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The Correlation Between Butterfly and Flower Plant: Study for Ecology Sustainability

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Abstract | This study examines the correlation between butterflies and plants in open and shaded habitats within Srengseng Urban Forest, West Jakarta, to understand biodiversity patterns and inform sustainable urban landscape planning. Field observations were conducted from January to March, 2024, in two habitat types open (sunlit) and shaded (canopied). Butterfly species and flowering plants were recorded using purposive sampling, alongside measurements of environmental factors. Species diversity was analyzed using the Shannon-Wiener and evenness indices, while Pearson correlation assessed the relationship between butterfly abundance and flowering plant percentage. A total of 601 butterfly individuals from 43 species were found, with higher richness in open habitats (401 individuals, 40 species) than in shaded ones (200 individuals, 27 species). Diversity in both habitats was moderate, and the evenness index showed high distribution uniformity. A strong positive correlation (r = 0.76) was found between butterfly abundance and flowering plant presence. These findings suggest that both plant availability and microclimatic conditions significantly influence butterfly distribution. The study underscores the importance of flowering plants in supporting pollinators and highlights the need for habitat-specific conservation. Efforts like eco-tourism and pollinator gardens can promote community involvement, sustain livelihoods, and preserve mutualistic plant-insect interactions in urban green spaces. Furthermore, this finding will have a significant impact, supporting the Sustainable Development Goals, particularly Goal 11: Sustainable cities and communities, and also sustainable agriculture.

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Introduction

Green spaces with trees in urban areas are called urban forests. These areas can act as climate stabilizers, improve city aesthetics, serve as groundwater recharge zones, and offer shelter that supports environmental sustainability (Asri *et al*., 2023; Hadinoto *et al*., 2023). Trees in urban forests also serve as natural filters, absorbing pollutants and releasing clean air that benefits human health (Brito, 2023). Additionally, these habitats support various flora and fauna including butterflies (Ramirez-Restrepo and MacGregor-Fors, 2017). Such ecosystems provide the essential resources butterflies need to thrive, helping to conserve urban biodiversity (Sari *et al*., 2023).

Butterflies, a group of insects from the order Lepidoptera, are widespread and highly sensitive to environmental changes (Gunjan *et al*., 2024; Ismail *et al*., 2020). They serve as pollinators by feeding on floral nectar and are typically active during the day (Ghazanfar *et al*., 2016a, b). Since their presence and diversity both in terms of species and individuals depend on abiotic and biotic factors (Koneri *et al*., 2022), butterflies can function as bioindicators of environmental change in specific areas (Ricco *et al*., 2019).

The role of host and feed plants is crucial for butterflies, especially during their sub-imago and imago stages (Hailay *et al*., 2022; Irsa *et al*., 2022). Therefore, vegetation complexity in an area influences the species composition. It is also notable that brightly colored flowers with mild scents are more attractive to butterflies (Herlinda and Sari, 2023), so their budding flowers are more likely to be well-pollinated with their help. Pollinating insects are highly valued in agriculture and agribusiness because they improve both the quality and quantity of production.

Budianto and Sukendah (2023) stated that butterflies, along with other pollinating insect species, affect the pollination process of the castor plant (*Ricinus communis* L.). With a visit rate of over 50 %, butterflies also significantly enhance pollination for macadamia (*Macadamia integrifolia* Maiden and Betche) production (Santos *et al*., 2020). Lestari *et al*. (2023) stated that *Phalanta phalantha* (Drury, 1773), *Eurema hecabe* (Linnaeus, 1758), Genus: *Tajuria* sp. (Moore, 1881, and *Jamides celeno* (Cramer, 1775) are pollinators in Sandalwood plants (*Santalum album* Linn.) in the Purwodadi botanical garden, East Java, Indonesia. Maryuni (2018) reported that several butterflies are pollinators of watermelon flowers (*Citrulus lanatus* Thunb.). Sari *et al*. (2016) further detailed that there are 16 species of butterflies belonging to 14 genera and five families that play a role in pollination in watermelon plants.

Daawia *et al*. (2024) emphasized that butterflies play a role as pollinators in sustainable agriculture. They stated that Lycaenidae plays a role in helping pollinate horticultural plants such as *Jamides soemias* (Druce, 1891), *Euchrysops cnejus* (Fabricius 1798), *Everes lacturnus* (Godart, 1824), *Catochrysops panormus* (C. Felder, 1860), *Zizula hylax* (Fabricius, 1775) helps pollinate *Momordica balsamina* L. It was also stated that *E. cnejus*, *E. lacturnus*, and *J. soemias* help pollinate the *Vigna unguiculata sesquipedalis (*L.) plant. *Eurema hecabe* (Linnaeus, 1758) helps pollinate wild cucumber (*Curcuma* sp.) and cucumber (*Crocus sativus* L.). *Eurema blanda* (Boisduval, 1836), also helps pollinate *C. sativus*. The species *E. hecabe, E. blanda,* and *Eupithecia puella* (Mironov and Galsworthy, 2004) were also observed visiting and helping pollinate sweet orange (*Citrus sinensis* (L.) Osbeck) flowers, while *Catopsilia pomona* (Fabricius, 1775) and *E. hecabe* helped pollinate *Cucurbita moschata* (Duchesne).

Abiotic factors include microclimates related to habitat exposure that affect butterflies, such as temperature, humidity, and light intensity (Ambarli, 2024). A study on butterfly biodiversity in Srengseng urban forest was conducted in 2014 (Ruslan *et al*., 2020), while another study on environmental factors influencing butterfly biodiversity was completed in 2023 (Amalia, 2023). The authors repeated their survey in 2014 at the same place to check whether there was a population change after 10 yr. The reason for the re-observation was related to several studies that reported a decline in butterfly populations.

Warrena *et al*. (2021) reported that in the United Kingdom, 8 % of resident species have become extinct, and since 1976, overall numbers have declined by around 50 %. In the Netherlands, 20 % of species have become extinct; since 1990, overall numbers have declined by 50 %. In Flanders (Belgium), 20 butterflies have become extinct (29 %), and between 1992 and 2007, overall numbers declined by around 30 %. Chowdhury *et al*. (2021) stated that the butterfly population in three urban parks in Dhaka City, Bangladesh, decreased sharply during 3 yr (January 2014 to December 2016). They feared that 40 % of butterfly species were threatened with extinction. Sulistyani *et al*. (2014) indicated that 19 types of Indonesian butterflies were threatened with extinction, while Ruslan *et al*. (2023) stated that there had been a 25 % decline in the abundance of butterflies in the Ragunan city forest (Indonesia).

