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Inventory of Epiphytic Lichen Foliose on Tea Plants in Ngargoyoso, Karanganyar, Central Java

Dika Dwi Irnawati, Efri Roziaty*
Biology Education Department, Faculty of Teacher Training and Education, Universitas Muhammadiyah Surakarta.
Jl. A. Yani Tromol Pos I, Pabelan, Kartasura, Surakarta 57162, Jawa Tengah, Indonesia
*Corresponding Author. E-mail address: er375@ums.ac.id

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ABSTRACT

Lichen is a combined organism between algae and fungi. Lichen has various body shapes, one of which is foliose. Lichen is found living epiphytic on the stems of tea plants. This study aims to determine the types of epiphytic lichen foliose on tea plants in Ngargoyoso, Karanganyar, Central Java. The method used is an exploratory method with purposive sampling techniques. Sampling was carried out at three stations with different altitudes. Station 1 (900 m asl), Station 2 (1.000 m asl), and Station 3 (1.100 m asl). The study results obtained a number 12 species of lichen foliose consisting of *Parmotrema tinctorum* (Delise ex Nyl.) Hale, *P. austrosinense* (Zahlbr.) Hale, *P. reticulatum* (Taylor) M. Choisy, *P. hypotropum* (Nyl.) Hale, *P. perlatum* (Huds.) M. Choisy, *Flavoparmelia soredians* (Nyl.) Hale, *F. caperata* (L.) Hale, *Hypogymnia physodes* (L.) Nyl, *Physcia stellaris* (L.) Nyl, *P. aipolia* (Ehrh. ex Humb.) Fürnr, *Heterodermia japonica* (Satō) Swinscow & Krog, and *Dirinaria applanata* (Fée) D.D. Awasthi. The most dominant species found at all three stations were *Parmotrema austrosinense* (Zahlbr.) Hale with a total of 104 colonies. The least encountered species was *Physcia stellaris* (L.) Nyl with a total of 3 colonies.

1. INTRODUCTION

Lichen is a lower plant derived from a combination of algae and fungi (Suharno et al. 2021). Thallus lichen comprises green algae (Chlorophyta) or blue algae (Cyanobacteria) with fungi from the Ascomycetes or Basidiomycetes groups. Thallus lichen is generally found gray or greenish-gray. These lichen species are yellow, orange, and brown or red, with diverse habitats (Andrea et al. 2018). Lichens are divided into three groups, one of which is lichen foliose. Lichen foliose has a leaf-like structure composed of lobes. This lichen is attached relatively looser to its substrate (Pratama and Trianto, 2020). This lichen is attached to a tool called rhizines. Rhizines have a role as a tool to absorb food. Examples of lichen foliose are Xantoria, Physicia, Peltigera, and Parmelia (Roziaty, 2016).

Lichen is commonly found living epiphytic life on trees, rocks, moist places, and soil. Epiphytic plants are plant species whose lives depend on or attach to other plants but do not harm the plants on which they live. These plants can carry out photosynthesis for their growth, so they do not include parasitic plants because they do not take food sources from plants where they live (Sadili and Royyani, 2018). In general, epiphytic plants can grow and develop as a single individual or in colonies on the branches or trunks of trees on which they live. One of the plants used as a place for lichen to live is the tea plant (Shofiana, 2017).

The lichen inventory in Indonesia has not been widely conducted, so research on lichen is still a great opportunity. According to information recorded in Herbarium Bogoriensis Bogor, around 40.000 lichen species exist in Indonesia. This fact shows that only a few types are known through biology books, even though there are as many as 40.000. Many studies have been conducted on lichen, including its use as an indicator of air pollution (Muslim and Hasairin, 2018).

Inventory is an activity to collect information and facts about understory plant species found in certain areas (Rachmawati et al. 2021). Inventory activities consist of exploration and identification activities. The inventory results are compiled into a flora book listing the names of various plant species and other data related to the types of plants in the region. Therefore, an inventory of lichen in an area is essential so that it becomes evidence or data on the richness of plant species owned by the region (Sjakoer et al. 2022).

