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Vegetation compotition and structure of the pole community in the Girimanik natural forest area

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ABSTRACT

The pole is needed to increase ecological stability. This research analyzes the composition and structure of the pole community in the Girimanik Natural Forest Area, Setren Village, Slogohimo District, Wonogiri. The objective is to acquire a representative depiction of the pole community's structure and composition in this area. The research employed 25 plots, each measuring 10x10 m, covering a total area of 0.25 ha, strategically established in the region of the Girimanik Natural Forest Area. Data collection utilized the quadrat method. The findings revealed 41 species across 23 families, with a total basal area of 5.06 m². The species *Schima walichii* (DC.) Korth. and *Quercus sundaica* Rehder are the two most dominant species, exhibiting Important Value Indices of 40.41% and 37.33%, respectively. The Moraceae family encompasses the highest number of species, totaling five. The Diversity Index (H') for pole species in the Girimanik Natural Forest Area is categorized as moderate, with an H' value of 1. Conversely, the Dominance Index (C) is classified as high, with a value of 1.15. This study can be concluded that further research is needed to examine or find rare species of poles, so that more comprehensive conservation follow-up is needed for these rare species.

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INTRODUCTION

Forest areas are areas designated by the government whose function is to maintain their existence as permanent forests (Rahman et al., 2020). Natural Forest Area (KHA) is a forest area that has certain characteristics, functions as a protected area for the diversity of animals and their ecosystem, which has an important function for the area's life support system (Damanik et al., 2022). Natural forest areas consist of three types, namely National Parks, Nature Tourism Parks and Grand Forest Parks. These natural forest areas have ecological characteristics including 1) storage of genetic resources, 2) hydrology, 3) regulation of forest soil fertility and climate, 4) carbon storage (Sari et al., 2023).

Indonesia is home to over 30.000 species of the approximately 40.000 plant species globally (Kusuma & Suryani, 2017). Central Java features a Natural Forest Area, specifically in Girimanik, which serves as a natural tourism destination characterized by cool air and picturesque scenery. The Girimanik Natural Forest Area is situated in Setren Village, Slogohimo District, Wonogiri Regency, Central Java Province. Vegetation comprises various plant species coexisting in a certain locale, with interactions occurring among the components, including both flora and fauna inhabiting that area (Nuraida et al., 2022., Kusuma & Suryani, 2017). Vegetation as a whole plant from an area that functions as a land cover area consisting of several types, including 1) herbs, 2) weeds, 3) trees (Aryani & Riskawati, 2023). Vegetation also has a role as a regulator of carbon dioxide and oxygen balance, improving the physical, chemical, and biological properties of the soil, and regulating groundwater management (Nurika et al., 2019).

Within the scope of forest ecology, there are various compositions of forest components (Roziaty & Utomo, 2020). The various types of forest components are trees, poles, sampling, and seedlings. Poles are tree growths that have a at breast height diameter ranging from 10-20 cm and a circumference ranging from 31.4 – 62.8 cm (Paembonan, 2020). Poles are components in the natural forest ecosystem, which support ecological functions, including 1) forest regeneration, which ensures natural forest regeneration, 2) micro habitat provider, although smaller, poles still provide habitat for insects, small birds, and other animals. 3) nutrient retention, to help maintain soil nutrients through the cycle of leaf litter and small twigs (Ali & Wang, 2021).

Vegetation analysis in Indonesia has a diversity of planted vegetation (Roziaty & Pristiwi, 2020). Several studies have conducted research on vegetation analysis. For example, in the Tomohon District area, the kutu-kutu species (*Aphis gossypii)* type of pole community dominates the Irang forest area (Kawung et al., 2020). In the Kalimantan forest area of the Ecology Park area, Bogor Botanical Gardens, the majority of plants grow plants that can grow and develop in areas that have high soil temperatures and soil acidity levels. Meanwhile, the plants that dominate the forest area are the saray palm species (*Caryota mitis*) (Ahsan et al., 2021). Meanwhile, in the Nunukan Regency area, North Kalimantan, the red meranti plant (*Shorea leprosula*) is the type of pole that dominates the forest area (Thamrin et al., 2022).

