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Interaction of Butterfly (Lepidoptera: Papillionoidea) and Flowering Plants in The Forest Area of The Cibubur Arboretum Jakarta

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Abstract

Butterfly observation research in the Arboretum City Forest area has been widely known, but research related to interaction of butterflies and flowering plants is still scarce. The Aim of this study was to determined the interaction of butterflies and flowering plants in the Cibubur Arboretum City Forest area. We found 45 species, 4 families with 232 individuals, which consists of four butterfly families, includingPapilionidae, Pieridae, Nymphalidae, and Lycenidae. The results of this study are different from the results ofresearch conducted in 2014. We found that the number of individuals and species are decreased. Based on the diversity index value in 2014, and current situation,has a similar moderate category diversity index. This can be due to the presence of the same feed plants and host plants in this area. Several types of flowering plants were found at the research site: *Asystasiagangetica*, *Emilia sanchofolia*, *Synedrella* sp., *Kyllinga*sp., and *Mimosa pudica*. There are some of the same plants found in both opened and closed habitats such as*Polyalthialongifolia*, *Diffenbachiaseguine*, *Cecropianpeltata*, *Parkiaspeciosa* , and *Swieteniamahagoni*. The butterfly species *Leptosianina* is one of the species found in high numbers in the Arboretum City Forest area, due to the many host plants found in this area. The correlation analysis showed a strong relationship between flowering plants and the number of individual butterflies in both habitats (opened and closed). The *Asystasyagangetica* plant is widely used by butterflies as a food source

Keyword: Arboretum, butterflies, flowering plant, interaction.

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INTRODUCTION

Butterflies belong to the order Lepidopteraare easily recognized by the presence of fine scales on the wings and body surface. Butterflies are known as cosmopolit insect and can be found in diverse habitats (Adriano et al., 2018). In ecosystems, butterflies has role as indicators of environmental change, because of their rapid response to environmental changes such as humidity, light temperature, and habitat type (Zulaikha et al. 2021).

The interaction between flowering plants and butterflies is a relationship that occurs related to a co-evolutionary process that has occurred over a long period of time. Flowering plants are a butterfly resource which is a food source for butterfly imago. Butterfly imago use pollen and nectar

from plants as a food source which affects the fitness of butterfly imago (Subedi et al., 2020). The relationship of flowering plants interacting with butterflies can be specialist or generalist. In addition, there is a mutualistic activity in which butterflies and flowering plants both benefit from this interaction (Nepi et al., 2019). Due to the mutualism of butterflies and flowering plants, the distribution of flowering plants is closely related to the distribution of butterflies that use them.

Cibubur Arboretum is one of the interesting research sites to obtain information related to the interaction of butterflies and flowering plants. Ruslan, et al. (2020) published in a study conducted at this location, found as many as 46 species of butterflies belonging to 4 families. The same publication also identified 65 plant species found at the Cibubur arboretum location. The high diversity of plant species found in this location can be an interesting background for further research related to the interaction between flowering plants and butterflies.

METHOD

Time and Place of Research

The research was carried out in February 2021 - March 2021 in the Jakarta Arboretum City Forest.

