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Planting of Nectar Plants As Feed of Butterflies Imago in Bantimurung Bulusaraung National Park

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Bantimurung Bulusaraung National Park is a forest area designated as a conservation area in Sulawesi. The diversity of flora and the presence of unique wildlife supported by the karst ecosystem are the basis for the protection of thia area. Community presure and habitat destruction is the causes of decreasing butterfly populations. Habitat rehabilitation need to be carried out in order to maintain the butterfly population. The understanding of diversity of butterfly species and the selection of protective tree species and animal nests or food are important aspects for sustainablelity. Most of the types of forage plants are unknown species, so an understanding of planting methods in the field is needed. The research was conducted in observing the diversity of *Rhopalocera* (butterfly) species as a preliminary research and planting nectar-producing plants as the main research. Research result showed that *Nymphalidae* family is highest in species diversity index, *Nymphalidae* and *Papilionidae* family are highest in richness index, and all families are low in species dominance index and evenness index. *Nimphalidae* and *Papilionidae* family is the largest species has been found. Planting nectar plants i.e *mali-mali* and *dao* on degraded land with fertilization treatment showed the best results are 600 grams per planting hole for *mali-mali* and 900 grams per planting hole for *dao*.

Keywords: butterfly, diversity, planting, nectar plant,

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1. Introduction

Bantimurung Bulusaraung National Park is one of the forest locations in Sulawesi that the government has designated as a conservation area. The Bantimurung forest area is safeguarded due to the presence of unique *Rhopalocera* (Butterflies) wild animals and the diversity of flora, which is sustained by a karst ecosystem. Butterfly diversity is significantly influenced by ecosystems (Bahar, 2016). The achievement of three conservation targets, namely the maintenance of ecological processes that support life support systems, the maintenance of diversity of genetic resources and ecosystem types, and the regulation of the methods of utilising biological natural resources to ensure their sustainability, is closely correlated with the success of National Park management (Kadir et al., 2013). Nevertheless, the administration of a conservation area is not always successful. In nature, animal populations frequently undergo fluctuations.

The population of butterflies has experienced a decline as a result of habitat degradation caused by community pressure, area encroachment, and tourist activities. The ecosystem is disrupted by the use of conservation area land for rice fields and residences by local communities. One of the factors contributing to the reduction in diversity and the number of individual animals in a community is the devastation of habitats, which leads to a decrease in the number of food plants. To ensure that butterfly

populations remain in equilibrium with the carrying capacity of their habitat, it is necessary to implement habitat development and rehabilitation initiatives that involve the establishment of larval food plants and nectar food. The primary resource that sustains the existence of pollinating insects in Bantimurung Bulusaraung National Park is flower plants that produce nectar and pollen (Ngatimin et al., 2020).

The forest is rebuilt to its original state during the rehabilitation process. These circumstances facilitate the development of endemic animals. Consequently, the comprehension of endemic plant species is a critical component of successful rehabilitation. The butterfly will emigrate in search of a suitable habitat that can support its survival if the habitat components are not in alignment (Harlina, 2016). In addition to land degradation, the decrease in animal populations is a result of the sluggish regeneration of food plants, which has decreased the number of food plants. Development of habitat is a viable method for recovery. The diversity of food plants and host plants at all stages of growth, including undergrowth, saplings, poles, and trees, is closely correlated with the presence of a particular type of butterfly and its abundance in a given habitat. This is due to the fact that each stage of growth serves a unique purpose for butterflies, including serving as a source of food and a host tree for the laying of eggs and the development of the eggs into cocoons (Irni, 2017).

The Minister of Forestry of the Republic of Indonesia's Regulation Number 48 of 2014 mandates that habitat development is accomplished by planting or enriching species to enhance living spaces, food sources, nesting sites, and exploration sites by incorporating a variety of local native and/or endemic plants (Ministry of Forestry of the Republic of Indonesia 2014. It is impossible to disentangle the conservation aspects of butterfly habitat rehabilitation and development. It is crucial to select a plant that provides sustenance for animals or protects trees and nests. Certain varieties of food plants and specific parts of plants are necessary for the development of butterflies. The juvenile leaves are the organ of each plant type that butterfly larvae prefer to consume (Tambaru, 2015).

