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The Diversity of Understorey Plants in Siranggas Wildlife Reserve, Pakpak Bharat District, North Sumatra

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ABSTRACT

Information on the diversity of understorey plants in Siranggas Wildlife Reserve is still limited. This research was carried out to determine the diversity of the understory at the Siranggas Wildlife Reserve Area, Pakpak Bharat Regency, North Sumatra, Indonesia. The study was conducted using a purposive sampling method, with 5 sampling sites. Twenty plots measuring 2m × 2m were placed at each site to obtain a total of 100 plots. The result showed that there were 41 species of understory plants found in the Siranggas Wildlife Reserve, consisting of two divisions namely Pteridophytes (10 species) and Spermatophytes (31 species). The highest Important Value Index (IVI) of understory plants in the study was obtained for *Selaginella intermedia* at 28.6%. The species of understory plants in the study area must be preserved to maintain their sustainability.

Keyword: Important Value Index, Siranggas, Understorey, Vegetation, Wildlife Reserve

1. Introduction

A forest is an ecosystem that contains biological natural resources and is dominated by trees in its environment, one another inseparable. Forests are also an important part of the sustainability of ecosystems, both abiotic and biotic ecosystems. Forests have very high species diversity with complex structures so they become important ecosystems for human life, and interrelated flora and fauna [8]. Indonesia is a tropical region that has tropical rainforests. Rainfall and high sun exposure make forests in Indonesia rich with various types of vegetation ranging from the level of trees, and shrubs to lower plants [5]. Undergrowth is vegetation that is in the lower layers of the tree community. Lower plants occupy stratum D and stratum E in a stratified arrangement where they are in the fourth and fifth layers with a height of 0-4 m [2]. Generally, the lower vegetation is dominated by Cyperaceae, Asteraceae, and ferns.

The diversity of understory plant species determines the structure of the forest which will affect the function of the forest. Understory plants can increase organic matter in the soil, as the reeds that dominate the forest floor can be a major source of organic matter because they are slow to decompose. The higher the organic matter content, the higher the nitrogen content in the soil, thus increasing the growth of stems and leaves [11]. Understory plants also have a dense root system and can protect the soil from rain to prevent erosion [9].

The Siranggas Wildlife Reserve is a natural reserve forest area whose main function is to preserve flora and fauna that are considered endangered or already rare. This area has quite high air humidity ranging from 78-87.50%, and air temperature ranging from 21.87-23.31 ºC. Siranggas Wildlife Reserve is rich in a diversity of plant species, which can be seen based on the existing communities, some trees have large trunk diameters with dense crowns that support the growth of understory plants. This research aims to determine the composition of the understory in the Siranggas Wildlife Reserve.

2. Research Methods

This research was conducted from March to April 2022 in the Siranggas Wildlife Reserve area, Pakpak Bharat Regency, North Sumatra, Indonesia (Figure 1). Plant identification and data management are carried out at the Plant Systematics Laboratory, Faculty of Mathematics and Natural Sciences, Universitas Sumatera Utara.

