Phenetic Relationship of Lichens Grown on Tea Plants (*Camellia sinensis* (L.) Kuntze) in Tangsi Baru Village, Kabawetan Subdistrict, Kepahiang District

Rochmah Supriati¹, * Dwi Agustian ² RR Sri Astuti ¹
Riandini Evelyne¹ Fatimatuzzahra¹

¹Department of Biology, Faculty of Mathematics and Natural Sciences, University of Bengkulu, Kandang Limun, Bengkulu 38112, Indonesia
²Undergraduate Student, Department of Biology, Faculty of Mathematics and Natural Sciences, University of Bengkulu, Kandang Limun, Bengkulu 38112, Indonesia

*Corresponding author. Email: rsupriati@unib.ac.id

ABSTRACT

Lichen is a mutualism symbiotic organism between fungi (mycobiont) and photosynthetic symbiont in the form of algae (photobiont). Lichens can be found from the lowlands to the highlands, growing epiphytes in soil, rocks, weathered wood, and on tree bark, such as on the surface of tea plants (*Camellia sinensis* (L.) Kuntze) in PT Sarana Mandiri Muki, Tea plantation Kepahiang District, Bengkulu Province. This study aims to determine the phenetic relationship of lichen on tea plants (*Camellia sinensis* (L.) Kuntze) which was conducted in May-October 2020 in Tangsi Baru Village, Kabawetan Subdistrict, Kepahiang District. Sampling using a purposive sampling method. The samples were identified in the Laboratory of Plant Biosystematics Basic Sciences, Faculty of Mathematics and Natural Sciences, Bengkulu University. Lichens were analyzed based on 51 characters and converted into matrix data using the MS Excel program and the Numerical Taxonomy System (NTSYS) version 2.02. There are 20 species of lichens consisting of 12 species of thallus crustose type, and 8 species of thallus foliose type; belonged to Ascomycota division, 2 classes (Lecanoromyces and Eurotiomycetes), 5 orders, and 7 families. The lichen relationship phenogram shows a similarity coefficient ranging from 0.38 to 0.94 which is divided into 2 main groups A and B. The closest similarity coefficient value, 0.94, was found in *Graphis intricata* with *Graphis dichotoma*, *Glyphis cicatricosa* with *Sarcographa labyrinthica*, species *Parmotrema tinctorum* with *Parmotrema crinitum*.

Keywords: Phenetic Relationship, The Tea Plant, Lichens, Kepahiang

1. INTRODUCTION

Kinship in biosystematics is defined as a pattern of relationships or similarities between plant groups based on the characteristics, or characteristics of each plant group to determine the extent of kinship between the two plant groups. Methods that using whole parts of an organism to determine relationships and form classifications based on inherited characters are called phenetics [6]. Phenetic kinship is determined qualitatively by comparing the similarities and differences in the characteristics of each taxon using many similarities in character (morphology, anatomy, embryology, palynology, cytology, chemistry, reproductive biology, ecology, and physiology). The term phenetic was first proposed by [1] which aims to show kinship using the same characteristics.

Lichens are symbiotic organisms between fungi (mycobionts) and photosynthetic symbionts in the form of algae (photobionts) so that morphologically and physiologically they form a unity. The fungus in lichen functions to provide water and minerals to maintain moisture and strengthen the body. Meanwhile, algae function as partners that produce carbohydrates with the help of sunlight for photosynthesis. The form of symbiosis between fungi
and algae is symbiotic mutualism [5]. Based on the morphology of the thallus, lichens are grouped into 4 main groups: crustose, foliose, fruticose, and squamulose. Crustose lichens have thallus like crusts and are firmly attached to the substrate surface, foliose lichens have leaf-like talus or grooved sheets, fruticose lichens have bush-like thallus, and squamulose lichens have talus like overlapping scales [2].

Based on observations in Tangsi Baru Village, Kabawetan District, it was found that there were many variations in the shape, size, and color of lichen growing on the surface of the tea plant stems. It is suspected that until now there has been no information regarding the phenetic relationship of lichens, especially in Tangsi Baru Village, Kabawetan Subdistrict, Kepahiang District. Based on this, a study was conducted to determine the phenetic relationship of lichen on tea plants (Camellia sinensis (L.) Kuntze) in Tangsi Baru Village, Kabawetan Subdistrict, Kepahiang District.

2. MATERIALS AND METHODS

The study used a purposive sampling method, only lichens that grown on Tea plants barks. It was conducted in May – October 2020 in Tangsi Baru Village, Kabawetan Subdistrict, Kepahiang District. Lichen samples were identified at the Plant Biosystematics Laboratory of Basic Science, Faculty of Mathematics and Natural Sciences, Bengkulu University. Tangsi Baru Village Map, Kabawetan Subdistrict was showed in Figure 1.