The Girimanik Natural Forest Area, overseen by indigenous communities under Tahura KGPAA Mangkunagaro I, is now undergoing a transfer to Perhutani. Prior studies on vegetation in this region include saplings by Putri et al., (2025) and fern communities by Anggraeni & Sathyami, (2025); however, no research has been conducted to assess the variety of the pole community vegetation. Therefore, the purpose of this study was to determine the diversity of the pole community in the Girimanik Natural Forest Area, Setren Village, Slogohimo District, Wonigiri. This study is the first study related to the analysis of the vegetation of the pole community conducted in the Natural Forest Area. Analysis of species diversity data collected on a 0.25-hectare plot will be limited to forest representation with reference to relative abundance patterns, species richness, and family structure.

RESEARCH METHODS

Research Design

This research design used a plot of 25 plots with each size 10x10 m with a total area of 0.25 hectare developed purposively in the Girimanik Natural Forest Area. Data collection was carried out using the quadrat method (Mueller-Dombois & Ellenberg, 1974). The identification of pole species was conducted at the Biology Laboratory of the Faculty of Teacher Training and Education, Universitas Muhammadiyah Surakarta, utilizing identification references (Tjitrosoepomo & Press, 1985) and (Hyam, 2025).

Population and Samples

The population in this study was all the vegetation of the pole community in the Girimanik Natural Forest Area, Wonigiri Regency, Central Java Province. The sample in this study was the vegetation of the pole community in the plot in the Girimanik Natural Forest Area, Wonigiri Regency, Central Java Province that had been determined by the researcher (*Purposive Sampling*). Plot placement used the Purposive Sampling method, which is a data source sampling technique with certain considerations, so that the plots will be placed according to predetermined criteria. The plot criteria to be used are that cover the vegetation, must be homogeneous, and the density of the tree canopy must be dense (Mueller-Dombois & Ellenberg, 1974). Sampling was carried out in the Girimanik Natural Forest Area, Setren Village, Slogohimo District, Wonigiri Regency, Central Java Province. Wonigiri Regency is one of the regencies in Central Java Province, which is geographically located at 110°41'-111°18' East Longitude and 7°32'-8°15' South Latitude, and its natural conditions mostly consist of mountains. The Girimanik Natural Forest Area is included in the high mountain forest with an altitude of between 1200 m to 2500 m above sea level, with a map. The soil conditions in the Girimanik natural forest area are exceptionally fertile due to the presence of humus and adequate moisture content. The air temperature in this region is contingent upon altitude, resulting in significant variation among the plant species present. The Girimanik Natural Forest in Wonogiri regency has a temperature range of 22-26°C, soil moisture levels between 20–40%, air humidity of 91%, and a soil pH of 7.5-7.8 (Kusuma & Suryani, 2017). The Girimanik Natural Forest Area (NFA) encompasses 10.6 hectares. Wonogiri Regency is delineated by the following territorial boundaries: 1) West: Gunung Kidul Regency, 2) North: Sukoharjo and Karanganyar Regencies, 3) Eastern Region: Ponorogo and Magetan Regencies; 4) Southern Region: Pacitan Regency. Wonogiri Regency has an area of 190.432 Ha or 5.85% of the area of Central Java Province. Wonogiri Regency consists of 25 sub-districts, 43 sub-districts, and 251 villages. Wonogiri Regency is one of the five largest regencies in Central Java Province (Sari et al., 2023). The research location map can be seen in Figure 1.