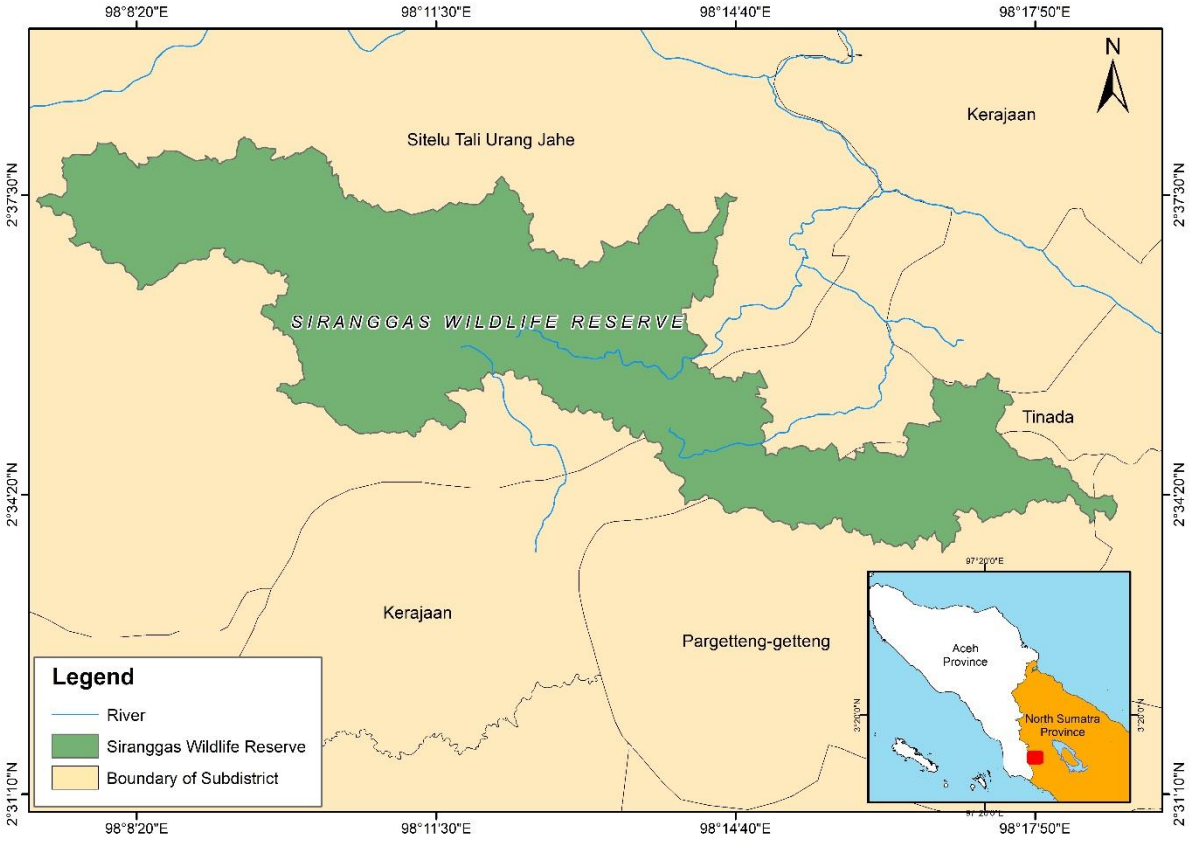

Figure 1. Map of Research Location in Siranggas Wildlife Reserve

2.1 Procedures

This research was carried out using the Purposive Sampling method, namely by determining the location of the research deliberately which was considered representative. Observations were made starting from an altitude of 800 m from the foot of the hill to 1,300 meters above sea level at the hilltop, selecting 5 locations. The observation locations will be divided according to the mountain forest zone as follows; a) 800 – 900 masl as Location 1; b) 900 – 1,000 masl as Location 2; c) 1,000 – 1,100 masl as Location 3; d)1,100 – 1,200 masl as Location 4; and e) 1,200 – 1,300 masl as Location 5.

At each research location, 2×2 m plots were made as many as 20 plots with an interval of 10 m. It gives a total of 100 observation plots. The plants obtained are photographed and recorded as important characters. Then they were collected and labeled as hanging. Physical factor measurements include altitude measurement with an altimeter, air temperature, air humidity with a hygrometer, light intensity with a lux meter, soil moisture, soil pH with a soil tester, altitude measurement with an altimeter, and coordinate points taken using GPS. Plants are collected and then photographed on a black cloth with a ruler as a comparison. Plant samples are arranged in newsprint, put in a plastic bag, and given 70% alcohol until wet. The air in the plastic bag is removed, covered with duct tape, and then taken to the laboratory to be dried and identified.

2.2 Data Analysis

The vegetation data was analyzed to obtain the Important Value Index (IVI) by looking for the Relative Density (RD) and Relative Frequency (RF) values. Species diversity and uniformity can be analyzed using the Shannon-Wienner Diversity Index (H') and Uniformity Index (E). Abiotic factor parameters will be tested for Pearson Correlation statistics using PAST software. Data analysis was conducted to calculate the composition of vegetation which is carried out by the following formula.

$$\text{Density of a type (D)} = \frac{\sum individual\ a\ type}{\text{Area of plot}} \quad (1)$$

$$\text{The relative density of a type (RD)} = \frac{\text{Density of a type}}{\text{Density of all species}} x\ 100\% \quad (2)$$

$$\text{Frequency of a breed (F)} = \frac{\sum Plot\ found\ a\ type}{\sum the\ whole\ plot} \quad (3)$$

$$\text{Relative frequency of a type (RF)} = \frac{\text{Frequency of a type}}{\text{Frequency of all species}} x\ 100\% \quad (4)$$

$$\text{Important Value Index (IVI)} = \text{RD} + \text{RF} \quad (5)$$

$$\text{Diversity Index (H}') = -\sum_{i=1}^{s}[\left(\frac{ni}{N}\right)\ln\left(\frac{ni}{N}\right)] \quad (6)$$

