

Moss Plant Biodiversity (Bryophyta) Around Rojo Camp Gardens, Dau District, Malang Regency

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Abstract: Moss plants (Bryophyta) are living things that include multi-celled green plants. Growing mosses (Bryophyta) are known to have a simple arrangement of organs. This study examines the biodiversity of moss plants which aims to determine the biodiversity of moss plants found around Rojo Camp Gardens, Dau District, Malang Regency. This study uses the observation method to collect data by direct observation. This method is used as an observation of the object of research, especially on the focus of the problem under study. The data obtained was in the form of the number of species and body morphological characteristics of the moss plant species. The results of the study found that 7 types of moss plants were found with different body morphologies. The special characteristics of moss plants are that they have rhizoids and leaves, but do not yet have true roots, stems and leaves. Moss plants have a role in ecosystems, including as water absorbers (the nature of their cells resembles sponges), to retain moisture, produce oxygen through a fast photosynthetic process and as pollutant absorbers so that these moss plants can be found around Rojo Camp Gardens, Dau District, Malang Regency.

Keywords: Diversity; Rojo Camp Gardens; Moss plants

Introduction

According to Triyono in (Raihan et al., 2018) said that Indonesia is one of the many countries in the world that has a high level of diversity. This strategic geographical presence has earned Indonesia the nickname as a Mega Biodiversity country, or a country that acts as a center for biodiversity in the world.

One of the biodiversity in Indonesia is the moss plant (Bryophyta). Mosses are the second largest group of plants after higher plants (Rianti et al., 2019). Bawaihati, Istomo, & Hilwan in (Raihan et al., 2018) explain that there are approximately 1800 species of moss plants spread throughout the world, while in Indonesia alone the diversity of moss plant species is spread over 1500 species.

Mosses are small plants that grow attached to substrates such as rocks, trees, wood, and soil. Moss life is influenced by several environmental factors such as temperature, humidity and light. Differences in the tolerance of each species of moss to environmental

factors will affect the level of adaptation, species composition, and distribution of mosses (Windadri, 2013).

Mosses can reproduce both sexually and asexually. Sexual reproduction can occur through fusion between male and female gamete cells. While asexual reproduction with fragmentation and the formation of gemma. Mosses experience metagenesis (generational turnover) throughout their lives.

The diversity of moss plants (Bryophyta) in Malang Regency has never been done, especially in the Rojo Camp Garden area, Dau District, Malang Regency. Based on this, it is necessary to conduct research in the Rojo Camp Garden area, Dau District, Malang Regency. This study aims to determine the types of moss plants (bryophyta) found in Rojo Camp Gardens and to determine the level of diversity of moss plants (bryophyta) in Rojo Camp Gardens, Dau District, Malang Regency.

Factors that cause the diversity and abundance of moss plants in several areas. Although lichens are

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widely distributed on land, different types of lichens have a certain range of climatic and environmental conditions in which they can survive and reproduce successfully. Topographical factors such as aspect, slope, and elevation; climate factor; Soil factors include type, humidity, and pH; vegetation type and cover; and the type of substrate on which the moss grows are all important environmental factors that influence the distribution of mosses (Song et al., 2015).

The environment around Rojo Camp Gardens, Dau District, Malang Regency provides environmental conditions with relatively low light intensity, air temperature and high air humidity. According to Putri (2019), emphasized that at an average temperature of 10-30°C there are many types of moss that grow in that place. The condition of the Rojo Camp Gardens, Dau District, Malang Regency, which is shady and has relatively high humidity at temperatures around $\pm 18^\circ\text{C}$, many mosses are found because these conditions are very supportive for the germination of moss spores, their growth and development (Bullu et al., 2021).

The moss population has many species and its richness is strongly influenced by external factors such as water, light and temperature which make mosses an efficient bioindicator of environmental changes. The biotic factors that influence moss growth are shade trees (Maharani & Murdiyah, 2017).