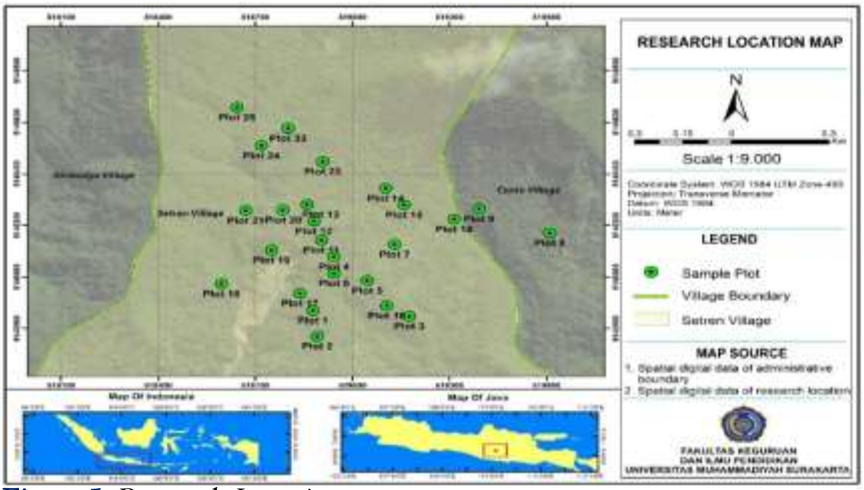

Figure 1. Research Location

Determination of the minimum area using the Species Area Curve (ASC). This method is used to ensure the adequacy of sample representation. The Species Area Curve (ASC) functions to show the representativeness system of the represented forest so that the vegetation analysis carried out can represent the forest being studied, and from the species area curve, the minimum plot area and the minimum area used can be determined (Mueller-Dombois & Ellenberg, 1974).

Instruments

This research, the indicators to be analysed are vegetation analysis, including density, frequency, dominance, Important Value Index, Diversity Index, and Dominance Index. The tools used in this study include raffia rope with a length of 10x10 m, complete stationery (1 set), meter roll (2 pieces), thermohygrometer (2 pieces), soil tester (2 pieces), pegs (4 pieces), hammer (1 piece), GPS (Global Positioning System) Essentials (1 piece), Google Earth Pro (1 piece), observation table (1 set), road board (1 piece), cutter (1 piece), spray paint (1 piece), G-Tik brand plastic sample bag measuring 11x17 cm (1 bundle), documentation tool (1 piece).

Procedures

This research has two stages in the research procedure, including the preparation stage and the implementation stage. The procedures of the research are shown in Figure 2.