Tea (*Camellia Sinensis* (L.) O. Kuntze) is a plant belonging to the family Theaceae, tree-shaped with a height of up to 4.5 m in the wild. However, cultivated tea plants are only between 0.6 and 1.5 m (Pamungkas and Supijatno, 2017). The leaves have a light green color with a length of 5 – 30 cm and a width of ± 4 cm. Whiteare flowers are 2.5 – 4 cm in diameter. It has fruits of flattened and rounded shapes. Have one seed on each fruit. Tea plants live and grow well in humid climates with temperatures between 10 – 30 °C, rainfall of 2.000 mm per year, and altitudes of 600 – 2.000 m asl. One of the tea plantations in Central Java can be found in Ngargoyoso (Syahbudin et al. 2019).

Ngargoyoso is a highland area with a high level of plant diversity. Kemuning Tea Plantation is a tourist attraction in Ngargoyoso, Karanganyar, Central Java. Kemuning Tea Plantation has climatic conditions that support the existence of lichen. Kemuning Tea Plantation is located at an 800 – 1.500 m asl. This height supports the presence of crustal lichen such as thallus foliose-type lichen, which can live at an altitude of 600 – 3.500 m asl (Mercado-Díaz et al. 2015). The ambient temperature in Kemuning tea plantations is around 21 °C, and air humidity ranges 70 – 80 %.

Ngargoyoso is a highland area with climatic conditions that favor lichen growth. Therefore, the area has the potential to research data collection of one type of lichen, namely lichen foliose. However, there have been many previous researchers who researched lichen foliose. Until now, no information has been containing epiphytic lichen foliose on tea plants in Ngargoyoso, Karanganyar, Central Java. Therefore, this study needs to be conducted to determine the types of epiphytic lichen foliose on tea plants in Ngargoyoso, Karanganyar, Central Java.

2. Materials and Methods

2.1. Time and Place of Research

This research will be conducted in March 2023 in the Kemuning Ngargoyoso Tea Plantation Area, Karanganyar, Central Java. Sampling was carried out at three stations with different heights. Station 1 with an altitude of 900 m asl, station 2 with an altitude of 1.000 m asl, and Station 3 with an altitude of 1.100 m asl. The method used is an exploratory method carried out by exploring the research site to take the necessary lichen samples (Fatma et al. 2017). The sampling technique used is purposive sampling. Purposive sampling is a sampling technique based on specific considerations. The map of the research location can be seen in **Fig.1**.

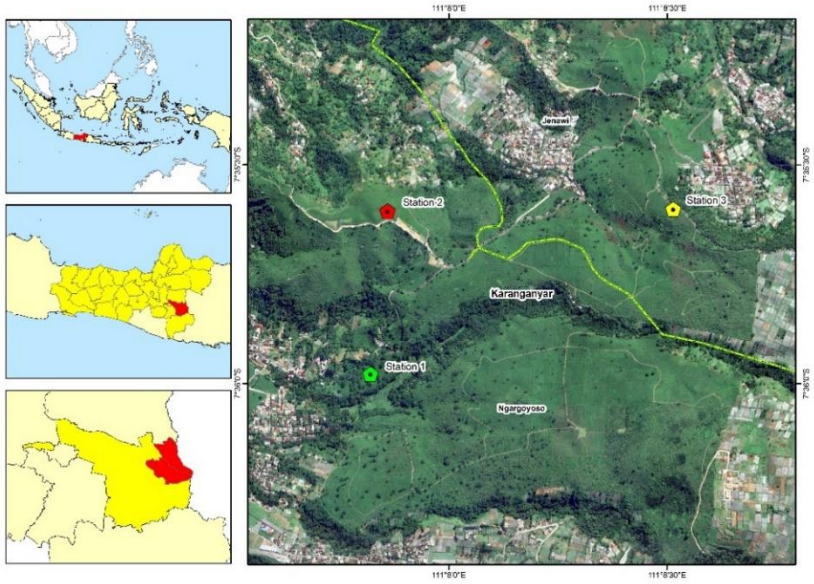

Fig. 1. Map of Research Location Points in Kemuning Tea Plantation Area, Ngargoyoso, Karanganyar, Central Java

