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Diversity of Ferns (Pteridophyta) in the Montana Zone, Samiran Village, Selo District, Boyolali Regency, Central Java Province

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ABSTRACT

Ferns (Pteridophyta) are one of the Indonesian flora groups with high diversity and wide distribution, one of which is in the montana zone, an ecosystem zone at an altitude of 1500-2400 m asl. Samiran Village is located in the District of Selo, Boyolali Regency, between two mountains, namely Mount Merapi and Mount Merbabu. This type of research was conducted at an altitude of 1600 m asl to 1800 m asl in Samiran Village, Selo District, Boyolali Regency. This study aims to determine the types of ferns and their distribution in the montane zone of Samiran Village, Selo District, Boyolali Regency. The method used is purposive sampling, a data collection technique based on points determined deliberately with a distance of 10 meters with a total of 21 points carried out in the Montane zone of Samiran village. Fern (Pteridophyta) that have been found in the montana zone of Samiran Village, are group into 2 families of 6 species consisting of *Adiantum raddianum* C. Presl, *Notholaena copelandii* c.c. Hall, *Adiantum hispidulum* Sw., *Pityrogramma austroamericana* Domin, *Cyathea arborea* L. Sm, *Antrophyum sessilifolium* (Cav.) Spr. The Diversity value (H') is 1.22, a category as relatively low. Ferns are most commonly found on soil hosts. The most abundant species were dominated by *Adiantum raddianum* C. Presl with 107 individuals at 14 out of 21 points. This species is one type of terrestrial fern that is also often found growing between rocks, pool walls, fences, wells, ditches, river banks other damp places. Therefore, this location is a suitable environment for the growth of *Adiantum raddianum*.

1. INTRODUCTION

Ferns (Pteridophyta) are a type of Indonesian plant that have a diverse range of species (Kurniawati et al., 2016). In addition to flourishing in moderate regions, woodlands, and streams, this plant is frequently seen in tropical rainforests. Additionally, this plant can be found in water (hydrophytes), adhering to other plants (epiphytes), and growing on plant remains (saprophytes) (Hutasuhut & Febriani, 2019). Ferns in the montana zone are exposed to a lot of sunlight so that their fast growth and assisted by the right environmental factors can encourage the growth of ferns so that many variations are found.

Generally speaking, ferns take the shape of herbs, bushes that resemble trees, spores in clustered sporangia, and immature spores that are typically green in color and dispersed or small. On the underside or edge of the leaf, spores are communally living organisms. Whether solitary or complex, ferns have dark green leaves. In most cases, the stems grow on the ground, creep on trees as epiphytes, or float freely in the water; they are rarely visible. The spores' morphological characteristics serve as ferns' defining characteristics. One of the criteria for identifying ferns is

based on their spores (Pranita et al., 2017). Ferns (Pteridophyta) are an important component of biodiversity as a plant community that aids in the development of soil and serves as a cover for vegetation for organisms in the forest. Another function of ferns is as germplasm, as well as food and medicine (Mowata et al., 2020).

The montana zone is an ecological zone located between 1500 and 2400 meters above sea level. Smaller diameter stems vegetation, and lots of mosses and ferns are characteristic of the region. Compared to the submontane zone, this montana zone has lower tree heights. The diversity of tree species in the montana zone is not very high. Exposure to direct sunlight on forest soil can encourage the growth of grass and other plants. The montana zone has shorter trees than the submontane zone. In the mountainous zone, trees are 8–20 m high and have fewer species than the area beneath, the irregular shape of the trunks and low tree density create a lot of bare soil. Plants also became scarce and were replaced by lichens, lichens, bamboo, and shrubs (Anesta et al., 2020) such as needle leaf plants (*Dacrycarpus imbricatus* and *Podocarpus neriifolius*) and puspa plants (*Schima wallichii*) whose species diversity decreases with increasing soil altitude (Supriatna, 2014).

A village called Samiran is located between 1500 and 1800 meters above sea level. Samiran Village is specifically located in Selo District, flanked by Mount Merapi and Mount Merbabu. According to PPID Boyolali, this district experienced quite high rainfall in 2011, with a total of 4.232 mm and 229 rainy days. In general, the Selo sub-district has a moist type C climate that is suitable for the growth of ferns in the region. There are numerous locations and varieties where this fern grows and spreads. Cool environments are ideal for ferns to flourish. Ferns can also be found close to running water, and they have a substrate that is rooted to the ground. Numerous fern species, including those from the tribes Lycopodiaceae, Nepenthes, and Hymenophyllaceae, as well as Coniogramme, Dipteris, Gleichenia, and Blechnum, can be found in the montana zone (Muhaimim et al., 2018).

