Original Research Paper

Diversity of Epiphytic Ferns in the Girimanik Natural Forest Area (NFA), Wonogiri Regency, Central Java

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Abstract: The Girimanik Natural Forest Area (NFA) dominated by that has the potential to harbor high biodiversity, but research on this potential is still limited, especially on low-level plants such as epiphytic ferns. This study aims to ascertain the existence and variety of epiphytic ferns in the Girimanik Natural Forest Area (NFA). The data collection strategy employed was an exploratory approach utilizing the *Systematic Line Sampling* technique. The assessment of fern diversity in the Girimanik Natural Forest Area (NFA) revealed the presence of 18 species across 7 families: Lomariopsidaceae, Aspleniaceae, Polypodiaceae, Davalliaceae, Dryopteridaceae, Hymenophyllaceae, and Nephrolepidaceae. Epiphytic ferns inhabit the surfaces of host trees (phorophytes) and are characterized by rough and aged bark. *Davallia denticulata* and *Davallia solida* dominate the distribution of individual epiphytic ferns. Among the 18 species, two epiphytic ferns, *Dryopteris arguta* and *Elaphoglossum blumeanum*, are endangered, necessitating intensified conservation efforts to avert extinction. The findings of this study may serve as recommendations for stakeholders involved in conservation initiatives for epiphytic fern species, particularly those that are threatened.

Keywords: Biodiversity, epiphytic, Girimanik Natural Forest Area (NFA).

Introduction

Indonesia is an equatorial archipelagic nation. Geographically, Indonesia extends from 6°N to 11°S and from 92°E to 142°E. Indonesia's equatorial position renders it a tropical region abundant in biodiversity, particularly in plant species. Indonesia possesses the second-largest biodiversity globally, following Brazil (Yulisma & Fathiya, 2023). A highly diverse and widely distributed group of Indonesian flora is ferns (Pteridophyta) (Lestari et al., 2019). Ferns (Pteridophyta) are spore-producing cormophytes that thrive in diverse habitats, including aquatic environments (hydrophytes), decaying plant matter (saprophytes), and as epiphytes on other plants (Raunsay et al., 2020). Ferns are characterized by juvenile leaves that initially curl and subsequently unfurl upon maturation Epiphytic ferns represent a form of biological diversity that remains largely unexamined, resulting in its restricted utilization. This epiphytic fern prefers shaded environments characterized by low air temperatures and elevated humidity levels, such as Natural Forest Areas (NFA).

Natural Forest Areas (NFA) are verdant open places mostly characterized by trees, exhibiting favorable bioecological conditions that sustain diverse plant species, including epiphytic ferns. One of the Natural Forest Areas (NFA) in Indonesia is the Girimanik Natural Forest Area (NFA) which is located in Setren Village, Slogohimo District, Wonogiri Regency. This region comprises high mountain woods at altitudes ranging from 1200 m to 2500 m above sea level, covering an area of 10.6 ha, with GPS coordinates: 7°43'54"S 111°10'28"E (Roziaty & Utomo, 2020). It has a tropical climate with average rainfall ranging from 1,557 - 2,476 mm/year and average air temperature of 24˚ - 32˚C (Hernowo, 2012).

Based on the described geographical location and conditions, it is anticipated that

the Girimanik Natural Forest Area (NFA) has a significant quantity of ferns. As of now, there is no recorded information concerning the diversity of epiphytic ferns. Therefore, undertaking the study is crucial as a preliminary measure to determine the variety of epiphytic ferns in the Girimanik Natural Forest Area (NFA).

Materials and Methods

Time and location

Research on the diversity of epiphytic ferns was conducted from October to December 2024 at the Girimanik Natural Forest Area (NFA), Setren Village, Slogohimo District, Wonogiri Regency, Central Java.

Research methodology/classification

This study uses non-experimental research or direct exploration methodologies.

Research population and sample

The study population comprises all epiphytic fern species located in the Girimanik Natural Forest Area (NFA), the designated research site. The samples utilized were epiphytic ferns situated along the primary path to the Girimanik Natural Forest Area (NFA) waterfall. The employed sampling technique is *Systematic Line Sampling* technique (Sirami, 2019). This data collection approach adheres to a principal pathway leading to the Girimanik Natural Forest Area (NFA), spanning 2 km to the Tejo Moyo waterfall. Sub-lanes are erected perpendicular to the main route, each measuring 10 meters in length, with a 100-meter interval between lanes.

