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Study of Butterfly Diversity in Botanical Garden Indonesia

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Abstract--*The diversity and the number of butterflies decrease every year due to various environmental factors and unscientific management of natural resources. This study is focused on the assessment of diversity, abundance and uniformity, as well as the dominance of butterfly species in relation to vegetation composition in a habitat. In this study, we also investigate the factors that affect the life of butterfly species in the Cibodas Botanical Garden, Indonesia. This report reflects the common condition of botanical gardens in Indonesia, which function as a conservation garden while their surrounding areas are quickly being converted to make way for property and industrial development. We use catch and release technique for sampling over a period of three months in four different types of locations. From May to July 2018, we recorded as many as 885 butterflies (33 species) from five families. Our assessment of diversity shows that the waterfall location had the most diversity of species (H = 2.44), with a high abundance (R) and was the most balanced (E) with an index of 4.647 and 0.749 respectively. Delias belisama and Ypthima pondacus were two species that were the most dominant in numbers. The butterfly species that were observed generally preferred a humid area with varied vegetation, such as the Ciismun Waterfall. Our study shows that a high variety of vegetation and humidity in habitat, as well as its proximity to residential areas, have a significant correlation to the diversity of the butterfly species in a habitat.*

Key words--*Butterfly, Cibodas Botanical Garden, Diversity, entomology, Biodiversity.*

I. INTRODUCTION

Within the last decade, biodiversity conservation has become the focus of sustainable businesses all over the world in their effort to curb environmental destruction and prevent declining biodiversity. Some species have gone extinct because they have lost their natural habitat due to agricultural activities and urbanization [1]. Land conversion could lead to changes in temperature, climate, substrate and ecosystem. Effective and efficient land management could help conserve biodiversity [2]. The classification of an abundant species and the habitat identification are among the first steps of effective biodiversity conservation. Butterflies (Lepidoptera) are insects with colours and decorations in their wing pattern [3] that plays an important role as a bioindicator of a healthy environment as well as in the food chain and the balance of nature [4]–[6]. But we are lacking information about its ecology, distribution and abundance.

The decline of butterfly biodiversity caused by the loss of their habitat triggered by development and urbanization is a common phenomenon. Habitat that is changing because of changing host plants, predatory risks, water regime, microclimate, pesticide, air pollution, land solidification, changing light and nutrition could

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influence the life of butterflies. Butterflies need host plants lay eggs and obtain food for caterpillars. Butterflies need a natural habitat with a wide variety of flowering plants that habitat change impacts the population of butterflies. The presence of invasive plants that shove host plants and cause forest fires is another reason for declining species habitat. Morret et al (2006) highlight the declining number of arthropod species on former land forest fire areas, compared to that in unburned areas as control plots [7]. A number of ecological studies on the abundance and classification of butterfly species have been published recently. However, those studies are still limited to certain types of areas, such as residential areas, urban areas, and forest outskirts, while specific areas such as protected forests and botanical gardens are not widely used as the location of a study. A new, recent study is needed, especially considering the fact that habitat modification has occurred in the area for tourism and business purposes. The purpose of this study is to identify the diversity and abundance of butterfly species in human-modified habitats.

II. MATERIALS AND METHOD

This research was conducted from May to July 2018 at Cibodas Botanical Garden. The Cibodas Botanical Garden is located on the slopes of Mount Gede, located in the Cibodas subdistrict of West Java, Indonesia. The botanical garden is one of four Indonesian Botanic Gardens (Kebun Raya Indonesia), located at 1300-1425 m high on the slopes of Mount Gede in Cibodas subdistrict of West Java, Indonesia. The botanical garden has average rainfall is 2380 mm, and the weather is cool (18°C) and moist. The Garden covers about 125 ha of undulating topography, with grassy expanses and valleys filled with tree ferns and waterfalls. Cibodas Botanic Garden is a popular recreational centre, research for students and scientists studying tropical mountain flora. Catch and release technique was directly applied in these sampling sites given that the method could count the number of butterflies in a certain place and time [8]. Butterflies were caught using an insect net when they are active in the morning throughout the afternoon [9]. Sampling was done in four locations: Ciismun Waterfall, The Fountain, Sakura Garden, and Guest House. The data collected was then analysed using the Shannon-Wiener diversity index, Margalef richness index, Pielou Evenness index, and Simpson dominance index.