General characteristics of lichens. Moss morphology in terms of size. The size of the moss tends not to be large or grow tall. This is because the physiological structure of mosses is lower than tall plants or seed plants. According to Glime (2013), moss grows with a certain size limit which characterizes that moss does not have lignin. This makes mosses have different shapes and sizes which are the characters and uniqueness in the level of diversity of moss plants. Several types of mosses are quite interesting, both from their colors and their group life which forms cushions like carpets (Maharani & Murdiyah, 2017).

The ecological role of lichens. Moss has a very important role for our lives and the environment, especially in the ecosystem. Moss in forest areas and gardens plays an important role in increasing the ability of forests to hold water (water holding capacity) (Lukitasari, 2018). Because moss plants are also plants that have a green substance, these plants also carry out photosynthesis, where one of the results of this photosynthesis is to produce the benefits of oxygen for humans and surrounding organisms. Mosses in several countries such as North America, China, and India use various Bryophytes as medicinal, antibiotic, antimicrobial, and painkillers. Moss is one of the supporting parts of flora diversity and the presence of moss in an ecosystem can be an important indicator of climate change in an area so that it can provide an early

warning of possible environmental damage (Lukitasari, 2018).

Lichen way of life and habitat. Environmental conditions in tropical forests and on forest soils in humid climates are ideal conditions and are often found in moss-covered waterfall areas. Mosses are often found in damp and wet places, for example in forests and live attached to various substrates, including soil in the jungle, rocks, peat, attached to trees (both branches, twigs or tree trunks). and others. This is because moss does not really like high temperatures or direct exposure to sunlight. In the area around Rojo Camp Gardens, Dau District, Malang Regency, there are many mosses that form elongated colonies and ride on (epiphytes) on pine trees (Lukitasari, 2018).

Based on the introduction above, researchers conducted research to determine the diversity of moss plants and how the environmental conditions were, especially in the Rojo Camp Gardens area through research with the title Moss Plant Biodiversity (Bryophyta) Around Rojo Camp Gardens, Dau District, Malang Regency. This research is expected to provide benefits to carry out further research in the Rojo Camp Gardens area.

Method

Time and place

This research was conducted on October 4, 2022 at Kebun Rojo Camp, Princi Gading Kulon, Godehan, Kucur, Dau District, Malang Regency, East Java Province. The research was conducted around 12:00 WIB to 14:00 WIB.

Tools and materials

During the course of this research, we used the following tools: 1.) Stationery. Used when direct observation is carried out which functions to record things that are considered important during observation. 2.) Camera. The camera feature on the smartphone is used to document the observed Bryophyta. 3.) Ambient temperature gauge. The temperature measurement feature on the smartphone is used to find out the temperature at the observation location. 4.) Google Lens. An application feature on a smartphone called Google Lens is used to identify the taxonomy of several types of Bryophyta found. 5.) Microscope. Used to see the Bryophyta more clearly.

While the materials used include: 1.) Various types of Bryophyta found in the Rojo Camp Garden naturally without any planting. 2.) Water. Used to moisten Bryophyta so that it can be stored for a long time and to wet preparations.

Methods and Data Sources

The research was carried out descriptively using observation techniques through direct observation to collect data (Sari & Bayu, 2019). Data collection was carried out by observing and researching moss plants in the Rojo Camp Gardens area. The moss plants that were found were mostly attached to the pine trees in the Rojo Camp Gardens area. Furthermore, the moss plants that have been found are identified related to the implementation date, observation location, type of moss, moss habitat and other characteristics. Identifying moss plants is done by observing the external morphology of the sample and then matching it with literature reference sources.

