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## Diversity and Frequency of the Kind of Lichen in Gunitir Mountain Area of Jember Regency

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### ABSTRACT

The area of Indonesia is 1.3% of the Earth, but it has the highest level of biodiversity. Biodiversity in environment needs to be explored. The mountain area is one of the most suitable environments for exploring biodiversity, such as the Gunitir Mountain. Gunitir Mountain has altitude around 620 meters above sea level. Gunitir Mountain has high biodiversity. Mosses (*Bryophyta*), ferns (*Pteridophyta*), till seed plants (*Spermatophyta*), and including Lichen was found in this area. Lichen is a mutualism symbiotic organism between fungi and green algae or blue-green algae that lives on the surface of the tree or other substrate with variation of shapes and colors. This study aims to determine the diversity of kinds and frequencies of each kind of lichen that found in the Gunitir Mountain area of Jember Regency. This research classified into exploratory research. Data retrieval is using the cruised method. Lichens are found in 20 species with *Phlyctis argena* (Ach.) Flot. as kind of lichen that is abundant in Gunitir Mountain Area.

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### INTRODUCTION

The area of Indonesia is 1,3% of the Earth, but it has the high level of biodiversity. Indonesia have 20.000 species of flower plants, 4.000 species of ferns, 1.260 species of herbs, 400 species of palm that spread all over Indonesia and many other diversity including Lichen (Kusmana and Hikmat, 2015). The high-level of diversity in Indonesia supported by it's forest. The forest of Indonesia is the ninth largest forest in the world (Rahman, 2017). Lichen are formed by mutualism symbiosis between fungi and green or blue-green algae. According to Negi (2003), total number of species of lichen in the world reached 100.000 species. According to Suwarso (1995),

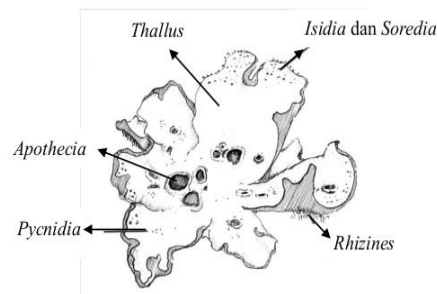
based on data of Herbarium Bogoriensis Bogor, the number of species of lichen in Indonesia reached 40.000 species. Lichen used as medicine, bioindicator for environmental issue, raw material for perfume, and as dye. Lichen has been used as a traditional medicine by the world community such as a cough medicine by Indians tribes from America. *Usnea* spp. is a species of lichen that has been used by the Indonesian people as a medicine in a mixture of tradisional herbs (Sudirman, 2017).

Identification and inventory activities are needed to obtain data for quality and quantity of biodiversity, one of it is lichen diversity of an environment. Identification interpreted as effort to establish the identity of organism that is right in the classification based on the similarity with real specimens, both living or preserved specimens (Tjitrosoepomo, 2009). Inventory is an activity to collect data and classify a type of organisms that exists in an area. Inventory activities are needed to measure the potential of an area that including aspects of diversity, distribution, and biological populations including lichen (Akin, 2010). Biodiversity of environment is needed to explore through identification and inventory activities. The mountain area is one of the most suitable environments for exploring biodiversity, such as the Gunitir Mountain area. Gunitir Mountain has altitude of 620 meters above sea level. Gunitir Mountain located in the border region between Jember Regency and Banyuwangi Regency, East Java (Wardani, 2014). Gunitir Mountain area located at coordinates 8°16'13" S and 113°56'05" E (Google Maps, 2018).

The Gunitir Mountain Area has high of biodiversity. Mosses (*Bryophyta*), ferns (*Pteridophyta*), and seed plants (*Spermatophyta*) found in that area (Windari, 2015). The diversity of lichens have been investigated by many reseachers, but still no investigation related to the diversity of lichen in the Gunitir Mountain area. With its potential, it is necessary to conduct lichenes identification in that particular area. The preliminary survey showed there are many species of lichen found with different morphological such as *foliose*, *crustose*, *leprose*, and *fructicose*, as well as variety of colors. The results of identification and inventory of lichen diversity will also used as a source of information for the public.