2.2. Tools and Materials

Tools used include documentation tools (Handphone), Digital thermohygrometer, pH stick, Altimeter, Luxmeter, Roll meter, Stereo microscope, Permanent scalpel, Tweezers, Kitchen knife, Cutter, Plastic mica, Tissue, Ruler, Coins, Stationery, Libraries that are references for researchers for identification purposes such as lichen identification books, Journals about lichen foliose, Articles, Photos that are valid and relevant. The material used was samples of epiphytic lichen foliose on tea plants found at each research station.

2.3. Research Stages

The stages carried out in this study are: 1) Preparatory stage consists of field observation, preparation of tools and materials needed in research, and conducting literature studies. 2) Implementation stage consists of abiotic factor measurement activities, which include temperature, air humidity, light intensity, and altitude of the place. Document any foliose lichen samples found at each station before they were taken. Take lichen foliose samples by breaking the twigs of tea stems contained in samples or slowly scraping from the stems of tea plants using a scalpel or kitchen knife not to damage the colony, inserting the sample into plastic mica that has been perforated and giving a tissue base. 3) Identification stage, at this stage, lichen foliose samples are brought to the Biological Laboratory of FKIP UMS for identification. Observe samples using stereo microscopes and describe morphological structures in the form of color and shape of the thallus, as well as reproductive structures of lichen samples obtained one by one. Identify lichen samples by comparing the characteristics of the samples found with several sources that are used as references in identification, namely the determination book *The Lichens of British Columbia Illustrated Keys Part 1 – Foliose and Squamulose Species* (1994), *Field Oriented Keys To The Florida Lichens* (2015), books, and research journals related to lichen foliose.

2.4. Data Analysis

The results of research data obtained from the field were then grouped using a correlation test using the SPSS 23rd edition application, which was based on the correlation between environmental conditions (abiotic factors) and the presence of lichen foliose. Furthermore, data processing is carried out in a qualitative descriptive manner by writing down the scientific name, classification of lichen foliose, key determination, and describing the morphology of the types of lichen foliose found along with their habitat characteristics. The research data results are presented as descriptions, tables, and figures.

3. RESULTS AND DISCUSSION

3.1. Inventory Results of Epiphytic Lichen Foliose on Tea Plants in Ngargoyoso, Karanganyar, Central Java

Based on research that has been done, several types of epiphytic lichen foliose were obtained on tea plants in Ngargoyoso, Karanganyar, Central Java (**Table 1**).

Table 1. Types of epiphytic lichen foliose on tea plants in Ngargoyoso, Karanganyar, Central Java at each station

No	Species	Station			∑ Colony
		1	2	3	
1	*Parmotrema tinctorum* (Delise ex Nyl.) Hale	12	10	60	82
2	*P. austrosinense* (Zahlbr.) Hale	23	35	46	104**
3	*P. reticulatum* (Taylor) M. Choisy	15	24	33	58
4	*P. hypotropum* (Nyl.) Hale	-	-	20	20
5	*P. perlatum* (Huds.) M. Choisy	32	18	13	63
6	*Flavoparmelia soredians* (Nyl.) Hale	10	21	30	61
7	*F. caperata* (L.) Hale	5	9	16	30
8	*Hypogymnia physodes* (L.) Nyl	-	-	8	8
9	*Physcia stellaris* (L.) Nyl	-	-	3	3*
10	*P. aipolia* (Ehrh. ex Humb.) Fürnr	8	7	25	50
11	*Heterodermia japonica* (Satō) Swinscow & Krog	-	-	32	32
12	*Dirinaria applanata* (Fée) D.D. Awasthi	29	13	26	68
	Total	134	137	312	583

Note:
Station altitude 1 : 900 m asl
Station altitude 2 : 1.000 m asl
Station altitude 3 : 1.100 m asl
** Total colonies found the most
* Total colonies found least

