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Diversity and Community Structure of Butterly in Teijsmann and Soedjana Kassan Park, Bogor Botanical Garden

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Abstract

As a megadiversity country, Indonesia is home to a large number of flora and fauna, one of which is the butterfly. The Bogor Botanical Garden, situated at the center of Bogor City, not only serves as a green open space but also as a conservation area for plants and animals composed in it. This study aimed to assess the diversity of butterfly species in Teijsmann Park and Soedjana Kassan Park, Bogor Botanical Garden through inventory and identification. Sampling was carried out at spots that were 100 meters apart from each other on a walked-line transect defined at the two parks. The diversity parameters assessed and analyzed are relative abundance, relative frequency, Shannon-Wiener (H') diversity index, Evenness index (E), and dominance. In a total of 202 sample individuals, there were identified 38 species of butterflies belonging to 5 families namely *Papilionidae*, *Pieridae*, *Nymphalidae*, *Lycaenidae*, and *Hesperiidae*. The highest abundance found in Teijsmann Park is *Ypthima philomela* from the *Nymphalidae* family and Zizina otis from the *Lycaenidae* family. Species with the highest frequency are *Junonia hedonia* and *Ypthima philomela* from the *Nymphalidae* family. On the other hand, the highest frequency and abundance found in Soedjana Kassan Park was *Leptosia nina* from the *Pieridae* family. Teijsmann Park showed a slightly higher value of diversity and evenness indexes (H'=2.62, E=0.84) when compared to Soedjana Kassan Park (H'=2.50, E=0.76).

Keywords: Community structure, diversity, butterfly, Bogor botanical garden

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INTRODUCTION

Indonesia is referred to as one of the world's mega biodiversity centers because it has a very high diversity of flora and fauna [1]. To date there was estimated 1,500 species of algae, 80,000 species of spore plants, 595 species of lichens, 2,197 species of ferns, 30,000 species of seed plants, and 8,157 species of vertebrates consisting of groups of mammals, birds, herpetofauna, and fish [2]. Among all, insects are one of the animal groups with the highest diversity. There are around 151,847 butterfly species, or 15% of all insects in the world found in Indonesia, and about 1,900 of them have been identified [2], [3].

It was well known that insect has important ecological roles including as pollinators and natural predators of plant pests [3]. Most of all, insects, especially butterflies, provide many benefits in terms of environment, economic value, ecology, aesthetics, education, conservation, and culture. That is the reason why butterfly diversity needs to be preserved [4-6]. According to [7], ecologically butterflies contribute to maintaining ecosystems, because they are sensitive to changes in habitat and population density, so their existence can be used as bioindicator of environmental quality.

Bogor Botanical Garden is one of the ex-situ plant conservation centers in Indonesia which has an area of 87 ha [8-10]. The ex-situ plant conservation area in the Bogor Botanical Gardens collects various types of native Indonesian plants that have survived for hundreds of years. Some of the parks in the Bogor Botanical Gardens include Teijsmann Park, Soedjana Kassan Park, Orchidarium Garden, Medicine Garden, Nepenthes Garden, Mexican Garden, Bamboo Garden, Astrid Park, Araceae Park, Black Orchid Garden, Aquatic Park [11].

In addition to its function as a green open area, the Bogor Botanical Gardens, which are located in the city center, also have a public function as a recreation area for residents [12]. In addition, the Bogor Botanical Gardens is also a center for ex-situ conservation and research which is a habitat for various plants and fauna that are present in it [10], as well as various types of Araceae plants that grow naturally or in collections [13]. Thus, the Bogor Botanical Gardens is one of the worth area to serve as a research site for butterfly diversity.

Given the important role of butterflies in ecosystem and their functions as environmental indicators, continuous research on butterfly diversity is important so that existing data can be continuously updated and supplemented. The Bogor Botanical Gardens butterfly diversity survey conducted in 2012 and 2019 successively found 60 species in 5 parks and 78 species in 10 sites [14], [5].

Therefore, this study aims to determine the diversity of butterflies found in two parks at the Bogor Botanical Gardens, i.e. Teijsmann Park and Soedjana Kassan Park. The findings are expected to enrich data of butterfly species diversity in the Bogor Botanical Garden.

METHOD

Location and Time of Research

Sampling was carried out in June 2021 twice a day, in the morning between 08:00-12:00 and afternoon between 13:00-15:00. Sampling sites were determined using purposive techniques. Teijsmann Park and Soedjana Kassan Park (Figure 1) were chosen as research locations because these two locations have a fairly diverse vegetation composition, especially flowering plants that are attractive to adult butterflies, such as *Zephyranthes candida*, *Mandevilla sanderi*, *Bauhinia coccinea*, *Heliconia* sp., *Hibiscus* sp., *Ixora javanica*, *Heliconia* sp., *Bougainvillea glabra*, *Bauhinia purpurea*, *Spathiphyllum* sp., *Stachytarpheta jamaicensis, Jatropha* sp., *Hibiscus* sp., *Tabernaemontana* sp., *Lantana camara*.

