
Inventory of Moss Plants (Bryophyta) in the Montana Zone, Samiran Village, Selo District, Boyolali Regency, Central Java Province

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ABSTRACT

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Green plants known as moss plants (Bryophyta) are considered low plants. Mosses can dwell in tropical regions, the highlands, and the lowlands, and some species even live in water. Temperature, humidity, living conditions, light intensity, habitat pH, substrate, and altitude are all known to have an impact on moss growth. At a height of 1,500–2,400 meters, in the montana zone, the diversity of species declines. Samiran Village, Selo District, Boyolali Regency, Central Java Province is one of the locations in the montana zone. Numerous variables in this location contribute to the habitat for moss growth. This study aims to ascertain the diversity and distribution of moss plants (Bryophyta) in the montana zone, Samiran Village, Selo District, Boyolali District, Central Java Province. There has never been researching on the inventory of moss plants in the montana zone of Samiran Village, Selo District. The study's findings revealed three divisions, Bryopsida, Hepacopsida, and Anthoceroopsida, which were further divided into seven families, Marchantiaceae, Hypnaceae, Pottiaceae, Polytrichaceae, Lejeuneaceae, and Anytoniaceae. At an elevation of 1600–1800 meters above sea level, in the montana zone of Samiran Village, Selo District, Boyolali Regency, Central Java Province, the index value of moss plant diversity is 1.679, which is categorized as moderate. This is so because the study site functions well as a moss plant habitat.

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1. INTRODUCTION

A less-noticed part of biodiversity is moss. The humidity, temperature, the environment in which it lives, the amount of light, and the pH of the environment all have an impact on moss growth. Its development may also be aided by the presence of substrates including dirt, rocks, and bark (Santi 2021). The degree of moss dominance can be impacted by abiotic factors including height. The group of epiphytic plants also includes moss plants, which are poikilohydric, meaning that the turgor pressure of their body cells depends on the humidity of the surrounding environment.

Green plants known as moss plants (Bryophyta) are considered low plants. Bryopsida, Hepaticopsida, and Anthocerotopsida are the three major divisions of the phylum Bryophyta. The three Bryopsida divisions can easily be distinguished from vascular plants due to their very distinctive features. Because they initially appear unsightly and are frequently blamed for making the environment appear unclean, moss plants are a type of biodiversity plants that have not been investigated very extensively (Wati et al. 2016).

The montana zone is a mountainous region located between 1500 and 2400 meters above sea level. Typically, this area is covered in dense vegetation with skinny stems. Ferns and mosses can be found in the montana zone. Only the second stratum in the sub-mountain zone restricts the height of the trees in this zone (Anesta et al. 2020). Moss is one of the main plant types that may be found in the montana zone. Because they can protect themselves and rehydrate when moisture

is present, even when they lose a lot of water, mosses can survive in extremely dry or cold settings. (Jayanti 2020). One of the wet tropical forest formations that develops in high places is mountain forest, also known as montane forest (Hilwan and Wiraatmadja 2021). This forest is notable for its frequent cloud cover, which typically occurs at the height of the canopy roof. These forests have a lot of moss, which covers the trees and the ground frequently. The ability to withstand soil erosion, lessen the risk of flooding, absorb water during the dry season, maintain moisture, produce oxygen through a quick photosynthesis process, and act as a pollutant absorber are just a few of the traits and functions that moss species possess.

Based on the background above, research on the inventory of moss plants in the montana zone of Samiran Village, Selo District, Boyolali Regency, Central Java Province has never been carried out and information about the types of moss plants that exist is not yet available, so it is necessary to find information about the types and distribution of moss plants in the montana zone, Samiran Village, Selo District, Boyolali Regency, Central Java Province. Therefore, this study aims to determine the species diversity and distribution of moss species (Bryophyta) in the montana zone of Samiran Village, Selo District, Boyolali Regency, Central Java Province.