The survival of butterflies is influenced by the availability of suitable vegetation as a food source and a sanctuary (Lestari et al., 2018). Consequently, it is also crucial to comprehend certain aspects of the diversity of butterfly species and sustenance plants in a given region. Nevertheless, the majority of food plants are unidentified species, which is why it is imperative to comprehend the sowing methods in the context of rehabilitating degraded land. The objective of this research is to develop sylvicultural techniques for butterfly food plants. This is accomplished through two research stages: preliminary research, which involves observing species diversity to ascertain the types of plants that will be planted, and main research, which involves planting food plants to determine sylvicultural techniques.

2. Method

1) Research Area

A study was conducted to observe the diversity of butterflies in the Bangkesangkeang forest, specifically in the undisturbed hilly primary forest of Balocci Resort. Additionally, planting activities were carried out in the degraded area of Pattunuang Resort, which is located in the Bantimurung Bulusaraung National Park area. The research took place from January to December 2011.

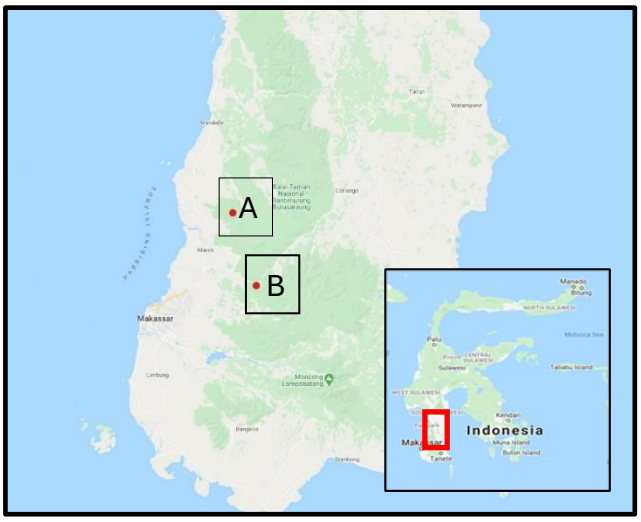


Figure 1. Map of research location: A. Location of observing butterfly diversity in Bangkesangkeang., B. Location of planting food plants in Pattunuang.

2) Material

The primary materials utilised in research endeavours comprise of seeds from nectar-producing plants such as *mali-mali* (*Leea indica*) and *dao (Dracontomelon dao)* found in the Bantimurung Bulusaraung National Park. Research instruments: (a) Tools for quantifying and documenting observations of plant diversity and growth, such as a measuring tape, writing utensils, and paper. (b) Tools for the cultivation and upkeep of plants, such as a hoe and a shovel.

3) Research Stages

The study was conducted in two distinct phases: an initial phase involved examining the variety of *Rhopalocera* (butterfly) species, while the main phase focused on planting nectar-producing plants. Butterfly species diversity was observed in primary forests to assess the population and variety of butterfly species in conservation zones and identify appropriate types of food plants for cultivation. The Pollard walk was employed as the observation method. Field observations were conducted along a preset transect path, which was separated into three sample stations. The contacts with butterflies were recorded, and the parameters measured included the type and number of butterflies. Observations were conducted in the morning from 08.00 to 12.00 WIB and in the afternoon from 14.00 to 16.00 WIB. The primary focus of the research entails the cultivation of nectar-producing plant species in areas that have been depleted or damaged. The study was conducted

using a randomized complete block design (RCBD) with 3 planting blocks and 4 treatments, specifically 0 as the control, and 300, 600, and 900 grammes of manure. The recommended spacing between each plant is 150 centimeters by 150 centimeters. The parameters measured were the plant's growth in terms of its height and stem diameter.

