

Forest edge effects on medicinal plants diversity in lowland forest in Gunung Tilu, West Java, Indonesia

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Abstract. *Herlina N, Widhiono I, Proklamaningsih E, Sudiana E, Nasihin I, Nurdin. 2025. Forest edge effects on medicinal plants diversity in lowland forest in Gunung Tilu, West Java, Indonesia. Biodiversitas 26: 2873-2881.* Forest edge effect is an ecological phenomenon that affects diversity of medicinal plants in the border area between forest edge and the interior. Gunung Tilu in West Java, Indonesia, is a lowland forest area with abundant natural resource potential, but the surrounding communities often use various resources in the form of wood and non-wood forest products, specifically medicinal plants which might cause edge effect. This study aims to analyze the diversity of medicinal plants and determine the effect of forest edges on the diversity of medicinal plants on the northern slopes and western slopes in the Gunung Tilu forest area. Line transect method was used to collect medicinal plant data. Sampling was done by making plots to analyze the composition, dominant species, diversity index, evenness index, and community similarity index. Furthermore, environmental variables such as temperature, humidity, sunlight intensity and soil pH were analyzed using the Spearman correlation test. The results showed that there were 89 species of medicinal plants classified into 41 families. The families with the largest number of medicinal plants came from the Asteraceae and Moraceae families. On the western slope, the understory, seedling, pole, and tree levels did not experience significant composition at various distance, but at the sapling level, changes occurred at a distance of 260 meters. On the northern slope, there were different variations in edge depth at each growth level where in understory, seedlings, and saplings, the edge depth reached up to 260 meters, while at the pole level, changes occurred at a distance of 240 meters and trees at 120 meters. This shows that tree communities adapt more quickly to environmental condition in the forest compared to other stages.

Keywords: Biodiversity, edge effect, Gunung Tilu, lowland forest, medicinal plants

INTRODUCTION

Edge effects are the boundaries between forested and non-forested ecosystems or between two forests with different compositions or structures (Magrach et al. 2013; Supartono et al. 2016; Nascimento et al. 2019; Darsono et al. 2020). The existence of forest edge is caused by the discontinuity between two distinct environments (Otalora-Ardila and López-Arévalo 2021), which occurs as a result of abiotic and biotic changes at the boundaries of the two forest edges as well as between two adjacent ecosystems (Laurance et al. 2007). Edge effects can result in the alteration of physical gradients, species distribution, composition, and abundance (Faria et al. 2009; Haddad et al. 2015; Hao and Xiao 2020). Edge effects can also lead to various direct and indirect impacts on biota and alterations in microclimate between forest edge and interior (Brunialti et al. 2013; Hentz et al. 2017; Jankowski et al. 2021).

Previous studies have shown that forest edge effects significantly influence the structure and composition of biodiversity because the distribution of plant species and communities often occurs due to disturbance (Chabrierie et al. 2013; Pellissier et al. 2013; Govaert et al. 2020;

Franklin et al. 2021; Jin et al. 2021). Environmental factors play an important role in forest edge effect, including microclimates, such as humidity, light intensity, air pressure, and wind speed (Hentz et al. 2017; Jankowski et al. 2021). This will affect plant physiology, increase plant mortality and cause changes in the structure, composition, community dynamics and diversity of plants on the forest edge (Franklin et al. 2021; Pereira et al. 2021). Edge effects are the most important factor driving changes in plant communities (Seidl and Turner 2022) which certain species can respond more quickly or slowly to environmental changes (Yu et al. 2022).

Environmental changes occurring at the forest edge can have negative impacts on plants that are unable to survive (Du et al. 2025) and adapt to high light intensity or the presence of invasive species that can dominate the forest edge area, but on the other hand have a positive impact in increasing the abundance and richness of certain species (Cubino et al. 2024). Edge effects also contribute to soil quality degradation, loss of wildlife habitat, changes in animal migration patterns, and a decrease in the ability of forests to provide ecosystem services. The presence of disturbances in forest edge has led to growing awareness of

the importance of biodiversity and conservation since forest ecosystem that experiences disturbance due to humans and natural factors can change over time. To resolve the problems caused by edge effects in forest ecosystem, regional identification is needed to develop strategies to preserve genes, species, and ecosystems (Razafimahefa et al. 2022). Studies on plant species diversity and forest edge effects with various themes have been conducted, but the majority were carried out without comprehensive exploration (Astiani et al. 2018; Hofmeister et al. 2019).