Tools and materials

The tools used in this study were insect nets, air thermometers and hygrometers, anemometers, GPS, cameras, stationery, clear files for temporary storage of specimens, field identification guides, worksheets and white ink to mark individual butterflies caught.

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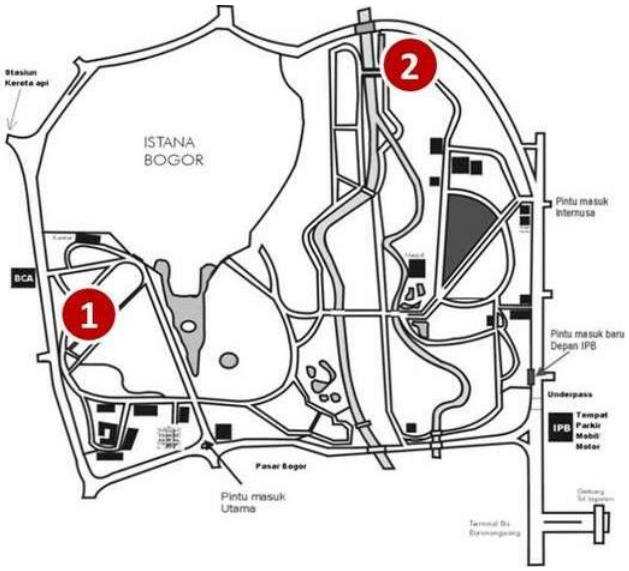

Figure 1. Location map of the Bogor Botanical Gardens, (1) Teijsmann Park and (2) SoedjanaKassan Park, where the butterfly sampling carried out. The picture was modified from Savitri (2013).

Sample Collection Techniques

Sample collection was carried out using the line transect method by following the footpath. Each line transect consists of 8 plots with a distance of 100 meters between plots. At every 100-meter distance, butterfly sampling was carried out using an insect net and data collection on environmental parameters such as air temperature, air humidity, and wind speed. Sampling time and the number of each type of butterfly caught were recorded to determine butterfly activity based on the time of observation made. Butterfly sampling was carried out using the capture–recapture method, where each captured butterfly was documented, marked using white ink on the thorax, identified directly using a field manual, and released back into nature. Recording of vegetation data around the sampling location is done descriptively.

Butterfly identification

Butterflies that have been documented are then identified with the help of field identification guidebooks entitled Practical Guide to Butterflies in the Bogor Botanical Gardens, Getting to Know Butterflies [16], and Identification guide for butterflies of West Java [17]. If immediate identification cannot be carried out thoroughly in the field then the identification process out in laboratory based on the photo documentation that has been taken.

Data analysis

Data analysis was performed by calculating the values of relative abundance, relative frequency, Shannon-Wiener species diversity index (H'), evenness (J'), and dominance. These values are used to describe the community structure and diversity of butterflies at the study site.

RESULTS AND DISCUSSION

Butterfly Species in Teijsmann and Soedjana Kassan Parks

From a total of 202 individuals at both locations, there were 38 species of butterflies from 5 families, namely Papilionidae, Pieridae, Nymphalidae, Lycaenidae, and Hesperiidae (Table 1). In general, the two locations have a different wealth of butterflies where in SoedjanaKassan Park there are several types of butterflies that are not found, especially from the Hesperiidae tribe. There are 11 types of butterflies that can be found in both locations, namely *Eurema blanda*, *Leptosia nina, Elymnias hypermnestra, Hypolimnas bolina, Junonia atlites, Junoniahedonia, Junonia iphita, Junonia orithya, Phaedyma columella, Ypthima philomela*, and *Zizina Otis* (Table 1). The highest number of individuals was found in SoedjanaKassan Park with a total of 123 individuals consisting of 27 species and belonging to 4 families (Figure 3).

Meanwhile, in Teijsmann Park, there were 79 individuals from 23 species belonging to 5 families (Figure 3). The Nymphalidae tribe composes about 48% percent of the total butterfly species found in Teijsmann Park and 63% in SoedjanaKassan Park. In Teijsmann Park, the next most frequently

encountered species were from the families Pieridae (17%), Hesperidae (17%), Papilionidae (14%) and Lycaenidae (4%). Whereas in Soedjana Kassan Park, the highest percentage of species after the Nymphalidae tribe was the Pieridae tribe (19%), Lycaenidae (11%), Papilionidae (7%), but the Hesperiidae tribe was not found at this location.