The research variables include independent variables, namely environmental conditions such as tree height, tree diameter, temperature, humidity, and soil pH, together with dependent variables represented by the quantity and types of epiphytic fern species identified. Data collection was carried out by monitoring and recording the type and number of epiphytic ferns in the *systematic line sampling* route, augmented by assessing environmental parameters using tools such as a hygrometer for humidity and a soil meter for soil pH. The utilized materials comprise study worksheets, specimen labeling tags, and documentation
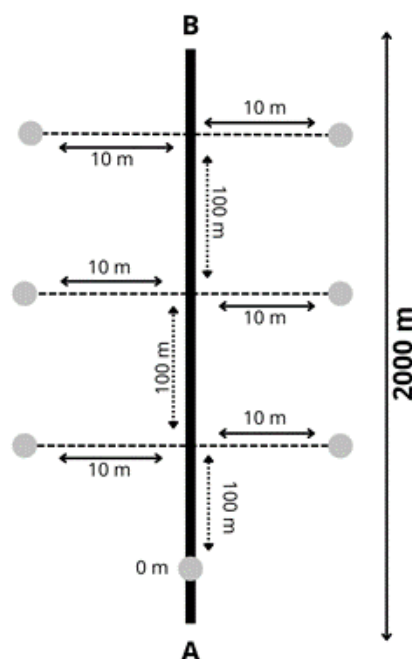
cameras.

Figure 1. Jalur Systematic Line Sampling

Research procedures

The research approach commences with observation, aiming to physically examine the research object and ascertain the distribution of epiphytic ferns and host trees, while also establishing the sampling route through the *systematic line sampling* method. Moreover, study investigations are conducted at designated sites. The collected material includes data concerning the varieties of epiphytic ferns, the population of each variety, and the specific tree portions where these ferns proliferate. Environmental variables, including air humidity, air temperature, and soil pH, are assessed utilizing a hygrometer and soil meter.

Data analysis techniques

Epiphytic fern specimens were subsequently identified utilizing a fern identification guide, namely Flora Indonesiana Fern of Bali and Fern of Malaysian Rain Forest (Yusuf, 2010). Subsequently, the analysis was performed using qualitative methods focused on morphological characteristics, with the nomenclature verified through the website https://www.plantlist.org.

Results and Discussion

Diversity of Epiphytic Ferns in the Girimanik Natural Forest Area (NFA)

The epiphytic fern species observed in the Grimanik Natural Forest Area (NFA) exhibit varying degrees of species richness, morphology, and dimensions. They thrive on host trees (phorophytes) characterized by rough and aged bark. Trees with larger diameters typically support a greater number of epiphytic spikes due to their canopy and bark characteristics that promote epiphytic growth. The optimal physical condition of tree bark is characterized by a flexible, fibrous texture that facilitates the penetration of epiphytic plant roots (Sholihah, 2018). Research findings on the diversity of epiphytic ferns in the Girimanik Natural Forest Area (NFA) revealed the presence of 18 species of epiphytic ferns exhibiting varied morphologies. All species are categorized into 7 families. The variety of epiphytic fern species present in the Girimanik Natural Forest Area (NFA) is illustrated in Table 1 as follows:

Table 1. Diversity of Epiphytic Ferns in the Girimanik Natural Forest Area (NFA).

No	Families	Spesies Name	Amount
1	Aspleniaceae	*Asplenium adiantum* Hoffm. (1795)	351
		Asplenium caudatum G. Forst (1786)	183
		Asplenium macrophyllum Sw. (1800)	62
		Asplenium nidus L. (1753)	31
		Asplenium onopteris L. (1753)	53
		Asplenium salignum Blume (1860)	33
2	Davalliaceae	*Davallia denticulata* (Burm. f.) Mett. ex Kuhn (1867)	5072
		Davallia solida (G. Forst.) Sw (1801)	1506
3	Dryopteridaceae	*Dryopteris arguta* (Kaulf.) Watt (1867)	59
		Elaphoglossum blumeanum (Fée) J. Sm (1866)	56
4	Hymenophyllaceae	*Hymenophyllum dilatatum* (G.Forst.) Sw. (1801)	396
5	Lomariopsidaceae	*Arthropteris Palisotii* (Desv.) Alston (1956)	108
6	Nephrolepidaceae	*Nephrolepis exaltata* (L.) Schott (1834)	5
		Nephrolepis biserrata (Sw.) Schott (1834)	345
7	Polypodiaceae	*Belvisia mucronate* Copel. (1947)	3
		Belvisia spicata (L. f.) Mirb.(1905)	105
		Drynaria fortune (Kunze ex Mett.) J.Sm. (1857)	512
		Goniophlebium percisifolium (Desv.) Bedd (1966)	553
	Total		**9024**

There are 7 types of tribes identified, namely from Aspleniaceae, Davalliaceae, Dryopteridaceae, Hymenophyllaceae, Lomariopsidaceae, Nephrolepidaceae and Polypodiaceae. The Aspleniaceae tribe exhibits the highest species diversity, comprising six species, among others *A. adiantum, A. caudatum, A. macrophyllum, A. nidus, A. onopteris* and *A. salignum.* Whereas, the Hymenophyllaceae and Lomariopsidaceae families have the lowest species diversity, with each comprising only one species.