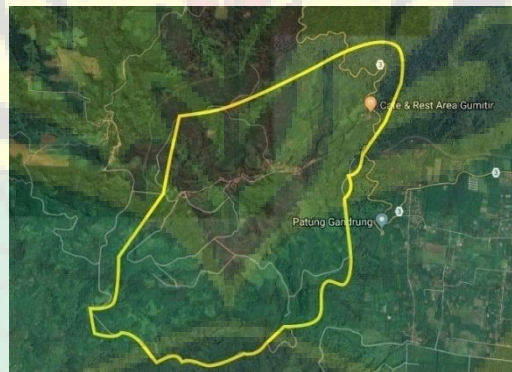
Identification is defined as an effort to establish the identity (name, size, etc.) of an organism in the classification. The identification of an organism is based on real specimens, both those that are still alive or those that have been preserved (Tjitrosoepomo, 2009). According to Yuniarti (2011), inventory are activities to collect data about the types of organisms that exist in a region. Identification and inventory is an important work to measure the potential of an area that includes aspects of diversity, distribution, and biological population (Akin, 2010).

Lichen is organism that formed by the mutualistic symbiosis between fungi from the Ascomycota division or Basidiomycota as mycobiont with green algae or blue-green algae as photobiont. The combination of the two is called holobiont. The existence of this symbiosis allows lichens to grow in different habitats with organisms in common and tolerate with extreme environments such as desert ecosystems and polar ecosystems (Atala et al., 2015). According to Bhat et al. (2013), the lichen body generally consists of several parts as shown in **Figure 1.** below.



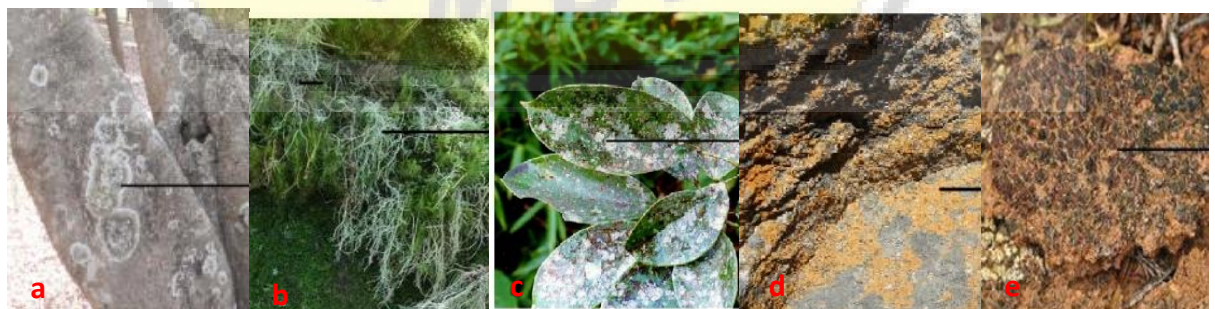
**Figure 1.** Part of Lichen (Source: Astiva, 2016)

The Gumitir Mountain area has a high biodiversity. Moss plant, ferns, to seed plants can be found in the region. Windari (2015) stated that there are 29 kinds of ferns in the area of Gumitir Mountain. Biotic factors greatly affect the vegetation that grows in the area. The Gumitir Mountain area is dominated by trees, making the area shady and cool where it supports the growth of vegetation, including lichen. The abiotic factors that affect the growth of vegetation in the region are soil acidity (pH), soil moisture, air humidity, temperature, light intensity, and wind speed. The Gumitir Mountain area has an average soil pH at 6.85; soil moisture at 15%; air humidity at 61.5%; temperature at 29.5°C; light intensity at 350.5 lux; and wind speeds at 18 m/s (Windari, 2015). The Gumitir Mountain area can be seen in **Figure 2**.