In both Teijsmann Park and Soedjana Kassan Park, butterflies from the Nymphalidae tribe have the most composition among other tribes (Table 1, Figure 3). It [18] stated that the Nymphalidae tribe is most frequently encountered when observing because the number of species is more varied and also the area of distribution is wider when compared to other tribes. It [19] estimated that there are about 6,500 species of butterflies in the Nymphalidae tribe. Thus, the chance of finding the Nymphalidae tribe in the Bogor Botanical Gardens is higher than other tribes. The Nymphalidae tribe also has polyphagous properties, namely species that are able to survive in meeting the need for host plants even though the main host plants are not available [20]. In his research, [21] added that the main food plants for the larvae of the Nymphalidae tribe include Annonaceae, Asteraceae, Moraceae, Rubiaceae, and Anacardiaceae. The results showed that of the 5 identified tribes, the tribes that were least encountered were the Hesperiidae and Lycaenidae tribes (Table 1, Figure 3). This result might have occurred because the body size of the Hesperiidae and Lycaenidae tribes was relatively small, making it difficult to observe in the field [22]. In addition, butterflies from the Hesperiidae tribe have a crepuscular nature which is generally active at sunrise and sunset, so they are rarer when observations take place in the morning and afternoon [16], [22].

The main factor that can affect the abundance of butterflies is the availability of host plants where butterfly larvae grow and food plants which act as a source of nectar for adult butterflies. The structure of the vegetation found at the study site also influences the abundance of butterfly species [20]. According to [23], the highest abundance of butterflies is found in bush habitats where various flowering plants from the Asteraceae, Mimosaceae, Poaceae and Rutacea tribes grow

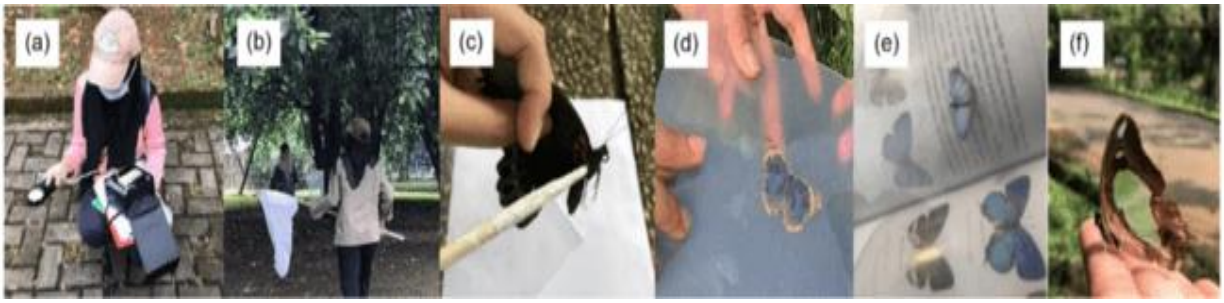

Figure 2. Stages of research activities (a) measuring and collecting data of environmental factors, (b) capturing butterflies using an insect net, (c) marking and recording individual samples, (d) documenting specimens captured, (e) identification of butterfly species using field manuals, (f) releasing butterflies back to nature

Table 1. List of butterflies caught in Teijsmann Park and Soedjana Kassan Park

No	Family	Species	Teijsman Park		Soedjana Kassan Park	
			Morning *	Afternoon*	Morning *	Afternoon*
1	Papilionidae	*Graphium doson* FELDER & FELDER	1			
2		*Graphium sarpedon* LINNAEUS			1	
3		*Papilio demolion* CRAMER	1			
4		*Papilio memnon* LINNAEUS	2			
5		*Papilio polytes* LINNAEUS			1	
6	Pieridae	*Appias olferna* SWINHOE			3	1
7		*Catopsilia Pomona* FABRICIUS			2	
8		*Delias hyparete* LINNAEUS	1			
9		*Eurema alitha* FELDER & FELDER	1		1	
10		*Eurema blanda* BOISDUVAL	1	1	5	2
11	Nymphalidae	*Leptosia nina* FABRICIUS	10		28	9
12		*Chersonesia rahria* WESTWOOD				1
13		*Cupha erymanthis* DRURY				1

