Lichen Family *Lobariaceae* Diversity as Air Pollution Bioindicator on Conservation National Park Gunung-Gede Pangrango (TNGGP)

Lilis Supratman Universitas Pakuan, Bogor, Indonesia

Corresponding email lilissupratman84@gmail.com

ABSTRACT

Lichen is a symbiosis between fungi and algae. Lichen family *Lobariaceae* is a group of foliose that is very sensitive to air pollution. This study used lichen explorations in Gunung-Gede Pangrango National Park (TNGGP) area which is good for biodiversity reservoir as a method. During exploration, on ascending tracks of Curug Cibeureum, *Lobaria pulmonaria* was found. The main characteristic of *L. pulmonaria* is they have isidia, lobulus, tomentum, cephalodium, and rhizine squares types, are reactive to the K^+ reaction test, have wavy lobus, and look like resemble lungs and photobiont as green algae. It also can be found in tree trunk substrate at an elevation above 1 to 2 Meters. The tree barks' characteristic which is being overgrown by *L. pulmonaria* woody, rough surface, moist, wet, and has *gemma* (bud). According to the lobus abundance indicator and wide lobus, it can be concluded that air quality in TNGGP ascending tracks of Curug Cibeureum has an excellent category.

Keywords: Bioindicator, conservation, lichen, lobaria, TNGGP

INTRODUCTION

Lichen is the most dominant pioneer after Bryophyta in tropical forests. Lichen is a symbiosis between fungi and algae. A group of fungi that made a symbiosis are *Ascomycota* and *Basidiomycota*, while a group of algae is included in *Cyanobacteria* and *Chlorophyta*. Based on morphology, lichen has varied thallus, i.e., *crustose* (crust-like), *foliose* (leaf-like), *fruticose* (bushes-like), and *squamulose* (scale-like). Generally, lichen thallus has no cuticula layers, stomata, and absorptive organs, so that lichen can survive under the pollutant threat in air and soil. Lichen is also the best bioindicator for air pollution. *Foliose* thallus could become an effective bioindicator for determining air pollution levels.

Lichen includes the *Lobariaceae* family, for instance: *Dendriscocaulon*, *Lobaria*, *Pseudocyphellaria*, and *Sticta* (Brodo et al., 1969). Its characteristic in general is tropical habituation and *foliose* thallus. *Foliose* has a structure like a leaf that is arranged by the lobes. This lichen is relatively loosely attached to the substrate, flat, wide thallus formation, like a wrinkle spiral leaf. Easily attached to the rocks, twig with *rhizines* or *tomentum* that has a role to absorb the water. In the land of the United Kingdom forest, it usually lives in *oak*, *beech*, and *maple* tree, and several of them live on the rocks. Whereas, in Indonesia, this lichen is mostly found in Kebun Raya Cibodas (KRC), on *Prunus cerasoides*, *Yucca elephantipes*, and *Araucaria bidwilli* stem tree (Supratman et al., 2016).

The *Lobariacea* reproduction system consists of sexual and asexual. The sexual reproductive system is using a disc that is known as an *apothecium* which contains an ascus. When an ascus contains a ripe spore, then the spore can be released into the air. The asexual

reproductive system is using *soredia* or *isidia*. *Soredia* or *isidia* in *Lobariaceae* can grow in new habitats and could be helped by wind or rain for the spreading. Several factors influence the distribution of *Lobariaceae*, i.e., temperature, humidity, sunlight, and air pollution level. In several qualitative evaluations, lichen growth is hard to be detected because of indigenous habitat differences that heat requirements and drought tolerance.

Based on Walser et al. (2002) that one of the lichens, *Lobariaceae* has sensitivity to environmental changing and acid pollutants in the atmosphere. The degree of sensitivity is close relations to the surface area for accumulating the pollutant in the air. The study was conducted at the conservation forest of TNGGP. The area of the national park is a conservation forest that is protected so that the biodiversity inside is saved. However, if the existence of *Lobariaceae* at TNGGP is rare, it is a sign that air pollution is already reaching the TNGGP area. Air pollution has already outside of the tolerance threshold, so this data can be used as a reference for the government to minimize carbon emissions from the vehicle, industries, and others.