Gunung Tilu forest area is known as one of the lowland mountains in Kuningan District, West Java Province, Indonesia. Some of the problems that occur around the Gunung Tilu forest area include the fact that the people around the Gunung Tilu forest do not yet know how much diversity there is in the types of medicinal plants, while the people continue to take medicinal plants on the edge of the forest, so that if this is left unchecked, it will cause local extinction. The existence of potential diversity, especially medicinal plants on Gunung Tilu, has not been fully published. Therefore, this study aims to analyze diversity of medicinal plants on the forest edge of Gunung Tilu and to investigate the effect of forest edge on the diversity of medicinal plants. The results of this study are expected to provide an in-depth understanding on forest ecology related to edge effect and to develop conservation measures and sustainable utilization of medicinal plants in the Gunung Tilu forest.

MATERIAL AND METHODS

Study area

This study was conducted in the Gunung Tilu forest area, which was administratively in Karangkencana and

Cibingbin Sub-districts, Kuningan District, West Java, Indonesia. The location is geographically located at 07°06'12.2" S and 108°41'47.7" E to 07°07'48.1" S and 108°41'39.0" E. Gunung Tilu has an altitude of 1,076 meters above sea level. The temperature ranges from 24°C to 28°C, with an average of around 25°C, humidity ranges from 81% to 91%, with an average of around 88%. The Gunung Tilu forest area is a secondary natural forest managed by Perum Perhutani KPH Kuningan (Figure 1).

Data collection procedure

Vegetation sampling was carried out by establishing transect line started from forest edge and then extending across the contour line. The initial point started along the transect line, shifting 20 meters to the right from the path boundary (Martin 2011) (Figure 2). From the starting point, observation plots were created, extending from forest edge into the interior. Medicinal plant data was collected using the mapped path method (Kusmana 2017) on the north and west slope of Gunung Tilu. Three transect lines were made on each slope with 15 plots created along each line, resulting in a total of 90 observation plots. Data were collected based on growth levels, which included understory, seedlings, saplings, poles, and trees. The size of the sample plots for collecting understory and seedling data was 2x2 m², saplings were 5x5 m², poles were 10x10 m², and trees were 20x20 m².

Variables were observed in the form of medicinal plant vegetation by counting the number of individuals, tree diameter, and tree height, as well as measuring environmental factors including temperature, humidity, and sunlight intensity as these factors play important role in changes in plant species and their diversity (Touarfia et al. 2021).