III. RESULTS AND DISCUSSION

Over the study period, a total of 885 butterfly individuals representing 33 species and five families were recorded in four areas. These individuals belonged to 5 families, Papilionidae, Nymphalidae, Hesperiidae, Pieridae, dan Lycaenidae (Table 1). The findings show there is an increase in the number of butterfly species found in Cibodas Botanical Garden compared to [10] which found 21 butterfly species. The difference in the number of species found is the result of differences in the habitats, time, length of sampling time, and the addition of one sampling site, the Ciismun Waterfall.

The number of butterfly species found in this research is lower than the findings of [9] in Suaka Elang National Park in Halimun Salak Mountain (170 individuals of 40 species), [11] which recorded 12.994 individuals of 99 species; in Serampore, West Bengal, India, which recorded 3.926 individuals of 38 species; [12] in Punjab, India, which recorded 54 species; [13] in Indian Institute of Forest Management (IIFM), Bhopal, India, which recorded 815 individuals of 55 species; [14] with 52 species in Karnataka, India; [15] which recorded 484 individuals of 68 species in District-Bharuch, Gujarat India; [16] in Gorewada International Bio-

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Park, Nagpur, Central India which recorded 92 butterfly species. [17] stated that there is no significant correlation between the size of the human population and the number of butterfly species in a country.

The highest number of species was found in Ciismun Waterfall (26 species), followed by Sakura Garden (20 species), Guest House (17 species), and The Fountain (10 species). This variation was likely caused by several environmental factors such as the host plants, temperature, and weather. The frequent and sudden weather change in The Fountain and Guest House, such as the fog and cloudy clouds in the afternoon, could make butterflies relatively inactive.

Table 1. Butterfly species found in the four sampling sites of Cibodas Botanical Garden

Butterfly species	**Family**	**Ciismun waterfall**	**The Fountain**	**Sakura Garden**	**Guest House**	**Total**
Notocrypta paralysos	Hesperiidae	5	0	1	0	6
Pelopidas mathias		3	0	3	0	6
Polantus omaha		8	0	0	0	8
Arhopala eumoulphus	Lycaenidae	1	0	0	0	1
Heliophorus epicles		8	0	7	4	19
Ionolyce helicon		8	0	23	4	35
Udara akasa		2	1	2	3	8
Graphium sarpedon	Papilionidae	18	9	16	10	53
Papilio helenus		2	1	0	0	3
Papilio memnon		14	3	16	6	39
Triodas Helena		1	0	0	0	1
Delias belisama	Pieridae	11	63	49	83	206
Eurema blanda		4	0	1	12	17
Eurema hecabe		10	8	26	26	70
Leptosia		0	0	2	0	2

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nina						
Agrynnis hyperbius	Nymphalidae	2	14	2	7	25
Ariadne ariadne		0	0	0	3	3
Chynthia cardui		7	17	5	43	72
Cryrestis lutea		2	0	3	0	5
Danaus chrysippus		0	0	0	1	1
Euploea Eunice		1	0	0	0	1
Euploea mulciber		1	0	0	0	1
Junonia iphita		0	0	1	0	1
Junonia orithya		0	15	2	2	19
Lethe confuse		3	0	1	0	4
Melanitis leda		0	0	0	1	1
Melanitis phedima		1	0	0	0	1
Melanitis zitenius		3	0	0	0	3
Mycalesis sudra		0	0	0	1	1
Neptis hylas		7	0	3	1	11
Neptis omeroda		2	0	0	0	2
Symbrenthia hypselis		9	0	1	0	10
Ypthima pondacus		84	53	62	51	250
Total		217	184	226	258	885

The most dominant family in this observation was Nymphalidae with 18 species which comprised Agrynnis hyperbius, Ariadne ariadne, Chynthia cardui, Cryrestis lutea, Danaus chrysippus, Euploea Eunice,