2. MATERIALS AND METHODS

Sampling Location and Sampling

This sort of observational research is concerned with the cataloging of moss plants (Bryophyta) in the montana zone of Samiran Village, Selo District, Boyolali Regency, Central Java Province. This study was carried out in the Central Java Province's montana Zone, Samiran Village, Selo District, and Boyolali District. This study was done at a height of between 1600 and 1800 meters above sea level, which is where the montane zone begins. The study site is situated in Samiran Village, Selo District, Boyolali Regency, Central Java Province, along the Mount Merapi climbing route. Area maps, a GPS, digital cameras, thermohygrometers, stationery, lux meters, lups, altimeters, soil testers, and meters are among the equipment utilized. The moss plants (Bryophyta) employed in this study are located in the montana zone of Samiran Village, Selo District, Boyolali Regency, Central Java Province, between an altitude of 1600 masl and 1800 masl. The procedures for carrying out the research are as follows: 1) Determining the stations and points to be carried out based on the type of research and limiting moss plants in the montana Zone, Samiran Village, Selo District, Boyolali Regency, Central Java Province. Determination of the station is chosen based on the height of the montana zone and the cost of the point totaling 21 points, each of which is 10 meters (Susilo et al. 2022). 2) Conduct investigation. 3) Calculate the coordinates, height, temperature, air humidity, soil pH, and light intensity of the area. 4) With a distance of 10 meters between each location, calculate the cruising point vertically, or up, from 1600 meters to 1800 meters above sea level. 5) Conducting research to locate moss plants at each location. 6) Identify and note the many kinds of moss plants you come across.

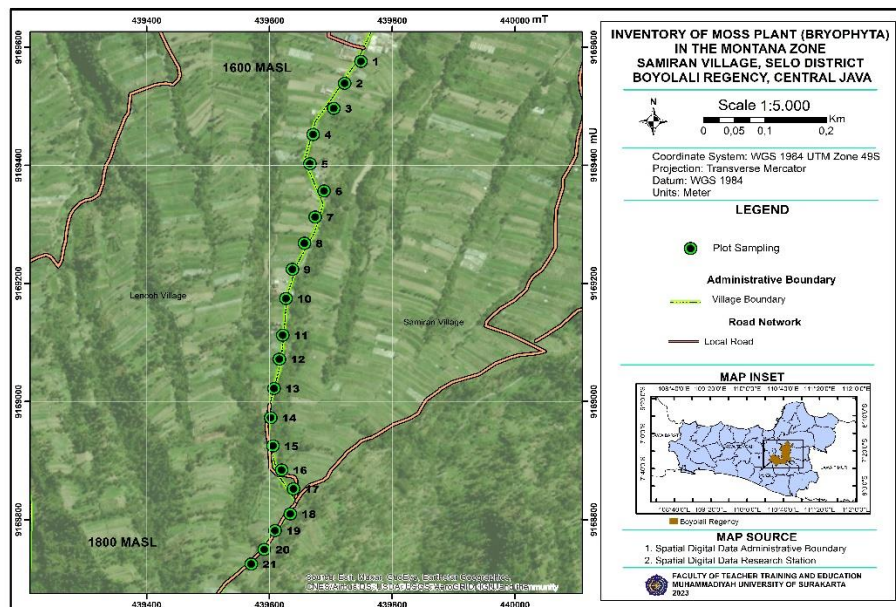


Figure 1. Locations for the map and research

Specimen Collection and Identification

Collections by gathering moss specimens of all species discovered. Thus the results of moss plants were identified at the University Muhammadiyah Surakarta's Biological Laboratory.

Data Analysis

Using the Species Diversity Index formula (Shannon & Wiener 1963), a search was conducted to ascertain the distribution of bryophytes discovered. The bigger the value of, the more diverse the species are. The following criteria are used to define Shannon species diversity value: 1) $\hat{H} > 3$ exhibit high species expertise in an area. 2) $1 \leq \hat{H} \leq 3$ indicates the current species' expertise in an area. 3) $\hat{H} < 1$ show low species yields in an area.

