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Correlation of Butterfly (Lepidoptera: Papillionoidea) With Flowering Plant In The Bodogol Nature Conservation Education Center, Mount Gede Pangrango

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Abstract

Butterflies are one type of insect that functions as a pollinator. Research on butterflies in the Bodogol Nature Conservation Education Area (PPKAB), has already been published, but research on the correlation of butterflies with flowering plants has yet to be published. This study aimed to determine the correlation between butterflies and blooming plants in the PPKB area. The research was conducted in February-June 2022 in heterogeneous and homogeneous forests. The research was conducted using a purposive sampling method. In each observation, 10 plots were observed in heterogeneous on 3 lanes (Rasamala, Canopi, and Aprika), and in homogeneous forest on 3 lanes (Cikaweini-Cipadaranten, and Gembong koneng). Research using cameras and insect nets. In this study, 78 species, 4 families with 261 individuals, were found in heterogeneous forests, and 39 species, 5 families with 158 individuals in homogeneous forests. Butterfly families: Papilionidae, Pieridae, Nymphalidae, Lycenidae, and Rionidae. The Nymphalidae family is one of the families with the highest number of species and individuals compared to other families. Based on the index value of butterfly diversity, it is classified as high (heterogeneous) and medium (homogeneous). High evenness index in both habitats. Jamides celeno is one of the dominant species in both habitats. Correlation analysis showed a strong relationship between flowering plants and the number of individual butterflies in both habitats (heterogeneous and homogeneous).

Keywords: bodogol, butterflies, correlation, , flowering plant

INTRODUCTION

Butterflies are a member of a group of insects that have a specific role in the ecosystem. In nature, butterflies can be found in various habitats such as forests, landscaping, agricultural, and urban areas. The butterfly's most familiar role is as a pollinator (Polinator) (Dylewski et al., 2019). Pollinators provide ecosystem services that are beneficial to many plant propagations. Because it has a valuable role in nature, butterfly

conservation efforts are essential in maintaining the stability of butterfly populations in nature (Wang et al., 2019).

The existence of various flowering plant vegetation is one of the main supporting factors for the existence of butterflies (Lin et al., 2021). Butterflies are attracted to flowering plants because of their color, size, aroma to the levels of nectar and pollen that flowers have (Mas'ud et al., 2019). One location that can act as a butterfly conservation site is the Bodogol Nature Conservation Center. The bodogol nature conservation education center (PPKAB) is one of the Tropical Rain Forests on Mount Gede Pangrango. The ecosystem type consists of various kinds of habitats such as heterogeneous forests and homogeneous forests, which are one of the conducive habitats for butterfly populations(Sigit et al., 2022).

Research on the diversity of PPKAB butterflies was conducted in 2011. This research was conducted by Ruslan (2012) in secondary, homogeneous habitats and agricultural land. Currently there is a decline in insect populations, including butterflies, due to environmental changes by expanding agricultural land (Habel et al., 2019). Habitat damage can also cause a decrease in butterfly populations (Azahra, 2012). Based on this, it is necessary to conduct further research to determine the correlation of butterflies in different habitats in PPKAB, Sukabumi, West Java.

METHOD

Time and Place of Research

The research was conducted in March 2022 – June 2022 in two locations, namely in heterogeneous forests and homogeneous forests in the Bodogol Nature Conservation Education Area, Sukabumi, West Java (Figure 1)

Figure 1. Research Location

Tools and Materials

The tools used in this research are, 4 in 1 environment tester, anemometer, luxmeter, camera (Figure attachment 1).

1. Butterfly observation

Butterfly observations were carried out using a purposive sampling method. At each observation, 10 plots were observed in the heterogeneous forest in 3 lanes (Rasamala, canopi, and aprika), and homogeneous in three lanes (Cikaweini, Cipadaranten, and gembong koneng) Appendix Figure 2. In each plot, observations were made 2 times with

an interval of 15 days. Observations were made at 08.00-12.00 WIB. Observation of butterflies using digital cameras and insect nets. The names of known butterfly species and their number were recorded at the time of observation. Observations of flowering plants were also carried out by observing the percentages in each observation plot.

2. Observation of environmental factors

Observed environmental factors such as: air temperature, humidity, light intensity, and wind speed.