14		*Doleschallia bisaltide* CRAMER			1	
15		*Dophla evelina* STOLL	1			
16		*Elymnias hypermnestra* LINNAEUS	3		3	
17		*Euploea* sp.	1			
18		*Euthalia monina* FABRICIUS	1			
19		*Hypolimnas bolina* LINNAEUS	3		3	1
20		*Junonia atlites* LINNAEUS	3		1	
21		*Junonia erigone* CRAMER			3	
22		*Junonia hedonia* LINNAEUS	8	3	6	1
23		*Junonia iphita* CRAMER	1		4	1
24		*Junonia orithya* LINNAEUS	1		4	2
25		*Mycalesis horsfieldii* MOORE			2	
26		*Mycalesis janardana* MOORE			1	1
27		*Mycalesis mineus* LINNAEUS				1
28		*Neptis hylas* LINNAEUS			1	1
29		*Phaedyma columella* CRAMER	2		1	
30		*Polyura hebe* BUTLER			2	
31		*Ypthima philomela* LINNAEUS	2	11	11	14
32		*Castalius rosimon* FABRICIUS				1
33		*Jamides Alecto* FELDER			1	
34	Lycaenidae	*Zizina Otis* FABRICIUS	6	7	1	
35		*Ancistroides nigrita* LATREILLE	1			
36		*Badomia exclamationis* FABRICIUS	1			
37	Hesperiidae	*Oriens gola* MOORE	4	1		
38		*Pelopidas agna* MOORE		1		
Total individuals			55	24	86	37

*morning observations are made at 08:00-12:00 and afternoon observations are made at 13:00-15:00

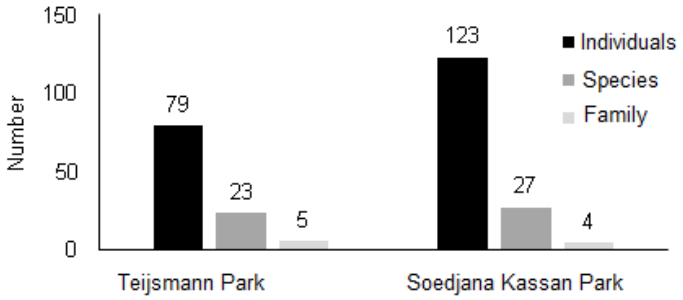

Figure 3. Comparison of individuals, species and families in Teijsmann and Soedjana Kassan Parks

Figure 4. Photographs picturing sampling locations (a) Teijsmann Park (b) Soedjana Kassan Park

In general, both research locations are open areas with abundant lighting (Figure 4). Both locations also have vegetation composed of grasses, flowering plants to large canopy trees. Based on observations of vegetation at the two study sites, 6 flowering plants were recorded in Teijsmann Park (*Zephyranthes candida, Mandevilla sanderi, Bauhinia coccinea, Heliconia* sp., *Hibiscus* sp., and *Ixorajavanica*) and 10 flowering plants in SoedjanaKassan Park (*Heliconia* sp., *Bougainvillea glabra*, *Mandevilla sanderi, Bauhinia purpurea, Spathiphyllum* sp., *Stachytarpheta jamaicensis, Jatropha* sp., *Hibiscus* sp., *Tabernae montana* sp., *Lantana camara*). The greater variety of flowering plants that provide a source of nectar for adult butterflies, making the total number of species and individuals found in SoedjanaKassan Park more abundant than in Teijsmann Park (Table 1,

Table 2). Researcher [24] also stated that fewer butterflies would be found if there were no sources of nectar which could become food plants around the observation site.

In addition to the diversity of plants at the observation site, the presence and activity of butterflies is greatly influenced by environmental factors such as temperature and humidity. Butterflies are diurnal animals that are active during the day, so their activities are greatly influenced by the weather conditions around them. In general, an overview of environmental conditions at the time of observation is described in Table 2. The air temperature on the day of observation ranged from 26.8–32.1°C with air humidity between 59–85% (Table 2). According to [25] and [26], the air temperature that supports butterfly life is in the range of 25–41°C with an optimum temperature of 28–35°C. Meanwhile, the humidity preferred by butterflies ranges from 54–94% [4], [6]. The wind speed on the observation day was very low, ranging from 0-1 m/s (Table 2). According to [27], butterflies do not like places with wind speeds that are too high because it can affect flying activities and can cause damage to vulnerable butterfly wings, especially wings that are wide.