The grouping of the collected lichens was analyzed based on morphological and anatomical characters. Of the 51 morphological and anatomical character statuses used, they were analyzed qualitatively (type, shape, and color) and quantitatively (length and thickness). The characters are converted into matrix data using the MS program Excel. Matrix data were analyzed using NT Edit and

![Figure 1. Map of Tangsi Baru Village, Kabawetan Subdistrict (Source: Kepahiang District Profile and Google Earth)
processed using the Numerical Taxonomy and Multivariate Analysis System (NTSYSpc) version 2.02 program. Data analysis was made based on the Simple Matching (SM) similarity coefficient with the Unweighted pair group method with arithmetic average (UPGMA) methodology [4].

3. RESULT AND DISCUSSION

The results showed that there were 20 species of lichen, belonging to the division of Ascomycota, 2 classes (Lecanoromycetes and Eurotiomycetes), 5 orders, and 7 families. Classification and types of the thallus of Lichens grown on Tea plants (Camellia sinensis (L.) Kuntze) are presented in Table 1.

Phenograms of lichen relationship grown on the surface of the stem (bark) of Tea plants (Camellia sinensis (L.) Kuntze) were obtained from analysis based on 51 phenetic characters including thallus, prothallus, rhizine, cilia, photobiont, soredia, isidia, perithecia, and apothecia. Apothecia are divided into apothecia in the form of plates and lirellae. The apothecia plate consisted of a flat, concave plate. Meanwhile, lirellae consist of striped and round lirellae. Lirellae lines consisted of branched and unbranched lirellae, and some have labia and no labia.

The results of study, the lichen relationship analysis showed a phenogram with similarity efficiency values ranging from 0.38 to 0.94. Phenogram of 20 lichen species relationship can be seen in Figure 2.

<table>
<thead>
<tr>
<th>No</th>
<th>Class/Ordo/Familia</th>
<th>Genus</th>
<th>Species</th>
<th>Type of thallus</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ostropales/Graphidaceae</td>
<td>Graphis</td>
<td>Graphis scripta (L.) Ach</td>
<td>Crustose</td>
</tr>
<tr>
<td>2</td>
<td>Lecanorales/Stereocaulaceae</td>
<td>Lepraria</td>
<td>Lepraria incana (L.) Ach</td>
<td>Crustose</td>
</tr>
<tr>
<td>3</td>
<td>Lecanorales/Parmeliaceae</td>
<td>Parmelia</td>
<td>Parmelia sulcata Taylor</td>
<td>Foliose</td>
</tr>
<tr>
<td>4</td>
<td>Pertusaria/ Pertusariaceae</td>
<td>Pertusaria</td>
<td>Pertusaria multipuncta (Turner) Nyl.</td>
<td>Crustose</td>
</tr>
<tr>
<td>5</td>
<td>Teloschistales/ Physciaceae</td>
<td>Heterodermia</td>
<td>Heterodermia obscurata (Nyl.) Trevis</td>
<td>Foliose</td>
</tr>
<tr>
<td>6</td>
<td>Teloschistales/ Caliciaceae</td>
<td>Dirinaria</td>
<td>Dirinaria applanata (Fee) D.D. Awasthi</td>
<td>Foliose</td>
</tr>
<tr>
<td>7</td>
<td>Pyrenulales/ Pyrenulaceae</td>
<td>Pyrenula</td>
<td>Pyrenula macrospora (Degel.) Coppins &amp; P.James</td>
<td>Crustose</td>
</tr>
</tbody>
</table>

Table 1. Classification, Types of the thallus of lichens found in Tea Plants (Camellia sinensis (L.) Kuntze) in Tangsi Baru Village, Kabawetan Subdistrict, Kepahiang District
Figure 2. Phenogram of lichens grown on Tea Plants bark based on phenetic characters

The higher the phenogram similarity coefficient value produced, the closer the lichen relationship coefficient. On the other hand, the lower the resulting phenogram similarity coefficient value, the further the relationship is. All of lichens species belong to one group with a similarity of 0.38. At the similarity value of 0.38, there are 20 species and divided into two main groups, those are group A and group B. The main group A and B are separated on the characters of the thallus type, variations in the thallus, abaxial thallus, species color, thallus margins, prothallus, lobes, rhizine, cilia, and photobiont.