Data Analysis

1. Butterfly Species Composition

Butterfly species data found during the study were recorded in the data tabulation. To determine the level of similarity of species composition between locations using the similarity index (IS) based on the formula (Magurran, 1988), as follows.

$$IS = \frac{2j}{a+b} \times 100\%$$

Information:

IS=similarity index

a = Number of species in habitat type

ab=Number of species in habitat type b

j=Number of species found in both habitat types

The criteria used to determine IS are, if the IS value is >50%, it indicates a similarity in species composition between habitats, while the IS value is <50%, indicating a difference in species composition between habitats.

2. Butterfly Species Diversity Index

$$H' = - \Sigma Pi \ln Pi$$

Information:

H= Shannon-Wiener Diversity Index

Pi=Proportion of species abundance

ni= Number of individuals i

N=Total number of individuals

The criteria for the value of the species diversity index based on the Shannon-Wiener are as follows.

NilaiH" 1,5	: Low diversity
Nilai H >1,5 ± 3,5	: Medium diversity
NilaiH>3,5	: High diversity

3. Butterfly Species Evenness Index

The evenness of butterfly species in a habitat can be calculated using the species evenness index formula according to Magurran (1988), with the following formula.

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

Information:

H'=Shannon-Wiener Diversity Index

S=Number of species found (species richness)

If the value of the evenness index of species is close to one, it indicates that the butterfly species in a habitat are more evenly distributed and if the value of the evenness index is close to zero, it indicates that there is an inequality of butterfly species in a location.

4. Abundance value (RA), The alue of the Relative Frequency (RF)

The Relative Abundance value (RA) was determined using the formula (Fachrul,2012)

$$RA = \frac{\text{Number of individuals of a Species}}{\text{Number of individuals of all species}} \text{ x } 100\%$$

The value of the Relative Frequency (RF) is determined using the formula,

$$RF = \frac{\text{Individual frequency of a species}}{\text{The total frequency of all types}} \text{ x } 100\%$$

The Butterfly Important Value Index is obtained by the formula,

$$IVI = RA + RF$$

5. Correlation of the number of butterflies and the percentage of flower plants

The correlation coefficient measures the strength and direction of the linear relationship of two variables. To calculate the correlation used using the Microsoft Excel application with the formula.

=PEARSON (row 1 of variable 1 is clicked to the last row; row 1 of variable 2 is clicked to the last row)

Pearson correlation value (-1 to 1)

The closer to 1, the stronger the relationship between variables

The closer to -1, the weaker the relationship between variables

Criteria for the relationship between two variables (Sugiyono 2017)

0	: No correlation
0.00-0.25	: Very weak correlation
0.25-0.50	: Correlation is sufficient
0.50-0.75	: Strong correlation
0.75-0.99	: Very strong correlation
1	: Perfect correlation

RESULT

Based on the data obtained in heterogeneous habitat area found 78 species from 261 individuals, in homogeneous habitat found 39 species from 158 individuals (Figure 1) belonging to 5 families, namely Lycaenidae, Nymphalidae, Papilionidae, Pieridae, and Rionidae (Table 1).

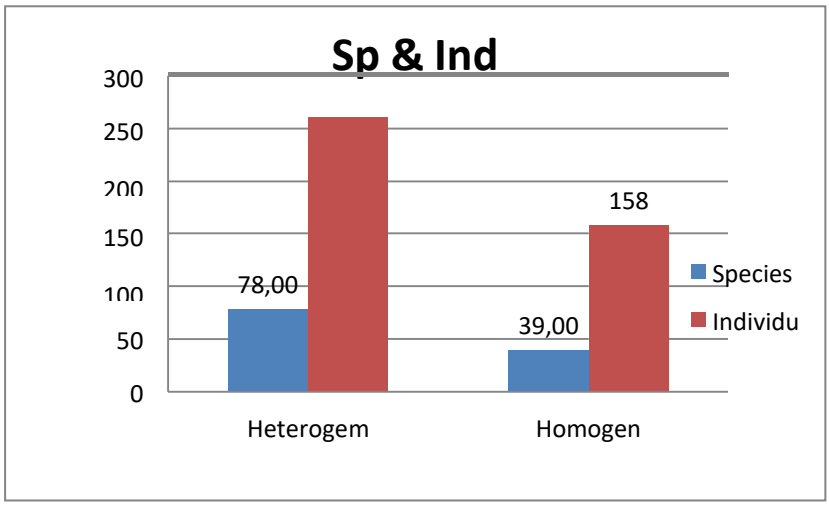

Figure 1. Comparison of the number of species and individuals in the two habitats