Result and Discussion

Leucobryum glaucum (Pin cushion moss)

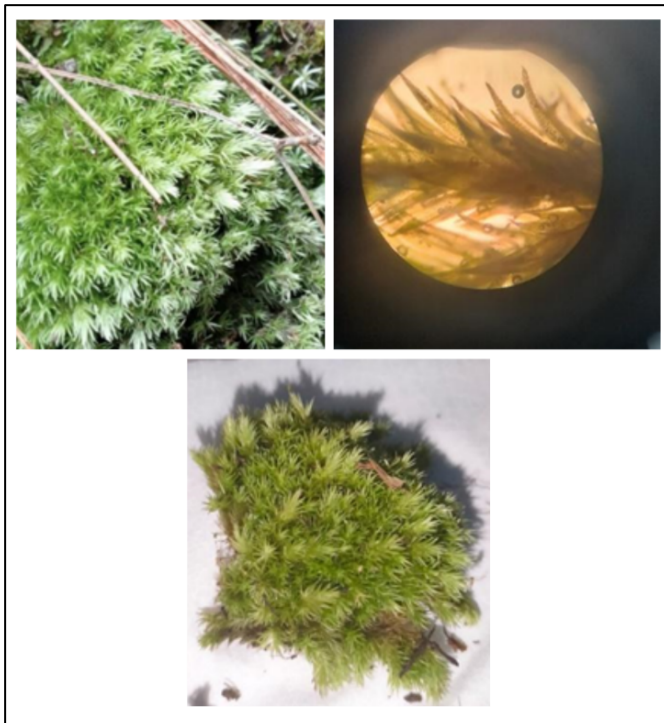


Figure 1. *Leucobryum glaucum* moss

Classification of *Leucobryum glaucum* include:

Kingdom : Plantae

Sub-Kingdom : Viridiplantae

Division: Bryophyta

Class: Bryopsida

Subclass : Bryidae

Order: Discrenales

Family: Leucobryaceae

Genus: *Leucobryum*

Species : *Leucobryum glaucum* (Paradise, 2020)

Moss which has the Latin name *Leucobryum glaucum* belongs to the class of true mosses or mosses.

This moss is a moss that is commonly found in a fairly wide ecological range, but this moss is most commonly found in acid forests, wet meadows, mud forests, and swamps. Mounds in the forest can also be used as colonies of this moss. *Leucobryum glaucum* usually avoids growing in wet places, and is frequently found on tree bases, soil, and forest rocks (Rothero, 2020b). Based on observations made, Moss *Leucobryum glaucum* has shiny light green leaf color, smooth leaf surface, blunt leaf base and pointed leaf tips, and gametophyte in the form of leaves (resembling leaves) that grow thickly. At the research site, *Leucobryum glaucum* type moss was found on logs and some were on the ground around the entrance to the Rojo Camp Gardens.

Uses: Moss that lives on logs and soil will be an environmental bioindicator that can maintain the rate of water defense (Firdaus, 2020). Distribution: *Leucobryum glaucum* moss comes from Europe and North America. This moss has been found in many countries in the world, especially in Indonesia, such as in South Bangka and East Java (Firdaus, 2020).

Marchantia polymorpha (Liverwort)



Figure 2. Moss *Marchantia polymorpha*

Moss which has the Latin name *Marchantia polymorpha* is included in the liverwort class. *Marchantia polymorpha* moss has a habitat where it is damp or wet. The characteristic feature of this moss is the thick sheet-shaped thallus. This moss gametophyte forms anteridium and archegonium which have an umbrella-like shape and the sporophyte growth is limited because it does not have meristematic tissue (Sayati, 2015). Based on observations in the field, the moss *Marchantia polymorpha* has a green thallus, broadly flat in shape, at the base of the thallus is blunt or flat while at the end of the thallus it is uneven (wavy), the thallus is thick, on the smooth surface, and there are rhizoids on the bottom which serves as a place to attach moss to a substrate that can absorb water and nutrients. At the research location, *Marchantia polymorpha* moss was found at the bottom of the pine trees in the Rojo Camp Gardens.

Uses: This type of moss can be used as a medicine for hepatitis. In China, North America, and Europe this moss is used as a traditional medicine (Cicilia, 2021).