Ferns were chosen as the subject of the study because they are crucial to the humus-forming process, shield the soil from erosion, and preserve soil moisture. It is vital to conduct a study on ferns in the montana zone of Samiran Village because there is little data and knowledge about the different kinds of ferns there. The purpose of this study is to identify the fern species that can be found in the montana zone, specifically in Samiran Village, Selo District, and Boyolali Regency.

2. MATERIALS AND METHODS

Sampling Location and Sampling

This research was conducted in the montana zone of Samiran Village, Selo District, Boyolali, Central Java (Figure 1). The research was conducted in the montana zone of Samiran Village at an altitude of 1,600–1,800 m asl, with an average air temperature of 20–30 °C and an average humidity of 75–90%. The research was conducted in February - March 2023. The tools used included a thermohygrometer, altimeter, GPS, Lux meter, and soil tester. The materials used are ferns that live in the montana zone (1.600m asl, up to 1.8000m asl) in Samiran Village, Selo District, Boyolali District, Central Java.

The procedures used include 1) Determining stations and points; 2) Measuring location altitude, temperature, air humidity, soil pH, light intensity, and location coordinates; 3) Exploring; 4) Identifying and recording the types of ferns found.

This study used a survey method with a purposive sampling technique. This method was used in the montana zone of Samiran Village in the Selo District of the Boyolali Regency of the Central Java Province. Purposive sampling, which means a data gathering technique based on points that are determined intentionally with a distance of 10 meters and a total of 21 points.

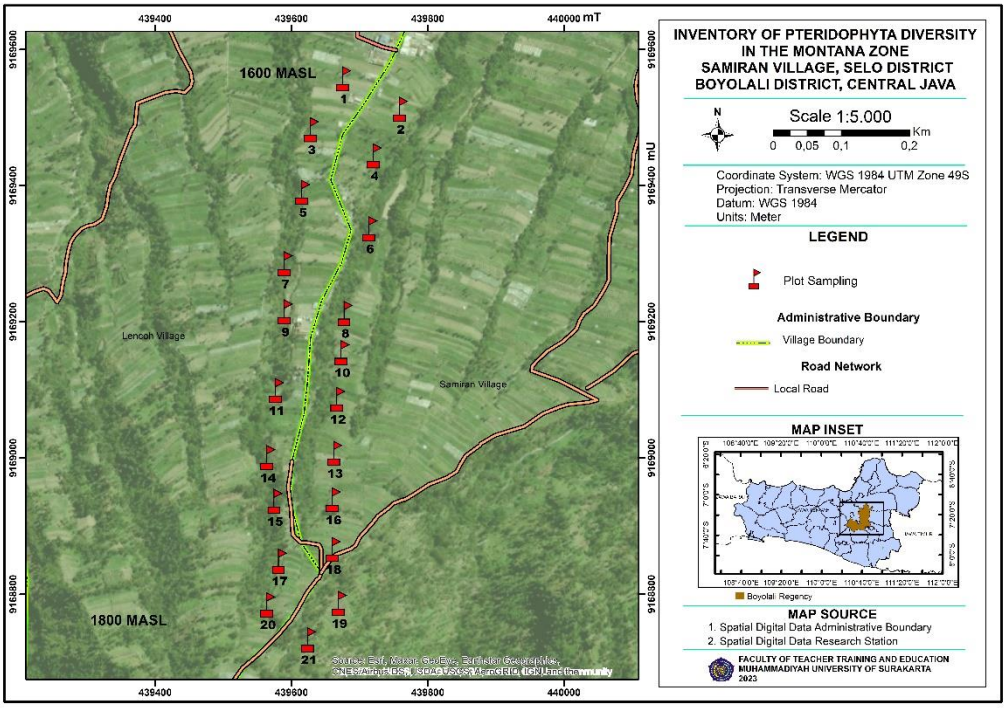

Figure 1. Research map

Specimen Collection and Identification

Collected specimens were identified in the Biology Laboratory Universitas Muhammadiyah Surakarta. Identification was carried out by observing using a monocular microscope and desk study based on the book Flora (Steenis, C.G.G.J., 2013) and Plant Taxonomy (Schizophyta, Thallophyta, Bryophyta, Pteridophyta) by Tjitrosoepomo (1989).