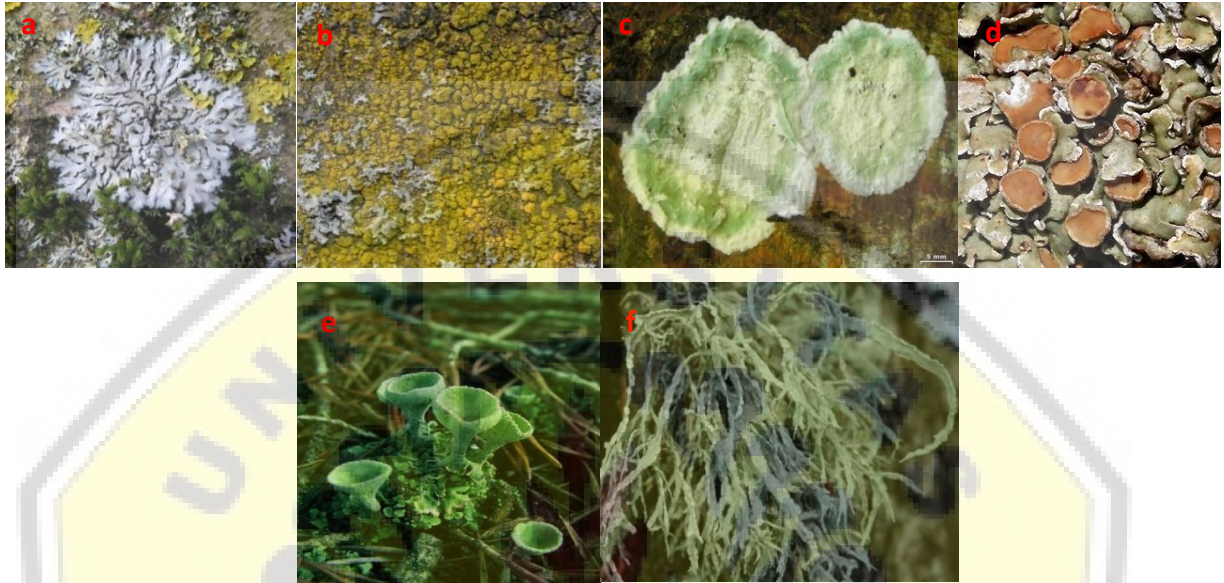
**Figure 2.** Gumitir Mountain Area (Source: Google Maps, 2018)

According to Roziaty (2016), Lichen divide into several group based on habitat, that are corticolous, muscicolous, follicolous, saxicolous and tericolous lichenes. As describes in **Figure 3**.



**Figure 3.** Types of lichenes based on habitat. a) corticolous, b) muscicolous, c) fillicolous, d) saxicolous, e) tericolous lichenes. (taken from Roziaty, 2016).

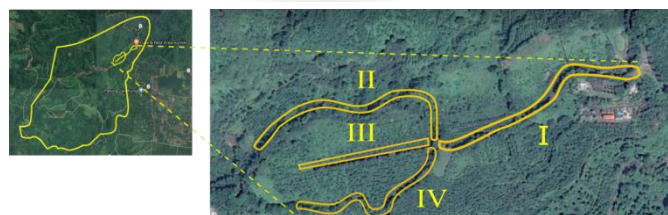
Apart from its habitat, lichens also being recognized from the shape of its thallus. Goward, et al (1994) stated there are several types of lichens based on the shape of its thallus. Those are leaf-like, drust-like, crust-like, scale-like, club-like and hair-like lichens. The thallus of lichens describe in **Figure 4**.



**Figure 4.** Thallus lichens; a) leaf-like, b) drust-like, c) crust-like, d) scale-like, e) club-like, and f) hair-like lichen. (Sources: a. Nature Spot, 2019; b. Silverside, 2014; c. Way of Enrichement, 2017; d-f. Silverside, 2014).

## METHODOLOGY

This exploratory research aimed to find, collect, describe, and interpret species of lichens found in the field systematically, factually, and accurately. The research took place in the Gunitir Mountain Area, Jember Regency. The tools used were identification books, stationery, cameras, meters, slap straps, rulers, label, plastic clips, scissors, knives, thermohygrometers, luxmeter, anemometers, and GPS. The materials used in this research are samples of lichen found in the Gunitir Mountain Area, a liter of Aquadest, 50 ml of Formalin 4%, 100 ml of Alcohol 70%, 10 ml of  $\text{CH}_3\text{COOH}$  40%, and 0.4 grams of  $\text{CuSO}_4$ . Data obtained by cruise method. Cruise is done by tracing a predetermined route so that there are four sampling locations of lichen as shown in **Figure 5**.



