



# Inventory of Butterfly Species and Diversity (Lepidoptera) in Mataram City

Putu Eka Gunadi<sup>1\*</sup>, Lu'lu'atul Husna Izzati<sup>2</sup>, Intan Nurasm<sup>2</sup>, Els Houtave<sup>3</sup>

<sup>1</sup>Yayasan Lingkungan Tanpa Batas, Mataram, Indonesia;

<sup>2</sup>Universitas Mataram, Mataram, Indonesia;

<sup>3</sup>VZW Grenzeloos Milieu, Belgia;

## Article Info

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## \*Corresponding Author

Putu Eka Gunadi,

Yayasan Lingkungan Tanpa Batas,

Mataram, Indonesia;

e-mail: [raga.gtsr@gmail.com](mailto:raga.gtsr@gmail.com)

## Abstract

Changes in the urban landscape can affect the structure of insect communities, including butterflies, which are sensitive to environmental conditions. This study aims to inventory butterfly species, analyze ecological indices, and examine how environmental factors influence butterfly communities in the city of Mataram. The method used was a field survey employing the time-search technique, with measurements of temperature, humidity, and light intensity, and analysis of the Shannon-Wiener diversity index, Margalef species richness, Pielou evenness, and Simpson's dominance. The results revealed 44 species from five families, with high diversity ( $H' = 3.081$ ), high species richness ( $R = 7.018$ ), high evenness ( $E = 0.814$ ), and low dominance ( $D = 0.077$ ). Generalist species dominate the community, although a limited number of specialist species remain. The study's conclusions indicate that the butterfly community in Mataram City is relatively stable yet beginning to be affected by urban environmental pressures. The implications of this research underscore the importance of managing diverse, sustainable green open spaces to support butterfly conservation as an urban ecosystem bioindicator.

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**Keywords:** butterfly diversity; community ecology; environmental bioindicators; urban landscape; microclimate



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## INTRODUCTION

Butterflies (Lepidoptera) are a group of insects frequently used in ecological research due to their sensitivity to environmental changes (Rohman et al., 2025; Habel et al., 2021). Butterflies are also sensitive to changes in habitat conditions, such as variations in vegetation and microclimate, which can directly influence the presence and composition of butterfly communities. This responsiveness makes butterflies effective indicators for assessing environmental quality (Hailay & Getu, 2023). The continuous expansion of urban areas also leads to significant changes in land use, resulting in the loss or fragmentation of pollinator habitats, including butterfly habitats (Gupta et al., 2019). These conditions often result in a reduction in natural habitats and a decline in biodiversity, particularly in areas with high levels of urbanization (Piano et al., 2019). Observations of butterflies can be used as one approach to understanding the impacts of such land-use changes and urbanization (Zhang et al., 2025).

Butterfly diversity is shaped by a variety of interrelated factors, particularly the availability of host plants and nectar sources, which are key to supporting their life cycles (Han et al., 2021). Environmental conditions such as temperature and humidity also determine species presence within a habitat, including through seasonal and annual variation (Beirão et al., 2020). Diverse vegetation structures tend to provide a wider range of habitats and resources for various butterfly species, including cooler or more humid microhabitats (Álvarez et al., 2024). Conversely, fragmented habitats and a lack of green open spaces can hinder species movement and distribution and reduce species richness in highly urbanized areas (Tzortzakaki et al., 2019). The presence of green open spaces in urban areas is a key element in maintaining the sustainability of butterfly communities (Azahra et al., 2022; Cooper et al., 2024).

Research on butterflies in urban areas remains limited compared with studies in natural or semi-natural habitats. However, some studies have highlighted the

important role of urban parks and green spaces in supporting butterfly communities (Bruschini et al., 2024). This pattern also holds for the city of Mataram, which features diverse landscapes with varying degrees of urbanization, potentially creating a biodiversity gradient that has not yet been well documented. Information on species composition and butterfly diversity in this region remains insufficient to support conservation planning in urban environments. Differences in land use in Mataram City can create a range of habitat types that influence butterfly populations, as seen in other cities where land cover and landscape configuration strongly determine butterfly communities (Birch et al., 2025). These data limitations mean that the use of butterflies as bioindicators in urban areas has not yet been optimized, and the relationship between butterfly diversity and environmental factors at the city scale has also rarely been studied.

