of photosynthesis in the alga (photobiont) in the thallus. Sufficient light maximized growth. Hence, areas with low light intensity due to shading had fewer species.

Limited lichens could survive in areas with more than 75% humidity and temperatures of around 18°C. Lichens could survive in very humid areas due to the gelatine in their hypha and thallus, which enabled them to absorb and fix water. Gelatine in the hypha also protected the lichen from dryness, particularly in higher temperatures. Lichens could absorb water from dews, fogs, and directly from the air when the humidity was relatively high and low temperatures (Jannah 2018). The lichen types of Maribu Village varied depending on the altitude (Figure 3).

Most lichens thrive on tree bark due to the preference for damp and relatively low-temperature environments. According to Muslim and Hasairin (2018), lichens flourished on trees due to the stable temperature and moisture on the trunks. Suharno et al. (2020) reported that lichens thrived well in mountainous regions on various types of tree substrates. Trees bark, branches, or rock and soil surfaces became the growth media. Each tree species had physiological differences such as pH, moisture, structure, and water content. These differences determined colonies, shapes, structures, and species diversity.

Lichen Abundance

The Maribu forest area had 22 lichen species distributed in three observation plots, ranging from 14 to 45 colonies per plot (Table 3). Station II had more colonies than other stations, possibly due to the distance from the highway, tree diversity, and proximity to water sources. According to Madjeni et al. (2020), the substrate moisture could influence growth stability. In this condition, the surface of plant stem bark was more humid with sufficient water content

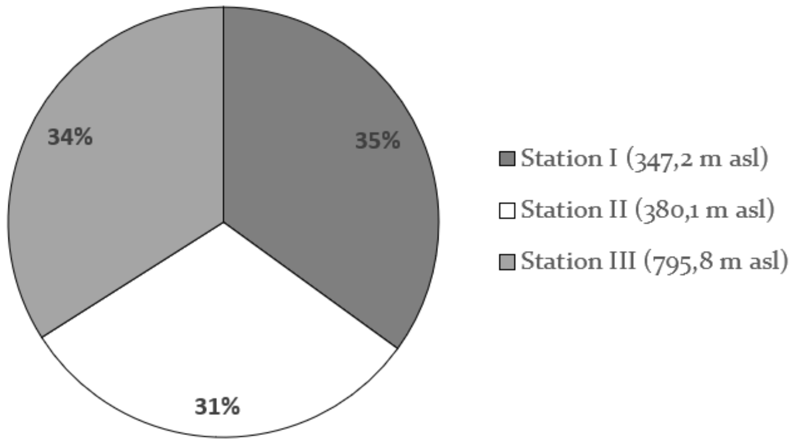

Figure 3. Percentage of lichens types based on location altitude

Table 3. Abundance of lichens at each observation station

No.	Species	Station I (plot)			Station II (plot)			Station III (plot)			Σ Colonies
		1	2	3	1	2	3	1	2	3	
1.	*Bacidia viridi farinosa*	-	-	12	-	-	-	-	-	-	12
2.	*Collema subflaccidum*	-	-	-	-	-	-	-	1	-	1
3.	*Cryptothecia* sp.	-	-	-	-	16	-	-	-	-	16
4.	*Cryptothecia striata*	-	-	-	6	-	8	4	4	10	32
5.	*Diorygma poitaei*	-	-	2	-	-	-	1	-	-	3
6.	*Dyplolabia afzelii*	-	-	-	-	-	-	5	-	-	5
7.	*Graphis* sp.	8	-	-	-	-	-	-	-	-	8
8.	*Graphis subelegans*	6	-	-	-	-	-	-	-	-	6
9.	*Lecidella alaeochroma*	-	-	6	8	5	-	-	-	3	22
10.	*Lecidella stigmatea*	10	-	-	-	-	-	-	-	-	10
11.	*Lepraria* sp.	6	-	-	-	8	-	-	-	-	14
12.	*Opegrapha* sp.	-	-	-	-	-	2	-	-	-	2
13.	*Parmelia* sp.	-	-	-	-	4	-	-	-	-	4
14.	*Parmelia sulcata*	-	-	-	12	-	-	-	-	-	12
15.	*Parmotrema* sp.	-	-	-	-	-	-	1	-	-	1
16.	*Phlyctis argena*	-	14	-	-	-	25	-	-	-	39
17.	*Phsycia phaea*	-	-	-	-	-	-	15	-	-	15
18.	*Phylictis* sp.	-	-	12	-	-	-	-	-	-	12
19.	*Physcia* sp.	-	-	-	-	-	-	-	9	5	14
20.	*Pyrenula concatervans*	-	-	-	-	-	-	-	-	4	4
21.	*Pyrenula pseudobufonia*	5	-	8	-	-	-	-	-	-	13
22.	*Sarcographa labyrinthica*	-	-	-	-	12	-	-	-	13	25
	Σ colonies	35	14	40	26	45	35	26	14	35	
	Total colonies		89			106			75		270

and could remain stable for an extended period. The species with the highest abundance was *Phlyctis argena* (39 colonies), followed by *Cryptothecia striata* (32 colonies), while those with the lowest abundance were *Collema subflaccidum* and *Parmotrema* sp.