Specifically, in the transition from forests to oil palm plantations, it was reported that butterfly species were lost (Ginoga *et al*., 2019; Hamer *et al*., 2015; Koh and Wilcove, 2008). Hamer *et al*. (2015) stated that species lost from 79 % to 83 %, while Ginoga *et al*. (2019) reported 15.79 % to 23.81 %. However, there was a butterfly species gain of 128.57 % to 136.84 % (Ginoga *et al*., 2019).

Several researchers (Chowdhury *et al*., 2021; Ghazanfar *et al*., 2016a, b; Mallick *et al*., 2023; Warrena *et al*., 2021) have stated that the decline in butterfly populations is due to the use of agricultural chemicals, the expansion of monoculture agriculture crops, and global warming. Chuan-ming *et al*. (2021) declared that the decline in butterfly populations is also due to the reduction in amino acids in flower nectar. Amino acid reduction (Setyobudi *et al*., 2023, 2024) occurs because absorption of nutrients and water is inhibited by microplastic (MPs) particles (De Silva *et al*., 2021; Setyobudi *et al*., 2025). The United Nations Environment Program (UNDEP) has designated global warming as the main danger to living things, while the second danger is MPs pollution due to the ubiquitous pollution (Loganathan and Kizhakedathil, 2023; Saati *et al*., 2025; Wahyudi *et al*., 2025).

This study explores the correlation between butterflies and plants in open and shaded habitats to understand biodiversity patterns, ecosystem health, also to provide insights into ecosystem transport-energy chain production. The continuing research can track how butterfly communities change over time, especially in response to ongoing urbanization and habitat transformation.

Many studies documenting the decline in butterflies with urbanization are not fully disentangled; more research is needed to clarify how these factors interact to shape butterfly communities in urban settings and to quantify the actual benefits butterflies provide to urban agriculture and green infrastructure. Furthermore, this research supports sustainable agriculture, particularly in its emphasis on the role of butterflies as pollinators (Bardales *et al*., 2017; Daawia *et al*. 2024; Rivest *et al*., 2023; Saldivar *et al*., 2022; Yek *et al*., 2024). It also supports the achievement of Sustainable Development Goals, particularly Goals 2, 3, 11, and 13 (United Nations, 2025).

Materials and Methods

Conducted from January 1 to March 10, 2024, butterflies within the area of Srengseng urban forest, West Jakarta, Indonesia (Figure 1, coordinate S 6°12'33.192" E 106°45'42.6024") were observed.

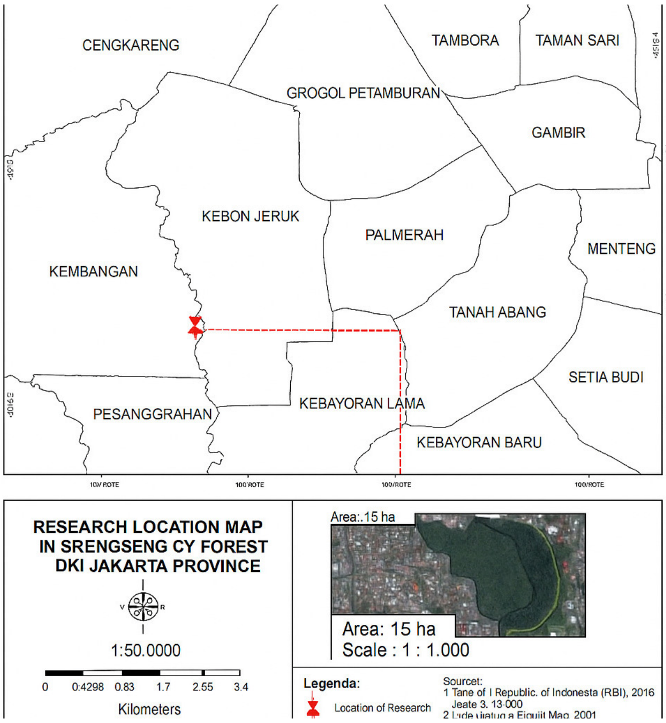

Figure 1: *Map of Srengseng Urban Forest, West Jakarta.*

Figure 2: *Open habitat.*

Two habitats were pinpointed for the purpose: open habitat, which is exposed to direct sunlight with minimum shade from tall trees or buildings where plants can generally adapt to hot, dry conditions such as shrubbery or grass and flower plants are likely found (Figure 2), and shaded one which is blocked out from sunlight by either natural or artificial canopy where plants can generally adapt with humidity condition such as tall trees, vines, and undergrowth (Figure 3).

Figure 3: *Close habitat.*

A purposive sampling plot was prepared for each habitat, which was monitored daily between 08.00 to 12.00 and 14.00 to 16.00 West Indonesian Time (WIB). The purpose was to align with the primary diurnal activity species under stable microclimatic conditions. The plot size was 20 m × 20 m and 10 m × 10 m to present a commonly used unit in tree and shrub/herb-level vegetation sampling, allowing for the simultaneous assessment of butterfly-habitat structure that influences their distribution. Butterfly-feed plants were marked within the plot count. The unrecognized ones corresponded with the identification book (Engel and Phummai, 2002; Yudhono and Sukarya, 2013). Butterfly sampling was conducted using visual encounter surveys and photographic records. Observers stay in a fixed plot and record all butterflies seen within a set distance. Repeated data were used three times to ensure and enhance their utility for understanding diversity patterns at the microhabitat scale. Recognized species of butterflies and their quantities were collected, while unrecognized ones were captured or photographed before being matched with the identification book (Kirton, 2021; Peggie and Amir, 2006; Weei and Mun, 2008). This method is typically used for non-invasive and visible species, also non-destructive for rare or protected species.

