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Diversity and distribution of ferns at different altitudes in Central Java

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Abstract. Fern is one of the vegetation that makes up the forest ecosystem in low, medium, and highland areas. This study aimed to analyze the diversity of ferns in Central Java at different heights. The research zone consists of zone I lowlands (Pagerwunung Nature Reserve, Darupono, Kendal, 100-300 masl), zone II medium plains (Forest Penggaron, 300 - 800 masl), and zone III highlands (Forest Mount Ungaran and Mount Lawu). The results showed that the diversity of plants in the zone I consisted of 8 families with 15 species, zone II consisted of 3 families with 23 species, and zone III consisted of 18 families with 32 species. The highest distribution of ferns diversity was in zone III because the increasing altitude causes the soil condition to become more humid. After all, forest trees provide water composition for the soil, lower temperatures make high air humidity, and light intensity is a suitable bioecological factor for all ferns' habitat.

1. Introduction

Indonesia is one of the countries with the highest plant diversity in the world. One group of plants that live in Indonesia territory is ferns. This plant is an avascular and spore plant capable of living cosmopolitan except in snowy areas and deserts. The abundance and distribution of ferns are very high, especially in the tropics. Indonesia, which is included in the tropics, and located at 6⁰LU-11⁰LS and 95⁰BT-141⁰BT, has a rich diversity of ferns [1].

Fern's life at the habitat scale is controlled by light, humidity, soil, and topographical conditions. Open conditions allow light; thus, soil moisture is reduced, so the ferns diversity in that location is small [2]. The Central Himalayan in Nepal showed differences in fern species' diversity at each altitude [3]. The Central Java geographical condition consists 38% of the land has a slope of 0 - 2%; 31% of the land has a slope of 2 - 15%; 19% of the land has a slope of 15 - 40%, and the remaining 12% the land has a slope more than 40%. Regencies/cities in Central Java are grouped into low, medium, and high altitude.

Ferns are widespread and exist in almost all of Central Java. The distribution is in low, medium, and high land areas, and mostly in shaded land. Biotic factors that affect ferns are the shade of other plants and abiotic factors, including high humidity, soil acidity, large water flows, fog and high rainfall, and light intensity.



2. Methods

This research was ferns exploration using observation technique that analyzed descriptively. The research area was selected based on previous research and community interviews, divided into three zones. They were zone I - lowlands (Pagerwunung Nature Reserve, Darupono, Kendal, Central Java), zone II - medium plains (Penggaron Forest), and zone III - highlands (Mount Ungaran Forest and Mount Lawu). The tools used to identify ferns were cameras, stationery/pencils, rulers, labels, altimeters, soil meters, lux meters, and the key determining ferns.

3. Results and Discussion

The ferns found and identified in 3 zone areas consisted of 70 species presented in Table 1.

Table 1. Diversity of ferns in the lowlands, medium plains, and highlands in Central Java.