3. RESULTS AND DISCUSSION

The result of an inventory of moss plants found in the montana zone ecosystem of Samiran Village, Selo District, Boyolali Regency, Central Java Province, at an altitude of 1600–1800 meters, include the identification of 7 families: Marchantiaceae, Hypnaceae, Pottiaceae, Polytrichaceae, Lejeuneaceae, Anthocerotaceae, and Anytoniaceae. (Table 1). The Marchantiaceae family of moss plants, specifically *Marchantia treubii* Schiffn and *Marchantia polymorpha* L, were discovered based on the observations. One species was found in the Hypnaceae family, namely *Hypnum cupressiforme* Hedw. In the Pottiaceae family there is 1 species, namely *Barbula consanguinea* A. Jeger. In the family Polytrichaceae, 1 species was found, namely *Pogonatum neesi*. There are one species from the Lejeuneaceae family, namely *Cheilolejeunea meyeniana*. One species was found in the Anthocerotaceae family, namely *Phaeoceros laevis* L. This species lives on moist soil substrates. A total of 1 species from the Anytoniaceae family was found, namely *Reboulia hemisphaerica* L.

The ability of moss plants to survive can be impacted by host availability (Marhento and Zaenab 2021). Three substrates soil, aged trees, and rocks are employed as a place for mosses to live, according to the data collected. How well moss plants can support life depends on the presence of hosts. From the data collected, it has been determined that soil, worn trees, and rocks are the three substrates that serve as homes for mosses. (Table 1). This is consistent with research Fanani et al (2019) that shows lower plants like mosses may grow on a variety of substrates, such as rocks,

soil, trees, worn wood, and litter. The damp soil has the maximum moss growth on it of the three substrates that are covered in moss at a height of 1600–1800 meters above sea level. According to research Krisnawati (2022) moss habitats are on the ground because soil may create a variety of substrates that serve as a stable platform for spore germination and moss growth. Moss spores fall to the ground during the rainy season where they germinate to become new moss plants. The reason worn wood is a favorable substrate for moss growth, according to study Putri et al (2019) is because it holds water between its wood cells, creating a high humidity and the nutrients mosses require to grow.

The moss plants that inhabit a habitat are influenced by a number of additional elements in addition to the substrate. According to studies Purbasari and Akhmadi (2019) in addition to substrate, living moss plants need abiotic elements to support their growth, including humidity, light intensity, temperature, and soil pH.

Table 1. Types and Habitats of Moss Plants (Bryophyta) in the Montana Zone, Samiran Village, Selo District, Boyolali Regency, Central Java Province.

Num	Species	Family	Division	Number of Individuals	Habitats	Altitude and literature source
1	<i>Hypnum cupressiforme</i> Hedw.	Hypnaceae	Bryopsida	589	Soil, rocks, weathered trees	800 m asl (Kartikasari et al. 2023)
2	<i>Marchantia treubii</i> Schiffn	Marchantiaceae	Hepaticae	294	Soil and rocks	50-100 m asl (Azwir et al. 2022)
3	<i>Barbula consanguinea</i> A. Jeger	Pottiaceae	Bryopsida	222	Soil, rocks, weathered trees	<100 m asl, 100-200 m asl, 200-500 m asl, and >500 m asl (Aripulis and Sujadmiko 2019) 108 m asl (Salamah et al. 2019)
4	<i>Pogonatum neesi</i>	Polytrichaceae	Bryopsida	142	Soil	Around 1.000 m asl (Roziaty et al. 2019)
5	<i>Reboulia hemisphaerica</i> L.	Anytoniaceae	Hepaticopsida	118	Soil and rocks	<100 m asl, 100-200 m asl, 200-500 m asl, and >500 m asl (Aripulis and Sujadmiko 2019)
6	<i>Phaeoceros laevis</i> L.	Anthocerotaceae	Anthocerotopsida	81	Soil	700-1.500 m asl (Pratama et al. 2022)
7	<i>Marchantia polymorpha</i> L.	Marchantiaceae	Hepaticae	31	Soil	1400 m asl (Febriansyah et al. 2019)
8	<i>Cheilolejeunea meyeniana</i>	Lejeuneaceae	Hepaticae	15	Soil	Lowland (Putrika et al. 2017)