**Figure 5.** Sampling Location of Lichen

Data then were analyzed descriptively. The level of abundance from each kind of lichen in the sampling area was calculated through the frequency equation. The frequency equation is formulated as follows (modification from Supratman, 2016):

$$f = \frac{n}{N} \times 100$$

$f$  : Frequency of each kind of lichen

$n$  : Number of stations that lichen found at each location

$N$  : Total number of stations in each location

## RESULT AND DISCUSSION

Retrieval of data in the form of environmental factors and diversity of lichen in the research "Identification and Inventory Kind of Lichen in Gunitir Mountain Area of Jember Regency" was done on January 12<sup>th</sup>, 2019 until January 23<sup>th</sup>, 2019. The data collection in the form of lichen samples were identified using identification books, credible web pages, articles and photos that are relevant and valid on January 24<sup>th</sup>, 2019 until February 22<sup>nd</sup>, 2019. As much as 20 species were found on the overall sampling area.

The data on the lichen species along with the frequency can be seen below in **Table 1**.

**Table 1.** Lichen that Found in Sampling Area

No	Spesies	Sampling Area			
		Locatio n I	Locatio n II	Location III	Locatio n IV
1	<i>Candelariella reflexa</i> (Nyl.) Lettau	-	++	+	+
2	<i>Chrysothrix candelaris</i> (L.) J. R. Laundon	+	+	+	+
3	<i>Cryptothecia striata</i> G.Thor	++	-	+	+
4	<i>Dirinaria applanata</i> (Fée.) D.D. Awasthi	+++	++	++	++
5	<i>Graphis scripta</i> (L.) Ach.	+	-	+	-
6	<i>Heterodermia diademata</i> (Taylor) D.D. Awasthi	+	+	+	+
7	<i>Lecanora symmicta</i> (Ach.) Ach.	+	-	-	-
8	<i>Lepraria incana</i> (L.) Ach.	+	++	+	+
9	<i>Leptogium cyanescens</i> (Rabehn.) Korb.	-	+	-	-
10	<i>Opegrapha gyrocarpa</i> Flot.	+	++	-	+
11	<i>Ophioparma ventosa</i> (L.) Norman	+	+	-	+
12	<i>Parmelia sulcata</i> Taylor	+	+	+	+
13	<i>Parmotrema hypotropum</i> (Nyl.) Hale	+++	++	+	+
14	<i>Phaeographis neotricosa</i> Redinger	+	+	-	+
15	<i>Phaeophyscia orbicularis</i> (Neck.) Moberg	+	++	+	+
16	<i>Phlyctis argena</i> (Ach.) Flot.	+++	+++	+++	+++
17	<i>Pyrenula nitida</i> (Weigel) Ach.	+	+	-	+

No	Spesies	Sampling Area			
		Locatio n I	Locatio n II	Location III	Locatio n IV
18	<i>Pyxine sorediata</i> (Ach.) Mont.	+	+	+++	++
19	<i>Ramalina farinacea</i> (L.) Ach.	+	+	+	+
20	<i>Usnea subfloridana</i> Stirt.	+	+	+	+

- : None, if frequency of lichen = 0%
  - + : A little, if the frequency of lichen is < 40%
  - ++ : Quite a lot, if  $40\% \leq$  frequency of lichen  $70\%$
  - +++ : Many, if frequency of lichen  $\geq 70\%$
- (Source: Author)

Based on information on Table 1, the species of lichen with the highest frequency is *Phlyctis argena* (Ach.) Flot. followed by *Dirinaria applanata* (Fée.) D.D. Awasthi. The least frequent species is *Lecanora symmicta* (Ach.) Ach. All lichens species found and their taxonomic group can be seen in Table 2.