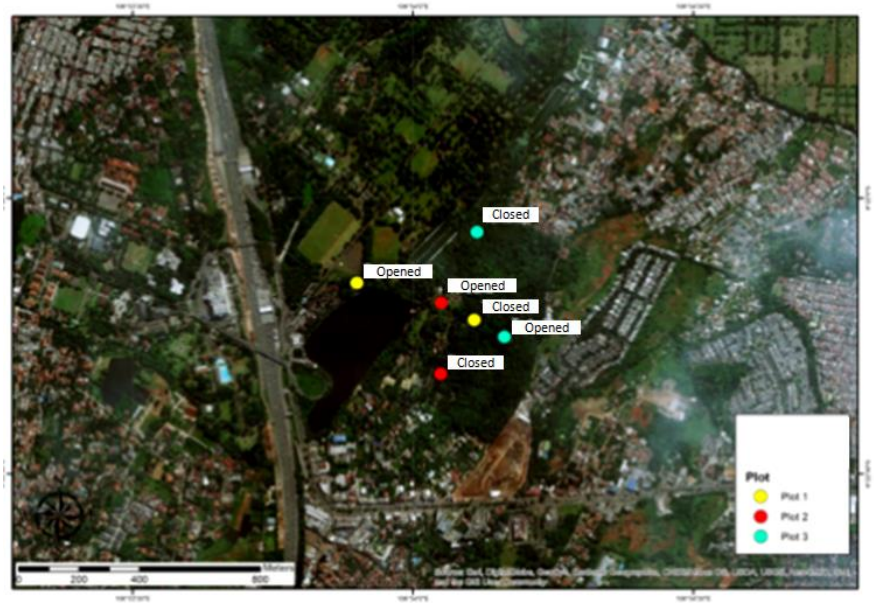

Figure 1. Research Location

Tools and Materials

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

Method

1. Butterfly observation

The Observations of butterflies were carried out by quantitative descriptive method, with purposive sampling plot determination. At each observation, 6 plots of butterflies were observed (opened and closed). Figure Appendix 2. In each plot, observations were made 3 times, with

aninterval of7 days. Observations were made at 08.00-12.00 WIB. Observation ofbutterflies using digital cameras, and insect nets. At the time of obseration, the names of known butterfly species and their numbers were recorded. The observations of flowering plants are also carried out by observing the percentage 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

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 data obtained in the Cibubur Arboretum City Forest, 45 species of butterflies were found which belong to 4 families with a total of 232 individuals can be seen Table 1.

Tables 1. Number of Families, Species, Individuals in the Urban Forest boretumCibubur

Taxon	Habitat		
	Opened	Closed	Total
Families	4	3	4
Species	40	25	45
Individu	135	94	232

From the data obtained in this study, it is known that there is a decrease in the number of species and the number of individual butterflies at the Cibubur Arboretum location when compared to the previous observation data conducted in 2014 (Ruslan, et al., 2020) can be seen in Table 2.

Table 2. Comparison of the Number of Families, Species, and Individuals of Butterfly Years2014 and 2021 at Cibubur Arboretum

Years	2014	2021
Families	4	4
Species	46	45
Individu	352	232

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

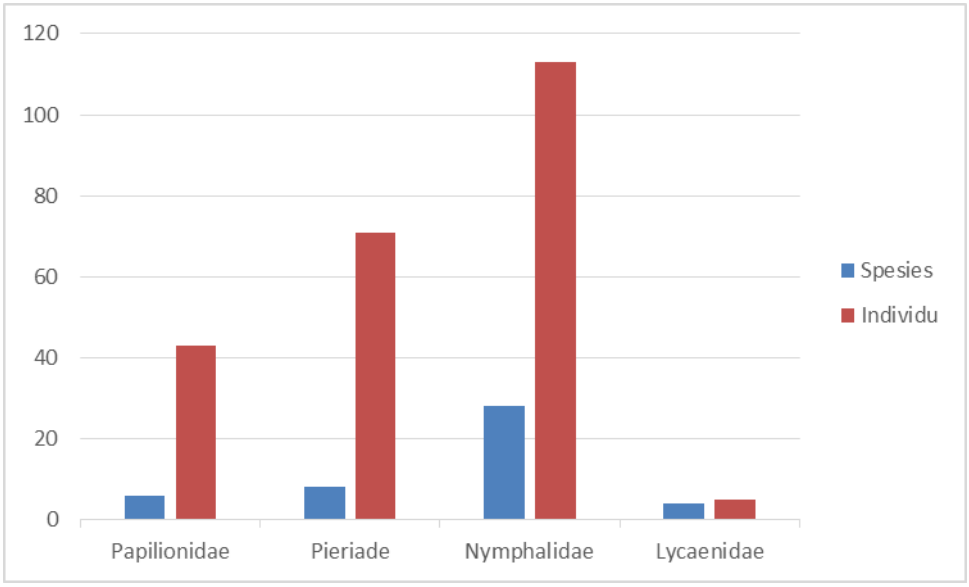

Figure 1. Comparison of the average number of species and individuals per families

Based on the data obtained in closed and opened habitats, it is known that the butterfly diversity index in opened habitats is not different from the butterfly diversity index in closed habitats. The diversity index (H') in open habitats is 3.41 which is classified as moderate, while the diversity index (H') in closed habitats is 2.95 which is also still in the moderate category.

The evenness index value found in the open habitat was 0.92 which was included in the high category. Likewise, the evenness index value found in closed habitats showed a high value of 0.91.

The correlation between butterflies and flowering plants in open habitats can be seen in graph 1 as follows.In opened habitat, a strong correlation was found (R = 0.6085) between flowering plants and butterflies.