Distribution: This type of moss is found in many parts of the world, such as those found in China, North America, Europe and Indonesia (Cecelia, 2021). In Indonesia, this moss is found in several areas such as in the forests of Malang, Lumajang (Fajri, 2019) and Bogor districts (Solihat & Kurnia, 2021). *Marchantia polymorpha* classification includes:

Kingdom : Plantae
 Sub-Kingdom : Viridiplantae
 Division: Marchantiophyta
 Class : Hepaticopsida
 Subclass: Marchantia
 Order: Marchantiales
 Family : Marchantiaceae
 Genus: *Marchantia*
 Species: *Marchantia polymorpha* (Solihat & Kurnia, 2021)

Octoblepharum albidum



Figure 3. *Octoblepharum albidum* moss

Moss, which has the Latin name *Octoblepharum albidum*, belongs to the class of true mosses or mosses. *Octoblepharum albidum* moss is a type of moss that is commonly found in tropical areas. Based on observations made, *Octoblepharum albidum* moss has a pale light green color that tends to be whitish, the shape of the leaves is slender at the ends tapered and has flat edges, the leaves are shaped like flowers that are in bloom, have a thick texture, the stems are covered with leaves so they are not visible when viewed from the outside. on. At the time of observation of the moss found yellow orange sporophytes, and rhizoids function as a place to attach the moss to the substrate. At the research site, *Octoblepharum albidum* moss was found on the tree trunks in the Rojo Camp Gardens which formed thick and soft cushions.

Uses: *Octoblepharum albidum* moss has many benefits, namely as a producer of oxygen and keeping the substrate moist on which it grows (Firdaus, 2020). Distribution: This type of moss is found in several regions of the world such as India, Sri Lanka, Java, Papua New Guinea, China, Columbia, Myanmar, Nepal,

Peru, the Philippines and Venezuela. *Octoblepharum albidum* classification includes:

Kingdom : Plantae
 Sub-Kingdom : Viridiplantae
 Division: Bryophyta
 Class: Bryopsida
 Subclass : Bryidae
 Order: Dicranales
 Family: Leucobryaceae
 Genus: *Octoblepharum*
 Species : *Octoblepharum albidum* Hedw.

Ceratodon purpureus



Figure 4. *Ceratodon purpureus* moss



Figure 5. Leaf microscopy of *Ceratodon purpureus*

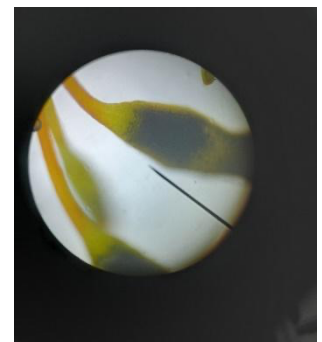


Figure 6. Seta microscope and capsule of *Ceratodon purpureus*

This moss, which has the Latin name *Ceratodon purpureus*, belongs to the class of true mosses or leaf mosses. *Ceratodon purpureus* is a moss that can grow in various types of substrates, one of which is peat soil, and has a longer life span. This moss varies in color from yellow to mid-green to red to purplish brown (Rothero, 2020a). Based on observations made by *Ceratodon purpureus* moss, it has gametophyte parts (leaves, stems and rhizoids), has green leaf color which contains chlorophyll for photosynthesis, leaves have pointed tips, leaves have a thin thickness, there are setae which have a yellowish color, have sporangium color or yellowish green capsule, the stem has a very short size that is not visible from the outside and is covered by leaves. At the research site, *Ceratodon purpureus* type moss was found on the trunks of pine trees in the Rojo Camp

Gardens. This type of moss is found in shady and damp areas.

Uses: This type of moss can be used as an indicator of air pollution because it is tolerant of metals and as an ornamental plant (Rosyanti, 2020). Distribution: This moss is found in many areas of the world. This moss can be found in several areas in Indonesia, such as in Banten and Malang. Classification of *Ceratodon purpureus* include:

Kingdom : Plantae
 Sub-Kingdom : Viridiplantae
 Division: Bryophyta
 Class: Bryopsida
 Subclass : Bryidae
 Order: Dicranales
 Family : Ditrichaceae
 Genus: Ceratodon
 Species : *Ceratodon purpureus* var. *rotundifolius* (Hedw.) Brid.