4) Data Analysis

The data obtained from observing butterfly species diversity were analysed using the Shannon-Wiener diversity index, *Margalef* species richness index, and Simpson dominance index. Additionally, the plant growth data obtained from planting trials were analysed using analysis of variance (ANOVA). If significant differences were found, Duncan's Multiple Distance Follow-up Test would be conducted. The abbreviation DMRT stands for "Doublesex and Mab-3 Related Transcription factor". According to Magurran (1988), the formula for calculating the Shannon Wiener diversity index, the *Margalef* species richness index, and the Simpson dominance index is as follows:

a) Shannon-Wienner Diversity Index:

$$H' = -\sum pi \ln pi$$

$$pi = \frac{n}{N}$$

Information: H' = Shannon-Wienner Diversity Index
ni = Number of individuals of type i
N = Number of Individuals of All Types.

b) Margalef type wealth index:

$$Dmg = \frac{S-1}{\ln(s)} X\ 100\%$$

Information: Dmg = Dominance index
S = Number of type found
N = Number of Individuals of All Types

c) Simpson's dominance index:

$$D = \sum pi^2 \text{ dimana } \frac{ni}{N}$$

Information: D = Dominance index
ni = Number of individuals of a type
N = Number of Individuals of All Types

d) Species evenness index

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

Information: H'= Shannon-Wienner Diversity Index
S = Number of type found

3. Result and Discussion

1) Butterfly Diversity

The observation findings indicated the presence of 35 distinct species of *Rhopalocera* at the observation site. There are 10 species belonging to the *Papilionidae* family, 16 species belonging to the *Nimphalidae* family, 7 species belonging to the *Pieridae* family, and 2 species belonging to the *Lycanidae* family. The butterflies exhibited high levels of activity in the observation plot, engaging in egg-laying behaviour and actively seeking floral nectar. Figure 1 displays a percentage diagram illustrating the distribution of members in the family. The most prevalent butterflies belong to the *Papilionidae* family, accounting for 47.10% of the total, followed by *Nymphalidae* at 34.62%. *Nimphalidae* is a butterfly family that has multiple host plants, each belonging to a different type of food plant. Sulistiyani et al. (2014) said that the *Nimphalidae* family of butterflies has polyphagous traits, meaning they have more than one type of larval feeding plant. *Euploea algea* is a polyphagous butterfly belonging to the *Nimphalidae* family. Its primary hostplant is Ficus, although the larvae of this butterfly also consume plant species from the *Streblus* genus. The presence of various food sources contributes to the thriving of the *Nimphalidae* family population. There are variations in the conditions within the *Papilionidae* family. The larvae of this particular butterfly species exhibit *monophagy*, meaning they exclusively consume a single type of food plant.

The *P. Peranthus* butterfly exclusively consumes the *Micromelum minutum* plant species. Decreasing the population of this particular plant species will lead to a decline in the population of *P. Peranthus* butterflies. The conservation of the larval food plants of the *Papilionidae* species at the observation site ensures the stability of the population of the *Papilionidae* family in its natural habitat. Additional study indicates the identification of the *Nimphalidae* family at various other observation sites. This species exhibits characteristics of a butterfly with a broad geographical range and strong ability to adapt to various environmental conditions and food sources. Contrarily, *Papilonidae* is sparsely distributed in multiple locations. The lack of *Papilionidae* feeding plants in that place could be the underlying cause of this ailment.

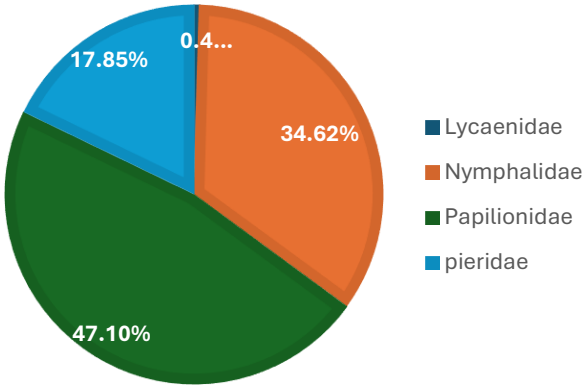


Figure 2. Percentage diagram of the number of individuals in the family

The number of species in a community is heavily influenced by the characteristics of the ecosystem. The *Margalef* species richness index ranges from 1.36 to 2.95 for several butterfly families. The *Nymphalidae* family has the highest species richness index score of 2.95, which is considered medium criterion. On the other hand, the *Lycanidae, Papilionidae,* and *Pieridae* families are classed as having low criteria. The presence of diverse plant species in primary forests provides an abundant food source for both larvae and adult butterflies.