Table 1. Number of Species (S) and Individi (I) Family Butterfly that is found in 2 habitats at PPKA Bodogol area

	Hutan Heterogen		Hutan Homogen	
	S	I	S	I
Lycaenidae	17	62	9	47
Nymphalidae	43	141	19	89
Papilionidae	3	15	7	10
Pieridae	13	43	4	12
Rionidae	0	0	1	1

From the data obtained in this study it was found that there was a decrease in the number of species and the number of individual butterflies at the Bodogol PPKA location

when compared to previous observational data conducted by Ruslan (2012). However, the number of families in this observation was more than Ruslan (2012) who only found families.

Based on the number of species and individuals per family, the highest number of species and individuals were in the families Nymphalidae, Papilionidae, Pieridae, Lycaenidae and Rionidae, while the lowest was in the family Rionidae (Table 1).

Based on the data obtained in Heterogen and Homogen forest, it is known that the butterfly diversity index in Heterogen forest is not significantly different from the butterfly diversity index in Homogen forest. The diversity index (H') in Heterogen forest is 3.9 which is classified as High, while the diversity index (H') in Homogen forest is 3.2 which is in the moderate category.

The evenness index value found in the Heterogen habitat was 0.9 which was included in the high category. Likewise, the evenness index value found in Homogen forest showed a high value of 0.8.

The butterfly dominance index obtained from the sum of relative abundance and relative frequency in heterogeneous forests is *Jamides celeno, Ypthima baldus, Ypthima pandocus,* and *Eurema hecabe.* In the homogeneous forest are *Jamides celeno, Mycalesis janardana, Mycalesis moorei* and *Faunis canens* (Table 2)

Table 2. Species with the highest individual abundance in heterogen florests and homogen

Heterogen	Homogen
Jamides celeno	*Jamides celeno*
Eurema hecabe	*Mycalesis janardana*
Ypthima baldus	*Mycalesis moorei*
Ypthima pandocus	*Faunis canens*

The correlation between butterflies and flowering plants in heterogen forest can be seen in graph 1 as follows. In opened habitat, a strong correlation was found (R = 0.58) between flowering plants and butterflies.

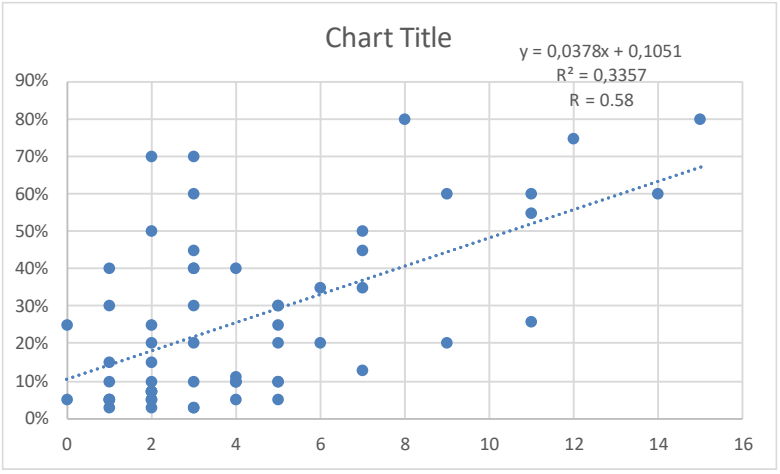

Figure 2. R value of the correlation between butterflies and percentage flowering plants in heterogen forest

The correlation between butterflies and flowering plants in homogen forest can be seen in graph 2 as follows. In homogen forest, a strong correlation was found (R = 0.58) between flowering plants and butterflies.