The diversity index is divided into 3 categories, namely:
H' < 1 : Low species diversity
1 < H' < 3 : Medium species diversity
H' > 3 : High species diversity
[13]

$$\text{Uniformity Index } (E) = \frac{H'}{ln(S)} \quad (7)$$

The uniformity index is divided into 3 categories, namely [7];
E < 0.5 : Low uniformity level
0.5 < E < 0.6 : Medium uniformity level
E > 0.6 : High degree of uniformity

$$\text{Similarity Index (SI)} = \frac{2C}{A+B}\text{x}100\% \quad (8)$$

Information [7]:
A = number of individuals of each type present at location A
B = number of individuals of each type present at location B
C= the same number of individuals present in both communities
Where:
Similarity <25% : very not similar
25-50% similarity : not similar
50-75% similarity : similar
Similarity >75% : very similar

3. Result and Discussion

3.1 Diversity of Understory Plants

The results obtained understory plants consisting of two divisions, namely Pteridophyta as many as 10 species in 5 families, and Spermatophyta as many as 31 species in 10 families (Table 1).

Table 1. Species of Understory Plants and Number of Individuals in Siranggas Wildlife Reserve

No.	Division	Family	Spesies	Number of individuals/ Locations					IUCN
				1	**2**	**3**	**4**	**5**	
1	Pteridophyta	Aspleniaceae	*Blechnum occidentale*	8	-	-	-	-	-
2			*Diplazium esculentum*	-	5	-	-	-	LC
3			*Thelypteris gracilescens*	18	22	33	51	-	-
4			*Asplenium normale*	10	-	-	-	-	-
5		Gleicheniaceae	*Dicranopteris linearis*	-	-	28	-	-	LC
6			*Gleichenia vulcanica*	-	12	-	-	-	-
7		Lindsaeaceae	*Lindsaea cultrata*	-	-	-	11	-	-
8			*Lindsaea orbiculata*	-	-	2	-	-	-
9		Polypodiaceae	*Microsorum scolopendria*	-	-	-	33	-	-
10		Selaginellaceae	*Selaginella intermedia*	106	19	7	41	5	-
11	Spermatophyta	Araceae	*Aglaonema nitidum*	3	-	-	18	-	-
12			*Aglaonema simplex*	10	-	5	20	-	LC
13			*Alocasia arifolia*	-	4	-	-	-	-
14			*Alocasia cucullata*	-	-	-	-	4	-
15			*Alocasia longiloba*	1	-	-	-	-	-
16			*Alocasia wentii*	-	3	-	-	-	-
17			*Amydrium humile*	-	-	-	-	3	-
18			*Homalomena cordata*	-	-	-	-	4	-
19			*Homalomena cristata*	-	-	-	23	-	-
20			*Homalomena rostrata*	-	-	3	-	-	-
21			*Homalomena rubescens*	30	-	-	23	-	-
22			*Pothos curtisii*	-	-	-	20	-	-
23			*Rhaphidophora sylvetris*	-	8	10	10	-	-
24			*Schismatoglottis* sp.	-	-	-	6	-	-
25			*Scindapsus longispitatus*	-	-	-	5	-	-
26			*Scindapsus rupestris*	-	11	13	5	8	-
27			*Scindapsus pictus*	2	2	-	-	-	-
28		Begoniaceae	*Begonia rostrata*	-	2	-	-	15	-
29		Cyperaceae	*Cyperus iria*	-	4	1	-	-	-
30		Fabaceae	*Bauhinia* sp.	-	-	-	-	5	-
31		Melastomataceae	*Phyllagathis rotundifolia*	71	-	77	42	-	-
32		Nepenthaceae	*Nepenthes rhombicaulis*	-	-	-	-	1	VU
33		Pandanaceae	*Pandanus* sp.	-	-	-	-	8	-
34		Primulaceae	*Labisia pumila*	3	21	-	5	-	-
35		Orchidaceae	*Bulbophyllum* sp.	-	-	-	-	1	-
36			*Corybas scuteliifer*	-	-	-	2	3	-
37			*Cystorchis variegata*	-	-	6	16	-	-
38		Zingiberaceae	*Globba aurantiaca*	2	-	-	-	1	NT
39			*Globba leucantha*	-	-	6	-	-	-
40			*Globba patens*	-	3	7	7	5	LC
41			*Globba pendula*	12	10	14	6	-	LC
		Number of individuals		276	126	212	344	63	
		Number of species		13	14	14	19	13	

Based on Table 1 above, there are differences in the number of species and the number of individual undergrowth plants in each location. The highest number of species was at location 4 (19 species with 344 individuals), and the lowest was at location 5 (13 species with 63 individuals). The least number of individuals across study sites was found in *Alocasia longiloba*, *Cyperus iria*, *Nepenthes rhombicaulis*, *Bulbophyllum*sp, and *Globba aurantiaca* of one individual each.