Table 1.Displays the values for the species diversity index, species richness index, species dominance index, and butterfly species evenness index.

Famili	Amount	Dmg	H'	D	E
Lycanidae	2	1,44	0,69	0,50	1
Nymphalidae	16	2,95	1,94	0,21	0,70
Papilionidae	10	1,67	1,60	0,26	0,69
Pieridae	7	1,36	1,40	0,32	0,72

Source: Survey 2022

Additionally, the lack of ecological disturbances, such as butterfly capturing or alterations in regional habitat conditions, facilitates the distribution and growth of various butterfly species in the observed area. The encroachment on regions and tourism activities have a detrimental effect on the abundance of existing species due to the loss of food plants and alterations in environmental conditions. According to Ahmad (2006), the distribution of butterfly species is affected by the kind of habitat. The availability of food for both butterfly larvae and adult butterflies, along with the prevailing environmental conditions, are crucial determinants of butterfly presence in a given location. Environmental conditions and the availability of host plants play a significant role in determining the presence and survival of butterflies (Lestari et al., 2020).

The importance of animals in an ecosystem is determined not only by the diversity of species present, but also by the abundance of individuals within each species. The value is quantified using a diversity index that takes into account the number of species and the variability in the number of individuals within each species. The Shannon-Wiener diversity index indicates that the butterfly family at the observation location has varying levels of variety. *Nymphalidae, papilionidae,* and *Pieridae* exhibit the highest values, ranging from 1.60 to 1.94. This quantity indicates that the abundance of *Nymphalidae, Papilionidae,* and *Pieridae* butterflies in the community is considered to be moderate. The observation data indicate that the *Lycanidae* family has a low diversity index value. The habitat exhibits a harmonious equilibrium that facilitates the growth of *Nymphalidae*, *Papilionidae*, and *Pieridae* butterflies, while experiencing a moderate level of ecological strain. Ecosystem balance is the state that is influenced by the abundance of individuals within a species and the diversity of species present. Ecology is based on the notion of maintaining balance and harmony among all natural elements. Ecology categorises living organisms based on their specific functions. Every organism in the natural world plays a distinct function in establishing equilibrium and coherence within the ecosystem. It is crucial to preserve this equilibrium in order to ensure long-term viability and the uninterrupted circulation of energy within the ecosystem. (Effendi et al., 2018).

Ecosystem appropriateness determines the prevalence of a species and the degree of species evenness. The observations of the dominance index values within the family at the observation location revealed values ranging from 0.21 to 0.5. This number is categorised as low, indicating that there is no dominant species in the community. Having a low level of dominance does not imply an inability to effectively utilise environmental conditions or attributes for each kind. However, each type does have a distinct purpose and unique habitat conditions (Muhammad et al., 2018). In addition to dominance, the abundance of individuals per species in a specific habitat can be evaluated by considering the evenness of the species. The observed species evenness index value within the family ranged from 0.695 to 1. This figure reflects a high level of species evenness in the family, meaning that there is no significant difference in the number of individuals.