Data Analysis

To determine the distribution, use the Species Diversity Index (Shannon & Wiener 1963) to calculate the value of diversity by dividing the number of individuals of a species by the total number of individuals. Then divide into three groups H<1.5 is low, 1.5<H<3.5 is moderate, or H>3.5 is high (Magurran, 1988).

3. RESULT AND DISCUSSION

From 21 points of the sampling site, we found two families of ferns, namely Pteridaceae and Cyatheaceae (Table 1). The most abundant species was from Pteridaceae. This is due to the fact that certain Pteridaceae fern species may grow at a particular height from open, dry areas to damp, shaded locations (Muswita et al., 2013).

Table 1. Types of Ferns (Pteridophyta) In Montana Zone, Selo District, Boyolali Regency

Num	Species	Family	Number of Individuals	Habitats	Altitude (m asl)	Literature
1	*Adiantum raddianum* C. Presl**	Pteridaceae	107	Land and rock	250 – 2000	Perwati, L. K (2009)
2	*Notholaena copelandii* c.c . Hall	Pteridaceae	87	Land	300 – 1500	Flora Komite Editorial Amerika Utara (1993)

Num	Species	Family	Number of Individuals	Habitats	Altitude (m asl)	Literature
3	*Adiantum hispidulum* Sw	Pteridaceae	39	Land and roc	1345	Taslim, E (2019)
4	*Antrophyum sessilifolium* (Cav.) Spr	Pteridaceae	6	Tree	1836 – 2270	Astuti (2017)
5	*Pityrogramma austroamericana* Domin	Pteridaceae	10	Land	876	Yuskianti, (2018)
6	*Cyathea arborea* L.Sm*	Cyatheaceae	5	Land	1836	Astuti (2017)

Note:
** : The highest number of individuals found
* : The lowest number of individuals found

In the Pteridaceae family, five species have been identified based on the findings of the identification process, including *Adiantum raddianum* C. Presl, *Notholaena copelandii* C.C. Hall, *Adiantum hispidulum* Sw., *Pityrogramma austroamericana* Domin, and *Antrophyum sessilifolium* (Cav.) Spr. However, only one species, *Cyathea arborea* (L) Sm, has been recognized within the Cyatheceae family.

Based on the sorus shape, plant height, and host site, these species are divided into 6 species. The section of the spore that is found in the space between the leaf veins is known as *Cyathea arborea* (L) Sm, and *Pityrogramma austroamericana* Domin. On the leaf's margin is *Adiantum raddianum* C. Presl, *Notholaena copelandii* c.c. Hall, and *Adiantum hispidulum* Sw. Meanwhile, plants that do not have spores are *Antrophyum sessilifolium* (Cav.) Spr. Leaf dots on ferns are signs that a sporangium, or spore box, is present. Ferns produce spores in their sporangium as a way of reproduction (Ulum & Dwi, 2015). Spore morphological traits can be detected by the form, size, and kind of spore laesura. Fern sporangium is found on the underside of the leaf and forms a brown or black circle (Yunita et al., 2021). Sofiyanti et al (2020) investigated spore properties, identifying ferns as having two types of spore laesura, namely monolete and trilete with round, kidney, elliptical, and triangle shapes.

There is also a difference in the growth of these six plants, which is the height of the plants. *Cyathea arborea* L.Sm. is a tall plant that can reach heights of nearly 2-5 meters. *Adiantum raddianum* C. Presl, *Notholaena copelandii* c.c. Hall, *Adiantum hispidulum* Sw, *Pityrogramma austroamericana* Domin, and *Antrophyum sessilifolium* (Cav.) Spr. are among the plants that grow tiny. The tallest ferns, including those in the genus Cyathea, may grow to heights of several meters (Tjitrosoepomo, 2011).