**Table 2.** Classification of Lichens

Family	Species	Division
Arthoniaceae	<i>Cryptothecia striata</i>	Ascomycota
Caliciaceae	<i>Dirinaria applanata</i>	Ascomycota
	<i>Pyxine sorediata</i>	Ascomycota
Candelariaceae	<i>Candelariella reflexa</i>	Ascomycota
Chrysothricaceae	<i>Chrysothrix candelaris</i>	Ascomycota
Collemaaceae	<i>Leptogium cyanescens</i>	Ascomycota
Graphidaceae	<i>Graphis scripta</i>	Ascomycota
	<i>Phaeographis neotricosa</i>	Ascomycota
Lecanoraceae	<i>Lecanora symmicta</i>	Ascomycota
Opegraphaceae	<i>Opegrapha gyrocarpa</i>	Ascomycota
Ophioparmaceae	<i>Ophioparma ventosa</i>	Ascomycota
	<i>Parmelia sulcata</i>	Ascomycota
Parmeliaceae	<i>Parmotrema hypotropum</i>	Ascomycota
	<i>Usnea subfloridana</i>	Ascomycota
Phlyctidaceae	<i>Phlyctis argena</i>	Ascomycota
	<i>Heterodermia diademata</i>	Ascomycota
Physciaceae	<i>Phaeophyscia orbicularis</i>	Ascomycota
	<i>Pyrenula nitida</i>	Ascomycota
Ramalinaceae	<i>Ramalina farinacea</i>	Ascomycota
Stereocaulaceae	<i>Lepraria incana</i>	Ascomycota

(Source: Author)

Table 2 showed that all lichens belongs to the division of Ascomycota and grouped into 15 different families.

Research on identification and inventory of lichen species has been done in Gunitir Mountain Area of Jember Regency. Samples were identified using

identification book “A Key to Common Lichens on Trees in England by Pier Luigi Nimis”; “Epiphytic Field Guide to Macrolichens in Arizona by F. Bungartz”; “Identifying Mixed Hardwood Forest Lichens by Irwin M. Brodo”; “Guide to Common Macrolichens and Bryophytes of the Umatilla National Forest by Allison M. Kelly”; and “The Lichens of the British Columbia Illustrated Keys by Goward”. In addition, several webpage sources were used to strengthen the identification results including: Mycobank.org; Lichen Portal.org; Lichen Maritimes.org; and Nature Spot.org; and Way Of Enlichenment.org.

Based on Table 1, 20 species of lichen have been found, including *Candelariella reflexa* (Nyl.) Lettau, *Chrysothrix candelaris* (L.) J. R. Laundon, *Cryptothecia striata* G.Thor, *Dirinaria applanata* (Fée.) D.D. Awasthi, *Graphis scripta* (L.) Ach., *Heterodermia diademata* (Taylor) D.D. Awasthi, *Lecanora symmicta* (Ach.) Ach., *Lepraria incana* (L.) Ach., *Leptogium cyanescens* (Rabehn.) Korb., *Opegrapha gyrocarpa* Flot., *Ophioparma ventosa* (L.) Norman, *Parmelia sulcata* Taylor, *Parmotrema hypotropum* (Nyl .) Hale, *Phaeographis neotricosa* Redinger, *Phaeophyscia orbicularis* (Neck.) Moberg, *Phlyctis argena* (Ach.) Flot., *Pyrenula nitida* (Weigel) Ach., *Pyxine sorediata* (Ach.) Mont., *Ramalina farinacea* (L.) Ach., *Usnea subfloridana* Stirt. The 20 species come from 15 different families including Arthoniaceae, Caliciaceae, Candelariaceae, Chrysothricaceae, Collemataceae, Graphidaceae, Lecanoraceae, Opegraphaceae, Ophioparmaceae, Parmeliaceae, Phlyctidaceae, Physciaceae, Pyrenulaceae, Ramalinaceae, and Stereocaulaceae that all of which belong to the same division called Ascomycota.

Species that dominate a community can be influenced by several factors such as climate, food availability, and competition between species. Strong species will win and able to reduce the growth rate of other species. The less adaptive species will loses. A less adaptive species causes fewer reproductive and species densities (Emery dan Katherine, 2007). Based on Table 1, the lichen species that dominates is *Phlyctis argena* (Spreng.) Flot. This species grows almost in crops that grow in all four sampling locations. Eufemio et al. (2016) stated that *Phlyctis argena* (Spreng.) Flot is a species that has the ability to survive in extreme environments including those with high pollution levels. *Phlyctis argena* (Spreng.) Flot is a type of lichen with the Crustose talus type. *Phlyctis argena* (Spreng.) Flot has the highest tolerance to environmental conditions compared to lichen with other talus types such as Foliose and Fruticose.