Location 1 is dominated by *Selaginella intermedia* with a total of 106 individuals (Table 1). Location 1 has exposed vegetation with a canopy that is not too dense with a light intensity of 670 lux. According to [10], Selaginella species can live in various environmental conditions with physical factors such as light intensity 649.2-6,771.7 lux. *Selaginella intermedia* is a fern plant that has high adjustment and reproduction in the form of spores to support a wide distribution (Figure 2).

Location 2 was dominated by *Thelypteris gracilescens* (Figure 2) with 28 individuals (Table 1). Location 2 has an open habitat with an air temperature of 27 ºC. Growth and species distribution can be supportive if the temperature is suitable for growth. According to [6], ferns can be found in areas that are rather open to sunlight and can enter directly into the forest floor.

Location 3 is dominated by *Phyllagathis rotundifolia* (Melastomataceae) with a total of 77 individuals (Figure 2). Location 3 has an air temperature of 24.7 ºC and has rather open vegetation. The type of *Phyllagathis rotundifolia* found at the study site, found the presence of flowers and fruits. This can affect the abundance of these species at the study site. Plants from the tribe Melastomataceae can live among trees to the edge of the forest, how to multiply by producing fruit that can be carried by birds so that it is good in its distribution.

Location 4 is dominated by *Thelypteris gracilescens* (Aspleniaceae) with 51 individuals (Table 1 and Figure 2). Location 4 has research site conditions near river flows, trees that are not too tight, and abiotic factors that are good for plant development. According to [6], growth for ferns is faster in more open areas compared to ferns protected from sunlight. Location 4 has a temperature of 24 ºC which is relatively constant in plant development. This condition can affect growth that cannot tolerate temperatures that are too low or too high so that in this location more species of plants are found. According to [8], the difference in height of a place will cause a difference in environmental temperature.

Location 5 has an altitude of 1,200-1,300 meters above sea level dominated by *Begonia rostrata* with as many as 15 individuals (Table 1). According to [1], in general, wild begonias (Figure 2) that grow in nature are found in mountains that are quite high, which is between 900-1,500 meters above sea level. The vegetation of location 5 is dominated by many trees with a dense tree canopy so that at this location sunlight does not penetrate directly to the forest floor. Begonia species generally grow well in closed vegetation, not exposed to the sun directly [7].

(a) *Selaginella intermedia* (b) *Thelypteris gracilescens* (c) *Phyllagathis rotundifolia* (d) *Begonia rostrata*

Figure 2. The dominator of location 1 (a), 2 (b), 3 (c), 4 (b), and 5 (d)

3.2 Diversity Index and Uniformity Index of Understory Plants

The diversity index is used to determine the structure of the community which shows the number of species from the total number of individuals present. According to [8], the high and low diversity index of a plant community depends on the number of species and the number of individuals of each type. In a community in general there are various species of plants so the more stable the condition of a community, the higher the

diversity of plant species. The diversity and uniformity index values of the five study sites can be seen in Table 2.

Table 2. Diversity Index and Uniformity Index of Understory Plants

Location	Height (masl)	H' (Diversity Index)	E (Uniformity Index)
Location 1	800-900	1,805	0,703
Location 2	900-1000	2,420	0,893
Location 3	1.000-1.100	2,057	0,779
Location 4	1.100-1.200	2,653	0,901
Location 5	1.200-1.300	2,306	0,899

Based on Table 2 it is known that the diversity index of lower plants ranges from 1,805 to 2,653. The highest diversity index value was found at location 4 at 2,653 and the lowest at location 1 at 1,805. The value of species diversity at the five study sites showed that the bottom plants in the environment had moderate species diversity. The value of 1< H' < 3 indicates that species diversity in an area is moderate, the distribution of the number of individuals of each type is moderate and the stability of the community is moderate. The diversity value at location 5 was higher compared to location 1, while the number of species and the number of individuals was higher at location 1. This is because the distribution at location 1 is uneven and only a few are more dominant such as *Selaginella intermedia* and *Phyllagathis rotundifolia* while at location 5 almost all species dominate. According to [3], species diversity is said to be high when arranged by many species, while species diversity is said to be low when arranged by a few species and only a few are dominant.