Environmental parameters were measured every 2 h during research time 08.00 to 16.00, including humidity (%), temperature (°C), light intensity (lux), and wind speed (m s^{-1}). The instrument was used digital Lux Meter Smart Sensor series AS803 includes a temperature and humidity sensor (range 0 to 200 000 lux, -10 to 50 °C, and 0 % to 100 %), and a digital wind anemometer series GM816 (range 0 m s^{-1} to 30 m s^{-1}).

Data analysis

Assessment of butterfly composition: The composition of the taxa that comprise the butterfly community is assessed based on the number of taxa (class, order, family, and species) identified in the research area. The data are tabulated systematically to be directly compared between locations based on vegetation type.

Assessment of butterfly diversity index: The butterfly diversity index is based on species diversity based on Shannon-Wiener (Magurran, 1988), as shown in Equation 1.

$$H' = - \Sigma \text{ pi ln pi, where pi} = \text{ni} / \text{N} \quad (1)$$

Notes: H′= Diversity index, ni= number of individuals of species i, N= Total number of individuals found.

The criteria used to determine the H' value are as follows:
- Low = if the H' value < 1.5
- Medium = if the H' value is > 1.5 and < 3.5
- High = if the H' value > 3.5

Assessment of species evenness index

The species evenness index (E) is used to see the evenness of butterfly species. The Equation 2 based on Magurran (1988):

$$E = \frac{H'}{H'\,maks} \text{ or } E = \frac{H'}{Ln\,S} \quad (2)$$

With: H' max = maximum evenness index = In S

The range used in the evenness index is as follows:
0.0 < E ≤ 0.5: small population evenness
0.5 < E ≤ 0.75: medium population evenness
0.75 < E ≤ 1: high population evenness

The smaller the evenness index, the smaller the evenness of the butterfly population. It indicates that the distribution of the number of individuals of each species is not the same, so one individual tends to dominate. The greater the evenness value, it describes the distribution of the number of individuals of each type at each observation location as the same or not much different.

Assessment of the importance value index (IVI)

The importance of the dominance value index in butterflies are based on the abundance and distribution of a species in a habitat. The importance value index is based on the combination of relative abundance and frequency of presence of a species. Relative Abundance (RA) is based Brower *et al*. (1990). Abundance based on the proportion of a species using the Equation 3.

$$RA = \frac{Number\ of\ Individuals\ in\ each\ species}{\text{Total number of individuals}} \times 100\ \% \quad \ldots(3)$$

Relative frequency (FR) (Brower *et al*., 1990)

The distribution of a population is assessed based on the frequency of presence in various plots spread across a habitat. The frequency of presence value is determined based on Equation 4 (Krebs, 1985):

$$FR = \frac{Frequency\ of\ a\ type}{\text{Frequency of all type}} \times 100\ \% \quad \ldots(4)$$

The important value index (IVI) (Fachrul, 2012).

IVI of butterflies is determined using Equation 5:

$$IVI = RA + FR \quad \ldots(5)$$

Correlation of the number of individual butterflies and the percentage of flowering plants

The correlation coefficient measures the strength and the linear relationship of two variables. To calculate the correlation, using Equation 6 (Sugiyono, 2020):

$$r = \frac{n\sum XY - \sum X \sum Y}{\sqrt{(n\sum X^2 - (\sum X)^2)\,(n\sum Y^2 - (\sum Y)^2)}} \quad \ldots(6)$$

The value of the correlation coefficient (r) lies between -1 and +1

$$(-1 \leq r \leq +1)$$

If r = +1, there is a perfect positive correlation between variable X and variable Y.
If r = -1, there is a perfect negative correlation between variable X and variable Y.
If r = 0, there is no correlation between variables X and Y.
If 0 < r < +1, there is a positive correlation between variable X and variable Y.
If -1 < r < 0, there is a negative correlation between variable X and variable Y.

Results and Discussion

Composition

A total of 601 individuals from 43 butterfly species were recorded in the Srengseng urban forest. Based on the type of habitat in the Srengseng urban forest, a total of 401 individuals from 40 butterfly species were spotted in the open habitat, and 200 individuals from 27 butterfly species were spotted in the shaded habitat (Table 1).

Table 1: *Butterfly composition in two habitats: Compared with the data from 2014.*

Taxon	2014			2024		
	Open habitat	Shaded habitat	Total	Open habitat	Shaded habitat	Total
Family	4	4	4	4	4	4
Genus	18	12	20	23	15	30
Species	26	19	30	40	27	43
Individual	100	100	200	401	200	601

Compared to observations made in 2014 (Ruslan *et al*., 2020), Table 1 shows an increase in the number of individuals and species, from 200 to 601 individuals and from 30 to 43 species, respectively. Several reasons for the rise are thought to be because of location, the abundance of food plants (Mallick *et al*., 2023), the availability of habitat for breeding (Kemmerling *et al*., 2023), and it could also be because the habitat conditions at the time of observation were stable (Wicaksono *et al*., 2023).

After 10 yr, the Srengseng urban forest has become denser, affecting abiotic factors, namely temperature and humidity. Likewise, more flowering trees can be fed to butterflies. Another thing is that the community, including urban forest managers, is increasingly knowledgeable and aware of maintenance so that ideal conditions are created for the development of butterflies.

Table 1 also shows that more butterflies live in open habitats than in shaded habitats. It is due to the abiotic aspects in Table 2. Abiotic factors, including temperature and humidity, affect the preference of butterfly species (Koneri *et al*., 2022). In addition, sunlight in open habitats allows more flowering plants to grow, becoming a significant food source for butterflies. As a result, the abiotic dynamics above shape an ideal area for flowering plants as a biotic reason for butterflies to live. Ruslan *et al.* (2023) also support this by stating that the survival rate of butterflies in a habitat is highly dependent on environmental factors.

Table 2: *Abiotic factors in two habitats.*

Abiotic parameter*	Open habitat	Shaded habitat
Wind velocity (m s^{-1})	0.65	0.61
Light intensity (lux)	7 776.2	3 109.9
Humidity (%)	76.87	76.9
Temperature (°C)	30.2	29.6

*Abiotic parameter measurement in average

The diversity of plants in a habitat contributes to feed availability, making butterflies easier to find in open habitats than in shaded ones. Since biotic features of feed plant and host plant, as well as abiotic ones of temperature, humidity, and light intensity, are worthy for butterfly individual and species abundances in an area (Ambarli, 2024), it is deduced that the characteristics, including available resources, in both habitats are similar to each other.