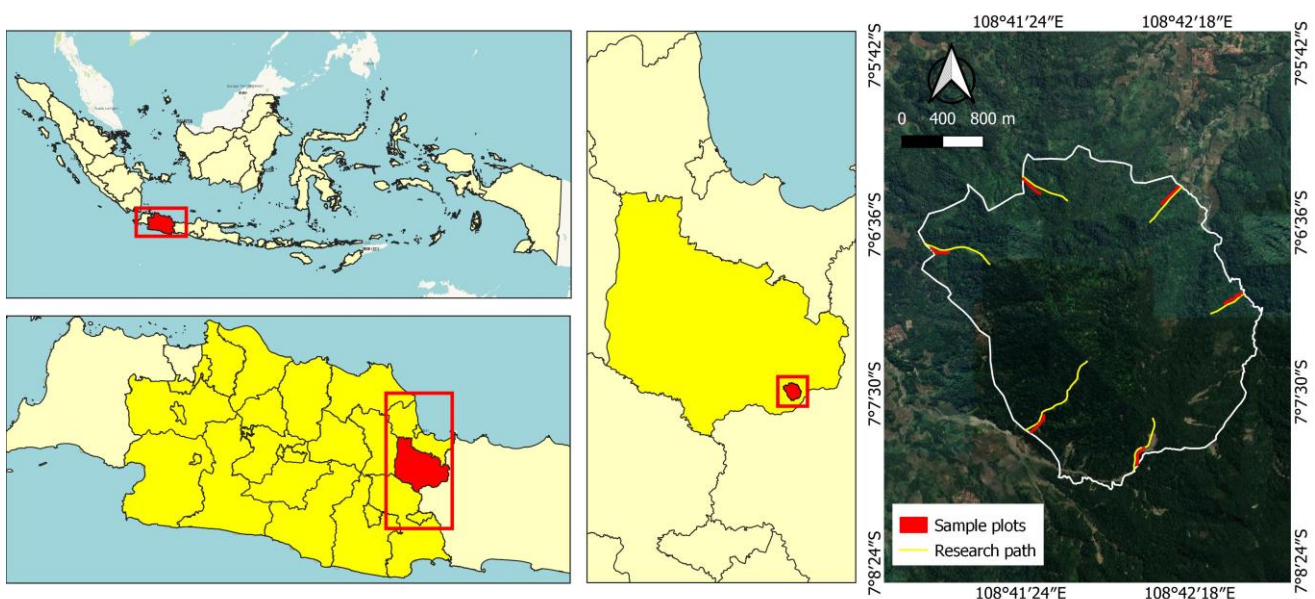


Figure 1. Map of study area and the sampling plots in Gunung Tilu forest, Kuningan District, West Java, Indonesia

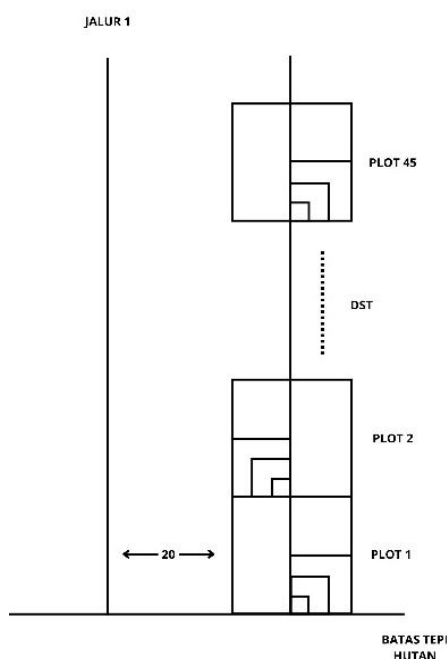


Figure 2. The diagram of observation plots for understory and seedling, sapling, pole, and tree

Data analysis

Diversity index

The Shannon-Wiener Diversity Index was used to analyze the diversity of medicinal plants. This index was calculated by the equation below following McCarthy and Magurran (2004):

$$H' = -\sum_{i=1}^S P_i \ln P_i; P_i = n_i/N$$

Where:

H' : Shannon-Wiener Diversity Index

P_i : Proportion of the number of individuals of type- i (n_i) to the total number of individuals (N)

S : Number of types

Vegetation species composition measured as Important Value Index (IVI) could provide an overview of the distribution, dominance, and abundance in an ecosystem. This parameter is expressed in absolute and relative values that included the species and relative density, frequency, and dominance calculated using the following formula (Kusmana 2017).

$$IVI_{\text{undergrowth, seedlings, saplings}} = RD + RF$$

$$IVI_{\text{poles, trees}} = RD + RF + RD$$

The basal area of a species is the sum of the basal area (LBDS) of each tree for a particular species and was calculated for each individual using the formula below.

$$Lbds = \frac{\pi D^2}{4}$$

Where:

D : Diameter value of an individual tree, while π was a constant with a value of 3.14

The Evenness Index is used to determine dominating species where low evenness value indicates the presence of a dominating species and vice versa. Evenness Index was calculated as follow:

$$E = \frac{H'}{\log S}$$

Where:

E : Species Evenness Index

H' : Shannon-Wiener Diversity Index

S : Number of species

The depth of the forest edge was analyzed based on the similarity between vegetation communities. The Morisita Horn Index compares the abundance of individuals per species and places more emphasis on the similarity of community structure based on the number of individuals of each species. This parameter was analyzed using the Morisita Horn Community Similarity Index with the formula used as follows:

$$M_{jk} = \frac{2 \sum_{i=1}^S X_{ij} X_{ik}}{\sum_{i=1}^S X_{ij}^2 + \sum_{i=1}^S X_{ik}^2}$$

Where:

M_{jk} : Morisita similarity index between the i -th and the k -th community

X_{ij} : Abundance of the i -th species in the j -th community

X_{ik} : Abundance of the i -th species in the k -th community

S : Total species encountered

Effect of forest edge on medicinal plants diversity

The results of environmental factor measurements were analyzed in the form of a partial Spearman correlation test using Statistical Package for the Social Sciences (SPSS) software calculations.