The high and low value of the diversity index is influenced by the large number of species and the number of individuals found. Location 1 and location 3 have been disrupted by local community activities that utilize forest products such as the cultivation of *Arenga pinnata* and *Parkia speciosa*. Location 5 has a moderate diversity index value, possibly due to the dense canopy cover, as found at the research location is *Baccaurea sumatrana*, preventing sunlight from penetrating directly to the forest floor, thus inhibiting the growth of undergrowth. The higher the value of diversity of an area, it will show the stability of the community in the region.

3.3 Similarity Index

The similarity index is used to determine the degree of similarity in the compared location. The similarity index value describes the degree of similarity of the type composition of the two locations. The similarity index values of the five research locations can be seen in Table 3.

Table 3. Similarity Index of Understory Plants in Siranggas Wildlife Reserve

Location	Location 1 (%)	Location 2 (%)	Location 3 (%)	Location 4 (%)	Location 5 (%)
Location 1	-	26	46	47	4
Location 2		-	37	13	10
Location 3			-	22	7
Location 4				-	4
Location 5					-

Based on Table 3 it is known that the similarity index value ranges from 4% to 47%. Location 1 with locations 2, 3, and 4 is categorized as not similar. Location 2 and location 3 are categorized as not similar, while others are very unsimilar. The IS value of <25% is said to be very unsimilar, if the IS 25-50% is said to be not similar, if the SI 50-75% is said to be similar, and if SI>75% then the vegetation of a community is very similar.

The lowest similarity index value is at location 1 with 5 and location 4 with 5 which is 4%. The low difference in the degree of similarity indicates that the number of species between the two locations has a low degree of similarity. Different environmental conditions will produce different vegetation. The canopy cover at location 1 tends to be more open then the abiotic factor is different from location 5 which has a denser canopy cover. Thus the vegetation constituents at the two locations are also different. Abiotic factors at locations 1 and 5 also differ quite significantly based on temperature, air humidity, soil pH, soil moisture, and light intensity. A low similarity value will indicate that the community between locations is different [8].

The highest similarity index value is between location 1 and location 4 at 47%. It is because locations 1 and 4 have almost the same environmental conditions, with open vegetation locations, and not too much shade, which can also be seen based on abiotic factors that are not much different between the two locations that have been measured. According to [8], the greater the similarity index value, the more the same type in a location is compared.

3.4 Pearson Correlation Analysis

Pearson correlation analysis was obtained by analyzing the relationship between diversity index and abiotic factors in the Siranggas Wildlife Reserve Area. The value of the correlation index (r) can be seen in Table 4.

Table 4. The value of pearson's correlation between plant diversity index and abiotic factors in the Siranggas Wildlife Reserve Area

No.	Parameter	Correlation Value
1.	Soil moisture	+0,911
2.	Height	+0,364
3.	Soil pH	+0,126
4.	Temperature	-0,047
5.	Air humidity	-0,289
6.	Light intensity	-0,373

Description: + = Positive correlation (unidirectional); - = Negative correlation (opposite)

Based on Table 4, the results of the Pearson correlation analysis test between abiotic factors and diversity (H') have positive (+) and negative (-) correlation values. A positive value indicates a unidirectional relationship between the value of abiotic factors and diversity (H'), which means that the greater the value of abiotic factors, the greater the value of diversity (H'). A negative value indicates an inversely proportional relationship between abiotic factors and diversity (H'). The greater the value of abiotic factors, the smaller the value of diversity. If it is close to zero, it indicates that the two variables are not related to each other.

Table 4 shows the parameters classified as opposite, very low, low, and very strong correlations. Parameters classified as opposites include temperature, air humidity, and light intensity. A very low correlation includes soil pH, a low correlation includes height and a very strong correlation is soil moisture. The high correlation of soil moisture at the study site is thought to be because the research site has quite a lot of litter and is evenly distributed on the forest floor. The presence of litter can maintain the level of moisture in the soil because the water content in the soil does not directly experience evaporation into the air. Soil moisture is the amount of water stored in the soil [8].

4. Conclusion

Understorey obtained 2 divisions, Pteridophyta (10 species with 5 families) and Spermatophyta (31 species with 11 families). The family that has the highest number of species is Araceae as many as 16 species. The highest diversity index value is in location 4 with a value of 2,653 and the lowest is in location 1 with a value of 1,805. The highest uniformity index value is found at location 4 with a value of 0,901 and the lowest is at location 1 with a value of 0,703. The similarity index value between location 1 and locations 2, 3, and 4 is categorized as not similar. Location 2 with location 3 is categorized as not similar, while other locations are very unsimilar. The correlation value between abiotic factors and the diversity index has a unidirectional and opposite relationship.

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