The Amarae woodland environment in Bantimurung Bulusaraung National Park is home to four families of Rhopalocera, which are *Lycanidae, Nymphalidae, Papilionidae*, and *Pieridae*. The *Nympahlidae* family, characterised by high species richness and diversity index values, as well as favourable evenness index values, is well-suited for breeding in diverse locales due to the abundance of food plants. *Papilionidae, Lycanidae,* and *Pieridae* are species that exhibit restricted distribution patterns as a result of their need on specific feeding plants. The population is influenced by the availability of food plants, favourable environmental conditions, and the absence of illicit fishing in the area. Based on the observation of family size, it is evident that the *P. Peranthus* species has the highest population among other species. *Micromellum minutum,* a plant species found in several areas of the Bantimurung Bubesaraung National Park, serves as the primary food source for the larvae of the *P. Peranthus* butterfly species. Due of its significant aesthetic and commercial worth, *P. Peranthus* has been subject to several illicit captures by individuals in various regions of Bantimurung.

2) Planting nectar producing plants

Planting occurred on land within the Bantimurung Bulusaraung National Park conservation area that had been degraded as a result of community activities involving the *dao (Draconto melondao) and mali mali (Leea Indica)* plant species. The imago of *Papilionidae* butterflies in Bantimurung Bulusaraung National Park rely on the nectar produced by these two plant species as a source of food (Suryanto, 2014). The choice of food plant species is determined by the abundance of butterfly populations and the ease of propagating planting material for these food plants.

a) *Mali-mali* (*Leea indica*)

This plant exhibits broad, toothed elliptical leaves and produces white flowers at the terminal ends of

its branches. Flowers of the *Mali-mali* plant emerge at the tip of each branch. Flowering characteristics are determined by the branch count of a single plant. The results of the variance test for the height and diameter of the branches with manure treatment at the 95% confidence level, as presented in Table 1, indicate that there are apparent differences in the average values for the height and diameter parameters. However, there is no significant difference observed in the number of branches produced.

Table 2. Indicator of various manure dosages for planting holes in *Leea indica* aged 24 months.

Source of diversity	High		Diameter		Number of Branches	
	Squared Mean	F. count	Squared Mean	F. count	Squared Mean	F. count
Fertilizer Dosage	3314,92	2,756**	101,577	11,880**	0,744	0,508ns
Block	2958,882	2,460ns	28,059	3,282**	70,475	48,175**
Galat	1202,773		8,550		1,463	

Information: * = Significantly different at the 5% test level
** = Very significantly different at the 5% test level
Ns = Not significantly different at the 5% level

The use of fertilisation therapy had a notable impact on the growth trajectory of *mali-mali* plants. However, it did not have any effect on the number of branches generated until the plants reached 24 months of age. The use of fertiliser has a significant impact on the development of plants. The drawbacks of use organic fertiliser include its relatively lower nutrient content compared to inorganic fertiliser and its characteristic of gradual release. Over the long run, the utilisation of organic fertiliser has a more favourable impact on soil and plant fertility and production compared to the usage of inorganic fertiliser (Kresnatita et al., 2013).

Table 3. Displays the results of Duncan's Multiple Range Test (DMRT) for the amount of manure applied per planting hole on *Leea indica* plants that are 24 months old.

Fertilizer Dosage	High (cm)	Diameter (mm)	Number of Branches
300	65,65 a	5,74 b	2,38 a
0	66,88 a	5,30 ab	2,46 a
900	68,08 a	4,17 a	2,52 a
600	83,82 b	7,98 c	2,72 a

Please note that values in columns with the same letter are not statistically different at a significance level of 5%, as determined using Duncan's multiple range test.

There were no notable variations in the number of branches observed across any treatment. The fertiliser dose of 600 grammes has the highest average number of branches, based on the computation. Shoot growth is mostly determined by factors unrelated to nutrition and is unaffected by the quantity of fertiliser applied. In their study, Susanto et al. (2018) asserted that enhancing plant development can be achieved by implementing a suitable silviculture system and carefully choosing trees with optimal genetic diameter. Genetic factors seem to play a role in the formation of plant branches. Fertilisation impacts the increase in plant height and diameter, yet the plant need a significant amount of time to utilise it.