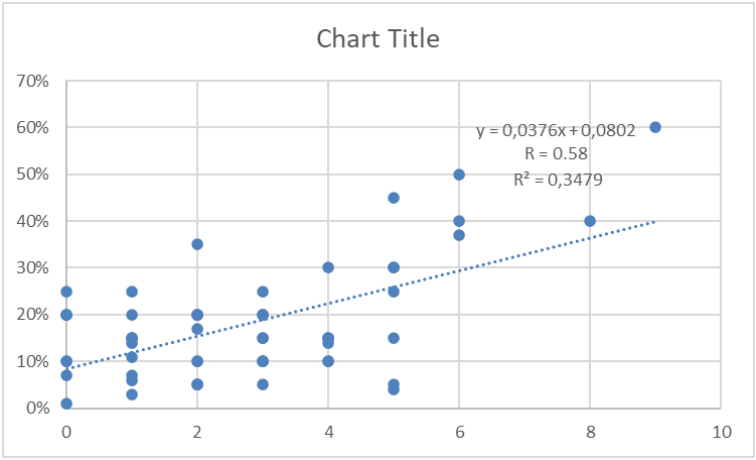

Figure 3. R value of the correlation between butterflies and percentage flowering plants in homogen forest

DISCUSSION

We found 78 species, and 261 individuals in heterogeneous forest which was higher than that found in homogeneous forest (39 species, 158 individuals in homogeneous forest). Heterogeneous forests have more varied vegetation than homogeneous forest habitats. Vu *et al.*, (2015), stated that homogeneous forest is a type of habitat that has limited butterfly diversity due to the low diversity of plants in this habitat. in heterogeneous forests there is a higher light intensity than in homogeneous forests (Appendix Table 5). In general, butterflies prefer higher light intensity for activities (Lestari et al., 2018).

From the data obtained in this study it was found that there was a decrease in the number of species and the number of individual butterflies at the PPKA Bodogol location when compared to previous observational data conducted by Ruslan (2012), the number of species found in heterogeneous forests was 104 species with a total of 1221 individuals. In

a homogeneous forest, the number of species found was 88 with a total of 133 individuals. The decrease in the number of species and changes in the abundance of individual butterflies (Table 2) found were thought to be influenced by several factors such as habitat conversion which is also associated with anthropogenic disturbance (Doré et al., 2021). Based on observations made at the research location, it is known that parts of the Bodogol PPKA area have started to function as locations related to human activities such as tourist attractions.In addition, the existence of a pandemic is thought to have influenced the presence of butterflies in an area. The pandemic has triggered a lot of spraying of disinfectants on the environment, which of course affects 2 trophic levels, namely plants that act as feed and host plants and the butterflies that use these plants (Choudhary & Chishty, 2020).

The Nymphalidae family was found with the highest number of species and individuals in each heterogeneous and homogeneous forest (Figure 1). Meanwhile, the family with the lowest number of species and individuals was found, namely the Rionidae family. The existence of butterflies from the Nymphalidae family was found in the greatest number, because the Nymphalidae family is one of the tribes with the most number of species in the Lepidoptera Order, making it possible to find them in large numbers in nature (Claridge, 1991). The Nymphalidae family was found in the highest numbers, this could be due to the presence of vegetation consisting of many flowering plants (a food resource for flowers) and food plants for larvae (Lestari et al., 2018).

Based on the data obtained, the diversity index (H') in heterogeneous forests is classified as high and in homogeneous forests is moderate. The results of the Hutchinson test for the diversity of butterfly species in the two habitats showed that the differences were not significant. The evenness index value of butterflies found in heterogeneous forest habitats was 0.9, and 0.8 in homogeneous forest habitats. The value obtained shows that the species evenness value is close to 1. According to Fachrul (2012) if the species evenness value is greater, then the distribution of the butterfly species is even. The high value of the evenness index of butterflies in these two habitats indicates that there is no dominance of certain butterfly species (Tarihoran, 2020).

Butterfly domination based on relative abundance (KR), relative frequency (FR) and important value index (INP) of butterflies found in heterogeneous forests was found in the species Jamides celeno, Ypthima baldus, Ypthima pandocus. Eurema hecabe (Table 2). In homogeneous forests, the abundance and frequency found to be high were *Jamides celeno M. janardana*, *M. moorei*, *Faunis canen* (Table 2). *Jamides celeno* is the species with the highest abundance in both heterogeneous and homogeneous habitats. Jamides celeno is a species belonging to the family Lycaenidae. Apart from the existence of Hostplants and Foodplants, the presence of many Lycaenidae species can also be caused by their high adaptability and ease of breeding in both habitats (Nurjanah, 2021). Based on previous publications, there are several plants that serve as host plants for this species, including Abrus precatorius, Cajanus albicans, Butea monosperma, Phaseolus adenanthus, Pongamia pinnata, Saraca asoca, Xylia xylocarpa, Heynea trijuga, Trichilia hirta, Trichilia triuga, Elettaria cardomum (ifoundbutterflies, 2022) which are suspected to exist in the research area