The abiotic conditions between open and shaded habitats showed distinct differences, particularly in light intensity and temperature, while humidity and wind velocity were relatively similar (Table 2). The difference in wind velocity was minimal, suggesting that vegetation cover in shaded areas reduces wind flow only slightly. Both values indicate relatively low wind velocity, typical of near-ground microhabitats. Light intensity in the open habitat was more than double that of the shaded habitat. This reflects canopy cover reducing sunlight penetration, a critical factor influencing plant photosynthesis, butterfly activity, and microclimatic conditions. Humidity levels were virtually identical, suggesting that despite differences in canopy cover, the overall atmospheric moisture remained stable across both habitats. The open habitat was slightly warmer (+0.6 °C) than the shaded habitat. The difference is small but ecologically relevant, as higher temperatures combined with higher light may enhance butterfly thermoregulation and activity in open habitats.

Diversity and evenness indexes

The results of the calculation of the Shannon-Wiener diversity index (H') and evenness index (E) in open and shaded vegetation habitats can be seen in Table 2. Open vegetation habitats have a higher diversity index value (H'= 3.05) than shaded vegetation habitats (H'= 2.95). However, both diversity index values are moderate, between 1.5 and 3.5. The evenness index value approaching 1 in both habitats also indicates a high level of evenness of butterfly species in open canopy vegetation habitats (E= 0.83) and shaded (E= 0.90). The outcomes are listed in Table 3.

Table 3: *Butterfly diversity index and evenness index values.*

Component	Open habitat	Shaded habitat
Diversity index	3.05	2.95
Evenness index	0.83	0.9

As for evenness values, an open habitat of 0.83 and a shaded habitat of 0.90 indicate that butterfly species are evenly spread the nearly 1.00 rates further represent high distribution in both habitats. The fact proves that an equally amiable quantity of resources is accessible in open and shaded habitats. This result corroborates the finding of Mas'ud *et al.* (2019) that the existence of highly preferred feed plants and host plants is paramount in maintaining butterflies in a habitat.

High species evenness is often positively correlated with ecological resilience, which is essential for sustaining biodiversity and ecosystem functionality. Evenness reflects how individuals are distributed across species in a community; when it is high, ecological roles are shared more evenly, preventing overdependence on a few dominant species. This balance supports functional redundancy, where multiple species contribute similarly to key processes like pollination, nutrient cycling, or pest control. As a result, ecosystems with high evenness can better withstand disturbances (*e.g.*, climate fluctuations or habitat changes) and recover more quickly, as other species can compensate if one declines.

Moreover, high evenness may reduce the risk of invasive species establishment by limiting ecological niches and increasing community resistance. These findings align with the insurance hypothesis, which suggests biodiversity buffers ecosystems against environmental uncertainty (Yachi and Loreau, 1999). Therefore, promoting evenness alongside species richness in conservation strategies enhances not only biodiversity but also long-term ecological stability and resilience. This concept is particularly relevant in urban green spaces where fluctuating environmental conditions and human disturbance are common.

Importance value index

Butterfly species with high IVI values (dominant) indicate habitat conditions and plant availability that support the species' survival. Three butterfly species with the highest IVI values in open habitats are: *P. hebe* (18.0 %), *E. hecabe* (17.3 %), and *Z. otis* (14.6 %). Three butterfly species with the highest IVI values in shaded vegetation habitats are *L. nina* (25.56 %), *D. hyparete* (21.11 %), and *H. bolina* (18.89 %). High IVI values can be caused by the presence of a butterfly species in all observation plots in the habitat. A high IVI value at a location indicates that the species has a vital role in the habitat, so it needs to be protected to maintain the sustainability of the ecosystem (Azizah *et al*., 2021; Sukma *et al*., 2021).

The three butterfly species with the highest IVI values in shaded canopy vegetation habitats were *D. hyparete* (22.4 %), *P. polytes* (21.5 %), and *N. hylas* (17.6 %) are the most seen species. Known to be able to live in various areas, including open environments, grassland, and woodland (Oo, 2020), *D. hyparete* should spawn well in shaded habitats. Additionally, its slow movement makes it easier to notice. *P. polytes*, Papilionidae family has a wider variety of host plants than other species (Peggie *et al*., 2022), allowing it to settle even in less warm areas. *N. hylas*, frequently spotted in oil palm plantations, can live in canopied surroundings (Ginoga *et al*., 2019), so the shaded habitat of the studied site is its natural territory. The adaptability of some species (e.g., *D. hyparete*, *P. polytes*, *N. hylas*) to various habitats, including open, shaded, and even disturbed environments, highlights their ecological flexibility and the importance of diverse habitat features for butterfly conservation.

Correlation

Pearson correlation was used to analyze the relationship between the percentage of flowering plants (variable 1) and the number of individual butterflies (variable 2). Based on the calculation results shown in Figure 4, a correlation value of R= 0.76 was obtained. Referring to the correlation interpretation criteria according to Sugiyono (2020), this value indicates a strong relationship between the number of individual butterflies and the percentage of flowering plants in the two habitats observed.