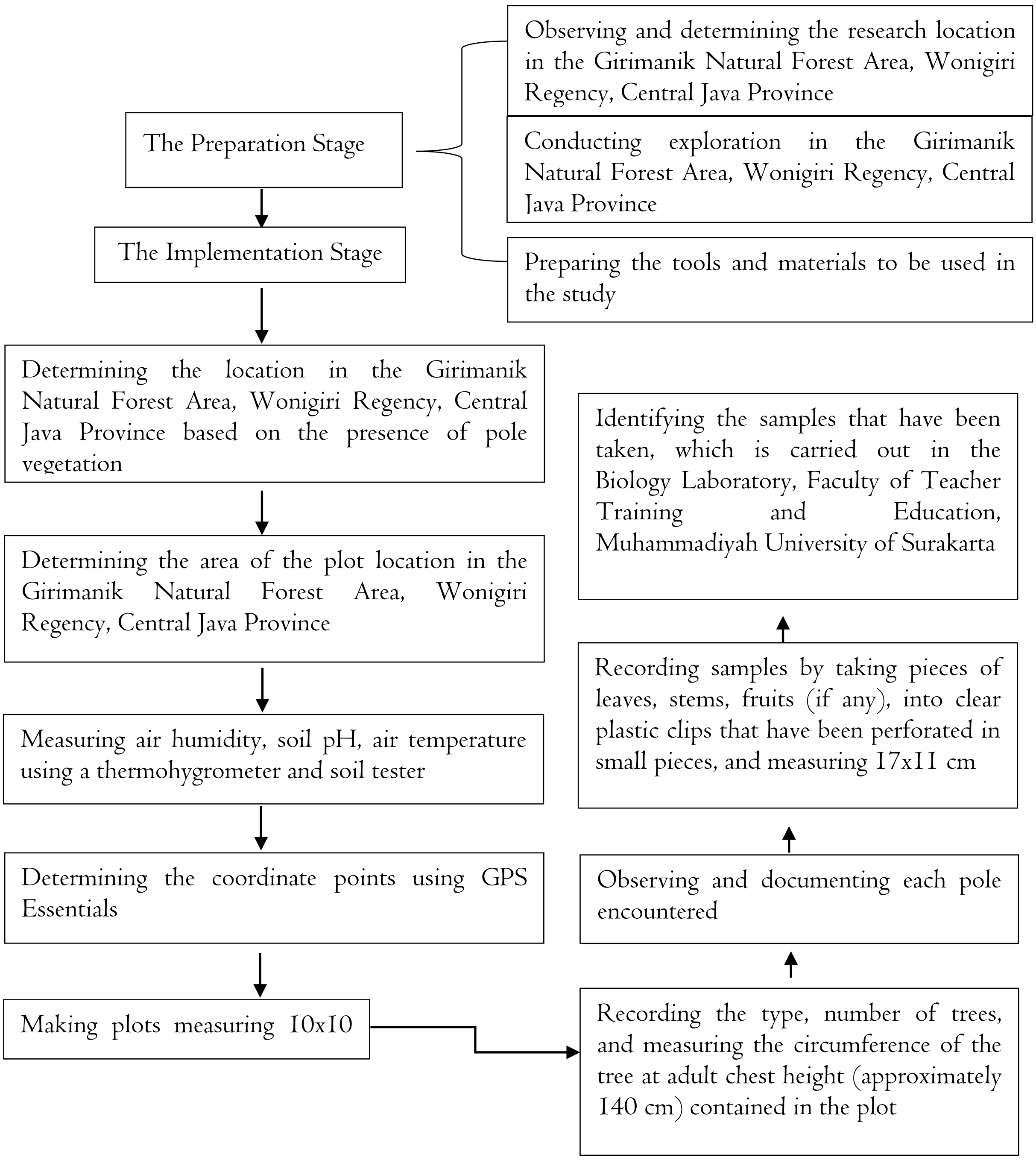

Figure 2. Research procedures.

Data Analysis

Total density, frequency, and dominance serve to quantify the significance of a species. These metrics are represented as relative values: Relative Density (RD), Relative Frequency (RP), and Relative Dominance (RDo) (Mueller-Dombois & Ellenberg, 1974). Subsequently, the Diversity Index (H') is computed according to (Shannon & Weaver, 1998), while the Dominance Index is derived from Simpson (1949).

RESULTS

Field data collected in the Girimanik Natural Forest Area, encompassing a plot of 0.25 hectares or 2.500 square meters, reveals the presence of 321 pole individuals from 41 distinct species. Each of the 14 species only has a density of one pole/0.25 ha (Figure 3).

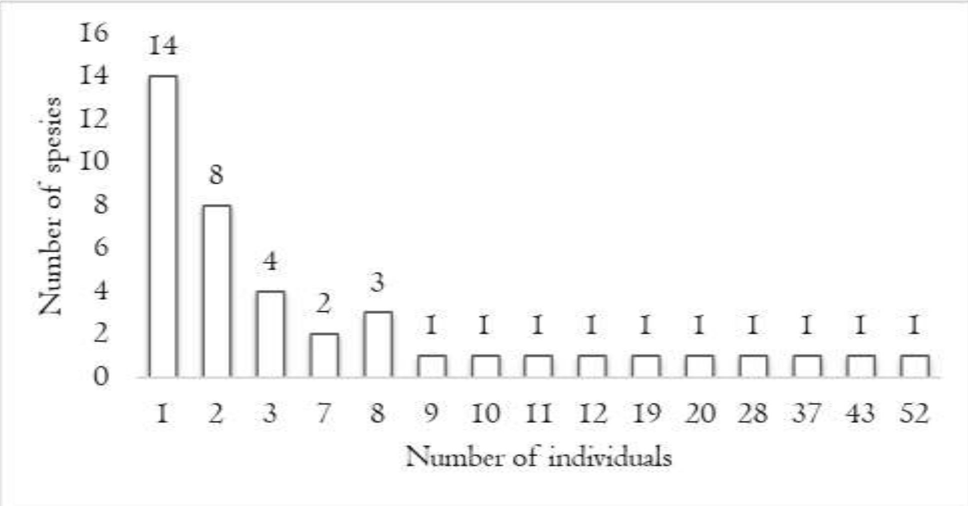

Figure 3. Number of species and number of individuals of the tiang community on an area of 0.25 ha in the Girimanik Natural Forest Area, Setren Village, Slogohimo District, Wonogiri