NO	Family	Types	Habitat*
Lowlands (Pagerwunung Nature Reserve, Darupono, Kendal, Central Java)			
1	<i>Dennstaedtiaceae</i>	<i>Davalia solida</i>	T
2		<i>Pteris ensiformis</i>	T
3		<i>Nephrolepis biserrata</i>	E/T
4		<i>Microlepia speluncae</i>	T
5		<i>Pteridium aquilinum</i>	T
6		<i>Elaphoglossum peninsulare</i>	E
7		<i>Elaphoglossum califolium</i>	E
8	<i>Schizaeaceae</i>	<i>Lygodium flexuosum</i>	T
9	<i>Thelypteridaceae</i>	<i>Thelypteris pectiniformis</i>	T
10	<i>Adiantaceae</i>	<i>Adiantum peruvianum</i>	T
11	<i>Grammitidoideae</i>	<i>Hypoderris brownii</i>	T
12	<i>Polypodiaceae</i>	<i>Drynaria quercifolia</i>	E
13		<i>Pyrrosia lanceolata</i>	E
14	<i>Equisetaceae</i>	<i>Equisetum hiemale</i>	A
15	<i>Selaginellaceae</i>	<i>Selaginella mayeri</i>	E
Medium Plains (Penggaron Forest, Semarang Regency, Central Java)			
1	<i>Schizaeaceae</i>	<i>Lygodium flexuosum</i>	T
2		<i>Lygodium japonicum</i>	E
3		<i>Lygodium palmatum</i>	T
4		<i>Lygodium circinatum</i>	T
5	<i>Polypodiaceae</i>	<i>Nephrolepis hirsutula</i>	T
6		<i>Nephrolepis biserrata</i>	E/T
7		<i>Dryopteris scotii</i>	T
8	<i>Polypodiaceae</i>	<i>Mickelopteris cordata</i>	T
9		<i>Pteris asperula</i>	T
10		<i>Pteris ensiformis</i>	T
11		<i>Pteris biaurita</i>	T
12		<i>Pteris vittata</i>	T
13		<i>Drynaria quercifolia</i>	T
14		<i>Platynerium bifurcatum</i>	E
15		<i>Microsorium scolopendria</i>	T
16		<i>Vittaria elongata</i>	E
17		<i>Tectaria crenata</i>	T
18		<i>Tectaria angulata</i>	T
19		<i>Tectaria maingayi</i>	T
20		<i>Tectaria heracleifolia</i>	T
21		<i>Pleocnemia irregularis</i>	T
22	<i>Adiantaceae</i>	<i>Adiantum philippense</i>	E/T
23		<i>Adiantum raddianum</i>	T

Highlands (Mount Ungaran, Semarang Regency and Mount Lawu, Karanganyar, Central Java)

1	<i>Gleicheniaceae</i>	<i>Gleichenia hirta</i>	T
2		<i>Gleichenia truncata</i>	T
3		<i>Gleichenia lineriaris</i>	T
4	<i>Woodsiaceae</i>	<i>Athyrium sorzogenense</i>	T
5		<i>Diplazium polypodiales</i>	T
6		<i>Diplazium symplivicianum</i>	T

Highlands (Mount Ungaran, Semarang Regency and Mount Lawu, Karanganyar, Central Java)

7	<i>Vittariaceae</i>	<i>Vittaria elongata</i>	E
8	<i>Pteridiaceae</i>	<i>Adiantum</i> sp	T
9		<i>Pityrogramma calomelanos</i>	T
10	<i>Nephrolepidaceae</i>	<i>Nephrolepis bisserat</i>	E
11	<i>Cyatheaceae</i>	<i>Cyathea</i> sp	T
12	<i>Davalliaceae</i>	<i>Davalia denticulata</i>	T
13		<i>Davalia trichomarsides</i>	T
14	<i>Aspleniaceae</i>	<i>Asplenium nidus</i>	T
15	<i>Polypodiaceae</i>	<i>Drynaria quercifolia</i>	T
16		<i>Drynaria sparsisora</i>	E
17	<i>Marattiaceae</i>	<i>Angiopteris angustifolia</i>	T
18	<i>Lycopodiaceae</i>	<i>Lycopodium cernuum</i>	T
19	<i>Dennstaedtiaceae</i>	<i>Dennstaedtia scrabra</i>	T
20		<i>Hypolepis</i> sp	T
21		<i>Pteridium aqualinium</i>	
22	<i>Dipteridaceae</i>	<i>Dipteris conjugata</i>	T
23	<i>Selaginellaceae</i>	<i>Selaginella willdnowii</i>	T
24		<i>Selaginella intermedia</i>	T
25	<i>Polypodiaceae</i>	<i>Belvisia</i> sp 1	E
26		<i>Belvisia</i> sp 2	E
27	<i>Aspleniaceae</i>	<i>Asplenium pellucidum</i>	T
28	<i>Blechnaceae</i>	<i>Blechnum vestitum</i>	E
29		<i>Blechnum orientale</i>	E
30	<i>Adiantacea</i>	<i>Adiantum pedatum</i>	T
31		<i>Adiantum trapeziforme</i>	T
32		<i>Adiantum hispidulum</i>	T