Bryophyta has 3 divisions namely Bryopsida, Hepaticopsida, and Anthocerotopsida (Figure 2). Three of these divisions were discovered by observation and identification of moss plants at altitudes between 1600 and 1800 meters. This is evident from the varied morphologies and properties of the moss plants in each division. The three Bryopsida divisions can easily be distinguished from vascular plants due to their very distinctive features. Although most moss plants lack vascular tissue or are sometimes referred to as nonvascular plants, some species nevertheless contain water-carrying vessels (Lukitasari 2019).

Due to the complexity of the gametophyte and sporophyte, leaf mosses (Bryopsida) are the most developed mosses. The upright habitus and the body's differentiation into rhizoids, cauloids,

and phylloid are traits of the Bryopsida class (Sujadmiko and Vitara, Pantalea 2021). The liverworts, or Hepaticopsida class, are mosses with gametophytes that have differentiated into stems and leaves and are shaped dorsoventrally. The sporophyte develops elongated after the development of the capsule. While liverworts have a similar body structure to hornworts (Anthocerotopsida), the only distinction is the sporophyte phase. Elongated capsules known as hornwort sporophytes develop into horns (Mulyadi 2014).



Figure 2. Hepaticopsida: *Marchantia treubii* Schiffn (a), Bryopsida: *Barbula consanguinea* A. Jeger (b), dan Anthocerotopsida: *Phaeoceros laevis* L. (c).

The upper montana zone, which has relatively closed environmental conditions and high humidity, is where this species of big moss may be found (Nadhifah 2018). According to information obtained from the identification of the moss type *Marchantia treubii* Schiffn, it can be found living on soil and rock substrates, but is primarily found on soil substrates. It has a slightly thick thallus with a purple center line. In addition to growing in the montana zone, *Marchantia treubii* Schiffn can also be found at elevations lower than 1,000 meters above sea level. This is consistent with studies Azwir et al (2022) showing the *Marchantia treubii* Schiffn species can be found in the Great Mosque Forest of Aceh Besar District at an elevation range of 50 to 100 meters above sea level.

The species *Marchantia polymorpha* L. identified in this study has a light green, branching, thick, stiff, and fleshy thallus that forms a flat rosette. It is also found in damp soil. According to studies Solihat and Kurnia (2021), the talus's base and end are both blunt or flat, its tip is wavy and branch-like, and the talus itself is thick and stiff. This variety of moss can be found in areas with favorable conditions for moss plant life, not just in the montana zone. According to research Febriansyah et al (2019), *Marchantia polymorpha* was found growing on a soil substrate with an altitude range of 1400 m above sea level in the Parangkikis waterfall which is one of the mountainous areas in Gambiran Village, Pagerwojo District, Tulungagung.

The *Hypnum cupresiforme* species, which has a green thallus and is found growing and crawling on weathered rocks, soil, and trees, belongs to the Hypnaceae family. This moss has overlapping and intersecting leaves. The size of this moss is modest to medium. The branched stalks have leaves on them. It is well known for this species to dwell outside of its natural habitat. so that it might have a habitat that is not limited to the montana region. According to research Kartikasari et al (2023), *Hypnum cupresiforme* has a stem that is almost entirely covered in leaves and long, curved, green leaves with a pointed tip. About 800 meters above sea level is the altitude at which this kind of moss can be found.

A *Consanguineous barbula* A. Jeger has a low, fringed talus that is distinguished by its pale green hue. langued leaves. A spore capsule with a diameter of 0.3 cm, a reddish-brown color, and

a tube-like shape with a point is present. The moss *Barbula consanguinea* A. Jeger is a member of the Pottiaceae family. This particular variety of moss is typically found 1,300 meters above sea level. According to Aripulis and Sujadmiko (2019), the species *Barbula consanguinea* A. Jeger was discovered to grow at altitudes of 100 masl, 100–200 masl, 200–500 masl, and >500 masl. According to research, *Barbula consanguinea* A. Jeger was discovered in the Selarong Cave Area, which is situated in Bantul at an altitude of around 108 m asl (Salamah et al. 2019). This demonstrates that the moss plant *Barbula consanguinea* A. Jeger is not restricted to the montane zone.