Table 2. Abiotic factors measured in Teijsmann Park and SoedjanaKassan Park

Location	Time of Observation	Temperature (°C)	Wind Speed (m/s)	Humidity (%)
Teijsmann Park	08:00-12:00 WIB	29.84 ± 0.58	0.26 ± 0.16	67.00 ± 1.39
	13:00-15:00 WIB	30.70 ± 0.56	0.00 ± 0.00	70.13 ± 1.43
Soedjana Kassan Park	08:00-12:00 WIB	29.47 ± 0.51	0.13 ± 0.08	74.75 ± 2.39
	13:00-15:00 WIB	31.14 ± 0.23	0.05 ± 0.05	74.00 ± 1.57

In Figure 5 it can also be seen the activity of the butterflies during the observation, where the most butterflies were found at 09:00 WIB in SoedjanaKassan Park and at 10:00 WIB in Teijsmann Park. Meanwhile, during the afternoon to evening observations, the highest number of butterflies at both locations occurred at 14:00 WIB (Figure 5). This is in accordance with the research by [28] who stated that the behavior of butterflies perching on vegetation often occurs in the afternoon to evening when the ambient temperature and humidity are too high. In Figure 5, the curve for the number of individuals found from noon to evening (13:00-15:00 WIB) is lower than morning to noon (08:00-12:00 WIB). The high temperature of the environment can reduce the flying activity of butterflies, so they prefer to perch on vegetation. In his research, he also added that there was no relationship between temperature and light intensity on the flight and nectaring behavior of butterflies, but both of them showed some closeness to perching or resting behavior.

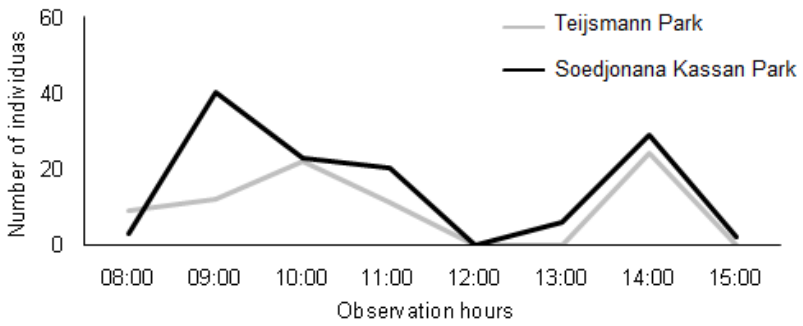

Figure 5. Butterfly activity based on observation time.

Frequency and Abundance of Butterfly Types

Based on the results of species frequency calculations, the highest relative frequency values in Teisjman Park were Junoniahedonia and Ypthimaphilomela from the Nymphalidae tribe with a value of 11.63%, followed by Zizinaotis from the Lycaenidae tribe and Leptosianina from Pieridae with a value of 9.3% (Table 3). In

SoedjanaKassan Park, the butterfly species that had the highest frequency were Leptosianina (11.86%) and Euremablanda (8.47%) from the Pieridae tribe, followed by Yphtimaphilomela (8.47%) from the Nymphalidae tribe (Table 3).

Table 3. Frequency and relative abundance of butterfly species

Tribe and Species Name	Teijsmann Park		Soedjana Kassan Park	
	FR (%)	AR (%)	FR (%)	AR (%)
Papilionidae				
Graphium doson	2.33	1.27		
Graphium sarpedon			1.69	0.81
Papilio demolion	2.33	1.27		
Papilio memnon	2.33	2.53		
Papilio polytes			1.69	0.81
Pieridae				
Appias olferna			5.08	3.25
Catopsilia pomona			3.39	1.63
Delias hyparete	2.33	1.27		
Eurema alitha	2.33	1.27	1.69	0,81
Eurema blanda	4.65	2.53	8.47	5.69
Leptosia nina	9.30	12.66	11.86	30.08
Nymphalidae				
Chersonesia rahria			1.69	0.81
Cupha erymanthis			1.69	0.81
Doleschallia bisaltide			1.69	0.81
Dophla evelina	2.33	1.27		
Elymnias hypermnestra	2.33	3.80	3.39	2.44
Euploea sp.	2.33	1.27		
Euthalia monina	2.33	1.27		
Hypolimnas bolina	4.65	3.80	5.08	3.25
Junonia atlites	4.65	3.80	1.69	0.81
Junonia erigone			5.08	2.44
Junonia hedonia	11.63	13.92	6.78	5.69
Junonia iphita	2.33	1.27	6.78	4.07
Junonia orithya	2.33	1.27	3.39	4.88
Mycalesis horsfieldii			3.39	1.63
Mycalesis janardana			3.39	1.63
Mycalesis mineus			1.69	0.81
Neptis hylas			3.39	1,63
Phaedyma columella	4.65	2.53	1.69	0.81
Polyura hebe			1.69	1.63
Ypthima philomela	11.63	16.46	8.47	20.33
Lycaenidae				
Castalius rosimon			1.69	0.81
Jamides alecto			1.69	0.81
Zizina otis	9.30	16.46	1.69	0.81
Hesperiidae				
Ancistroides nigrita	2.33	1.27		
Badomia exclamationis	2.33	1.27		
Oriens gola	6.98	6.33		
Pelopidas agna	2.33	1.27		