The area where growth is split into three areas, namely land, rocks, and trees. *Notholaena copelandii* c.c. Hall, *Pityrogramma austroamericana* Domin, and *Cyathea arborea* L.Sm. live on the land. The plant's *Adiantum raddianum* C. Presl and *Adiantum hispidulum* Sw. occupy the soil and rock locations. Meanwhile, only *Antrophyum sessilifolium* (Cav.) Spr. grows at the tree location. The soil's habitus, which has a wide canopy form, allows for enhanced humidity and lower solar intensity, resulting in a low temperature and relatively damp zone under the canopy. The amount of ferns that grow is also affected by the height of the ground surface (Nainggolan, 2014). This fern thrives on flat soil, ditches, cliffs, and other types of habitat. The quantity of fern species and individuals present in the soil shows that the soil is an appropriate area to act as a host. This is connected to epiphytic plant spores that fall on appropriate places and can result in the formation of new epiphytic individuals (Darma et al., 2018).

When compared to other fern species, *Adiantum raddianum* ferns have the most individuals. From the 21 locations that were observed spots, 14 points of this variety of fern were discovered at altitudes ranging from 1600 to 1800 meters above sea level. The location is ideal for the growth of a few fern species. This is a terrestrial fern that is commonly found growing among rocks. Their preferred habitats include pond walls, fences, wells, ditches, river banks, and other wet areas (Lestari, 2011). *Adiantum raddianum* is a fern found from the lowlands to the mountains.

Adiantum raddianum grows wild on the sides of rocks or cliffs in chilly mountain environments. When kept in the lowlands, growth barriers exist (Ramndana et al., 2023).

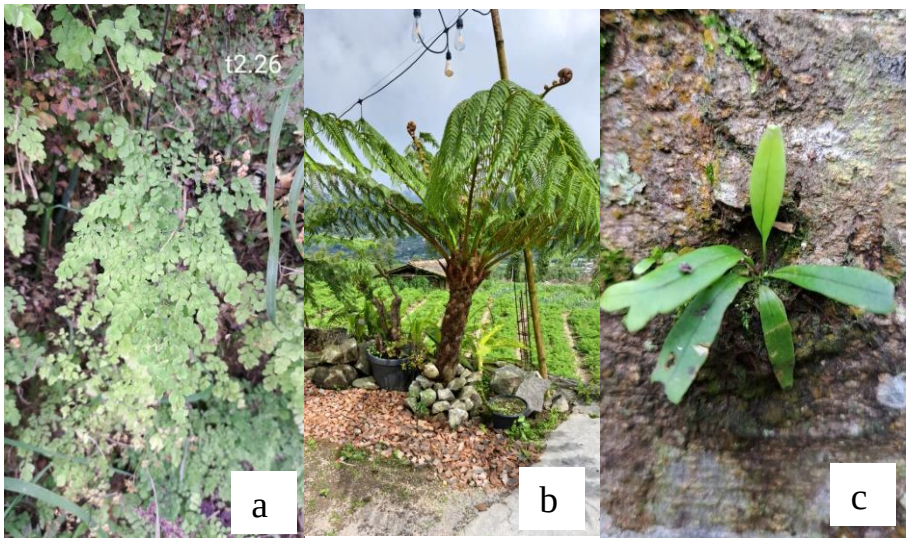

Figure 2. a. *Adiantum raddianum* C. Presl; b. *Cyathea arborea* L.Sm; c. *Antrophyum sessilifolium* (Cav.) Spr

The species diversity index (H') can be used to assess the diversity of fern species. It is possible to observe the H' value derived from each observation location. The H' value takes place between 1600 m asl to 1800 m asl and is 1.22. The criterion for identifying the level of diversity is H'<1.5, which indicates a low level of species diversity, 1.5<H<3.5 which indicates a moderate level of species diversity, and H'>3.5 which indicates a high level of species diversity (Magurran, 1988). According to Indriyanto (2006), if the diversity of species in a community is low, this is due to an area dominated by only a few species. According to Zulkarnain (2004), a community has high species diversity if several species are reasonably uniformly dispersed. However, if a community is made up of only a few species with an unequal number of members, the community has low diversity. Diversity can be used to assess the stability of a community. The size of the Diversity Index is related to environmental circumstances. The unequal distribution of individuals has an impact on species diversity, which is now deemed low.