RESULTS AND DISCUSSION

Diversity of medicinal plants

This study documented 89 species of medicinal plants in Gunung Tilu forest that belong to 41 families. Families with the greatest number of medicinal plants found in Gunung Tilu were from the Asteraceae and Moraceae families. The Asteraceae family had high species diversity due to its high adaptation to broad range of climate, rainfall, and altitude (Jafarina and Jafarina 2019). Similarly, Moraceae family consist of tropical and subtropical plants that are found in many regions, ecosystem types and environmental conditions (Somashekhhar and Sonnad 2018).

The north slope had lower number of species with 69 species compared to the west slope with 71 species of medicinal plants. The high diversity of medicinal plants on the western and northern slope of Gunung Tilu suggests that the area is suitable habitat for medicinal plants which help the plants to grow and regenerate well (Zhang et al. 2020; Roswell et al. 2021). When a community has many species with no dominating ones, then diversity of the

community can be categorized as high (Yan et al. 2023). The highest number of individuals was found at the understory level (Table 1), showing that there was a combination of sufficient light at forest edge, high humidity, good nutrient cycles, adaptability, and low competition with trees. All of these influencing factors created an ideal environment for the growth and diversity of understory plants, making it a very rich vegetation level in the mountain ecosystem. The lowest number of individuals was at the pole level which could be caused by several factors including competition, transition phases in plant life cycle, less supportive environmental conditions, and even disturbances by humans. On the edge of Gunung Tilu forest, disturbances were noted as community collected wood and non-wood to meet their needs, besides

that community also took plants that have medicinal potential. All these factors contributed to high mortality rates and low numbers of individuals that could survive and grow to tree level. This was consistent with the results of the study by Esseen et al. (2016) which stated that the low mortality rate of plant species was caused by the vulnerability of the habitat to disturbances. Forest edge is an important habitat for various plant species that depend on certain microclimate conditions, such as humidity, temperature, and sunlight intensity (Meeussen et al. 2021).

The composition of dominant medicinal plant species in Gunung Tilu measured as Important Value Index (IVI) was presented in Tables 2 and 3. The IVI value of a species shows how dominant it is in the community.

Table 1. Number of medicinal plant species in Gunung Tilu, Kuningan District, West Java, Indonesia

Location	Habitus and growth stage									
	Understory plants		Seedlings		Saplings		Poles		Trees	
	No. of species	No. of individuals	No. of species	No. of individuals	No. of species	No. of individuals	No. of species	No. of individuals	No. of species	No. of individuals
Northern slope	28	653	25	183	31	119	21	61	27	115
Western slope	26	559	28	164	22	91	26	59	33	133

Table 2. The composition of five dominant medicinal plant species at the understorey seedling and sapling levels in Gunung Tilu, Kuningan District, West Java, Indonesia