This study was conducted to provide a more comprehensive overview of the status of butterflies in Mataram. The research focuses on an inventory of butterfly species, an analysis of diversity levels, and the influence of environmental factors on community structure. This approach is expected to provide a more complete understanding by linking diversity data with environmental conditions. The research findings are expected to form the basis for the management of green open spaces and to support conservation efforts in urban areas. The contribution of this research lies in providing baseline data that integrates aspects of biodiversity and environmental factors within an urban landscape context. Therefore, the objective of this study is to inventory butterfly species in Mataram City, analyze ecological indices, and assess the influence of environmental factors on butterfly diversity.

**METHOD**

**Time and place**

This study was conducted in July 2025 at five green open spaces in the city of Mataram, namely Udayana Park, Selagalas Park, Pagutan Green Open Space, the Mataram University area, and Bintaro Cemetery. These five locations were selected because they represent variations in urban landscape conditions, including differing levels of disturbance and vegetation complexity, thereby illustrating the diversity of butterfly habitats in urban areas.

**Research design**

This study is a quantitative descriptive study employing a field survey approach. Data collection was carried out using the time-search method, a modification of the line transect method that uses time units as the basis for observation. This method allows active observation over a specific duration without fixed distance constraints, making it more flexible for detecting butterfly species with different activity patterns.

**Research population and sample**

The population in this study comprises all butterflies (order Lepidoptera) found in the city of

Mataram. The study sample consists of individual butterflies observed at each site, with a total observation effort of 90 minutes per site (15 minutes per session, repeated three times in the morning and afternoon). The sampling technique used was purposive sampling, i.e., selecting locations based on specific criteria, including: (1) the availability of vegetation as a food source and host plants, (2) differences in levels of anthropogenic disturbance, and (3) accessibility for repeated observations (Sugiyono, 2017).

Research variables included biotic variables (number of individuals, number of species, and butterfly ecological indices) and abiotic variables (air temperature, humidity, and light intensity). Data were collected through direct observation by recording the number of individuals and documenting species with a camera. Individuals that could not be identified in the field were captured with insect nets for further identification. The equipment used included insect nets, cameras, environmental measuring instruments, and species identification guides.

**Research procedure**

The study began with the selection of observation sites in accordance with predefined criteria. Observations were conducted twice daily, in the morning (08:00 AM–10:00 AM) and in the afternoon (14:00–16:00), periods of optimal butterfly activity. During each session, the researcher systematically walked through the observation area for 15 minutes, recording all butterflies encountered. Each individual was documented for identification purposes. Specimens that could not be identified immediately were captured using an insect net and temporarily preserved using simple techniques to maintain their morphological condition. Species identification was based on morphological characteristics, including wing patterns, color, and body shape, with reference to identification guides and digital applications. All observation data were then compiled for the analysis phase.

**Analysis of research data**

Data from field observations will be analyzed to determine the butterfly ecological index in the study area. The parameters to be analyzed include :

**Richness Index (R)**

The Species Richness Index (R) is calculated using Margalef's formula (Margalef, 1958) :

$$R = (S - 1) / \ln N \dots \dots \dots (1)$$

The R value is calculated as the ratio of the number of species (S) to the total number of individuals (N), thereby normalising for sample size. The higher the R value, the greater the species richness within that community. The interpretation of the species richness index is as follows:

- R < 3,5 = low
- 3,5 ≤ R ≤ 5,0 = medium
- R > 5,0 = hight

**Shannon–Wiener Diversity Index(H')**

The Diversity Index (H') is calculated using the Shannon-Wiener formula (Shannon,1948).

$$H' = - \sum pi \ln pi.....(2)$$

The pi value is the proportion of individuals of species i, obtained by comparing the number of individuals of that species (ni) to the total number of individuals (N), whilst S denotes the total number of species. General interpretation of the H' value:

- H' < 1 = low
- 1 ≤ H' ≤ 3 = medium
- H' > 3 = high

**Evenness Index (E)**

The Evenness Index (E) is calculated using Pielou's Evenness formula (Pielou, 1966):

$$E = \frac{H'}{\ln S}.....(3)$$

This index is calculated by comparing the Shannon–Wiener diversity index (H') with the maximum diversity value (lnS), thereby reflecting the degree of evenness of individuals across each species. The closer the value is to 1, the more even the distribution of individuals across species; conversely, a low value indicates dominance by a particular species. Interpretation of the E value:

- E approaches 1 = Even distribution among species
- E approaches 0 = Dominance by one or a few species

**Simpson's Dominance Index (D)**

The dominance index (D) is used to identify the species that dominate a community. The dominance level of each species can be assessed using Simpson's dominance index (Simpson, 1949), with the following formula:

$$D = \sum_{i=1}^s pi^2.....(4)$$

The value of pi indicates the proportion of individuals of species i relative to the total number of individuals in the community, whilst S denotes the total number of species found. The higher the value of D, the greater the degree of dominance by one or more species within that community. The interpretation of the value of D is as follows:

- 0 < D ≤ 0,50 = low
- 0,50 < D ≤ 0,75 = medium
- 0,75 < D ≤ 1 = high

**Analysis of Environmental Factors (Abiotic)**

The relationship between environmental factors and butterflies' ecological parameters was analyzed using descriptive statistics and correlation tests. The abiotic factors measured included air temperature, humidity, and light intensity. Ecological parameters such as the number of individuals, species, and diversity indices were correlated with abiotic variables using Pearson's or Spearman's correlation tests, depending on the data distribution (Azahra et al., 2022). This approach identifies the dominant environmental factors influencing butterflies' presence and activity, given their ectothermic nature, which makes them sensitive to temperature and light for flight, foraging, and reproduction.

**RESULTS AND DISCUSSION**

**Butterfly Species Composition in the City of Mataram**

The survey results indicate that the butterfly community in Mataram City comprises 44 species, totaling 458 individuals, belonging to five families (Table 1). This figure is quite high for an urban area. However, upon closer inspection, the distribution pattern is not entirely uniform. The Nymphalidae family has the highest number of species, namely 20 (45.45%), whereas only 4 (9.09%) species were found in the Lycaenidae family (Figure 1). This difference provides an initial indication that not all butterfly groups can utilize the available habitat in the same way. Some species, such as Papilio memnon and Euploea corinna, were found at almost all locations. This suggests that these species possess a wide range of adaptive capabilities. On the other hand, species such as Troides helena occur only in specific locations. This pattern suggests that the butterfly community in the study area comprises species with varying levels of tolerance to environmental conditions. These differences may be related to habitat factors, such as vegetation availability and microclimatic conditions, which are not uniform across all locations.

**Table. 1.** Butterfly Species Composition in the City of Mataram

No.	Family / Species	Common Name	Location				
			UD	UM	BN	SG	PG
<b>I. Papilionidae</b>							
1.	<i>Graphium agamemnon</i>	Tailed Jay	+	+	+	+	-
2.	<i>Graphium sarpedon</i>	Common Bluebottle	-	+	-	-	-
3.	<i>Papilio demoleus</i>	Lime Butterfly	+	+	+	-	+
4.	<i>Papilio demolion</i>	Banded Swallowtail	-	-	-	-	+
5.	<i>Papilio memnon</i>	Great Mormon	+	+	+	+	+
6.	<i>Papilio peranthus</i>	Yellow Mormon	+	-	-	-	-
7.	<i>Papilio polytes</i>	Common Mormon	-	+	+	-	+
8.	<i>Troides helena</i>	Common Birdwing	-	+	+	-	+
<b>II. Pieridae</b>							
9.	<i>Appias olferna</i>	Striped Albatross	+	+	-	+	+