Biodiversity in Indonesia is very high, but information about lichen biodiversity is still rare. It is proven that a few recent articles discussed the lichen family *Lobariaceae*. The previous study on the *Lobariaceae* has been conducted by Fatma et al. (2017) in East Java. Other research was also reported from South Korea (Wang and Hur, 2012), California (Peterson and Ikeda, 2017), and United Kindom (Mongada et al., 2013). Thus, there is needed research to collect the lichens' existences information. *Lobariaceae* is a rare lichen family, that statement strengthens that Herbarium Bogoriense of BRIN has not a collection for that, and also a few researchers discussed this lichen. Based on that problem, it is needed to collect information about rare lichen. So, it can be said that *Lobariaceae* is in endangered status, so it is needed to be researched seriously by doing prevention. This study aims to build data and make *Lobariaceae* rare lichen collections. The data collection included morphology level, anatomy, and existence comparison with the surrounding environment.

METHODS

Study Area

Exploration research for lichen was conducted on August 2019 at Conservation Forest TNGGP. Macroscopic and microscopic observations were conducted in Biology Laboratory, FKIP, Universitas Pakuan. Constructing permanent preparade using the paraffin method was conducting in Morphology, Anatomy, and Cytology Laboratory, Research Center for Biology, LIPI (currently BRIN), Cibinong, Bogor. Lichen mapping was conducted at TNGGP, entrance gate of Cibodas with the Curug Cibeureum track. This area has not been done for mapping before based on altitude below the sea level (DPL). Curug Cibeureum track is a tourist route. Lichen mapping was conducted by exploration method in track and cruising was conducted by observation of tree stems and rocks.

Data Collection

Research tools were a thermometer for measuring the temperature, a hygrometer for measuring humidity level, and a microtome. Chemical substances for reaction test in medulla using KOH 10% (K Test), Clorox (C Test), and another reagent. Lichen collection identification from mapping results has been conducted until the species level. Identification key followed Ren et al. (2012), and Sharnoff (2002). To know internal thallus tissue structure

was worked make fresh tissues prepare and preserve the preparade. Identification observation parameters consist of macroscopic observation and microscopic and chemical reaction tests. Macroscopic observation was thallus morphology that included thallus color, surface structure, vegetative structure, and reproduction organ. Tiny observation included internal thallus structure and medulla color. Medullas' chemical reaction with the color changing was as an indicator.

RESULTS AND DISCUSSION

Lichen mapping from entrance gate Cibodas to Curug Cibeureum on tree stem and the rocks. Based on the research result, the lichen family *Lobariaceae*, *L. pulmonaria* is found on woody tree stems, rough surfaces, humid, wet, and with *gemma* (bud), so that *L. pulmonaria* grows in diverse habitats. Astuti et al. (2021) mentioned that the TNGGP area is dominated by woody stand species. Every tree species has a different ability to save water; it depends on the porosity and texture of the stem. The rough surface is utilized by thallus to well attach. Every tree can expose to chemical compound naturally that supports lichen growth. Based on that, the properties and conditions of the bark plant influence thallus formation and growth (Brodo et al. 2001). Tree trunks are not woody, and have more water capacity and a slow evaporation rate compared to a hard-skinned tree, because of those factors, every single type of lichen is more like a tree with conditions that are proper for their growth. Based on Supratman et al. (2016), stem substrate that is liked by *L. pulmonaria* are woody, rough surface structure, humid, and wet. While the stem tree along the Curug Cibeureum track is woody, the stem structure is slippery, damp, and wet. It can be predicted that *rhizines* and *tomentum* on thallus *L. pulmonaria* has difficulties being steady on stem tree substrate. The tree structure with the slippery surface is also related to the phytochemistry metabolism of the stem tree, bark acidity, and level of light inclination. If light supplies are sufficient, so it has possible stem surface is not slippery, these reasons are strengthened if the stem tree has exudate-like sap that causes the *rhizines* and *tomentum L. pulmonaria* not steady with the substrate. Another factor that affects the growth of lichen is temperature, mountainous areas have similar temperatures, such as the info submitted by Marhento et al. (2021) which explains the temperature of the Mount Halimun Salak National Park Area, West Java, has a light intensity range of 165-780 lux, a temperature range of 29 °C-30 °C, a humidity range of 57-65%. This data is supported by Hernawati et al. (2021) the Galunggung Mountain area has a temperature range of 13°C-32°C. Optimally, lichen can live in the range of mountain temperatures.