Habitus	Local name	Scientific name	Family	RD	RF	IVI
Northern slope						
Understorey	<i>Cakar ayam</i>	<i>Selaginella doederleinii</i>	Selaginellace	13.80	9.20	22.94
	<i>Kayu rapet</i>	<i>Parameria laevigata</i>	Apocynaceae	9.49	9.22	18.65
	<i>Jukut pendul bodas</i>	<i>Cyperus kyllingia</i>	Cyperaceae	10.10	6.33	16.45
	<i>Harendong bulu</i>	<i>Clidemia hirta</i>	Melastomataceae	6.43	9.85	16.29
	<i>Binahong</i>	<i>Anredera cordifolia</i>	Basellaceae	7.96	7.74	15.71
Seedlings	<i>Simpur</i>	<i>Dillenia indica</i>	Dilleniaceae	8.19	12.00	20.20
	<i>Kopi liberika</i>	<i>Coffea liberica</i>	Rubiaceae	10.92	8.00	18.93
	<i>Dahu</i>	<i>Dracontomelon dao</i>	Anacardiaceae	9.28	9.23	18.62
	<i>Kemuning</i>	<i>Murraya paniculata</i>	Rutaceae	7.65	9.33	16.98
	<i>Buni</i>	<i>Antidesma bunius</i>	Phyllanthaceae	8.19	5.33	13.53
Saplings	<i>Simpur</i>	<i>Dillenia indica</i>	Dilleniaceae	10.92	10.93	21.86
	<i>Kondang</i>	<i>Ficus variegata</i>	Moraceae	8.40	9.37	17.78
	<i>Sintok</i>	<i>Cinnamomum sintoc</i>	Lauraceae	6.72	4.68	11.41
	<i>Nangka</i>	<i>Artocarpus heterophyllus</i>	Moraceae	8.40	7.81	16.22
	<i>Padali</i>	<i>Radermachera gigantea</i>	Angiospermae	5.88	4.68	10.57
Western slope						
Understorey	<i>Pungpulitan</i>	<i>Urena lobata</i>	Malvaceae	13.42	13.51	26.93
	<i>Karas Tulang</i>	<i>Choloranthus elatior</i>	Chlorantaceae	14.13	12.16	26.29
	<i>Palias</i>	<i>Pogonatherum crinitum</i>	Poaceae	8.41	9.45	17.86
	<i>Kayu rapet</i>	<i>Parameria laevigata</i>	Apocynaceae	9.30	8.10	17.41
	<i>Korejat</i>	<i>Isotoma longiflora</i>	Campanulacea	7.16	8.10	15.26
Seedlings	<i>Kopi liberika</i>	<i>Coffea liberica</i>	Rubiaceae	47.56	36.50	84.07
	<i>Caruy</i>	<i>Pterospermum javanicum</i>	Malvaceae	9.14	7.90	17.08
	<i>Cangcaratan</i>	<i>Nauclea subdita</i>	Rubiaceae	5.48	7.93	13.42
	<i>Kiteja</i>	<i>Cinnamomum iners</i>	Lauraceae	3.04	4.76	7.81
	<i>Dahu</i>	<i>Dracontomelon dao</i>	Anacardiaceae	4.26	3.17	7.44
Saplings	<i>Kopi liberika</i>	<i>Coffea liberica</i>	Rubiaceae	56.04	40.90	96.95
	<i>Dahu</i>	<i>Dracontomelon dao</i>	Anacardiaceae	5.49	6.81	12.31
	<i>Cangcaratan</i>	<i>Nauclea subdita</i>	Rubiaceae	4.39	4.54	8.94
	<i>Padali</i>	<i>Radermachera gigantea</i>	Angiospermae	7.29	4.54	7.84
	<i>Sulangkar</i>	<i>Leea indica</i>	Vitaceae	2.19	4.54	6.74

Table 3. The composition of five dominant medicinal plant species at the pole and tree level in Gunung Tilu, Kuningan District, West Java, Indonesia