The group of leaf mosses includes the moss plant species *Pogonatum nesii*. *Pogonatum nesii* typically grows between 700 and 2210 m above sea level, ranging from the lowlands to the highlands. *Pogonatum nesii* is a species that grows at an altitude of roughly 1,000 m asl (Roziaty et al. 2019). This shows that *Pogonatum nesii* is not only found in the montana zone.

Cheilolejeunea meyeniana is a moss that belongs to the class of leafy liverworts. The thallus of the *Cheilolejeunea meyeniana* moss has lateral leaves that are light green to yellowish in color. The shape is ovoid to elongated with a blunt tip and flat leaf edges. This moss has rhizoids with a length of 0,5 cm - 1 cm which are light brown in color. This type of moss is also found as an epiphyte in urban forests and on the main roads of the University of Indonesia campus (Putrika et al. 2017)

The thallus of *Phaeoceros laevis* L. is light green in color and measures 2 cm long by 2 cm wide. The thallus shape forms clusters with horn-shaped sporophytes. This species can be found elsewhere besides the montana region. However, it is also present at elevations lower than 1600 meters above sea level. *Phaeoceros laevis* L. is a type of hornwort that belongs to the Anthocerotophyta division, according to research Pratama et al (2022). This species can be found at the Nature Conservation Education Center Bodogol (PPKAB), which is a part of the Mount Gede Pangrango National Park (TNGGP), at an elevation of between 700 and 1,500 meters above sea level.

Reboulia hemisphaerica has a thick talus that widens from light green to dark green. The rhizoid is the place where the moss attaches to its substrate. The rhizoid or root of *Reboulia hemisphaerica* has a size of 4 cm, brownish white, cylindrical and fibrous. According to research Aripulis and Sujadmiko (2019) that at a range of altitudes, namely <100 masl, 100-200 masl, 200-500 masl, and >500 masl in Sleman Regency, *Reboulia hemisphaerica* was found, this is because the ambient temperature at that altitude is still optimal for growth. mosses in the tropics.

At an altitude of 1600 masl–1800 masl, moss plants (Bryophyta) with the division of leaf mosses (Bryopsida) are most frequently found. The leaf moss species with the highest population at the study site is *Hypnum cupressiforme* Hedw., which has a good survival rate. According to research Ivone et al (2022), mosses are frequently found in a variety of environments because they have a very wide geographic range and the greatest number of species when compared to other classes. These leaf mosses (Bryopsida) can flourish in grasses, amid rocks, on tree trunks, and on barren land that occasionally encounters drought. The identified division of hepaticopsida has a smaller number of individuals than the division Bryopsida. *Marchantia treubii* Schiffn is included in the liverwort which has a smaller number of individuals than the *Hypnum cupressiforme* Hedw species which is included in the leaf moss division. Meanwhile, the number of individuals from the division of anthocerotopsida has the least number, because the moss plants from this division are more susceptible to growth. This is in line with research Gista et al (2020) that few or even no hornworts are found due to the small distribution of hornworts in nature and are a small group in Bryophyta of less than 100 species with 8-9 genera.

Table 2. Species Diversity Index (H') Mosses (Bryophyta) in the Montana Zone, Samiran Village, Selo District, Boyolali Regency, Central Java Province.

Altitude Point	H'	Information
1.600 m asl-1800 m asl	1,679	Moderate

The level of diversity of moss species from an altitude of 1600 masl to 1800 masl in the montana zone of Samiran Village, Selo District, Boyolali Regency, Central Java Province is classified as moderate, as indicated by the Shannon-Wiener (H') diversity index value of 1.679 (Table 2). The significance of the derived moss species diversity demonstrates how variations in an ecosystem's or environment's conditions can have an impact on the diversity of moss plant species. In addition, removing land may result in less plant diversity of a particular kind.