Based on the determination key Ren et al. (2012) and Sharnoff (2002), *L. pulmonaria* can be described as: *L. pulmonaria* has a green color thallus, is strongly attached to the substrate, green algae *photobiont*, white medulla, *rhizines* are not branched, and dark brown *tomentum*. K+ reaction test on medulla *L. pulmonaria* produces a red color. *Soredium* existence still has to be researched because of the high rainfall in TNGGP, so based on macroscopic, *soredium* flour is invisible and tough to be reduced. Based on microscopic, *soredium* cannot be seen in cross-section, so it is suggested to make permanent preparade by using the paraffin method, so *soredium* could be seen clearly. Thallus *L. pulmonaria* is found on the Curug Cibeureum track. Its abundance can be used as an indicator of forest ages (Sharnoff, 2002).

High-level air pollution can cause the loss of certain lichen species or lichen community composition change, which is preceded by morphology changes and the physiology of lichen thallus (Purvis, 2000). Based on *L. pulmonaria* morphology proves that

air condition at TNGGP is in the excellent category. However, three other genera, *Pseudocyphellaria*, *Sticta*, and *Dendriscocaulon* are not found. The sensitive one is expected to be found far from the source of pollution, and the type with the highest tolerance level is predicted to be found at the closest distance from the source of pollution (Beaven, 2008). This is related to the TNGGP track with minimum pollution like emission gases from vehicles.

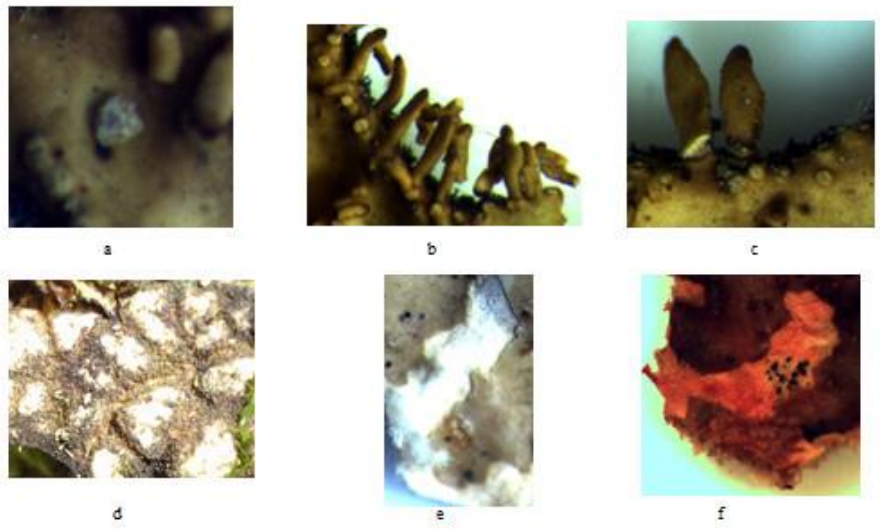

Figure 1. Morfology of *L. pulmonaria*: a. Sepalodium, b. Isidia, c. Lobul, d. Tomentum, e. Medula, f. Medula (K^+)

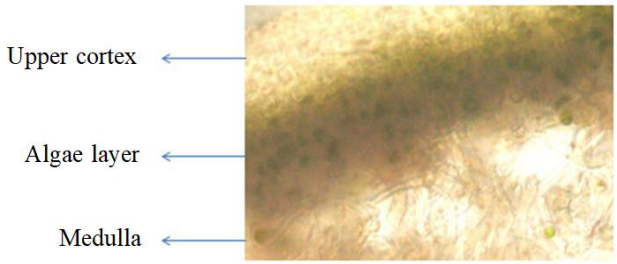

Figure 2. Thallus anatomy of *L. pulmonaria*

CONCLUSIONS

The lichen family *Lobariaceae* found in this study is *L. pulmonaria* with the main characteristics has *isidia*, *lobulus*, *tomentum*, *cephalodium*, *rhizin*e type *squares*, reactive with K^+ reaction, wavy lobe, like *pulmo* (lungs) and *photobion*t as green algae. Founded at tree stem substrate on altitude over 1-2 M. Based on abundance indicator and lobe size, the air quality at TNGGP Curug Cibeureum track is an excellent category.

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