Habitus	Species name	Scientific name	Family	RD	RF	RD	IVI
Northern slope							
Poles	<i>Lame</i>	<i>Alstonia scholaris</i>	Moraceae	11.47	11.47	1.36	24.31
	<i>Sulangkar</i>	<i>Flacourtia rukam</i>	Dilleniaceae	9.80	9.80	1.60	21.35
	<i>Beunying</i>	<i>Ficus fistulosa</i>	Moraceae	6.55	6.55	7.10	20.22
	<i>Dangdeur</i>	<i>Bombax ceiba</i>	Bombacaceae	1.63	1.63	12.77	16.05
	<i>Saninten</i>	<i>Castanopsis argentea</i>	Fabaceae	4.90	4.90	6.00	15.84
Trees	<i>Nangka</i>	<i>Artocarpus heterophyllus</i>	Moraceae	10.43	10.43	4.34	25.22
	<i>Benda</i>	<i>Artocarpus elasticus</i>	Moraceae	0.87	0.87	22.56	24.30
	<i>Simpur</i>	<i>Dillenia indica</i>	Dilleniaceae	9.57	9.57	2.43	21.56
	<i>Picung</i>	<i>Pangium edule</i>	Achariaceae	7.83	7.83	5.86	21.52
	<i>Malaka</i>	<i>Phyllanthus emblica</i>	Phyllanthaceae	7.83	7.83	1.22	16.88
Western slope							
Poles	<i>Kopi liberika</i>	<i>Coffea liberica</i>	Rubiaceae	49.15	49.15	4.92	103.23
	<i>Kihiang</i>	<i>Albizia procera</i>	Fabaceae	3.38	3.38	11.28	18.07
	<i>Kihampelas</i>	<i>Ficus ampelas</i>	Moraceae	5.08	5.08	4.82	15.00
	<i>Lame</i>	<i>Alstonia scholaris</i>	Apocynaceae	5.08	5.08	4.34	14.51
	<i>Huru bodas</i>	<i>Litsea umbellata</i>	Lauraceae	3.38	3.38	4.90	11.69
Trees	<i>Kopi liberika</i>	<i>Coffea liberica</i>	Rubiaceae	26.31	26.31	0.18	52.82
	<i>Keruing gunung</i>	<i>Dipterocarpus retusus</i>	Dipterocarpaceae	14.28	14.28	3.86	32.43
	<i>Dahu</i>	<i>Dracontomelon dao</i>	Anacardiaceae	7.51	7.51	6.39	21.44
	<i>Karaminan</i>	<i>Dysoxylum parasiticum</i>	Meliaceae	4.51	4.51	6.86	15.89
	<i>Saninten</i>	<i>Castanopsis argentea</i>	Fagaceae	3.75	3.75	4.50	12.02

The results showed that on the northern slope of Gunung Tilu, *cakar ayam* (*Selaginella doederleinii*) dominated the understory with IVI of 22.94%. This plant is commonly found along forest edges and can grow in various conditions. At the seedling and sapling levels, the plant with the highest IVI was *simpur* (*Dillenia indica*) with 20.2% and 21.86%, respectively. This finding is in line with Siahaan et al. (2022) who said that *simpur* adapts well to a broad range of environment, including along forest edges and near lakes, making it easy to grow. At the pole level, *lame* (*Alstonia scholaris*) had the highest IVI with 24.31%. It is a fast-growing species found throughout Indonesia and is considered a potential medicinal plant. The highest IVI at tree level was *nangka* (*Artocarpus heterophyllus*) with 25.22%. This plant could tolerate many environmental conditions, such as infertile soils and various climates, allowing *nangka* trees to survive and grow in many places. Many *nangka* trees were observed in the study area.

On the western slope of Gunung Tilu forest, *pungpulutan* (*Urena lobata*) had the highest IVI at the lower plant level, with 26.93%. This plant grew along forest edges. Gomes et al. (2022) stated that *U. lobata* commonly grow in open areas with lots of sunlight. Sunlight and soil fertility are crucial factors for lower plants along with temperature, air humidity, and soil chemistry (Driesen et al. 2020). At the seedling, sapling, pole, and tree levels, *kopi liberika* (*Coffea liberica*) had the highest IVI values with 96.95%, 103.23%, and 52.82%, respectively. Hendrayana et al. (2023) mentioned that local people living near the forest deliberately planted it. *Coffea liberica* had larger and wider leaves compared to *C. robusta* or *C. arabica*. It required good sunlight, fertile soil, and proper drainage to grow, and could be found in both lowlands and highlands, between 200 and 1200 m asl. The

high IVI indicated that these plants adapted well to the forest edge of Gunung Tilu which aligned with the studies by Razali et al. (2014) and Zaki et al. (2022).

Forest edge effects on medicinal plants diversity

The Shannon-Wiener Diversity Index (H') and Species Evenness Index of medicinal plants showed that species diversity on the north slope was higher at all growth stages. The largest diversity index was at the sapling level with 3.03 and trees with 3.00. This showed that the north slope had more diverse plants, especially larger ones like saplings and trees. On the north slope, more species grew and developed better than on the west slope, which was drier with more direct sunlight.

The study showed that medicinal plant diversity was higher at the forest edge than inside the forest. Open areas at the edge allowed more species to grow. This was similar to Hofmeister et al. (2019) who found that in Central Europe, plant diversity decreased from the forest edge to the interior. She et al. (2023) said that diversity was influenced by how species interacted with each other to maintain stability. Growth is affected by changes in the environment and ecological factors including climate, temperature, humidity, and how plants are distributed (Chang and Turner 2019; Zaki et al. 2022). Species diversity helped keep the forest stable and protected it from disturbances (Santhyami et al. 2024).