Table 1. The results of the study show that there are several species of poles found in the Girimanik Natural Forest Area. There are 41 species with a total of 23 families. The highest Importance Index value found is 40.41%.

Table 1. Pole Species Found in the Girimanik Natural Forest Area

No	Species	Family	RD (%)	RF (%)	RDo (%)	IV (%)
1	*Schima walichii* (DC.) Korth.	Theaceae	16.20	7.75	16.46	40.41
2	*Quercus sundaica* Rehder	Fagaceae	13.40	10.08	13.86	37.33
3	*Ficus padana* Burm.f.	Moraceae	11.53	6.20	12.30	30.03
4	*Pinanga coronata* Blume	Arecaceae	8.72	6.98	7.09	22.79
5	*Pygeum parviflorum* Craib	Rosaceae	6.23	6.98	6.09	19.30
6	*Antocarpus camansi* Blanco	Moraceae	5.92	4.65	6.26	16.83
7	*Ludwigia octovalvis* (Jacq.) P.H.Raven	Onagraceae	3.74	5.43	3.48	12.64
8	*Quercus lineata* Blume	Fagaceae	3.43	4.65	3.51	11.59
9	*Macropanax dispermus* (Blume) Kuntze	Araliaceae	3.12	5.43	2.59	11.13
10	*Cachosus altuans* L	Meliaceae	2.49	3.88	2.87	9.24
11	*Abelmoschus moschatus* Medik.	Malvaceae	2.80	2.33	2.99	8.12
12	*Saurauia bracteosa* DC.	Actinidiaceae	2.18	3.10	2.61	7.89

No	Species	Family	RD (%)	RF (%)	RDo (%)	IV (%)
13	*Macaranga gigantea* (Rchb.f. & Zoll.) Müll.Arg.	Euphorbiaceae	2.18	3.10	2.53	7.81
14	*Aglaia heptandra* Koord. & Valeton	Meliaceae	2.49	3.10	2.19	7.78
15	*Colona serratifolia* Cav.	Malvaceae	2.49	2.33	2.41	7.23
16	*Planchonia valida* (Blume) Blume	Lecythidaceae	0.93	1.55	0.91	3.40
17	*Aporosa villosa* (Lindl.) Baill	Phyllanthaceae	0.93	1.55	0.57	3.06
18	*Erythrina variegate* L.	Fabaceae	0.62	1.55	0.64	2.82
19	*Quercus lucida* (Roxb.) Rehd.	Fagaceae	0.62	1.55	0.53	2.71
20	*Endiandra* sp.	Lauraceae	0.62	1.55	0.52	2.70
21	*Caesalpinia bonducella* L.	Caesalpiniaceae	0.93	0.78	0.92	2.63
22	*Ficus fistulosa* Reinw. Ex Blume	Moraceae	0.93	0.78	0.66	2.37
23	*Breynia* sp.	Phyllanthaceae	0.62	0.78	0.79	2.19
24	*Dendrocnide stimulan* (L.f.) Chew	Urticaceae	0.62	0.78	0.71	2.11
25	*Tectona grandis* L.f.	Lamiaceae	0.62	0.78	0.63	2.03
26	*Phyllanthus urinaria* L.	Phyllanthaceae	0.62	0.78	0.61	2.01
27	*Dialium platysepalum* Baker	Fabaceae	0.62	0.78	0.53	1.92
28	*Eclipta prostata* (L.) L.	Asteraceae	0.31	0.78	0.53	1.62
29	*Ficus ribes* Reinw. Ex Blume	Moraceae	0.31	0.78	0.51	1.60
30	*Quercus gemelliflora* Blume	Fagaceae	0.31	0.78	0.50	1.58
31	*Pinus merkusii* Jungh. & de Vriese	Pinaceae	0.31	0.78	0.48	1.57
32	*Strychnos lucida* R.Br	Loganiaceae	0.31	0.78	0.43	1.52
33	*Macaranga tanarius* (L.) Müll.Arg.	Euphorbiaceae	0.31	0.78	0.40	1.48
34	*Falcataria moluccana* (L.) Greuter & R.Rankin	Fabaceae	0.31	0.78	0.31	1.39
35	*Syzygium polyanthum* (Wight) Walp.	Myrtaceae	0.31	0.78	0.31	1.39
36	*Calamus rotang* L.	Arecaceae	0.31	0.78	0.25	1.34
37	*Ficus uncinata* (King) Becc.	Moraceae	0.31	0.78	0.25	1.34
38	*Toona sinensis* (A.Juss.) M.Roem.	Meliaceae	0.31	0.78	0.23	1.32
39	*Vitex pinnata* L.	Lamiaceae	0.31	0.78	0.19	1.28
40	*Cinnamomum parthenoxylon* (Jack.) Meissn	Lauraceae	0.31	0.78	0.18	1.27
41	*Schleichera oleosa* (Lour.) Oken	Sapindaceae	0.31	0.78	0.16	1.25
	Total		100	100	100	300