Based on an inventory of epiphytic lichen foliose on tea plants in Ngargoyoso, Karanganyar, Central Java, a total of 12 lichen foliose were found (**Table 1**). At three stations with different heights, each species with a different number was found. The station 1 found eight species, Station 2 had 8 species, and Station 3 had as many as 12. The species found at all three stations belong to 3 families, namely Parmeliaceae, Physciaceae, and Caliciaceae. From the observations that have been made, there are 12 types of lichen foliose that can be identified, namely species *Parmotrema tinctorum* (Delise ex Nyl.) Hale, *P. austrosinense* (Zahlbr.) Hale, *P. reticulatum* (Taylor) M. Choisy, *P. hypotropum* (Nyl.) Hale, *P. perlatum* (Huds.) M. Choisy, *Flavoparmelia soredians* (Nyl.) Hale, *F. caperata* (L.) Hale, *Hypogymnia physodes* (L.) Nyl, *Physcia stellaris* (L.) Nyl,

P. aipolia (Ehrh. ex Humb.) Fürnr, *Heterodermia japonica* (Satō) Swinscow & Krog, and *Dirinaria applanata* (Fée) D.D. Awasthi.

At Station 1, which has an altitude of 900 m asl, 134 lichen colonies are found. The number of colonies found is the least compared to Station 2 and 3. The station 1 is on the side of the main road that is often traveled by vehicles, so lichen growth is not as much as in other stations. The species found come from 4 genera: Parmotrema, Flavoparmelia, Physcia, and Dirinaria. Station 2 has an altitude of 1.000 m asl, located in a tourist center area with a high level of human activity. At this station found as many as 8 species, the same as station 1, but with a more significant number of colonies of 137. The species found come from 4 genera: Parmotrema, Flavoparmelia, Physcia, and Dirinaria. Station 3 has an altitude of 1.100 m asl and is in an area that is quiet of visitors and rarely traversed by vehicles. Therefore, this station found more diverse species than other stations, with as many as 12 species with a colony of 312. The species found come from 6 genera: Parmotrema, Flavoparmelia, Hypogymnia, Physcia, Heterodermia, and Dirinaria. It shows that the level of pollution affects the number and variety of lichen colonies are found. This is in line with research of Ramadhanti et al. (2021) which stated that the small number of lichens found was also influenced by air pollution conditions.

Based on previous research conducted by Supriati et al. (2021) regarding the diversity of lichens in tea plants (*Camellia sinensis* (L.) Kuntze) in the PT Sarana Mandiri Mukti plantation, Kepahiang Regency, Bengkulu Province, the results of the registration of lichen found as epiphytes on the bark substrate of the tea plant (*Camellia sinensis* (L.) Kuntze), namely as many as 12 species of lichen foliose from the genera Parmelia, Parmotrema, Dirinaria, and Heterodermia. The number of these species is the same as the number of lichen foliose species found as epiphytes on tea plants in Ngargoyoso, Karanganyar, Central Java, but with less genus diversity.

The most dominating species of the three stations is *Parmotrema austrosinense* (Zahlbr.) Hale (**Fig. 2**). This species is found with 104 colonies. Based on observations, this lichen foliose species have a thallus measuring 4 – 10 cm, loosely attached to the substrate of tea stem bark. The lobes are spherical with a width of 5 - 15 mm, the edges of the thallus overlap, they are sinuous. The upper surface is grey to greenish-grey, shiny, and smooth, and older parts have cracks. The lower surface is smooth wrinkled, yellowish-brown, and light brown to blackish. It has rhizines measuring 1 mm arranged sparsely, still simple, and unevenly distributed. Species *Parmotrema austrosinense* (Zahlbr.) Hale was found scattered in large numbers at all three stations. This is because this species has a higher tolerance level than other species so that it can grow well in polluted environments. Species *Parmotrema austrosinense* (Zahlbr.) Hale is famous for its role as a bioindicator of an area's air quality. This is supported by Andrea (2018) research which states that lichen can grow well even in a polluted environment. This is because there are rhizines that function to absorb food. In addition, Parmotrema can also survive for a long time in environments that lack water.