The Evenness Index (E) shows the spatial distribution or dispersion of a species in community. Based on the results, medicinal plants on the north and south slope had high evenness, meaning the species were evenly distributed or the number of individuals in each is relatively the same. High evenness is important to keep ecosystem sustainable and to maintain medicinal plant resources. Evenness index (E) values approaching one indicate that a community is

increasingly evenly distributed, whereas if the value approaches zero then the distribution is increasingly uneven (McCarthy and Magurran 2004).

The similarity of medicinal plant communities on the western and northern slopes has important ecological implications in understanding how medicinal plants adapt and are distributed in both areas. The depth of the forest edge of Gunung Tilu varies at each growth stage (Figure 3). On the western slope, medicinal plants at the understory, seedling, pole, and tree levels do not show significant differences at any distance, indicating that edge effects are not seen in this habitus. However, at the sapling level, edge depth is seen at a distance of 260 meters, where significant changes in community composition occur. On the northern slope, edge depth varies more depending on growth stage. At the understory, seedling, and sapling levels, edge depth is seen at a distance of 260 meters, indicating that up to that distance there is still an influence from the forest edge environment. Meanwhile, at the pole level, edge effects are seen up to a depth of 240 meters. At the tree level, the edge depth is closer, around 120 meters, meaning that the tree community changes more quickly from the edge to the forest compared to other growth stages. This difference may be caused by environmental factors such as light intensity, temperature, and humidity that play a role in determining the distribution of plant species at various growth stages.

The depth of the forest edge varies from place to place, but a research by da Silva and Schmitt (2015) suggests that the depth of the edge effect on the diversity of fern species in the Araucaria forest in Southern Brazil is up to a depth of 50 meters from the forest edge. Other studies, such as those proposed by Govaert et al. (2020) state that the influence of the edge on the understory plant community in the Mediterranean is stable at a distance of 500 meters from the forest edge and a research by Fardila and Sutomo (2011) suggests that in the protected forest area of Bukit Pohen in Bali, Indonesian, stability at the *rasamala* tree level is measured up to a depth of 40-50 meters from the forest edge.

Forest edge effects on environmental variables

Forest edges have a major impact on ecosystem changes, especially microclimate changes in edge areas that

affect temperature, humidity, and light availability (Pöppel and Seidl 2021). The average temperature, humidity, sunlight intensity, and soil pH are presented in Table 4.

The distance from the edge of the forest on Gunung Tilu has a significant effect on the intensity of sunlight and temperature (Table 5). This is because the condition of the edge of the forest has a canopy opening so that sunlight exposure is greater than to the interior area of the forest and there is little shade. The further into the forest the intensity of the sun decreases gradually because the canopy becomes denser which blocks more sunlight from reaching the forest floor. These results are in accordance with research by da Silva et al. (2021) which states that at the edge of the forest, sunlight exposure is much higher compared to the interior of the forest. Hayati et al. (2021) stated that an increase in sunlight can change plant structure, species composition, and plant productivity. Temperature conditions at the edge of Gunung Tilu forest show a significant effect on the distance from the edge of the forest and are classified as moderate temperatures. Moderate temperatures will affect the metabolic processes and composition of plant vegetation (Kusmana and Yentiana 2021). Temperature plays an important role in the diversity of medicinal plant species through its influence on growth, production of active compounds, and interactions with other environmental factors. According to Destaranti et al. (2017) plants need a temperature between 15-25°C to grow optimally, if the temperature is too high or too low it will cause the plant to die. Several studies have suggested that temperature is a mechanism that drives changes in forest edge areas (Tuff et al. 2016; Arroyo-Rodríguez et al. 2017). In addition, forest edges tend to be warmer, drier, and brighter than forest interiors (Saeed et al. 2019; Maua et al. 2020; Jones et al. 2021).