The main group A consisted of 12 species of lichens; *Diorygma junghuhnii*, *Graphis scripta*, *Graphis vulgata*, *Graphis allugallenensis*, *Graphis intricata*, *Graphis dichotoma*, *Graphis cryonocarpa*, *Glyphis cicatricosa*, *Sarcographa labyrinthica*, *Pyrenula macrospera*, *Lepraria incana*, and *Pertusaria multipuncta*. It has similar characters in the type of thallus (crustose), presence of prothallus, presence of apothecia, lirellae, soredia, isidia, perithecium. At the similarity coefficient value of 0.61, the main group A was divided into two groups (A1 and A2). Groups A1 and A2 are separated by the character of the presence or absence of apothecia, perithecium, isidia, and soredia.

Group A1 consisted of 9 species of lichens of the genera *Diorygma*, *Graphis*, *Glyphis*, and *Sarcographa*. The similar characters including the type of thallus (crustose), variations in the thallus leprose, margins of the thallus, presence of prothallus, rhizine, cilia, soredia, isidia, and perithecium, apothecia in the form of striped and round lirellae. It has photobiont of the genus *Trentepohlia*. At a similarity coefficient of 0.80 group A1 is divided into A1a and A1b. The characters that makes the A1a and A1b groups separate is the apothecia type.

Group A1a is the lichen from the species *Diorygma junghuhnii* which has the character of the crustose thallus type, variations of the leprose thallus, flat margin of the thallus, white prothallus, does not have rhizines, cilia, soredia, isidia, and perithecium. It has *Trentepohlia* photobiont and has *apothecia* in the
form of line *lirellae* which sinks to the surface of the thallus. *Lirellae* are scattered all over the surface of the thallus, short branched, closely spaced, and have a thickness of 0.1 mm *lirellae*.

Group A1b consisted of 8 species of lichens of the genera *Graphis*, *Glyphis*, and *Sarcographa*. It has similar characters in the type of thallus (crustose), variations in the talus leprose, the flat margin of the thallus, black prothallus, without rhizine, cilia, soredia, isidia, and perithecia. Has apothecia in the form of striped and round *lirellae*. At a coefficient of 0.86, the genus *Graphis* is divided into two groups, namely groups of the species *Graphis scripta*, *Graphis allugallenensis*, *Graphis intricata* with *Graphis dichotoma* which have similar apothecia characters in the form of black *lirellae* lines, 0.05 mm thickness *lirellae*, white *lirellae* margins, and labia in black, and photobiont of the genus *Trentepohlia*. Meanwhile, the *Graphis* group of the species *Graphis vulgata* and *Graphis cryoscarpa* have similar black prothallus color characters, apothecia in the form of line *lirellae*, scattered on the surface of the thallus, the distance between the apothecia is tight, short *lirellae* has a prominent type (protrudes on the thallus surface), the thickness of the *lirellae* is 0.05 mm, *lirellae* 0.3 mm long, has a blacklabia, and photobiont of the genus *Trentepohlia*.

At a coefficient of 0.94, the species of *Graphis intricata* and *Graphis dichotoma* have similar characters in the type of thallus crustose, variations in the thallus leprose, whitish-gray talus color, black prothallus, black apothecia, appearing on the surface of the talus. *Apothecia* is a long, branched line, 0.05 mm thick, black labia, and photobiont of the genus *Trentepohlia*. The species *Glyphis cicatricosa* and *Sarcographa labyrinthica* have similar characters, namely the type of talus crustose, variations in the thallus leprose, black prothallus, having apothecia in the form of round *lirellae* submerged in the surface of the talus, the distance between the apothecia is rare, the thickness of the *lirellae* is 0.05 mm, the rim of the *lirellae* is white, black labia, and photobiont of the genus *Trentepohlia*. The species characters of *Graphis intricata*, *Graphis dichotoma*, *Sarcographa labyrinthica*, and *Glyphis cicatricosa* can be seen in Figure 3. Group A2 consisted of 3 species of lichens, namely *Pyrenula macrospora*, *Lepraria incana*, and *Pertusaria multipuncta* which have similar characters, including the type of thallus crustose, the margins of the thallus are flat, presence or absent of prothallus, has apothecia in the form of a cup, perithecia, isidia, and soredia. At a coefficient of 0.74 group A2 is divided into groups A2a and A2b. Group A2a and A2b are separated by the characters of the presence or absence of soredia, perithecia, and isidia.

The A2a group; *Pyrenula macrospora* species, have characters including the type of thallus crustose, variations in the perithecia leprose, flat thallus margins, black prothallus, presence of black scattered perithecia over the thallus surface, and photobiont genus *Trentepohlia*.

Group A2b consisted of 2 lichen species; *Lepraria incana* and *Pertusaria multipuncta*. It has similar characters including the type of crustose thallus, flat margin of the thallus, green adaxial thallus, no rhizine, cilia, and apothecia, has soredia, isidia. Photobiont of the genus *Trebouxia*.