Based on this data and several reasons above, the number of types of epiphytic ferns found was quite considerable, namely 18 varieties of epiphytic ferns. A community is said to have high species diversity if the community is formed of many species with many of the same or almost the same species abundance (Salatalohy et al., 2022). Meanwhile (Eman et al., 2022), it also claims that the greater the number of species, the higher the diversity.

The fluctuations in the abundance of epiphytic ferns referenced above are indirectly influenced by the topography of the Girimanik Natural Forest Area (NFA) across varying elevations (Kusuma & Suryani, 2017). Additionally, several environmental elements, including physical characteristics such as air temperature, air humidity, and soil pH, exert influence. The following are the results of measurements of environmental factors in the Girimanik Natural Forest Area (NFA). Listed in Table 2 below.

Table 2. Abiotic factors at the research site within the Girimanik Natural Forest Area (NFA).

No	Parameter	Range
1	Temperature (˚C)	32,1 - 22,6
2	Air Humidity (%)	20 - 64
3	Soil pH	4 - 6,2

The varieties of epiphytic ferns present in the Girimanik Natural Forest Area (NFA) are affected by abiotic conditions like temperature, air humidity, and soil pH. Table 2 indicates that the maximum air temperature is 32.1˚C, while the minimum temperature is 22.6˚C. Cold temperatures play a significant role in forest growth, with low temperatures and the creation of fog that often covers the roof of the canopy. Small leaf ferns necessitate low temperatures ranging from 13°C to 18°C. Simultaneously, large-leaved ferns necessitate elevated temps between 15°C to 21°C (Purnama Sari et al., 2020).

The atmospheric humidity levels in the Girimanik Natural Forest Area (NFA) fluctuate between 20% and 64%; insufficient humidity adversely affects fern growth. Fern growth requires optimal humidity levels, specifically between 60% and 80% (Karim et al., 2022). Soil pH parameters range from 4 to 6.2. The level of acidity correlates with optimal nutrient absorption at pH 5.5 - 6.5 in soil and pH 7 - 8 in rocky situations (Salamah et al., 2020). The examined abiotic parameters produced significant results across all metrics. The condition and growth of epiphytic ferns in the Girimanik Natural Forest Area (NFA) are adequate.

Figure 2. Predominant species of epiphytic ferns in the Girimanik Natural Forest Area (NFA): 1. *Davallia denticulata;* 2. *Davallia solida*

The variety of epiphytic ferns in the Grimanik Natural Forest Area (NFA) demonstrates that *D.denticulata* and *D.solida* are the most extensively distributed species. Table 1 demonstrates that *D.denticulata* comprises a total of 5,072 individuals, while *D.solida* consists of 1,506 individuals. The prevalence of epiphytic fern species and individuals indicates that the habitat is suitable for hosting them (Rahmawati & Santhyami, 2023).

D. denticulata and *D. solida* are constituents of the Davalliaceae family. This genus of the Davalliaceae family is distinguished by elongated, densely scaly rhizomes, a membranous lamina, and an indusium on the cup-shaped sorus located in each leaflet depression (Sofiyanti & Harahap, 2019). The Davalliaceae family typically sheds leaves under arid circumstances (Dubuisson et al., 2009). It is located as an epiphyte on significant trees along riverbanks, among bird's nest ferns in open regions (Darma & Peneng, 2007). Corresponds to *D. denticulata* and *D. solida*, recognized in studies, also proliferate on other plants (epiphytes), and some flourish on hard or stony substrates (lithophytes).

The leaves of *D. denticulata* display little serrated edges and a smooth texture, distinguished by a vibrant green colour. Conversely, *D.solida* has larger leaves than *D.denticulata*, showcasing a darker green hue. *D.denticulata* exhibits more slender rhizomes compared to *D.solida*. *D.denticulata* and *D.solida* have similar spores. The spore collections on these two plants are primarily situated near the leaf apices. The spores are minuscule, clustered, and lightweight, facilitating straightforward wind dissemination. Ferns can propagate through these spores (Putri et al., 2018). This may elucidate the considerable occurrence of the epiphytic ferns *D. denticulata* and *D. solida* in the Natural Forest Area (NFA) Girimanik.

The Girimanik Natural Forest Area (NFA) is near the waterfall, which generally sustains a diverse array of plant species, including ferns. Ferns require water during fertilization, and the water splashing in the waterfall region provides sufficient hydration for their growth and reproduction, facilitating the dispersal of spores (Idris et al., 2019). The majority of persons

employ this fern as an ornamental specimen and as a resource for traditional therapeutic uses (Swastanti Ridianingsih et al., 2017).