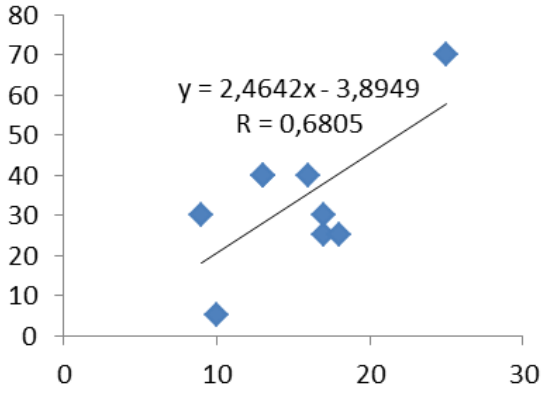

Figure 2.R value of the correlation between butterflies and percentage flowering plants in open habitat

The correlation between butterflies and flowering plants in closed habitats can be seen in

graph 2 as follows.In closed habitats, a strong correlation was found (R = 0.5636) between flowering plants and butterflies.

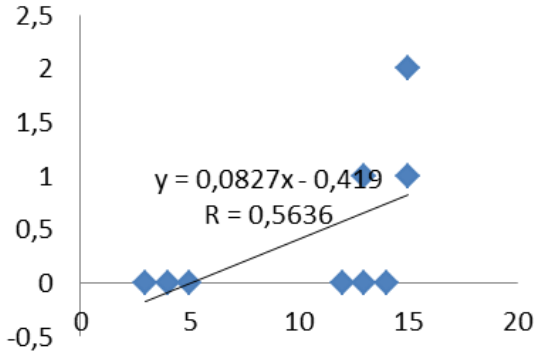

Figure 3. R value of the correlation between butterflies and percentage flowering plants in closed habitats

DISCUSSION

We found 40 species, and 135 individuals in open habitats were higher than those found in closed habitats (25 species, 94 individuals in closed habitat). Opened habitat is an ideal type of habitat for the development and life of butterflies. Habitats with high light intensity, and habitat openness are used by butterflies to carry out activities such as sunbathing and mating. Aryani, et al. (2020), stated that opened habitats not only provide a place with conducive abiotic factors for butterflies, but also habitats for butterfly host plants.

In addition, in opened habitats, a higher number of plants was found than in closed habitats which also affected the species richness of butterflies. The complexity of plant vegetation in an area affects species richness and individual abundance of butterflies (Medabilimi, et al., 2017).

From the data obtained in this study, it is known that there is a decrease in the number of species and the number of individual butterflies at the Cibubur Arboretum location when compared to the previous observation data conducted in 2014 (Ruslan, et al., 2020). The decrease in the number of species and changes in the abundance of individual butterflies (Table 2) that were found can be thought to be influenced by several factors such as habitat conversion which is also associated with anthropogenic disturbances (Dore, et al., 2021). Based on observations made at the research location, it is known that now some of the Arboretum area has begun to function as a location related to human activities such as shooting or taking pictures (Anthropogenic disturbing).

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 habitat type in opened and closed vegetation (Figure 1) with a total of 113 individuals. Meanwhile, the family with the least number of species and individuals was found, namely, the Lycaenidae family with a total of 5.Nymphalidae family.is the family with the highest species and number of individuals found in this study, followed by the Pieriadae, Papilionidae and Lycaenidae families. The presence of butterflies from the Nymphalidae family was found in the highest number, because the Nymphalidae family is one of the tribes with the highest number of species in the Lepidoptera Order, making it possible to be found in large numbers in nature. (Triplehorn& Johnson, 2005).The Nymphalidae family was found in the highest number, this could be influenced

by the ability of most of its species to eat from more diverse food sources such as rotten fruit, or urine from other animals (Sarma, et al., 2012; Sari, et al., 2013; Irni et al. al. 2016). The Pieridae family is strongly influenced by the presence of feed and host plants, abiotic factors such as temperature, humidity, sunlight intensity are also known to affect the presence of Pieridae (Sumah&Apriniarti, 2019). Species of *Leptosianina* from the Pieridae family were found in the highest number of 25 individuals. (Appendix Table 1). Based on research conducted by Hadi and Naim (2020), the presence of high numbers of *Leptosianina* in a habitat can be caused by the presence of many host plants in the observation location.

Based on the data obtained, the diversity index (H') in opened habitats and closed habitats is moderate. The diversity index is classified as moderate indicating the stability around the area is classified as moderate. This can be caused because in this area there are also several predators of butterflies that can control butterfly populations such as: Amphibians, Arachnida, Insects and Reptiles. According to Rizkiani (2018), natural enemies (predators) play a very important role in maintaining the balance of an ecosystem.