Signs of healthy plant development include a well-proportioned height and diameter. Table 2 displays the results of Duncan's additional testing on plant height and diameter. The data reveals that using a fertiliser dose of 600 grammes per planting hole yields the highest average plant height of 83.82 cm and the highest average plant diameter of 7.98 mm. There was no significant difference observed in the outcomes between the control treatments of 300 grammes and 900 grammes. High doses do not appear to impact growth in the same way that low levels do. An ideal dosage of 600 grammes is required for plants to effectively absorb. Exceeding the recommended amount of organic fertiliser to plants would result in a decrease in crop output (Lutfhyrakhman, 2013).

b) *Dao* (*Dracontomelon dao*)

Dao is a ligneous shrub with broad elliptical leaves and spherical, clustered berries. This plant is distributed over multiple areas within the Bantimurung Bulusaraung National Park region. According to the study of variations in manure dosage presented in Table 3, the measurements of height and diameter of the experimental plants exhibited statistically significant differences at the 95% confidence level. The use of fertiliser in deteriorated soil areas had a notable impact on the height and diameter growth of *dao* plants for a period of 24 months. Applying manure guarantees the presence of essential nutrients, enhances the circulation of air, and promotes the efficient drainage of the growing medium (Sudomo, 2011).

Additional experiments were conducted to determine the optimal fertiliser treatment. Table 4 indicates that there is no significant difference in the average height and diameter between the control treatment and the treatment with 300 grammes of fertiliser. Applying a quantity of 300 grammes of fertiliser does not provide any impact on the growth and development of plants. These parameters suggest

that substantial quantities of nutrients are required for the process of growth and development.

Table 4. Presents the Characteristics of Different Amounts of Manure Used for Planting Holes in *Dracontomelon dao* That Has Been Aged for 24 Months.

Source of diversity	High		Diameter	
	Squared Mean	F. count	Squared Mean	F. count
Fertilizer Dosage	11687,576	35,675**	219,49	14,453**
Block	74645,425	157,837**	1488,756	98,032**
Galat	472,927		15,186	

Information: * = Significantly different at the 5% test level
** = Very significantly different at the 5% test level
Ns = Not significantly different at the 5% level

The application of fertiliser at a dosage of 900 grammes led to the plants achieving the highest average height of 69.17 cm and diameter of 10.57 mm. Nevertheless, the fertiliser treatment did not exhibit a statistically significant distinction compared to the fertiliser dosage of 600 grammes. These conditions indicate that a dosage of 900 grammes yields the most favourable outcome for plant growth, while using 600 grammes for planting holes produces more effective and efficient results. The provision of N nutrients from a 600 gramme dose of manure in the planting hole seems to be ideal for promoting plant growth.

Table 5. Presents the Results of Duncan's Multiple Range Test (DMRT) for the Amount of Manure Per Planting Hole Used in 24-Month-Old *Dracontomelon Dao* Trees.

Fertilizer Dosage	High (cm)	Diameter (mm)
0	36,71 a	7,45 a
300	33,96 a	7,57 a
600	60,75 b	10,22 b
900	69,17 b	10,57 b

Note: Values in columns followed by the same letter are not significantly different at the 5% level based on Duncan's multiple range test

4. Conclusion

The Bangkesangkeang woodland environment, located inside the Bantimurung Bulusaraung National Park, has four families of Rhopalocera (butterflies): *Lycanidae, Nymphalidae, Papilionidae,* and *Pieridae. The Nymphalidae* family exhibits moderate species richness and diversity index values. The families *Papilionidae* and *Pieridae* exhibit a relatively low species richness index, accompanied by moderate species diversity index values. The *Lycanidae* family exhibits a comparatively low species richness index and species diversity index. The species dominance index and evenness index for all families indicate a lack of dominance or low dominance values in the environment. The families *Nimphalidae* and *Papilionidae* have the highest number of species. The most effective therapy for the cultivation of *Papilionidae* butterflies in degraded environments involved planting *mali-mali* and *dao* as nectar food plants, together with the application of fertiliser. The optimal amount of fertiliser for planting holes was 600 grammes for *mali-mali* and 900 grammes for *dao*.

5. Completing Interests

The authors declare that there is no conflict of interest in doing this research.

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