The study was conducted in the Girimanik Natural Forest Area with measurements of the abiotic factors obtained, including temperature, humidity and soil pH. In general, the measured abiotic factors are in Table 2.

Table 2. Environmental Factors in the Girimanik Natural Forest Area

No	Abiotic Parameter	∑ Average
1	Air temperature	22-26° C
2	Air humidity	91%
3	Soil moisture	20-40%
4	Soil pH	7.5-7.8

The density, dominance, and distribution of species in the plots varied. Nine of the ten species with the highest densities were also the species with the highest frequencies, but were still in different orders (Table 3). *Quercus sundaica* Rehder had the highest density and the highest frequency.

Table 3. Ten species with the highest frequency (F), density (D), and basal area (BA)

Species Group	Species
a. Ten species with the highest density (number of trees/ha)	*Schima walichii* (DC.) Korth. (52), *Quercus sundaica* Rehder (43), *Ficus padana* Burm.f. (37), *Pinanga coronata* Blume (28), *Pygeum parviflorum* Craib (20), *Antocarpus camansi* Blanco (19), *Ludwigia octovalvis* (Jacq.) P.H.Raven (12), *Quercus lineata* Blume (11), *Macropanax dispermus* (Blume) Kuntze (10), *Colona serratifolia* Cav. (9)
b. Ten species with the highest frequency (%)	*Quercus sundaica* Rehder (0.52), *Schima walichii* (DC.) Korth. (0.4), *Pygeum parviflorum* Craib (0.36), *Pinanga coronata* Blume (0.36), *Ficus padana* Burm.f. (0.32), *Macropanax dispermus* (Blume) Kuntze (0.28), *Ludwigia octovalvis* (Jacq.) P.H.Raven (0.28), *Quercus lineata* Blume (0.24), *Antocarpus camansi* Blanco (0.24), *Cachosus altuans* L (0.2)
c. Ten species with the highest basal area (m^3)	*Schima walichii* (DC.) Korth. (0.83), *Quercus sundaica* Rehder (0.70), *Ficus padana* Burm.f. (0.62), *Pinanga coronata* Blume (0.36), *Antocarpus camansi* Blanco (0.32), *Pygeum parviflorum* Craib (0.31), *Quercus lineata* Blume (0.18), *Ludwigia octovalvis* (Jacq.) P.H.Raven (0.18), *Colona serratifolia* Cav. (0.15), *Cachosus altuans* L(0.15)
d. Ten species with the highest Importance Value (%)	*Schima walichii* (DC.) Korth. (40.41), *Quercus sundaica* Rehder (37.33), *Ficus padana* Burm.f. (30.03), *Pinanga coronata* Blume (22.79), *Pygeum parviflorum* Craib (19.30), *Antocarpus camansi* Blanco (16.83), *Ludwigia octovalvis* (Jacq.) P.H.Raven (12.64), *Quercus lineata* Blume (11.59), *Macropanax dispermus* (Blume) Kuntze (11.13), *Cachosus altuans* L (9.24)

The results of the vegetation analysis showed that the Girimanik Natural Forest Area has a Diversity Index (H') value of 1, which is categorized as moderate diversity and has a Dominance Index (C) value of 1.15, which is categorized as high dominance.