*Description E = Epiphytic, T = Terrestrial, A = Aquatic

The results showed that the ferns in zone I - lowland consisted of 8 families with 15 species. The Denstaedtiaceae family dominated the diversity of ferns in this zone. The variety of ferns in zone II - medium plains consisted of 3 families with 23 types of members dominated by Polypodiaceae, while in zone III - highlands consisted of 18 families with 32 species. Zone III had a reasonably high diversity even though the higher the sea level, the smaller the species found. The research was in line with [4]; the results at three differently distributed sites in Longnan County, China, also showed that the decrease of species number was in line with altitude. Environmental conditions change with altitude changes from sea level, including temperature, air humidity, and light intensity distribution. In this condition, only a few types of ferns can adapt and survive.

The morphological shape of fern leaves in lowland areas is different from those of upland ferns. Lowland ferns with dry and hot environmental conditions have narrower leaf sizes; this is to minimize transpiration, drier rhizomes, dun scales are denser, thicker laminae are a form of adaptation to drought [5]. Other environmental factors that affect ferns' growth are temperature, humidity, soil pH, and light intensity.

The results of environmental conditions measurements are presented in Table 2.

Table 2. Bioecological factors that affect the spread of ferns

No	Area	Temperature	Humidity	Soil pH	Light Intensity	Elevation
1.	Forest in the eastern part of the Darupono Nature Reserve	28 ⁰ c	40%	6.3	201.5 lux	100 – 500 masl
2.	Penggaron Forest	25 ⁰ c	68%	5.5	170.2 lux	300 – 800 masl
3.	Ungaran Mountain	24 ⁰ c	70%	6-7	195.3 lux	1000-1500 masl
4.	Lawu Mountain	18-22 ⁰ c	78%	5.5 – 6	180.5 lux	1900 – 2200 masl

The ferns types found at the research location were varied; the higher the sea level, the greater the species number. The diversity of ferns is influenced by environmental conditions such as temperature, pH, humidity, and light intensity [6]. The air temperature affects air humidity. Increasing altitude causes the decreasing temperature, so the air humidity is higher. Conversely, lower height causes higher air temperature and lower humidity. Research in Temperate Forests, Northeast China, showed that altitude differences would affect the existing microclimate in weather, soil temperature, and humidity [7]. Their research found that the relationship between climatic variables and local species turnover is best described by the indirect link between climatic and regional species richness [8].

The soil pH measurements in zone I was about 6.3, zone II was 5.5, and Zone III was 6.5. It is a condition of neutral pH, which is a suitable condition for plant growth. Areas with a pH approaching neutral conditions allow more plant types to grow [9]. They said soil pH influences myriads of soil biological, chemical, and physical properties and processes that affect plant growth and biomass yield [10]. Another measurement of environmental factors, such as light intensity, showed that the zone I-lowlands, had a higher light intensity because there were not so many trees than zone II and III, causing the decrease of light intensity. The low light intensity is influenced by the presence or absence of canopy and cloud cover, and this condition is very suitable for ferns' habitat [11].

4. Conclusion

Central Java, the central part of Java island, has levels of the land slope, dividing the area into lowlands, medium lands, and highlands according to sea level height. Some areas still have forest areas where the diversity of ferns is grown. In zone I- lowland (Pagerwunung Nature Reserve, Darupono Kendal), eight families with 15 species, zone II-medium land, consisted of 3 families with 23 zone III upland 16 families with 32 species. The diversity of ferns is influenced by the bioecology in the environment, namely temperature, humidity, pH, and light intensity.

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