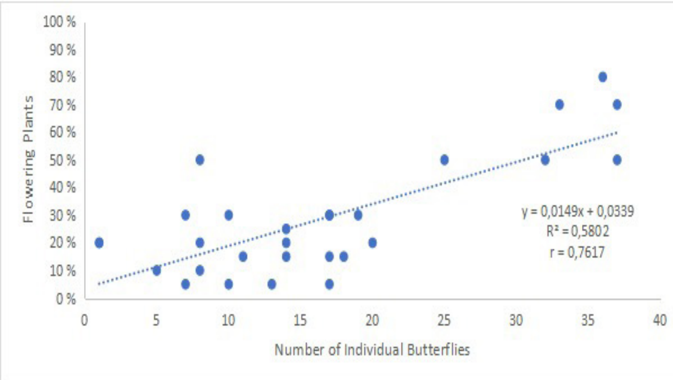

Figure 4: *Correlation of butterfly individual quantity and flowering plant.*

Table 4: *Vegetation in open and shaded habitat.*

Species name	Growth form	Habitat		Notes/Typical habitat
		Open	Shaded	
Asystasia intrusa (Forssk.) Nees	Herb	√	√	Low-growing, often in disturbed sites
Cyperus kyllingia Endl. ex Hassk.	Herb (Sedge)	√	-	Grass-like, found in moist areas
Cyperus rotundus L.	Herb (Sedge)	√	-	Perennial weed, grass-like
Tridax procumbens L.	Herb	√	-	Creeping, common weed
Cleome rutidosperma DC.	Herb	√	-	Small, annual, in open ground
Ageratum conyzoides L.	Herb	√	-	Erect, annual, invasive weed
Ixora coccinea L.	Shrub	√	-	Ornamental, evergreen
Chromolaena odorata (L.) R.M.King and H.Rob.	Shrub	√	-	Invasive, bushy, up to 2–3 m tall
Lantana camara L.	Shrub	√	-	Invasive, woody, can climb
Colocasia esculenta (L.) Schott	Herb	√	-	Large-leaved, tuberous, wet areas
Saraca asoca (Roxb.) Willd.	Tree	√	-	Medium-sized, ornamental
Mangifera indica L.	Tree	-	√	Large, fruit-bearing (mango)
Cinnamomum zeylanicum Blume	Tree	-	√	Medium, aromatic (cinnamon)
Polyalthia longifolia (Sonn.) Thwaites	Tree	-	√	Tall, ornamental
Pennisetum purpureum Schumach.	Herb (Grass)	-	√	Tall grass, fodder

Table 5: *Dominant larval host and nectar plants by habitat type.*

Habitat type	Dominant larval host plants	Dominant nectar plants	Citations
Open/ Grass-land/Scrub	Fabaceae, Malvaceae, Acanthaceae, non-natives	Asteraceae, Fabaceae, Lantana camara, Tephrosia purpurea	(Yek *et al.,* 2024; Arigela *et al*., 2024; Bardales *et al*., 2017)
Urban/ Agricultural	Fabaceae, Malvaceae, non-natives	Asteraceae, Fabaceae, Lantana camara, various ornamentals	(Saldivar *et al.,* 2022; Yek *et al*., 2024; Rivest *et al*., 2023; Arigela *et al*., 2024)

Tables 4 and 5 shows that the flowering plant is focal in inviting butterflies to settle in a locale habitat (Haaland, 2023). The insect is generally attracted to flower scent and color, indicating nectar and pollen (Nursia *et al*., 2022). To ensure continuous butterfly pollination for biodiversity balance, providing conservatory spaces in diverse climatic conditions and vegetation is called for (Habel *et al*., 2022). Further, adapting the favorable characteristics of open habitat in urban landscape for both commercial and non-commercial produce should encourage butterflies to pollinate more and, in the end, optimize the transport energy chain in ecosystems that work naturally. Information on key pollinator issues *i.e.,* feed and shelter should support a complete analysis of cover plant management, potential weed and herb cultivation, or other attempts to conserve pollinating insects like butterflies and bees.

Ecological challenges include climate conditions and vulnerability to pests and diseases. Based on environmental aspects and ecological sustainability, the success of a sustainable environment can be determined through the parameters of pest and natural enemy populations and beneficial insects. These are vital in sustaining ecosystem function and connectivity, such as pollinators that accelerate plant pollination, including butterflies, decomposers that recycle organic matter for soil fertility, and predators and parasitoids that control pests naturally. In addition, insects also function as bioindicators that provide an overview of the quality of the urban green landscape environment.

Larval host plants are often habitat-specific, with forests favoring woody species and open/urban habitats favoring herbaceous and sometimes non-native plants. Nectar sources are dominated by herbaceous perennials and flowering weeds (Asteraceae, Fabaceae), regardless of habitat, but diversity is highest in open and urbanized areas. Butterfly–plant interactions are dynamic, with some species adapting to non-native plants, especially in urban and disturbed habitats, highlighting the importance of plant diversity for butterfly conservation. The abundance and biodiversity of butterflies, with their connection to plants, play a key role in preserving mutualistic relationships while engaging communities in urban landscapes. For example, build an eco-tourism program centered on butterfly watching. It can involve local communities, promote environmental education, and support sustainable livelihoods that align with conservation goals.

Conclusions and Recommendations

Based on the study's results, a total of 601 individuals from 43 butterfly species were found in the Srengseng urban forest. A total of 40 butterfly species, with a total of 401 individuals, were recorded in open habitats, while 27 species, with 200 individuals, were found in shaded habitats. The diversity index in both habitat types falls within the moderate category. Correlation analysis showed a powerful relationship between the number of butterfly individuals and the percentage of flowering plants (R= 0.76). It indicates that various biotic and abiotic factors influence the abundance of butterfly individuals in a given habitat. Furthermore, this study recorded more species and individuals compared to the findings in 2014, suggesting a possible improvement in habitat conditions or vegetation quality over time.

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Novelty Statement

Compared to observations made in 2014 (Ruslan *et al*., 2020), this study showed an increase in the number of individuals and species of butterflies. This research combines urban ecological data, microhabitat comparison, robust analytical methods, and real-world conservation implications contributing fresh insights into urban biodiversity conservation in tropical megacities. It provides updated data to underrepresented and rapidly changing urban areas in Southeast Asia. Most previous studies focus on rural, agricultural, or protected forest zones, making this urban focus a significant contribution to understanding urban biodiversity dynamics.

Author's Contribution

Hasni Ruslan: Conceptualizing and designing research, outlining the contents of the paper, conducting literature searches, collecting data, analyzing data, preparing the manuscript, and revising the manuscript.
Maizirwan Mel: Research supervisor and guarantor.
Nonon Saribanon: Assist in writing drafts and revising manuscript.
Imran Said Lumban Tobing and Dimas Mulya Pratama: Manuscript review.
All authors have read and approved the final manuscript.

Generative AI and AI-assisted technology statement
The authors stated that they didn't use generative AI and AI-assisted technology in preparing this manuscrip

Conflict of interest
The authors have declared no conflict of interest.

References

Amalia, E.R., 2023. The determinant environmental factors of butterfly diversity in Srengseng Urban Forest, West Jakarta. Undergraduate thesis, IPB University, Bogor, Indonesia.