Although the environment at the research site is suitable for moss growth, human activities and the opening of natural attractions have led to a moderate level of species diversity. According to research Raihan et al (2018), a community is said to have high species diversity if there are many species present together with a fairly even distribution of each species' members. The presence of physical-chemical elements in the environment, as well as the availability of nutrients, can contribute to the high or low values of diversity at each research location. These factors also have a significant impact on the diversity of the moss itself.

Table 3. Abiotic factors of moss plants (Bryophyta) in the Montana Zone, Samiran Village, Selo District, Boyolali Regency, Central Java Province.

Abiotic Factors	Altitude Point	
	1.600 m asl	1.800 m asl
Air temperature (°C)	28,7	21,3
Humidity (%)	57	73
Soil pH	6	6
Atmospheric pressure (atm)	835,4	815,6
Light intensity (Cd)	18200	2180

Moss growth is generally influenced by several factors including temperature, humidity, living habitat, light intensity, and habitat pH and altitude. The research location at an altitude of 1600 masl has an air temperature of 28.7 °C and at an altitude of 1800 masl has an air temperature of 21.3 °C, this supports moss plants living on the available substrate. According to studies Azwad et al (2020), mosses grow best at temperatures between 15 and 25 °C and can tolerate temperatures between 40 and 50 °C. Samiran Village, Selo District's montana zone has a temperature that is still suitable for moss growth and development since mosses can survive in environments with air temperatures between 40 and 50 degrees Celsius.

Altitude can affect the growth of moss plants. Air humidity at an altitude of 1600 masl, namely 57%, can be found to be less optimal for moss growth while at an altitude of 1800 m asl, it is 73% which indicates that 73% humidity can support moss growth. This is in line with research Sopacua et al (2020) that humidity also supports moss growth, in general, mosses require relatively high humidity to support their growth. Moss can live in a humidity range between 70% -98%.

Moss plants require a strong amount of light to perform photosynthesis. The level of humidity will drop if the light intensity is quite high. This is due to the fact that the ambient temperature rises when more light is allowed to reach the moss-growing region or substrate. 10,000 lux is the recommended light intensity for moss plants to grow at in order to support photosynthesis Yohendri et al (2021). At an altitude of 1600 masl, it has a light intensity of 18200 Cd, while at an altitude of 1800 masl it is 2180 Cd. So that at an altitude of 1800 meters above sea level, it is still a good habitat for mosses.

4. CONCLUSIONS

Based on the results of the research and discussion it can be concluded that the identified mosses consist of 3 divisions namely Bryopsida, Hepacopsida, and Anthoceropsida which consist of 7 families namely Marchantiaceae, Hypnaceae, Bryaceae, Polytrichaceae, Lejeuneaceae, Anthocerotaceae, and Anytoniaceae. From the observations, 2 species were found from the family

Marchantiaceae, namely *Marchantia treubii* Schiffn and *Marchantia polymorpha* L. In the family Hypnaceae, 1 species was found, namely *Hypnum cupressiforme* Hedw. This species has the most number of individuals found. In the Pottiaceae family there is 1 species, namely *Barbula consanguinea* A. Jeger. In the family Polytrichaceae, 1 species was found, namely *Pogonatum neesi*. One species was found in the Lejeuneaceae family, namely *Cheilolejeunea meyeniana*. A total of 1 species from the Anthocerotaceae family, namely *Phaeoceros laevis* L. One species was found from the Anytoniaceae family, namely *Reboulia hemisphaerica*. There are 3 substrates used as a place for moss to live, namely rocks, weathered bamboo, and soil. Based on these three substrates, moss grows the most on moist soil substrates. On these three substrates, not all moss plant species can be found. According to the Shannon-Wiener (H') diversity index value of 1.679, the diversity of moss plant species in the montana zone of Samiran Village, Selo District, is in the moderate range.

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