FR: relative frequency; AR: relative abundance

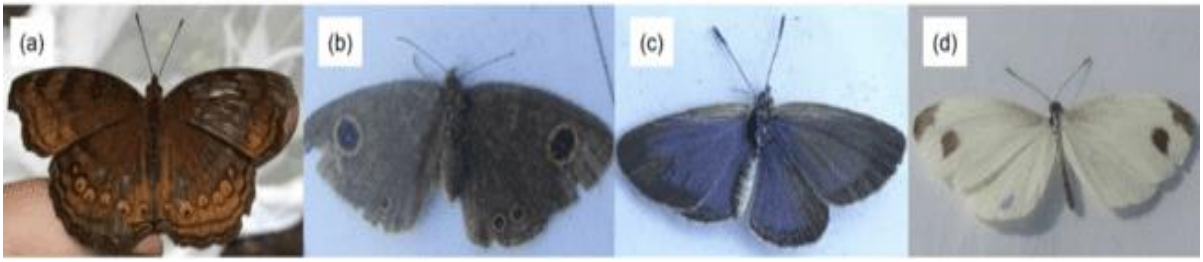

Figure 5. Types of butterflies that are most often in Teijsmann and Soedjana Kassan Parks: (a) *Junonia hedonia*; (b) *Ypthima philomela*; (c) *Zizina otis*; (d) *Leptocia nina*.

The relative abundance of butterfly species in Teijsmann Park shows that the species with the highest proportion are Ypthimaphilomela (16.5%) from the Nymphalidae tribe and Zizinaotis (16.5%) from the Lycaenidae tribe (Table 3). Meanwhile, in SoedjanaKassan Park, the butterfly

species that had the highest abundance proportion were Leptosianina (30.08%) from the Pieridae tribe and Ypthimaphilomela (20.33%) from the Nymphalidae tribe (Table 3). Differences in the abundance of species in the two locations may occur due to different conditions between Teisjman Park and SoedjanaKassan Park, both from the composition of the vegetation and the environmental factors that are formed.

Butterflies' Diversity, Evenness, and Dominance

From Table 4 it is revealed that the Shannon-Wiener diversity index (H') between the two study locations are different. Teijsmann Park has a diversity index of 2.62 while Soedjana Kassan Park has a value of 2.50. In addition to the diversity index, the evenness index in Teijsmann Park (0.84) also shows a higher value than SoedjanaKassan Park (0.76) (Table 4). There is not much difference between the two locations, because in both parks there are sources of food plants, shelter from attacks by predators, host plants, and water sources that support the various types of butterflies that are present in them.

Table 4. Diversity index (H'), evenness (E) and dominance of butterfly species in Teijsmann and Soedjana Kassan Parks

	Location	
	Teijsmann Park	**Soedjana Kassan Park**
H'	2.62 (Middle)	2.50 (Middle)
E	0.84	0.76
Dominance	0.10	0.15

The Shannon-Wiener (H') diversity index value obtained indicates that both locations have moderate levels of species diversity. The medium category means that the area has a sufficient level of productivity, fairly balanced ecosystem conditions, and moderate ecological pressure [29]. Therefore, the environmental conditions in Teijsmann Park and SoedjanaKassan Park can be said to be good. The condition of the area that has lots of open land and trees is a habitat that is quite preferred by butterflies. Gardens with open canopies allow more light to penetrate, so that butterflies can increase their body temperature effectively [30].

In the results of this study, indicate that the number of species and individuals is higher in Soedjana Kassan Park, but the diversity index (H') and evenness (E) showed higher values in Teijsmann Park. According to [31], if the evenness index value gets closer to zero, it can be said that the species are more and more unequally distributed. The results showed that the evenness value in SoedjanaKassan Park was slightly lower than Teijsman Park, which indicated that there were species slightly uneven or too abundant in Soedjana Kassan Park.

Dominance values at both study locations indicate that the Soedjana Kassan Park (0.148) was more abundant than that of Teijsmann Park (0.102) (Table 4). According to Odum (1993), a dominance index value of ≤0.5 indicates that there are no species that dominate in the area, whereas if the value is ≥0.8 then there is a dominant species. Based on the categorization of dominance values in [32], no species dominates in the two study locations. Even though at the time of observation there were frequent encounters with the type Leptosianina from the Pieridae tribe in Soedjana Kassan Park, where this species could be found in almost all observation points (7 out of 8 points) with a total of 37 individuals, its presence could still be categorized as normal. However, this minor dominance can still affect the value of diversity and evenness of butterfly species in Teijsmann Park and Soedjono Kassan Park.