The variety of epiphytic fern species present in the Girimanik Natural Forest Area (NFA) can yield advantages across multiple domains, including economic, aesthetic, and social spheres. The accessibility of educational materials in the Pteridophyta division of the Cryptogamae Botany course. Students can distinguish and identify fern species through their physical traits due to the diversity of ferns.

This activity will facilitate the execution of practical work on low-level plant identification, allowing students to collect plant specimens from the local environment for observation.

Epiphytic Fern Conservation Category in the Girimanik Natural Forest Area (NFA)

The conservation status of epiphytic ferns in the Girimanik Natural Forest Area (NFA), according to the IUCN *Red List of Threatened Species*, is detailed in Table 3.

Table 3. Conservation status of epiphytic ferns as per the IUCN *Red List of Threatened Species*

No	Species Name	Conservation Status
1.	*Arthropteris palisotii* (Desv.) Alston (1956)	LC
2.	*Asplenium adiantum* Hoffm. (1795)	NE
3.	*Asplenium caudatum* G. Forst (1786)	LC
4.	*Asplenium macrophyllum* Sw. (1800)	LC
5.	*Asplenium nidus* L. (1753)	LC
6.	*Asplenium onopteris* L. (1753)	LC
7.	*Asplenium salignum* Blume (1860)	LC
8.	*Belvisia mucronate* Copel. (1947)	LC
9.	*Belvisia spicata* a (L. f.) Mirb. (1905)	LC
10.	*Davallia denticulata* (Burm. f.) Mett. ex Kuhn (1867)	LC
11.	*Davallia solida* (G. Forst.) Sw (1801)	LC
12.	*Drynaria fortunei* (Kunze ex Mett.) J.Sm. (1857)	LC
13.	*Dryopteris arguta* (Kaulf.) Watt (1867)	VU
14.	*Elaphoglossum blumeanum* (Fée) J. Sm (1866)	VU
15.	*Goniophlebium percisifolium* (Desv.) Bedd (1966)	LC
16.	*Hymenophyllum dilatatum* (G.Forst.) Sw. (1801)	LC
17.	*Nephrolepis biserrata* (Sw.) Schott (1834)	LC
18.	*Nephrolepis exaltata* (L.) Schott (1834)	LC

Note:
LC : *Least Concern*
NE : *Not Evaluated*
VU : *Vulnerable*

Epiphytic fern species in the Girimanik Natural Forest Area (NFA) require protection for their viability. Protecting it can be achieved by understanding the conservation status of epiphytic fern species. The conservation status is the designation assigned by the IUCN to a plant species as a preliminary measure to avert its extinction, thereby facilitating prompt protective actions. According to the IUCN *Red List of Threatened Species*, the ferns found in the Girimanik Natural Forest Area (NFA) are classified as *Least Concern* (LC), *Not Evaluated* (NE), and *Vulnerable* (VU). The conservation status of epiphytic fern species in the Girimanik Natural Forest Area (NFA) is predominantly classified as safe; however, two species,

D.arguta and *E.blumeanum*, are categorized as *vulnerable* (VU) and are at risk of extinction. Consequently, conservation initiatives must be implemented to prevent the status from transitioning to extinction.

Understanding the conservation status of endangered flora significantly aids in biodiversity preservation efforts, particularly for lower plants like epiphytic ferns. Armed with this information, stakeholders can formulate effective conservation measures, including habitat protection, breeding programs, or ecosystem restoration initiatives. Policies and regulations can be enhanced to safeguard endangered species while also promoting research and innovation in agriculture, pharmaceuticals, and sustainable

forestry. Consequently, conservation initiatives preserve natural equilibrium while simultaneously yielding economic and social advantages for humanity.

Conclusion

The exploration results indicate the abundance and diversity of epiphytic ferns in the Girimanik Natural Forest Area (NFA). Eighteen species of epiphytic ferns were identified, and classified into seven families: Lomariopsidaceae, Aspleniaceae, Polypodiaceae, Davalliaceae, Dryopteridaceae, Hymenophyllaceae, and Nephrolepidaceae. The predominant epiphytic ferns in this forest region are *Davalia denticulata* and *Davalia solida*. The epiphytic ferns inhabit the host tree (phorophyte), which is characterized by rough and aged bark. The physical environmental characteristics of temperature, air humidity, and light intensity suggest that the Girimanik Natural Forest Area (NFA) is conducive to the growth of epiphytic ferns. Two species of epiphytic ferns, *Dryopteris arguta* and *Elaphoglossum blumeanum*, are classified as endangered, necessitating intensified conservation efforts to avert extinction.

Acknowledgments

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