DISCUSSION

Field data collected from a 0.25 hectare patch in the Girimanik Natural Forest Area revealed the presence of 321 individuals within the pole community, encompassing 41 species and 23 families. The vegetation structure shows that there are 14 species that have very low densities because there is only one individual per 0.25 ha (Figure 2). In the pole community, its diversity has forest ecological conditions that are still experiencing adaptation or pressure on certain environmental factors. This can explain that there is competition between species that affects the distribution of individuals in the Girimanik Natural Forest Area. The structure of the forest community is influenced by ecological interactions such as competition for resources and abiotic factors such as air humidity and soil pH (Ali & Wang, 2021). Several species that have low densities indicate that there is a dominance of certain species that can adapt better (Sarintan et al., 2022).

The Importance Value Index (IV) is a metric utilized to indicate the dominance of a species within a plant community. The plant species with the highest index is the most dominant, so it can be concluded that the plant has a high level of control over a community (Sosilawaty et al., 2020). Table 1. shows that based on the research conducted, it was found that the species with the highest Importance Value Index (IV) were *Schima walichii* (DC.) Korth. and *Quercus sundaica* Rehder with values of 40.41% and 37.33%. These two species are the most dominant and have a major role in the surrounding ecosystem. *Schima walichii* (DC.) Korth. It is a species classified within the pioneer tree group, capable of rapid growth in environments characterized by high humidity and fertile soil. In addition, *Schima walichii* (DC.) Korth. has a wide range of abiotic tolerance to variations in soil water content and humidity, so that the species *Schima walichii* (DC.) Korth. more competitive than other species in similar ecosystems (Fardhani & Kisanuki, 2019). Wu et al., (2024) research also explains that the *Schima walichii* (DC.) Korth. has efficiency in terms of the availability of nutritional resources.

Alongside *Schima walichii* (DC.) Korth., the *Quercus sundaica* Rehder species exhibited significant dominance, evidenced by an Important Value Index (IV) of 37.33%. The *Quercus sundaica* Rehder species has a deep root system, which can allow better access to nutrients and water in the soil, which makes it more competitive with other species (Moler et al., 2022). In addition, research by Queiros et al. (2022) showed that *Quercus sundaica* Rehder has a high adaptation capacity to moderate to high soil moisture conditions, and its growth can grow in environments with moderate to high levels of sunlight, so it is often found in high mountain forest areas (Mahaqi & Ristanto, 2022). *Quercus sundaica* Rehder also has a great physiological capacity in regulating transpiration rates, which allows this *Quercus sundaica* Rehder species to survive in environments with high humidity (Yang et al., 2023).

Density is the number of individuals of a plant species in a certain area, or the number of stands of a plant species in a certain area. Based on the results of the study, the ten species with the highest density include *Schima walichii* (DC.) Korth. (52), *Quercus sundaica* Rehder (43), *Ficus padana* Burm.f. (37), *Pinanga coronata* Blume (28), *Pygeum parviflorum* Craib (20), *Antocarpus camansi* Blanco (19), *Ludwigia octovalvis* (Jacq.) P.H.Raven (12), *Quercus lineata* Blume (11), *Macropanax dispermus* (Blume) Kuntze (10), *Colona serratifolia* Cav. (9). These species also have the highest basal area. The total basal area for all individuals is 5.06 m². The species *Schima walichii* (DC.) Korth has the highest basal area, which is 0.83 m² (Table 3). Frequency is the probability of finding a plant species in all plots. The results of the study showed that the species with the highest frequency were *Quercus sundaica* Rehder, which was 0.52 and *Schima walichii* (DC.) Korth, which was 0.4. *Quercus sundaica* Rehder is a species that has better adaptability in mountainous areas such as lower temperatures and high humidity, making it possible to grow and develop in these habitats (Istomo & Armila, 2023). Meanwhile, the species *Schima walichii* (DC.) Korth has the highest frequency value after *Quercus sundaica* Rehder, because it has high ecological tolerance to various environmental conditions and soil types (Hilwan & Rahman, 2021), as well as its wide distribution at various altitudes ranging from 800-2,000 meters above sea level so that the wide distribution increases the discovery of *Schima walichii* (DC.) Korth (Sudarmonowati & Kartawinata, 2022).