Dicranum scoparium



Figure 7. *Dicranum scoparium*

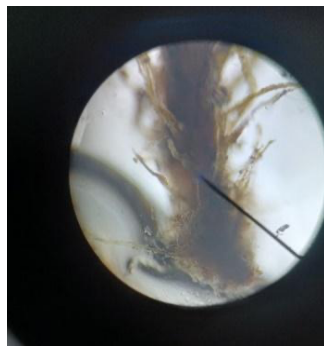


Figure 8. Rhizoid *Dicranum scoparium*

Moss which has the Latin name *Dicranum scoparium* is a class of leaf mosses. The leaves are in the form of elongated tufts (Wiadril et al., 2018). Based on observations made, the leaves of this moss are lance-shaped with long and slender ends. The middle to the top leaves are dark green, while the middle to the bottom is brown. This species is usually found in moist logs,

damp soil and rocks. At the study site, this moss was found at the bottom of the trunk of a pine tree.

Kingdom : Plantae
 Sub-kingdom : Viridiplantae
 Division: Bryophyta
 Class: Bryopsida
 Subclass : Bryidae
 Order: Dicranales
 Family : Dicranaceae
 Genus: Dicranum
 Species: *Dicranum scoparium*

Moss Plant Diversity Index in Rojo Camp Gardens, Dau District, Malang Regency

The diversity index can be used to measure the state of an ecosystem, an ecosystem is considered stable if it has a high diversity index. To find out the types of mosses in this rojo camp garden, we carried out identification of mosses in the laboratory and studied the literature to match the morphological characteristics and existing pictures. According to Odum (1971) the diversity index of lichen species can be calculated using the Shannon-Wiener Index formula.

$$H' = -\sum \left[\left(\frac{n_i}{N} \right) \ln \ln \left[\frac{n_i}{N} \right] \right] \text{ atau } H' = -\sum_{i=1}^s P_i \ln \ln P_i \quad (1)$$

Where:

H' = Species Diversity Index

P_i = n_i/N

N_i = Value of each individual of a type i

N = Total individuals of all species

i = The probability of importance for each type

The magnitude of the Shannon-Wiener species diversity index is defined as follows:

H' < 1 = Indicates that species diversity is categorized as very low,

1 ≤ H' ≤ 3 = Indicates that species diversity is categorized as moderate,

H' > 3 = Indicates that species diversity is categorized as high.

Table 1. Moss Species Diversity Index in Rojo Camp Gardens

Famili	Moss Species Name	Number of Species	n _i /N	ln n _i /N	H'
Leucobryaceae	<i>Leucobryum glaucum</i>	60	0.19	-1.64	-0.32
Marchantiaceae	<i>Marchantia polymorpha</i>	55	0.18	-1.73	-0.31
Leucobryaceae	<i>Octoblepharum albidum</i>	70	0.23	-1.49	-0.34
Ditrichaceae	<i>Ceratodon purpureus</i> var. <i>rotundifolius</i>	40	0.13	-2.05	-0.26
Dicranaceae	<i>Dicranum scoparium</i>	85	0.27	-1.29	-0.35
Total		310			1.58

Table 1 shows that overall the species diversity index (H') of mosses in Rojo Camp Gardens, Dau District, Malang Regency belongs to the medium category, which is 1.58. This is consistent with the criteria for the level of species diversity, where according

to (Fitria et al., 2018), the range of grouping the diversity index is low diversity if H' < 1, medium diversity if 1 ≤ H' ≤ 3, and high diversity if H' > 3. The index level of the diversity of moss species found in the Rojo Camp

Gardens shows that H' belongs to the medium category, namely 1.5797.

Parameters of Physical-Chemical Factors in Research Locations (Air Temperature, Sunlight Intensity, and Location Points). We carried out the physical and chemical parameters of the environment in the research area using existing technology on smartphones. These physical parameters include ambient temperature, sunlight intensity and altitude at the observation point, namely at Kebun Rojo Camp, Princi Gading Kulon, Godehan, Kucur, Kec. Dau, Malang Regency, East Java Province.