Ambarlı, D., 2024. Heterogeneity is key to supporting forest-dweller butterflies. Anim. Biodivers. Conserv., 47: 39–48. https://doi.org/10.32800/abc.2024.47.0039

Arigela, R.K., T. Kathula, R. Kumar, P.K. Deroliya, S. Jeevith and R.K. Singh. 2024. Tephrosia purpurea, the potential nectar source for the butterflies in Jodhpur, an arid zone of Thar Desert, Rajasthan, India. Stud. Natur., 9: 85–108. https://doi.org/10.24917/25438832.9.5

Asri, B.M., B. Supriono and D.A. Sasongko. 2023. The role of the Gelora Bung Karno city forest as an oxygen. J. Nusa Sylva, 23: 42–50. https://doi.org/10.31938/jns.v23i1.709

Azizah, A., I. Mustafa, Z.P. Gama and A.S. Leksono. 2021. The diversity and abundance of butterfly (Lepidoptera) in several urban green spaces of Malang city. IOP Conf. Ser. Earth Environ. Sci., 741(012057): 1–9. https://doi.org/10.1088/1755-1315/741/1/012057

Bardales, J., R. Gómez, P. Canaquiri, J. Jiménez, J. Hernández, G. Lamas, and P. García. 2017. Food plants of 19 species of diurnal butterflies (Lepidoptera) in Loreto, Peru. Rev Peru Biol., 24: 35–42. https://doi.org/10.15381/rpb.v24i1.13109

Brito, V., 2023. Characteristics of urban forestry and sustainable urban development for well-being. J. For. Res., 12: 459.

Brower, L.P., L.M. Cook and H.J. Croze. 1990. Evolutionary and ecological perspectives on the population structure of butterflies. Insect Sci. Its Appl., 11(4): 467–477. https://doi.org/10.1017/S1742758400021044

Budianto, S. and S. Sukendah. 2023. Pollinator insect control technology and conservation as one of the indicators of natural balance. J. Ilmu Pertan. Perkebunan, 5: 7–15. https://doi.org/10.55542/jipp.v5i1.508

Chowdhury, S. S.A. Shahriar, M. Bo¨hm, A. Jain, U. Aich, M.P. Zalucki, T. Hesselberg, F. Morelli, Y. Benedetti, A.S. Persson, D.K. Roy, S. Rahman, S. Ahmed and R.A. Fuller. 2021. Urban green spaces in Dhaka, Bangladesh, harbour nearly half the country's butterfly diversity. J. Urban Ecol., 7(1): 1–11. https://doi.org/10.1093/jue/juab008

Chuan-ming, L., X. Jian, L. Qin, H. Guang-jie, X. Bin, Y. Yi-zhong and L. Xian-jin. 2021. Potential influence of carbohydrate and amino acid intake by adults on the population dynamics of *Cnaphalocrocis medinalis* (Lepidoptera: Crambidae). J. Integr. Agric., 20(7): 1889–1897. https://doi.org/10.1016/S2095-3119(20)63419-0.

Daawia, N. Dianingsih, Y.M. Numberi and B. Suhartawan. 2024. Pollinating insects (Lepidoptera: superfamily Papilionoidea) to support sustainable agriculture in agro-ecosystems. J. Biol. Papua, 16(2): 87–97. https://doi.org/10.31957/jbp.3365

De Silva, Y.S.K., U.M. Rajagopalan and H. Kadono. 2021. Microplastics on the growth of plants and seed germination in aquatic and terrestrial ecosystems. Glob. J. Environ. Sci. Manage., 7(3): 347–368.

Engel, D.H. and S. Phummai. 2002. A field guide to tropical plants of Asia. Book News, Inc., Portland, USA

Fachrul, M. 2012. Bioecological sampling methods. Bumi Aksara, Jakarta, Indonesia.

Ghazanfar, M., M.F. Malik, M. Hussain, R. Iqbal and M. Younas. 2016a. Butterflies and their contribution in ecosystem: A review. J. Entomol. Zool. Stud., 4(2): 115–118.

Ghazanfar, M., S. Saeed, K.A. Khan and M. Ali. 2016b. Diversity and pollination role of butterflies in Pothwar Plateau, Pakistan. Pak. J. Zool., 48(2): 367–373.

Ginoga, L.N., Y. Santosa and A.R. Mutmainnah. 2019. The loss, gain, and diversity of butterfly species due to the development of PT PKWE oil palm plantation, West Kalimantan Province. IOP Conf. Ser. Earth Environ. Sci., 336(012025): 1–11. https://doi.org/10.1088/1755-1315/336/1/012025

Gunjan, H., V. Bharti and N. Sharma. 2024. Butterfly biodiversity (Nougraun village, Chail Chowk, Mandi, H.P.). J. Entomol. Zool. Stud., 12: 41–52. https://doi.org/10.22271/j.ento.2024.v12.i4a.9348

Haaland, C., 2023. Bumblebees and butterflies in green structure elements in Malmö, Sweden. Urban Ecosyst 26: 1559–1572. https://doi.org/10.1007/s11252-023-01400-5

Habel, J.C., V. Angerer, P. Gros, M. Teucher and J. Eberle, 2022. The relevance of transition habitats for butterfly conservation. Biodiv. Conserv., 32: 1577–1590. https://doi.org/10.1007/s10531-022-02411-y

Hadinoto, H., L. Zalizar, J. Triwanto, E. Ervayenri, R.H. Setyobudi, M. Chanan, N.T. Waskitho, J.T. Ibrahim, E. Suhesti, N.V. Minh, R. Tonda, S. Satrio and T.A. Pakarti. 2023. Bird diversity, abundance, and evenness rates in ecotone area of Sutan Syarif Hasyim forest park, Riau, Indonesia. E3S Web Conf., 374(14): 1–9. https://doi.org/10.1051/e3sconf/202337400014

Hailay, G., Y. Biru and A. Kassie. 2022. Butterfly diversity and abundance at two different habitat types of Gozamen woreda, Amhara regional state, Ethiopia. Arthropoda, 11(3): 153–163.