Lichens have fruiting bodies. The fruiting body is a fungal structure containing spores. The fruiting body has various sizes, shapes, and colors which are used as identification material (Pataky, 2004). Types of fruiting bodies that found include: *Apothecia*, *Lirellae*, and *Perithecia*. *Apothecia* found in *Ophioparma ventosa*. *Apothecia* is a fruiting body that usually looks like a small disc or resembles a bowl with a diameter of 0.5 - 20 mm on the upper surface of the thallus. The next fruiting body found is *Lirellae*. *Lirellae* is an *Apothecia* that elongated and branched with a hard and black outer edge. *Lirellae* is found in *Graphis scripta* and *Phaeographis neotricosa*. The next type of fruiting body that found is *Perithecia* which is found in *Lecanora symmicta*, and *Pyrenula nitida*. *Perithecia* is a fruiting body shaped like a pumpkin that sinks in the thallus with a diameter of about 1 mm. *Perithecia* will form a hollow or small hole when ripe. Silverside (2013) stated that this *Perithecia* can spread or cluster on the surface of the thallus. Other species identified included *Candelariella reflexa*, *Chrysothrix candelaris*, *Cryptothecia striata*, *Dirinaria applanata*, *Heterodermia diademata*, *Lepraria incana*, *Leptogium cyanescens*, *Opegrapha gyrocarpa*, *Parmelia*

*sulcata*, *Parmotrema hypotropum*, *Phaeophyscia orbicularis*, *Phlyctis argena*, *Pyxine soreliata*, *Ramalina farinacea*, and *Usnea subfloridana* where on the thallus surface there is no fruit body (sexual reproductive structure). The thallus surface of these species are scattered by *Soredia*. *Soredia* is a package spread of mold spores and algae. *Soredia* is not protected by the outer cortex layer. *Soredia* is produced in large quantities and will appear to resemble powder on the thallus, but has a short life span. Silverside (2014) stated that on a moist substrate, *Soredia* germinated rapidly and is an efficient way for lichen's distribution activities. Estrabou et al. (2004) stated that in extreme environments there would be an increase in the number of lichens with fruit bodies compared to the number of lichens which did not have a fruit bodies. These conditions in the research did not occur. The results of the identification showed that there was a significant difference between the amount of lichen and the fruiting body and the fruitless body. Lichen which found with fruit bodies are 6 species, whereas lichens which do not have a fruit body are 14 species.

## CONCLUSION

Lichens were found in the Gunung Gunitir area of Jember Regency is quite diverse with the number of lichen that found are 20 species. Lichen comes from a division of lichen, called Ascomycota division with 15 families which included Arthoniaceae, Caliciaceae, Candelariaceae, Chrysothricaceae, Collemataceae, Graphidaceae, Lecanoraceae, Opegraphaceae, Ophioparmaceae, Parmeliaceae, Phlyctidaceae, Physciaceae, Pyrenulaceae, Ramalinaceae, and Stereocaulaceae. The 20 species of lichens that found are *Candelariella reflexa* (Nyl.) Lettau, *Chrysothrix candelaris* (L.) J. R. Laundon, *Cryptothecia striata* G.Thor, *Dirinaria applanata* (Fée.) D.D. Awasthi, *Graphis scripta* (L.) Ach., *Heterodermia diademata* (Taylor) D.D. Awasthi, *Lecanora symmicta* (Ach.) Ach., *Lepraria incana* (L.) Ach., *Leptogium cyanescens* (Rabehn.) Korb., *Opegrapha gyrocarpa* Flot., *Ophioparma ventosa* (L.) Norman, *Parmelia sulcata* Taylor, *Parmotrema hypotropum* (Nyl.) Hale, *Phaeographis neutricosa* Redinger, *Phaeophyscia orbicularis* (Neck.) Moberg, *Phlyctis argena* (Ach.) Flot., *Pyrenula nitida* (Weigel) Ach., *Pyxine soreliata* (Ach.) Mont., *Ramalina farinacea* (L.) Ach., and *Usnea subfloridana* Stirt. As for the existence of each kind of lichen in the Gunitir Mountain Area of Jember Regency, it was found that *Phlyctis argena* (Ach.) Flot. is a kind of lichen that is abundant in the Gunitir Mountain Area.

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