Ambient temperature

The ambient temperature in the Rojo Camp Gardens on the research day through measurements on a smartphone has an average value of 24°C with the average weather conditions being overcast or cloudy and minimal direct lighting from the sun. If the temperature in the environment of the growth area is high, it can cause the water content in the soil and air to evaporate quickly so that the levels are reduced (Purbasari & Akhmadi, 2019).



Figure 9. Ambient Temperature in the Rojo Camp Gardens

Sunlight intensity

After going through measurements using an application on a smartphone, it is known that the light intensity in Kebun Rojo Camp at 12:00 WIB to 14:00 WIB has an average light intensity of 1309 lux. In research conducted by Purbasari & Akhmadi (2019), states that the high and low light intensity is influenced by the weather and weather conditions during measurement. Light intensity affects ambient temperature, humidity and water content in the soil. The more light that enters the moss growth area, the higher the temperature of the environment. Areas with low light intensity will have soil moisture that tends to be moist and wet compared to open areas that have high light intensity.

Location altitude



Figure 10. Location Altitude

The research location is located in Rojo Camp Gardens, Dau District, Malang Regency. When viewed via Google Earth, Kebun Rojo Camp has coordinates 7°55'44"S-112°31'05"E. Rojo Camp Gardens is located at an altitude of 1,192 above sea level. The altitude of the research location can affect air temperature conditions, where the higher the location, the lower the air temperature. In addition to air temperature, location altitude affects humidity, where the higher the location, the lower the humidity and vice versa (Prakoso, 2018).

Ecological Benefits of Moss Plants for the Surrounding Areas

Ecological use of moss to store water so as to maintain water balance in the forest or the ecosystem around Rojo Garden Camping, Dau District, Malang Regency. Besides being able to balance water, moss also acts as a pioneer plant, as evidenced by the presence of moss growing on unhealthy land due to illegal logging, moss usually grows on felled trees, moss also grows on weathered trees and dead trees. In addition, moss is also an important habitat for other organisms, especially the population of invertebrate animals, some types of orchids. Moss is also a good medium for the germination of seeds of higher plants. In addition, moss plants are bio-indicators of environmental pollution (Putri, 2019).

Ecologically, the presence of moss acts as a ground cover, also affects productivity, decomposition and community growth in the forest and prevents erosion. Moss plants that grow on the rain forest floor help reduce the danger of flooding, and are able to absorb air during the dry season. In addition, moss is also used as an indicator of changes in the environment or habitat (Rini, 2019).

Conclusion

Moss species (Bryophyta) found in Rojo Camp Gardens, Princi Gading Kulon, Godehan, Kucur, Dau District, Malang Regency, East Java Province, namely *Leucobryum glaucum* (pin moss cushion moss), *Marchantia Polymorpha* (liverworts), *Octoblepharum albidum*, *Ceratodon purpureus*, and *Dicranum*

scoparium. What is often encountered is this species of moss attached to pine trees. In addition, each species of moss has its uses as well as its distribution. The diversity index of the Bryophyta family in Rojo Camp Gardens, Princi Gading Kulon, Godehan, Kucur, Dau District, Malang Regency, East Java Province belongs to the medium category, with a value of $H' = 1.58$. The species with the highest number was *Dicranum scoparium*, while the lowest was *Ceratodon purpureus*.

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Author Contributions

Conceptualization, A.D.M., I.S., I.R.A., F.A.I., L.A.S., and N.R.S.; methodology, I.S., and F.A.I.; software, A.D.M., and L.A.S.; formal analysis, A.D.M., I.S., I.R.A., F.A.I., L.A.S., and N.R.S.; investigations, A.D.M., I.S., I.R.A., F.A.I., L.A.S., and N.R.S.; resources, I.R.A., and N.R.S.; data curation, A.D.M., I.S., I.R.A., F.A.I., L.A.S., and N.R.S.; wrote preparatory original drafts, A.D.M., and I.S.; writing reviews and editing, A.D.M. and I.S.; supervision, I.F. All authors have read and agree to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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