CONCLUSION

The community structure and diversity of butterflies in Teijsmann Park and Soedjana Kassan Park in the Bogor Botanical Gardens can be summarized as follows: the are 38 species of butterflies belonging to 5 families, namely Papilionidae (5 species), Pieridae (6 species), Nymphalidae (20 species), Lycaenidae (3 species), and Hesperiidae (4 species). Teijsmann Park showed slightly higher diversity and evenness values than Soedjana Kassan Park, but no butterfly species dominated at both locations.

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REFERENCES

[1] R. Panjaitan, P. Hidayat, D. Peggie, D. Buchori, S. Scheu, and J. Drescher, *The Butterflies of Jambi (Sumatra, Indonesia): An EFForTS Field Guide.* Jakarta. : LIPI Press. , 2021.

[2] E. A. Widjadja*et al.*, *Kekinian Keanekaragaman Hayati Indonesia*. Jakarta: cetakan kedua. LIPI Press. , 2015.

[3] D. Buchori*et al.*, *Keanekaragaman Serangga Hutan Hujan Tropis Dataran Rendah di Provinsi Jambi, Sumatra: Dampak Perubahan Tata Guna Lahan*. Jakarta: LIPI Press, 2021.

[4] A. Achmad, *Potensidan Sebaran Kupu-Kupu di Kawasan Taman Wisata Alam Bantimurung*. Bantimurung: Workshop Pengelolaan Kupu-kupu Berbasis Masyarakat., 2002.

[5] D. C. Lamatoa, R. Koneri, R. Siahaan, and P. V Maabuat, "POPULASI KUPU-KUPU (LEPIDOPTERA) DI PULAU MANTEHAGE, SULAWESI UTARA," 2013.

[6] T. H. Sulistyani, "Keanekaragaman jenis kupu-kupu (Lepidoptera: Rhopalocera) di kawasan Cagar Alam Ulolanang Kecubung Kabupaten Batang.," Skripsi, Universitas Negeri Semarang., Semarang, 2013.

[7] B. Priyono and M. Abdullah, "Keanekaragaman Jenis Kupu-kupu di Taman Kehati Unnes," Semarang, 2013. [Online]. Available: http://journal.unnes.ac.id/nju/index.php/biosaintifika

[8] A. Y. Ramdhani, S. P. Departemen, and A. Lanskap, "STUDI POTENSI KANOPI POHON DI KEBUN RAYA BOGOR DALAM MENYERAP EMISI KARBONDIOKSIDA DARI KENDARAAN BERMOTOR Study Potentials of Canopy Trees in Bogor Botanical Garden to Absorb Carbondioxide Emissions from Vehicles IndungSitti Fatimah," 2013.

[9] O. Hotimah, "Partisipasi Masyarakat Dalam Pelestarian Hutan Kota," *SPATIAL Wahana Komunikasi dan Informasi Geograf*, vol. 13, no. 1, 2015.

[10] K. Yuriawan, E. Supriatna, and I. D. Karyantara, *BukuPanduanWisataKebun Raya Bogor.* Jakarta. : LIPI Press. , 2017.

[11] Kebun Raya Bogor, "Spot menarik di Kebun Raya Bogor," Bogor, 2022.

[12] Friscarnela, H. J. T. R.B, and M. Yogie, "Identifikasi fungsi Kebun Raya Bogor sebagai ruang terbuka hijau (RTH) publik," *Jurnal Online Mahasiswa (JOM)*

Bidang Perencanaan Wilayah &Kot, vol. 1, no. 1, 2018.

[13] R. Koen Asharo*et al.*, "Araceae Floristic and Potential Study in Bogor Botanical Gardens," *Jurnal Riset Biologi dan Aplikasinya*, vol. 4, no. 1, pp. 9–18, 2022, doi: 10.26740/jrba.v4n1.p.

[14] S. D. Azahra, R. Hermawan, and L. N. Ginoga, "Pengaruh Karakteristik Habitat Ruang Terbuka Hijau terhadap Keanekaragaman Kupu-Kupu (Studi Kasus di Kebun Raya Bogor). Skripsi. Bogor. IPB. ," Skripsi, Institut Pertanian Bogor, Bogor, 2012.

[15] M. A. Rizky, L. N. Ginoga, and R. S. Hidayat, *Keanekaragaman Kupu-kupu dan Tumbuhan Pakannya di Kebun Raya Bogor.* Bogor, 2019.

[16] D. Peggie, *MengenalKupu-kupu.* Jakarta. : Pandu Aksara Publishing. , 2014.