The Girimanik Natural Forest Area has a Diversity Index (H') value of 1, where this value can be categorized as moderate diversity, while the Dominance Index (C) value is 1.15, which can be categorized as high dominance, indicating the ecology of tropical mountain forests with certain environmental pressures. The main factor that can cause moderate diversity is the limitation of natural regeneration due to several species that have high dominance, namely *Schima walichii* (DC.)

Korth., *Quercus sundaica* Rehder, and *Ficus padana* Burm.f., which can inhibit the growth of other species. This is in line with research Zhuang et al., (2020) which shows that in the Montane Forest ecosystem in stable environmental conditions but high resource competition, there are only a few species that can dominate the vegetation community. Among the three species (*Schima walichii* (DC.) Korth., *Quercus sundaica* Rehder, and *Ficus padana* Burm.f.), that have allelopathic content is the species *Schima walichii* (DC.) Korth. This species is an evergreen tree from the Theaceae family which is known to have various bioactive compounds. Methanol extract from the bark of *Schima walichii* (DC.) Korth. contains various secondary metabolites such as alkaloids, carbohydrates, glycosides, sterols, saponins, and tannins. Sterols were found as the most abundant component in the extract. The presence of these compounds indicates allelopathic potential because many secondary metabolites play a role in allelopathic interactions between plants (Lalthanpuii & Lalchhandama, 2024).

Other factors cause the Girimanik Natural Forest Area to have moderate diversity, because environmental pressures such as human activities that cause habitat damage can affect the moderate diversity index. This is in line with research by Ma et al. (2023), which shows that habitat damage due to human activities can reduce the level of species diversity by inhibiting natural regeneration. In addition, abiotic factors such as relatively neutral to alkaline soil pH in the range (7.5-7.8) and high air humidity (91%) can provide advantages to species that are more tolerant of relatively stable soil conditions that are more likely to cause a level of dominance of certain species that are more adaptive in resource competition, which can then increase the dominance of certain species (Edwards et al., 2024).

Natural disturbances such as forest fires can also affect the composition of vegetation in the Girimanik Natural Forest Area. During field observations, the Girimanik Natural Forest Area had experienced fire disturbances, and the local community even named the remains of the disturbance as "Kobongan". This is in line with research by Weiskopf et al. (2020), which shows that in the Motane Forest area with annual rainfall influenced by climate change, species that are more tolerant to changing environmental conditions tend to dominate. So that it can show that the Dominance Index (C) in the Girimanik Natural Forest Area is categorized as high dominance, where species that have stronger regional adaptation to certain environmental factors can dominate the vegetation community.

CONCLUSION

The investigation conducted in the Girimanik Natural Forest Area revealed the identification of 41 species across 23 families in thepole community. The plot used is 0.25 ha with a total basal area of 5.06 m². *Schima walichii* (DC.) Korth. and *Quercus sundaica* Rehder were the two most dominant species with values of 40.41% and 37.33%. The Diversity Index (H') value of the pole community in the Girimanik Natural Forest Area is 1, which can be categorized as moderate diversity, while the Dominance Index (C) value is 1.15 which is categorized as high dominance. Based on the conclusions mentioned above, the author has found the species of pole communities in the Girimanik Natural Forest Area, further research is recommended to examine or find rare pole species, so that more comprehensive conservation follow-up is needed for these rare species.

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