Table 2. Abiotic factors of ferns in the Montana Zone in the Selo Region, Boyolali, Central Java

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

The environment is a collection of numerous abiotic and biotic components that interact with one another to dramatically influence the conditions in which plants, particularly ferns, thrive (Nasrandi et al., 2022). Based on the table of abiotic parameters (Table 2) above, it is known that the altitude of 1600 m asl - 1800 m asl has a little temperature difference. At a height of 1600 m asl, the average temperature is 28.7 °C, while at 1800 m asl, the temperature drops to 21.3 °C. The average temperature at each elevation is ideal for the growth of ferns. According to Hoshizaki & Moran (2001), ferns that grow in the tropics require a temperature range of 21-27 °C to thrive. Many varieties of ferns spread in tropical forest environments due to ideal temperature conditions. Types of nails that reside in a temperature range of 27°C are often more tolerant of dim and bright environmental conditions.

Abiotic variables including soil pH influence Pteridophyta (ferns). The results of the research on soil pH ranged from 6 which means it is acidic. A pH of 6 indicates that the soil is acidic, however, fern rock regions require a more alkaline pH, precisely 7-8. Ferns (Pteridophyta) prefer chilly temperatures and high humidity, and soil pH should be between 6-7. If the pH of the soil is less than 7, it is acidic if the pH is greater than 7, it is alkaline (Permana, 2017). According to Lestari et al (2019), environmental conduciveness permits more plant species to grow in locations with a pH close to neutral and lower temperatures.

Soil moisture also affects the growth of Pteridophyta (ferns). Pteridophyta (ferns) in the montana zone of Samiran Village is classified as normal and good, with air humidity ranging from 57% to 73%. Each height has a pretty high average humidity because the research site is in a tropical rainforest with high rainfall and is at an altitude ranging from 1600 to 1800 meters above sea level, where the air temperature is lower. Because air temperature lowers with increasing altitude, humidity is highly influenced by it. The lower the temperature, the more air available. Because this humidity range is favorable for fern growth, it contributes significantly to the proliferation of ferns in this area. According to Hoshizaki & Moran (2001), the appropriate relative humidity for the growth of ferns normally varies from 60 to 80%.

The intensity of sunlight is also one of the environmental parameters examined in this study. The light intensity is 2180-18200 lux at an altitude of 1600-1800 m asl. According to Imaniar (2017), light intensity affects air humidity, the larger the light intensity, the faster the evaporation rate. According to Rizky et al (2018), canopy cover and clouds influence the high and low intensity of sunlight. Ferns prefer shady environments or those that are shaded by the intense sun. This variety of terrestrial fern requires moist climatic circumstances, thus it tends to form groups in the shade where the light intensity is lower (Katili, 2013).

Several types of ferns can only be found in the montana zone area, one of which is a plant of the Cyatheaceae family at an elevation of 1700 m above sea level. According to Astuti et al. (2017), *Cyathea* sp. lives at an elevation of 1836 m above sea level. This fern is commonly found in terrestrial environments, where it prefers moist conditions (Sengka et al., 2022). According to Suin (2022), stating the ideal humidity and temperature might cause specific types to thrive and reproduce properly. The largest ferns, such as those in the genus Cyathea, can grow to be several meters tall (Adlini et al., 2021). This is owing to the poor level of mastery over environmental variables in the fight for nutrients and growth space for the survival of this fern species.

4. CONCLUSIONS

From these findings, it was concluded that there are 2 families of ferns consisting of 6 species in the montana zone, Samiran village, Selo sub-district, Boyolali district, consisting of *Adiantum raddianum* C. Presl, *Notholaena copelandii* c.c. Hall, *Adiantum hispidulum* Sw., *Pityrogramma austroamericana* Domin, *Cyathea arborea* L.Sm, and *Antrophyum sessilifolium* (Cav.) Spr. The Diversity Index (H') is low, with a value of 1.22. The low diversity score is due to an imbalance in the number of individuals in each live fern species. *Adiantum raddianum* C. Presk had the most individuals from 14 points, with 107. The majority of ferns grow in dirt. Abiotic parameters at the study site include air temperature ranging from 21°C to 28°C, which is considered normal, air

humidity of 57%-73%, which is ideal for fern development, and soil pH of 6, which is acidic. The growth of the fern *Adiantum raddianum* in Samiran Village is highly influenced by diversity and abiotic conditions.

5. SUGGESTIONS

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