The lichen abundance level fell into category 4 (*very common)*, meaning there were >40 colonies in the research area. This very common condition corresponded to categories 4 and 3, indicating that, on average >20 individuals or colonies were found on trees or shrubs. In general, lichens developed relatively slowly, but crustose lichens had a wide distribution range and were poikilohydric organisms, implying survival ability in dry conditions. Several factors influenced the growth and development of crustose lichens, including macroclimate, microclimate, location, substrate characteristics, and others. Climate factors, such as temperature and rainfall, affected the growth pattern. Macroclimate factors, including light, humidity, and temperatures, caused variations in crustose lichens. In addition, substrate characteristics comprised tree species, bark type, pH, and bark nutrient content. These factors had significantly varying effects, affecting lichens' appearance, color, and other characteristics (Silva & Senanayake 2015; Bhagarathi et al. 2022).

Diversity Index

The diversity index (H') for each species varied, totaling 2.79 (Table 4), indicating a moderate diversity status according to the USDA 2004 standard (Suharno et al. 2021). Environmental conditions surrounding the forest area, such as temperature, humidity, elevation, and light intensity, resulted in a high diversity index (Jannah 2018; Bhagarathi et al. 2022).

Both biotic and abiotic factors influenced the diversity of lichens. Specifically, biotic factors consist of substrate types as habitats for growth. The lichen species could adapt to these environments, indicating a wide range of tolerance to abiotic factors. According to Murningsih & Mafazaa (2016), environmental factors, including temperature, humidity, light intensity, and topography, greatly influence species diversity, particularly growth stability. The research conducted by Mafaza et al. (2019) in Semarang City found 18 species of lichens from 13 families. It revealed varied indexes from three observation stations. The transportation hub area had a 1.88, industrial areas had 2.95 indices (moderate), and the Undip Tembalang Campus had a 3.71 index (very abundant diversity). These values indicated that air pollution in these areas was still within tolerable limits.

In the Abdul Latief Sinjai Borong Great Forest Park area, Nurhidayani (2021) reported a diversity index of 2.77, in the moderate category. Based on the results, each block demonstrated moderate diversity despite differences in the number of species and individuals. These differences suggested that the diversity of lichens was related to the number of individuals and species found. Additionally, environmental factors, such as temperature and humidity, played significant roles, with lower temperatures and higher humidity positively influencing growth conditions.

Generally, the presence of lichens could indicate environmental changes in an area (Aptroot & Herk 2007). As low-level plants with sensitive morphological structures, lichens were prone to growth changes (Suharno et al. 2021) occurring in morphological structures, colony numbers, species numbers, and communities (Aptroot & Herk 2007; Suharno et al. 2021). These changes escalated with air and environmental pollution (Jannah 2018). Therefore, monitoring the presence of lichens in an area could detect environmental changes periodically (Will-Wolf et al. 2017; Lawal et al. 2023).

Table 4. Diversity index of lichens

No.	Species	Σ Colonies	pi	ln pi	pi ln pi
1.	*Bacidia viridi farinosa*	12	0.04	-3.11	-0.14
2.	*Collema subflaccidum*	1	0.00	-5.60	-0.02
3.	*Cryptothecia sp.*	16	0.06	-2.83	-0.17
4.	*Cryptothecia striata*	32	0.12	-2.13	-0.25
5.	*Diorygma poitaei*	3	0.01	-4.50	-0.05
6.	*Dyplolabia afzelii*	5	0.02	-3.99	-0.07
7.	*Graphis sp.*	8	0.03	-3.52	-0.10
8.	*Graphis subelegans*	6	0.02	-3.81	-0.08
9.	*Lecidella alaeochroma*	22	0.08	-2.51	-0.20
10.	*Lecidella stigmatea*	10	0.04	-3.30	-0.12
11.	*Lepraria sp.*	14	0.05	-2.96	-0.15
12.	*Opegrapha sp.*	2	0.01	-4.91	-0.04
13.	*Parmelia sp.*	4	0.01	-4.21	-0.06
14.	*Parmelia sulcata*	12	0.04	-3.11	-0.14
15.	*Parmotrema sp.*	1	0.00	-5.60	-0.02
16.	*Phlyctis argena*	39	0.14	-1.93	-0.28
17.	*Phsycia phaea*	15	0.06	-2.89	-0.16
18.	*Phylictis sp.*	12	0.04	-3.11	-0.14
19.	*Physcia sp.*	14	0.05	-2.96	-0.15
20.	*Pyrenula concatervans*	4	0.01	-4.21	-0.06
21.	*Pyrenula pseudobufonia*	13	0.05	-3.03	-0.15
22.	*Sarcographa labyrinthica*	25	0.09	-2.38	-0.22
	Σ colonies	270	1	-76.60	-2.79
	Diversity index (H') = 2.79				

Conclusion

In conclusion, the Maribu forest area had 22 lichen species belonging to ten families. These lichens grow on tree substrates, with at least 13 tree species identified in the observation plot. *Phlyctis argena* (39 colonies) and *Cryptothecia striata* (32 colonies) became the most abundant lichens, categorized as *very common*. Additionally, lichens in this area had a diversity index value (H') of 2.79, indicating a moderate status.

Acknowledgment

The author is grateful to all those who supported the field research activities and the head of Maribu Village for granting permission and supporting the research. The author is also grateful to Johan Pali, Novela Napan, Gemala D. Dirgantari, Juana Y. Soleman, Ranum M.A. Mansawan, and Kristina I. Rahail for their assistance during the field research process.

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