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**Figure 3** Character species *Graphis intricata* (A); *Graphis dichotoma* (B), *Sarcographa labyrinthica* (C), and *Glyphis perithecia*.  

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The main group B consisted of 8 species of lichens belonging to the foliose thallus lichens, photobiont genus Trebouxia. Most of this group has color on the surface of the adaxial and abaxial thallus, presence of prothallus, perithecia, rhizin, cilia; some species are not found cilia. At a similarity coefficient of 0.66, the main group B is divided into two groups (B1 and B2). Groups B1 and B2 were separated by abaxial color characters of the thallus, apothecia, soredia, isidia, rhizin, and cilia.

Group B1 consisted of 7 species of lichens which have similar characters including the type of foliose thallus, presence of rhizin, and Trebouxia photobiont. At the coefficient of 0.85 group B1 is divided into groups B1a and B1b. Groups B1a and B1b were separated by the characteristics of the presence of soredia and isidia.

Group B1a consisted of 5 species of lichens; Dirinaria applanata, Parmelia sulcata, Parmotrema perlatum, Parmotrema robustum, and Heteroderma obscurata. Characterized by the type of thallus foliose, photobiont genus Trebouxia does not have apothecia, isidia, and perithecia, has rhizin, soredia, and cilia. Dirinaria applanata species do not have cilia. At a coefficient of 0.90, the Parmelia sulcata species are separated from the group because it has squarrose rhizine, unbranched rhizin, black cilia, unbranched cilia, sparse between cilia are rare, do not have apothecia, have a green powder type soredia scattered on the surface of the talus, and photobiont of the genus Trebouxia.

At a similarity coefficient of 0.94, Parmotrema perlatum and Parmotrema robustum species are closely related, have similar characters, namely black simple rhizin, unbranched rhizin, unbranched cilia, black cilia, the dense distance between cilia, do not have apothecia, has no isidia, has green powder type soredia, and the photobiont genus Trebouxia. The characters that distinguish Parmotrema perlatum and Parmotrema robustum species are the adaxial thallus color, the sparse and dense distance between rhizines, the location of Parmotrema perlatum soredia was in the middle of the thallus surface, while at Parmotrema robustum soredia is located at the lobe margins. The characters of the Parmotrema perlatum and Parmotrema robustum species can be seen in Figure 4.

Group B1b at a coefficient of 0.83 consists of 2 species of lichen, namely Parmotrema tinctorum and Parmotrema crinitum. The Parmotrema tinctorum and Parmotrema crinitum species are separated from their groups because they have similar characters including the foliose thallus type, greenish-gray adaxial thallus color, absent of prothallus, has simple black rhizin type, tight distance between rhizines, unbranched rhizin, absent of apothecia and soredia, have scattered isidia over thallus surface, photobiont genus is Trebouxia. Parmotrema tinctorum has cilia and green- fingerlike isidia, whereas Parmotrema crinitum has black cilia and gray – coralloid isidia. The characters of Parmotrema tinctorum and Parmotrema crinitum species can be seen in Figure 5.

![Figure 4](image-url)
Group B2 at a coefficient of 0.66 consists of Parmelia trabeculata. The Parmelia trabeculata species is separated from its group due to its foliose thallus type, simple rhizin, black cilia, the distance between cilia is tight, has apothecia in the form of brown plates, the distance between the apothecia is tight, the apothecia are scattered on the surface of the thallus, the margins of the apothecia wavy green color, has no soredia, has no isidia, and photobiont of the genus Trebouxia.

The lichens that have the closest coefficient value are 0.94, first in the species Graphis intricata and Graphis dichotoma, the second in the species Glyphis cicatricosa and Sarcographa labyrinthica, the third in the species Parmotrema tinctorum and Parmotrema crinitum have a parallel phenogram line. Parallel lines indicate that the two species are closely related and show many similarities in phenetic characters. This is by the opinion of [3], the more similarities one has between living things, the closer the relationship is and vice versa.

4. CONCLUSION

Analysis of the lichen relationship based on phenetic characters resulted in a phenogram of kinship with a similarity coefficient of 0.38 - 0.94. At the similarity coefficient value of 0.38, the phenogram was divided into two large groups (A and B). Group A consisted of 12 species of the thallus crustose type, while group B consisted of 8 species of the thallus foliose type. The closest similarity coefficient value is 0.94, found in species between Graphis intricata and Graphis dichotoma, species Glyphis cicatricosa with Sarcographa labyrinthica, species Parmotrema tinctorum, and Parmotrema crinitum.

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