Fig. 2. *Parmotrema austrosinense* (Zahlbr.) Hale

The fewest species found with 3 colonies are *Physcia stellaris* (L.) Nyl (**Fig. 3**). Based on observations, *Physcia stellaris* (L.) Nyl has a rounded or irregular thallus measuring 3 cm. The upper surface is coarse-textured, green to grayish-green. There are short-sized cilia arranged rather tightly at the edges of the thallus. It has a brown to black rounded saucer-shaped apothecia widely scattered in the middle of the thallus. The undersurface is brown to whitish-brown with brownish rhizines. This species is found only at station 3. This is because *Physcia stellaris* (L.) Nyl has a low tolerance level for air pollution. The physcaceae family includes lichens sensitive to pollution or poor air quality. Therefore, *Physcia stellaris* (L.) Nyl can only grow in environments where human activity or exposure to vehicle occlusion is rare. That is why this species is not found at Stations 1 and Station 2 which have higher pollution exposure levels than Station 3. This is in line with Hutasuhut (2021) research which states that the small number of physciaceae families found in an area is due to the low level of tolerance to pollutants (air quality).

Fig. 3. *Physcia stellaris* (L.) Nyl

3.2. Environmental Conditions

The results of abiotic factor measurements at each station are presented in **Table 2** below:

Table 2. Abiotic Environmental Parameters in Ngargoyoso Tea Plantation Area, Karanganyar, Central Java

No	Parameters	Station 1	Station 2	Station 3	Range
1	Altitude (m asl)	900	1.000	1.100	900 - 1.100
2	Ambient temperature (°C)	23,7	23,6	22,8	22,8 – 23,7
3	Air Humidity (%)	75	79	80	75 - 80

The existence of different types and total colonies of epiphytic lichen foliose found is influenced by the environmental conditions in which lichen foliose grows. Environmental parameters in this study consist of altitude, ambient temperature, and humidity. This is supported by Nasriyati et al. (2018) research which states that the growth of lichen is supported by abiotic factors. Abiotic factors in the form of environmental temperature and air humidity are important factors in supporting lichen growth.

Measurements of environmental parameters in the form of abiotic factors were carried out at three stations with different heights. Based on (**Table 2**) it can be seen that lichen foliose grows well in the range of altitude 900 – 1.100 m asl, ambient temperature ranges from 22,8 °C – 23,7 °C, and air humidity ranges from 75 – 80 %. The results of measuring abiotic parameters in the field show that the higher the research location, the lower the temperature and the higher the air humidity level. Research by Roziaty and Utari (2017) indicates that the higher the sampling site, the more total lichen colonies will be found. In addition, the total colony will increase in a low-temperature environment with high humidity.

To determine whether or not there is a correlation between environmental parameters and the total lichen foliose colonies found, a correlation test was carried out using SPSS edition 23. Effect of ambient temperature on the total lichen foliose colonies found can be seen in (**Fig. 4**). Based on the results of the correlation test, a significance value was obtained between the air humidity parameter and the total lichen foliose colony of 0.002 smaller than 0.05 with a coefficient value of - 0.510. This means that the correlation between air temperature and total colonies of epiphytic lichen foliose is negatively correlated, meaning the higher the air temperature, the fewer epiphytic lichen foliose found. Conversely, the lower the air temperature, the more epiphytic lichen foliose is found, provided that the temperature is still within the limits of lichen growth tolerance. This is in line with Murningsih (2016) research which states that the optimum temperature for lichen growth is below 40 °C because temperatures above 45 °C cause lichen chlorophyll to be damaged and interfere with the process of lichen photosynthesis.