In heterogeneous and homogeneous forests, a strong correlation (R = 0.58) was found between flowering plants and individual butterflies (Figures 2 and 3). There was a strong relationship in both habitats with the number of individual butterflies and flowering plants because of their close proximity. The distribution and abundance of butterflies in a habitat

can be affected by the distribution and abundance of host plants and their food (Islam et al., 2015; Subedi et al., 2020). Based on their function, flowering plants are one of the main attractants for butterfly imagos to come and visit (Irsa et al., 2022) Flowering plants provide food in the form of nectar and pollen, so their presence can be correlated with the presence of butterflies as found in heterogeneous forests (r = 0.58) and homogeneous forests (r = 0.58). Each flower has a different architecture that provides rewards for those who visit it, in the form of nectar and pollen (Martínez-Adriano et al., 2018). Some flowering plants have special interactions with certain butterfly species known as specialists, as was found in the interaction that occurred between Jamides celeno and Antigonon flowers (Rani & Raju, 2016). While some other types of flowers can be visited by various types of butterflies.

The similarity of the correlation values in the two habitats is thought to have the same function as flowering vegetation, namely attracting butterflies. However, the types and composition of butterflies that come to each habitat are not necessarily the same. Thus, further studies or publications regarding the specifications of butterflies found in each habitat and their interactions with their host plant species can be an interesting study. Other factors that can attract the existence of butterflies to be present in each habitat are abiotic factors such as wind and sunlight intensity (Irsa *et al*. 2022), close distances between locations, or contours of vegetation that are conducive to shelter from predators (Handayani & Rahayuningsih, 2022).

CONCLUSION

Based on the results of the research that has been done, it can be concluded that Butterflies in the Cibubur Arboretum City Forest area, found 45 species, 4 families with 232 individuals. The butterfly families: Papilionidae, Pieridae, Nymphalidae, and Lycenidae. The Nymphalidae family is one of the largest families with the number of species, and the largest number of individuals compared to other families. The butterfly diversity index is moderate, with a high evenness index. The species *Leptosianina* was found in the highest number of individuals. Butterflies found in opened habitats were higher in the number of species and individuals, and the interaction of butterflies with flowering plants had a strong relationship in the two habitats. Flowering plants found in open habitats include *Asystasiagangetica*, *Emilia sanchofolia*, *Synedrella sp*., *Kyllinga sp*., and *Mimosa pudica*. *Asystasyagangetica* plants are mostly used by butterflies as a food source. Abiotic data (light intensity) in open habitats was higher than in closed habitats. Further research is needed on the effect of flowering period on the abundance of butterflies in the rainy and dry seasons.

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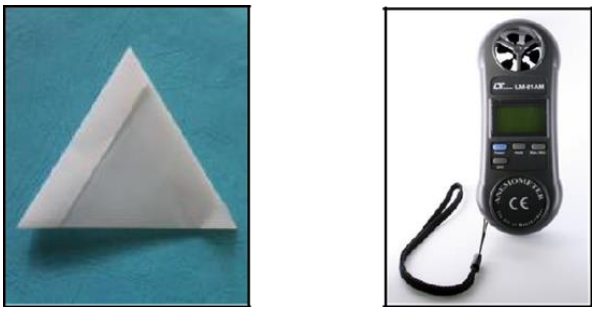
Appendix:

a. digital camera b. sweeping net c. GPS



d. papilot paper e. 4 in 1 environment tester

Figure 1. Research instrument

Rasamala Cikaweini

Canopi Cipadaranten

Aprika **Gembong Koneng**

Figure 2. Observation plots in heterogen and homogen forests

Table 1. The average value of abiotic factors at two location

Faktor abiotik	Heterogen	Homogen
Angin (m/detik)	0,22	0,23
Cahaya (lux)	6530	2839
Kelembaban (%)	74,3	79,21
Suhu (°C)	25,90	25,31