[17] C. H. Schulze, "Identification guide for butterflies of West Java (Families Papilionidae, Pieridae, and Nymphalidae).," *https://www.scribd.com/doc/59592328/Butterflies-W-Java*, May 10, 2010.

[18] S. Rizal, "PopulasiKupu-kupu di Kawasan Cagar Alam Rimbo Panti dan Kawasan Wisata Lubuk Minturun Sumatera Barat.," *Mandiri*, vol. 9, no. 3, pp. 177–237, 2007.

[19] R. I. Vane-Wright and R. de Jong, *The Butterflies of Sulawesi: annotated checklist for a critical island fauna.* , vol. 343. Zoologische Verhandelingen, 2003.

[20] D. F. Lestari, R. D. A. Putri, M. Ridwan, and A. D. Purwaningsih, "Keanekaragaman kupu-kupu (Insekta: Lepidoptera) di Wana Wisata Alas Bromo, BKPH Lawu Utara, Karanganyar, Jawa Tengah," *Prosiding Seminar Nasional Masyarakat Biodiversitas Indonesia.*, vol. 1, no. 6, 2015.

[21] B. Dendang Balai Penelitian Kehutanan CiamisJl Raya Ciamis-Banjar, "Keragaman Kupu-kupu di Resort Selabintana…(Benyamin Dendang) KERAGAMAN KUPU-KUPU DI RESORT SELABINTANA TAMAN NASIONAL GUNUNG GEDE PANGRANGO, JAWA BARAT (The Diversity of Butterflies in Selabintana Resort,

GunungGedePangrango National Park, West Java)*),” 2009.

[22] B. Dewi, A. Hamidah, T. Sukmono, and U. Jambi, “KEANEKARAGAMAN KUPU-KUPU DI KABUPATEN KERINCI DAN SEKITARNYA,” 2020.

[23] R. (2016). Koneri, “Kelimpahan Kupu-Kupu (Lepidoptera) di Kawasan Cagar Alam Gunung Ambang Sulawesi Utara.,” *Jurnal Pro-Life: Jurnal Pendidikan Biologi, Biologi, dan Ilmu Serumpun*, vol. 3, no. 2, pp. 71–82, 2016.

[24] G. Vinithashri and J. S. Kennedy, “Butterfly diversity in relation to host and nectar food plants in TNAU Botanical Garden, Coimbatore,” *J Environ Biol*, vol. 42, no. 4, pp. 1141–1151, Jul. 2021, doi: 10.22438/jeb/42/4(SI)/MRN-1535b.

[25] M. Watanabe and T. Imoto, “Thermoregulation and flying habits of the Japanese sulfur butterfly Coliaserate (Lepidoptera: Pieridae) in an open habitat. ,” *EntomolSci*, vol. 6, no. 3, pp. 111–118, 2003.

[26] F. Rohman, M. A. Efendi, and L. R. Andrini, *BioekologiKupu-kupu.* . Malang. : UM Penerbit&Percetakan., 2019.

[27] N. Fitriani, A. Royani, G. M. N. Iqbal, and Y. T. Rahmania, “ Keanekaragaman kupu-kupu di wilayah pemukiman Desa Pangandaran Ciamis Jawa Barat. ,” *ETHOS: Jurnal Penelitian dan Pengabdian Masyarakat*, pp. 48–54, 2017.

[28] P. N. Prasetyo, S. Noerfahmy, and H. S. Tata, *Jenis-Jenis Kelelawar Khas Agroforest Sumatera*. World Agroforestry centre-ICRAFT Sea Regional Office., 2013.

[29] S. Lamin, D. Setiawan, N. Sari, and J. Biologi, “KEANEKARAGAMAN DAN SEBARAN KUPU-KUPU (Lepidoptera: Rhacalopera) DI KAWASAN KAMPUS UNIVERSITAS SRIWIJAYA INDRALAYA SUMATERA SELATAN DISTRIBUTION AND DIVERSITY OF BUTTERFLIES (Lepidoptera: Rhopalocera) IN CAMPUS AREA INDRALAYA SRIWIJAYA UNIVERSITY OF SOUTH SUMATERA,” 2015.

[30] I. W. Natasa, F. Zahida, and P. Yuda, “The Diversity of Butterflies (Lepidoptera) in Plawangan, the area of Mount Merapi National Park, Special Region of Yogyakarta.,” Skripsi, UniversitasAtma Jaya. , Yogyakarta. , 2016.

[31] A. E. Magurran, *Ecological diversity and its measurement*. New Jersey. : Princeton University Press., 1998.

[32] Odum, *Dasar-Dasar Ekologi: Edisi Ketiga*. Yogyakarta: GadjahMada University Press, 1996.