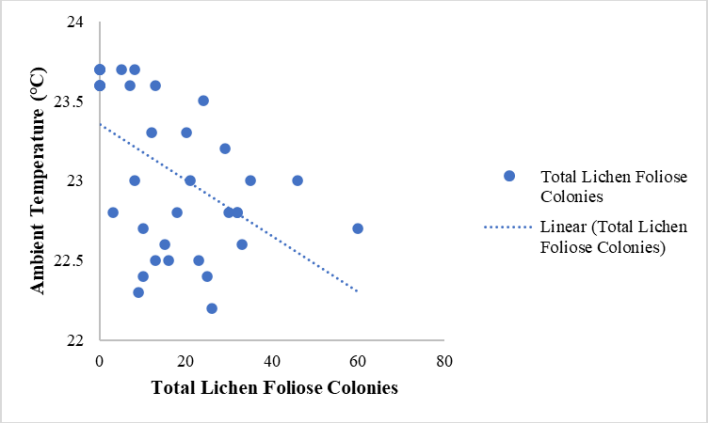

Fig. 4. Correlation of ambient temperature with total colonies of lichen foliose

The effect of humidity on the total lichen foliose colonies found can be seen in (**Fig. 5**). Based on the results of the correlation test, a significance value was obtained between the air humidity parameter and the total lichen foliose colony of 0.003 smaller than 0.05 with a coefficient value of 0.482, this means that there is an influence between air humidity and total lichen foliose colonies. The correlation between air humidity and total colonies is quite strong, and a positive correlation (+) formed. This means the higher the humidity, the more epiphytic lichen foliose will be found. This is supported by Roziaty et al. (2021) theory which states that the higher the air humidity in an area, the more types and total lichen found living in the area.

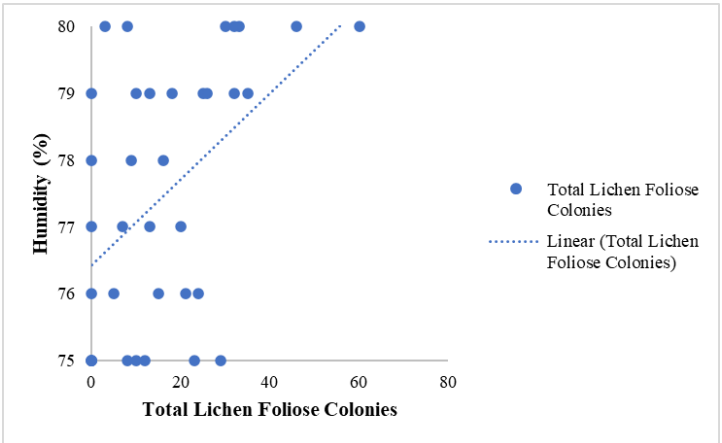

Fig. 5. Correlation of air humidity with total colonies of lichen foliose

4. CONCLUSION

The conclusion obtained from the results of the research conducted is that the epiphytic lichen foliose on tea plants in Ngargoyoso, Karanganayar, Central Java, consists of 12 species from 3 families, namely 1) family Parmeliaceae consisting of *Parmotrema tinctorum* (Delise ex Nyl.) Hale, *P. austrosinense* (Zahlbr.) Hale, *P. reticulatum* (Taylor) M. Choisy, *P. hypotropum* (Nyl.) Hale, *P. perlatum* (Huds.) M. Choisy, *Flavoparmelia soredians* (Nyl.) Hale, *F. caperata* (L.) Hale, and *Hypogymnia physodes* (L.) Nyl, 2) family Physciaceae consists of *Physcia stellaris* (L.) Nyl, *P. aipolia* (Ehrh. ex Humb.) Fürnr and *Heterodermia japonica* (Satō) Swinscow & Krog, 3) family Caliciaceae comprise *Dirinaria applanata* (Fée) D.D. Awasthi. The most dominant species at all three stations is *Parmotrema austrosinense* (Zahlbr.) Hale with a total of 104 colonies. The least encountered species was *Physcia stellaris* (L.) Nyl with a total of 3 colonies.

As for the suggestions that the author can convey regarding this research, it is necessary to conduct further research regarding the role of lichen foliose as an indicator of air quality in Ngargoyoso, Karanganyar, Central Java.

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