Hamer, K.C., R.J. Newton, F.A. Edwards, S. Benedick, S.H. Bottrell and D.P. Edwards. 2015. Impacts of selective logging on insectivorous birds in Borneo: The importance of trophic position, body size, and foraging height. Biol. Conserv. 188: 82–88. https://doi.org/10.1016/j.biocon.2014.09.026

Herlinda, S. and J.M.P. Sari. 2023. Conservation of entomophages and pollinators in freshwater swamps to support agricultural sustainability on suboptimal lands. In: S. Herlinda and J.M.P. Sari (Eds.), National Conference of Suboptimal Lands. Sriwijaya University Press, Palembang, Indonesia. pp.1–24.

Irsa, A., R. Rahadian and M. Hadi. 2022. Community structure, host plant diversity, and butterfly conservation status in Ngesrepbalong village, Limbangan district, Kendal regency. J. Ilmu Lingkungan, 20(4): 777–786. https://doi.org/10.14710/jil.20.4.777-786

Ismail N, A.A.A, Rahman, M. Mohamed, M. Fadzelly, A. Bakar and L. Tokiman. 2020. Butterfly as bioindicator for development of conservation areas in Bukit Reban Kambing, Bukit Belading and Bukit Tukau, Johor, Malaysia. Biodiversitas, 21(1): 334–344. https://doi.org/10.13057/biodiv/d210141

Kemmerling, L.R., A.C. McCarthy, C.S. Brown and N.M. Haddad 2023. Butterfly biodiversity increases with prairie strips and conservation management in row crop agriculture. Insect Conserv. Divers, 16(6): 828–837. https://doi.org/10.1111/icad.12675

Kirton, L.G., 2021. A naturalist's guide to the butterflies of Peninsular Malaysia Singapore and Thailand. John Beaufoy Publishing, Oxford, England.

Koh, L.P. and D.S. Wilcove DS. 2008. Is oil palm agriculture really destroying tropical biodiversity? Conserv. Lett., 1: 60-64. https://doi.org/10.1111/j.1755-263X.2008.00011.x

Koneri, R., M.J. Nangoy, P.V. Maabuat, Saroyo and Wakhid. 2022. Diversity and composition of butterflies in three habitats around Rayow waterfall, Minahasa district, North Sulawesi, Indonesia. Biodiversitas, 23(2): 1091–1098. https://doi.org/10.13057/biodiv/d230253

Krebs, C.J., 1985. Ecological methodology. 2nd Ed. Addison-Welsey Educational Publishers, California, USA.

Lestari, D.A., E.E. Ariyanti and F.A. Siahaan. 2023. Butterflies as Sandalwood pollinators. Forest Digest. https://www.forestdigest.com.

Loganathan, Y. and M.P.J. Kizhakedathil. 2023. A review on microplastics. An indelible ubiquitous pollutant. Biointerface Res. Appl. Chem., 13(2): 126. https://doi.org/10.33263/BRIAC132.126

Magurran, A.E., 1988. Ecological diversity and its measurement. Croom Helm, London. https://doi.org/10.1007/978-94-015-7358-0

Mallick, B., S. Rana and T.S. Ghosh. 2023. Role of herbicides in the decline of butterfly population and diversity. J. Exp. Zool. A: Ecol. Physiol., 339(4): 346–356. https://doi.org/10.1002/jez.2688

Maryuni, S., 2018. Types of polinator insects on watermelon flowers (*Citrulus lanatus* Thunb.) in Padang Dama village, Bayang district, South Coast district. J. Ilmiah Mahasiswa STKIP PGRI Sumatera Barat.

Mas'ud, A., A.D. Corebima, A. Haerullah, S. Hasan and A. Alisi. 2019. Types of butterflies visiting mussaenda and asoka flowers in the Mount Sibela nature reserve area, Bacan Island. J. Biol. Trop. 19(2): 189–196. https://doi.org/10.29303/jbt.v19i2.1108

Nursia, F. and N.F. Sam. 2022. Butterfly (Lepidoptera: Rhopalocera) preference host plant and food plant in North Borneo. IOP Conf. Ser. Earth Environ. Sci., 1083(012059): 1–12. https://doi.org/10.1088/1755-1315/1083/1/012059

Oo, K.M.M., 2020. Morphology and life cycle of the pierid butterfly species, *Delias hyparete* Indica Wallace, 1867. J. Myanmar Acad. Arts Sci., 18: 247–255

Peggie, D. and M. Amir. 2006. Practical guide to the butterflies of Bogor botanical garden. Cibinong. Zoologi LIPI, Indonesia

Peggie, D., S. Supadi, G. Guntoro, S. Sarino, F. Fatimah, R. Rachmatiyah and C. Haeuser. 2022. *Papilio demoleus* L. and *Papilio polytes* L. (Lepidoptera: Papilionidae) reared on some host plants at butterfly research facility, LIPI-Cibinong, West Java, Indonesia. Treubia, 49(1): 41–56. https://doi.org/10.14203/treubia.v49i1.4468

Ramírez-Restrepo, L. and I. MacGregor-Fors. 2017. Butterflies in the city: A review of urban diurnal Lepidoptera. Urban Ecosyst, 20: 171–182. https://doi.org/10.1007/s11252-016-0579-4

Ricco, F., K. Kustiati and R. Riyandi. 2019. Insect diversity in the IUPHHK-HTI area of PT. Muara Sungai Landak, Mempawah Regency, West Kalimantan. Protobiont 8(3):122–128. https://doi.org/10.26418/protobiont.v8i3.36965

Rivest, S., E. Wolkovich, and H. Kharouba. 2023. Flowering phenology influences butterfly nectar foraging on non-native plants in an oak savanna. Ecology, e4004. https://doi.org/10.1002/ecy.4004

Ruslan, H., I.S.L. Tobing and D. Andayaningsih. 2020. Butterfly biodiversity (Lepidoptera: Papilionoidea) in urban forest areas. LPU-UNAS, Jakarta, Indonesia.