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Euploea mulciber, Junonia iphita, Junonia orithya, Lethe confuse, Melanitis leda, Melanitis phedima, Melanitis zitenius, Mycalesis sudra, Neptis hylas, Neptis omeroda, Symbrenthia hypselis, and Ypthima pondacus. Hesperidae family was the least in number where only three of its species were found in CBG. They were Notocrypta paralysos, Pelopidas mathias, and Polantus Omaha. Three other families were also found, each comprising four butterfly species. Samples from Papilionidae family consist of Graphium sarpedon, Papilio helenus, Papilio memnon, and Triodes Helena. Samples from Pieridae family consist of Delias belisama, Eurema blanda, Eurema hecabe and Leptosia nina. As for the samples from Lycaenidae family, they consist of Arhopala eumoulphus, Heliophorus epicles, Ionolyce helicon, and Udara akasa.

A number of researchers from various countries show that Nymphalidae butterflies are widely distributed in Indonesia, India, Brazil, Korea, and Sri Lanka [9]; [11]; [18], [19], [13], [16]; [20]; [21]; and [22]. This wide distribution is a result of Nymphalidae's beneficial characteristics such as having various wing colours and shapes, diverse sizes [9], host plants availability for larval development and the abundance of flowering plants that adult butterflies feed on [18]; [4], However, research by [18] in Kolkata, India, and in Phaltan, Maharashtra, show a different result as the highest number of butterflies found were from the Lycaenidae family with 30 species and 13 species, respectively [23].

Butterfly Diversity

Based on the data depicted in Table 2, the butterfly diversity index (H) in Cibodas Botanical Garden is at a moderate level. The Shannon diversity index (H) of the four sampling sites are as follows: Ciismun Waterfall = 2,44; The Fountain= 1,63; Sakura Garden = 2,24; dan Guest House = 2,20. These data show that the number of butterfly species in CBG was not greatly abundant.

Table 2. Indices of Butterfly Species Diversity (H'), Species Evenness (E), Species Dominance (C), and Species Richness (R) in Cibodas Botanical Garden

Indices	**Station location**			
	Ciismun waterfall	**Fountain**	**Sakura Garden**	**Guest House**
Species Diversity Index (H')	2,44	1,63	2,24	2,2
Species Evenness Index (E)	0,749	0,708	0,748	0,777
Dominance Index (C)	0,17	0,16	0,17	0,26
Species Richness Index (R)	4,647	1,726	3,505	2,881
Number of species	26	10	20	17

The value of diversity index is directly proportional to the value of species richness and evenness of a location. The highest value of diversity index was found in Ciismun waterfall (2,44) while the lowest value was found in The Fountain (1,63). This observation is in line with the statement of Murwitaniingsih & Dharma, (2014), which says the higher the values of species richness and evenness, the higher the value of its diversity index.

The high number of species richness in a certain location is determined by the number of species observed. Ciismun waterfall hosted 26 butterfly species, this is the highest number compared with The Fountain

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(10 species), Guest House (17 species), and Sakura Garden (20 species). In the meantime, species richness and evenness indices reached 4,647 and 0,749. This was influenced by the high level of plant varieties (heterogenous), narrower open space, as well as more stable environmental condition (as the fog rarely descends to this place). Dobson, (2012) says that butterflies prefer open spaces that are sunny but sheltered with many vegetations.

The highest dominance index (C) in Cibodas Botanical Garden was found in Guest House sampling site (0.26) while the other three locations only had 0,17; 0,17, and 0,16. There were two dominant species found in each location. They were *Delias belisama* and *Ypthima pondacus. Delias belisama* was mostly found in areas where the flowers of Bottlebrush plant (*Callistemon citrinus)* bloomed, while *Ypthima pondacus* was mostly found in sheltered places (not directly exposed to sunlight) with long grasses. It is likely that these butterfly species use this kind of place to camouflage from its predators. Their brownish wings also help them blend into their surroundings. [24] says large trees and shrubs are good places that provide shelter for butterflies.

IV. CONCLUSION

The study into the distribution of butterfly species shows that the diversity of butterfly species in the Cibodas Botanical Garden is at a medium level, and so are the levels of evenness and dominance. *Delias belisama* and *Ypthima pondacus* are two of the largest species that we found in the Cibodas Botanical Garden. Our study indicates that the butterfly population is affected by the structure of the habitat. A further study on the nature and characteristics of butterflies in a habitat is needed for further conservation.

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