Table 4. Average temperature, humidity, light intensity, and soil pH in Gunung Tilu, Kuningan District, West Java, Indonesia

Location	Average			
	Temperature (°C)	Humidity (%)	Ligth intensity (Lux)	Soil pH
Northern slope	25.87	89.91	21.015.62	6.93
Western slope	24.31	86.87	14.493.71	7.01
Average	25.09	88.39	17.754.66	7

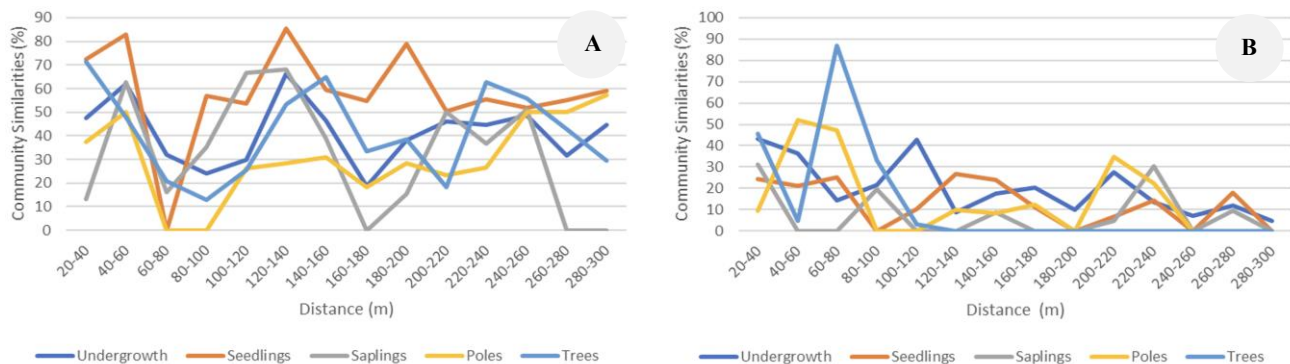


Figure 3. Plant community similarity at various distances from the forest edge in Gunung Tilu, Kuningan District, West Java, Indonesia. A. Western slope; B. Northern slope

Table 5. Correlation between the distance of the forest edge and the intensity of sunlight, temperature, humidity, and soil pH in Gunung Tilu, Kuningan District, West Java, Indonesia

Variable	Northern slope		Western slope	
	r	p	r	p
Intensity of sunlight	-0.386	0.009	-0.489	0.001
Temperature	-0.064	0.678	-0.668	0.000
Humidity	-0.430	0.003	0.540	0.000
Soil pH	0.271	0.072	-0.427	0.003

Distance from the forest edge significantly affects sunlight intensity, temperature, and species on both slopes of Gunung Tilu. Light intensity is higher at the edge of the forest and decreases towards the forest, due to increased shade from denser tree canopies in the forest (Astiani et al. 2018). In addition to sunlight intensity, temperature tends to decrease from the edge of the forest into the forest. In addition, distance affects the number of species, and the deeper into the forest, the number of species found decreases. Humidity increases with increasing distance from the edge of the forest inward, indicating that the environment inside the forest has higher humidity due to greater evaporation and more shade from tree canopies (Meeussen et al. 2021). However, the humidity factor on both slopes of Gunung Tilu shows that the effect of distance on the humidity factor is not significant and quite weak. This is due to the condition of the vegetation on the western slope and northern slope of Gunung Tilu in each observation plot there is a pattern of decline in some parts, and there is also an increase at certain distances.

In conclusion, there are 89 species of medicinal plants and 41 families in the Gunung Tilu forest. The diversity of medicinal plants on the northern slope tends to be higher at all growth levels, with the largest diversity index value at the sapling level of 3.03 and the tree level of 3.00, while on the western slope the largest diversity index value is at the tree level of 2.80. On the western slope, the edge effect is less visible at the understory, seedling, pole, and tree levels while at the sapling level, changes occurred at a distance of 260 meters, indicating that there is a limit to the influence of the forest edge on the plant community. On the other hand, the northern slope shows different variations in edge depth at each growth level. In understory, seedlings, and saplings, the edge depth reaches up to 260 meters, indicating that the edge effect still has an effect up to that distance. At the pole level, changes occur at a distance of 240 meters, while in trees, the edge effect limit is closer, which is around 120 meters. This shows that tree communities adapt more quickly to environmental conditions in the forest compared to other growth stages.

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