Ruslan, H., I.S.L. Tobing and D. Andayaningsih. 2023. Monitoring of butterfly abundance in the urban forests of Cibubur arboretum and University of Indonesia. J. Subopt. Lands, 12: 62–71. https://doi.org/10.36706/jlso.12.1.2023.624

Saati, E.A., R.H. Setyobudi, I. Iswahyudi, R. Asiyah, M. Taufiq, M. Churochman, M. aula, S.K. Wahono, A. Hidayati, M.P. Garfansa, F.K. Hartati, A.D. Puspitarini, G.S.P. Diksa, and S.A. Aman. 2025. Number and characteristics of microplastics contamination in commercial red palm oils. Food Hum., 5: 100737. https://doi.org/10.1016/j.foohum.2025.100737

Saldivar, J., A. Romero and E. Rankin. 2022. Community science reveals high diversity of nectaring plants visited by painted lady butterflies (Lepidoptera: Nymphalidae) in California Environ. Entomol. Entomol., 51: 1141–1149. https://doi.org/10.1093/ee/nvac073

Santos, R. da S., M. de O. Milfont, M.M. Silva, L.T. Carneiro and C.C. Castro. 2020. Butterflies provide pollination services to macadamia in Northeastern Brazil. Sci. Hortic., 259: 108818. https://doi.org/10.1016/j.scienta.2019.108818

Sari, H.P.E., A.Y. Persada, W.A. Mustaqim, K.A. Putri and I.Y. Wafa. 2023. Butterfly diversity from isolated lowland area: An assessment in Langsa urban forest, Langsa, Aceh, Indonesia. J. Trop. Biodiv. Biotechnol. 8(2): 1–18. https://doi.org/10.22146/jtbb.74610

Sari, S., Dahelmi and Mairawita. 2016. Visitor butterflies of watermelon (*Citrullus lanatus*) (Thunb.) Matsum and Nakai in Katapiang Ujuang and Karambia Ampek, Batang Anai, Padang Pariaman, West Sumatra. BioConcetta II(1): 35-42. https://doi.org/10.22202/bc.2016.v2i1.1297

Setyobudi, R.H., D. Damat, S. Anwar, A. Fauzi, T. Liwang, L. Zalizar, Y.A. Nugroho, M. Wedyan, M. Setiawan, S. Husen, D. Hermayanti, T.D.N. Subchi, P.G. Adinurani, E.D. Septia, D. Mariyam, I.R. Utarid, I. Ekawati, R. Tonda, E.D. Purbajanti, S. Suherman, M.S. Susanti, T.A. Pakarti, I. Iswahyudi, B.A. Prahardika and A.R. Farzana. 2023. Amino acid profiles of coffee cherry flour from different origins: A comparative approach. E3S Web Conf., 432(32): 1–11. https://doi.org/10.1051/e3sconf/202343200032

Setyobudi, R.H., D. Hermayanti, S. Husen, M.P. Garfansa, T.D.N. Subchi, S. Suherman, S. Anwar, I. Iswahyudi, Y. Sincihu, A. Anekawati, M.S. Susanti, M. Anwar, T.A. Pakarti and S.A.A. Putra. 2025. Bioremediation using microorganisms and earthworms in reducing the impact of microplastics in potato cultivation. Sarhad J. Agric., 39(Special issue 1): 171–184. https://doi.org/10.17582/journal.sja/2023/39/s1.171.184

Setyobudi, R.H., S. Anwar, M.A. Wedyan, D. Damat, Y.A. Nugroho, T. Liwang, P.G. Adinurani, S.K. Wahono, E.S. Savitri, B.A. Prahardika, I.R. Utarid, I. Iswahyudi and H.A. Rachmawati. 2024. Characterization of amino acids in coffee cherry flour from different coffee cultivation areas: As potential functional food. Sarhad J. Agric., 39(Special issue 1): 36–46. https://doi.org/10.17582/journal.sja/2023/39/s1.36.46

Sugiyono, 2020. Educational research methods quantitative, qualitative, and R and D Approaches. Alfabeta, Bandung, Indonesia.

Sukma, M.O., L. Lianah and S. Hidayat. 2021. Diversity of butterflies (ordo Lepidoptera) and flower plants in Mount Muria Kudus, Central Java. J. Biodjati, 6(1): 122–135. https://doi.org/10.15575/biodjati.v6i1.10070

Sulistyani, T.H., M. Rahayuningsih and Partaya. 2014. Diversity of Lepidoptera butterfly species: Rhopalocera in the Ulolanang Kecubung nature reserve area, Batang regency. Unnes J. Life Sci., 3(1): 9–17.

United Nations, 2025. The 17th goal. UN Department of Economic and Social Affairs Sustainable Development.

Wahyudi, A., R.H. Setyobudi, I. Iswahyudi, M.P. Garfansa, E.S. Savitri, B.A. Prahardika, P. Patmawati, R.D. Putri, R.A.D. Sukma, N.S. Putra, E. Yunita and S.K. Wahono. 2025. Determination and quantification of microplastics in goat farms. Bioresour. Technol. Rep., 31: 102199. https://doi.org/10.1016/j.biteb.2025.102199

Warrena, M.S., D. Maes, C.A.M. van Swaayc, P. Goffart, H. Van Dyck, A.D.N. Bourn, I. Wynhoff, D. Hoaref and S. Ellis. 2021. The decline of butterflies in Europe: Problems, significance, and possible solutions. Proc. Natl. Acad. Sci. U.S.A., 118(2): e2002551117. https://doi.org/10.1073/pnas.2002551117

Weei, C.Y. and C.H. Mun. 2008. A photographic guide to the butterflies of Peninsular Malaysia, Singapore and Thailand. Singapore: Sun Tree Publishing.

Wicaksono, R.B., I. Kurnia and I. Widodo. 2023. Diversity of butterfly species in the Goalpara-Perbawati cultivation area, Sukabumi Regency. Jurnal Penelitian Biologi, 9(1), 66–79.

Yachi, S. and M. Loreau. 1999. Biodiversity and ecosystem productivity in a fluctuating environment: The insurance hypothesis. Proc. Natl. Acad. Sci. U.S.A., 96(4): 1463–1468. https://doi.org/10.1073/pnas.96.4.1463

Yek, S., Z. Wong and P. Hon. 2024. Non-native plants provide nectar and host plant resources to native butterflies. J. Trop. Biol. Conserv., 21: 88–95. https://doi.org/10.51200/jtbc.v21i.5590

Yudhono, A. and G. Sukarya. 2013. The 3500 plant species of the botanic gardens of Indonesia. PT Sukarya and Sukarya Pandetama, Jakarta, Indonesia.