The evenness index value found in the opened habitat was 0.92 which was included in the high category. Likewise, the evenness index value found in closed habitats showed a high value of 0.91. A high evenness index value indicates that there is no dominance of certain butterfly species (Tarihoran, 2020).

In opened habitats, a strong correlation was found (R = 0.6085) between flowering plants and butterflies, and in closed habitats a strong correlation was also found (R = 0.5636). Flowering plants as a source of butterfly food are a vital need for butterflies (Nasrudin & Gasa, 2018). There is a strong relationship in both habitats the number of individual butterflies and flowering plants due to their close location. The distribution and abundance of butterflies in a habitat can be influenced by the distribution and abundance of plants that host and feed them (Islam, et al., 2015, Subedi, et al., 2020).

Several plant species were found in flowering condition in open habitats at the time of data collection, including *Asystasiagangetica*, *Emilia sanchofolia*, *Synedrellasp*.,*Kyllinga sp*., and *Mimosa pudica* (Figure 3). These five plant species were only found in openedhabitats, which was thought to affect the presence and abundance of butterflies in open habitats. *Asystasiagangetica*, *Emilia sanchofolia*, *Synedrella sp*., *Kyllinga sp*., and *Mimosa pudica* are plants commonly found in opened habitats which are known to attract a wide variety of pollinator insects such as butterflies, bees to beetles (Medabalimi et al. 2017; Suarna et al., 2019). Butterflies come to visit flowers by first seeing the flower's character, such as shape, color, aroma and others. In the *Emilia sanchofolia* plant, butterflies and other pollinators come because they are attracted to the capitulum organ found in flowers (Medabalimi et al., 2017). The existence of flowering plants as a source of imago feed is an important factor related to the presence and abundance of both species and individual butterflies (Subedi, et al., 2020).

The results showed that the interaction of several butterflies using flowering plants, *Asystasiagangetica* plants as food was more abundant than other plants. This can be caused because *Asystasiagangetica* is a weed plant that is widely found in the research location.*Asystasia* plants are classified as understorey plants which are a source of nectar for imago butterflies (Santosa, et al., 2017). *Asystasia* as a source of food for nymphalidae butterflies (Menasagi&Kotik, 2012). Butterflies *Appiasolfernae*, *Leptosianina*, *Euremahecabe*, *Neptishylas*, *Hypolimnasbolina*, *Zizinaotis*, *Yptimaphilomela*, and *Yptimabaldus* at the time of observation, were observed sucking the nectar of *Asystasiagangetica*. *Junoniaerigone* sucks the nectar of *Emilia sanchofolia*. *Zizinaotis* and *Arhopalacentaurus* suck the nectar of *Ageratum conyzoides*. *Phaedymacolumella* sucks the nectar of *Gnetumgnemon*. *Appiasolferna* sucks the nectar of *Asynedrellanodiflora*.

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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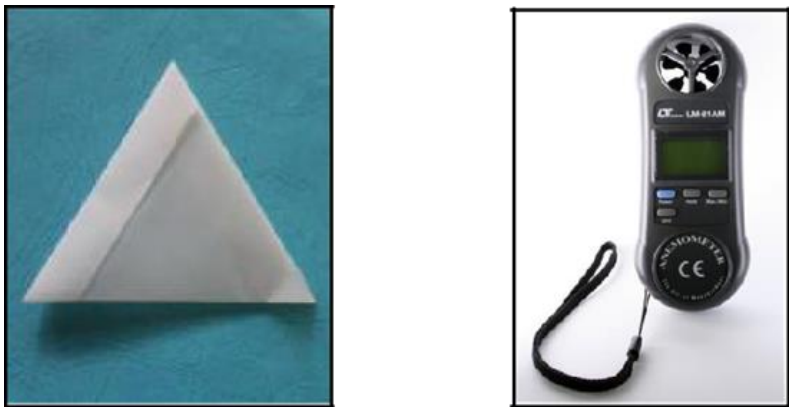
a. digital camera **b. sweeping net** **c. GPS**



d. papilot paper **e. 4 in 1 environment tester**

Appendix Figure 1. Research instrument

Appendix Figure 2. Observation plots in open and closed habitat

Asystasiagangetica, *Tridaxprocumbens,*

Synedrellanodiflora *Emilia sonchifolia*

Appendix Figure 3. Several types of flowering plants

Appendix Figure 4. Some butterflies suck *Asystasiagangetica*