No.	Family / Species	Common Name	Location				
			UD	UM	BN	SG	PG
10.	<i>Catopsilia pomona</i>	Lemon Emigrant	+	-	+	+	+
11.	<i>Catopsilia pyranthe</i>	Mottled Emigrant	-	-	+	-	-
12.	<i>Delias hyparete</i>	Painted Jezebel	-	-	-	+	-
13.	<i>Delias oraia</i>	Jezebel sp.	-	-	+	-	-
14.	<i>Eurema hecabe</i>	Common Grass Yellow	+	-	-	+	+
15.	<i>Leptosia nina</i>	Psyche	+	+	-	+	+
<b>III. Nymphalidae</b>							
16.	<i>Acraea terpsicore</i>	Tawny Coster	-	-	+	-	-
17.	<i>Ariadne ariadne</i>	Angled Castor	-	+	+	-	+
18.	<i>Danaus chrysippus</i>	Plain Tiger	-	-	+	-	-
19.	<i>Danaus genutia</i>	Striped Tiger	-	-	-	-	+
20.	<i>Doleschallia bisaltide</i>	Autumn Leaf	-	-	-	+	+
21.	<i>Elymnias hypermnestra</i>	Common Palmfly	+	+	-	+	+
22.	<i>Euploea climena</i>	Common Crow	+	-	-	-	+
23.	<i>Euploea corinna</i>	Common Blue Crow	+	+	+	+	+
24.	<i>Euploea phaenareta</i>	King Crow	+	-	-	-	+
25.	<i>Euploea sylvester</i>	Double-branded Crow	-	-	-	-	+
26.	<i>Euthalia aconthea</i>	Common Baron	+	-	-	+	+
27.	<i>Hypolimnas bolina</i>	Great Eggfly	+	+	-	+	+
28.	<i>Ideopsis juventa</i>	Grey Glassy Tiger	-	-	+	-	-
29.	<i>Junonia atlites</i>	Grey Pansy	-	-	-	+	-
30.	<i>Junonia erigone</i>	Yellow Pansy	-	-	-	-	+
31.	<i>Junonia iphita</i>	Chocolate Pansy	-	-	-	-	+
32.	<i>Junonia orithya</i>	Blue Pansy	+	-	-	-	+
33.	<i>Melanitis leda</i>	Common Evening Brown	+	-	-	+	+
34.	<i>Moduza procris</i>	Commander	-	-	-	-	+
35.	<i>Neptis hylas</i>	Common Sailor	+	+	-	+	+
<b>IV. Lycaenidae</b>							
36.	<i>Arhopala centaurus</i>	Centaur Oakblue	+	-	-	-	-
37.	<i>Jamides celeno</i>	Common Cerulean	-	-	-	+	-
38.	<i>Lampides boeticus</i>	Pea Blue	-	-	+	-	-
39.	<i>Zizina otis</i>	Lesser Grass Blue	+	+	+	-	-
<b>V. Hesperidae</b>							
40.	<i>Parnara sp.</i>	Rice Swift	+	-	+	+	-
41.	<i>Pelopidas sp.</i>	Swift spp.	-	-	+	-	-
42.	<i>Taractrocera nigrolimbata</i>	Grass Dart	-	-	+	-	-
43.	<i>Telicota sp.</i>	Palm Dart	-	-	-	+	-
44.	<i>Udaspes folus</i>	Grass Demon	-	-	-	+	-
<b>.Total</b>			<b>34</b>	<b>29</b>	<b>32</b>	<b>34</b>	<b>44</b>

Notes: UD (Udayana); UM (Universitas Mataram); BN (Bintaro); SG (Slagalas); PG (Pagutan); ditemukan (+); tidak ditemukan (-)

These findings become more meaningful when considered in the context of community ecology (Figure 1). The families Nymphalidae and Pieridae are frequently reported to be dominant across habitat types, including those subject to disturbance and mosaic land-use patterns (Mukherjee & Hossain, 2024). These groups have strong adaptive capacity to environmental change and tend to be more flexible in using a variety of vegetation types and food sources, enabling them to occupy many habitat types within both fragmented and urban landscapes (Rohman et al., 2025). Both families also tend to be more flexible in selecting host plants and food sources (Biswas et al., 2025; Han et al., 2021). A similar pattern was found in studies of tropical urban areas, where butterfly community composition differed among habitat types but was dominated by species capable of adapting to thermal conditions and the heterogeneity of urban habitats (Ombugadu et al., 2023). Generalist species are more frequently dominant than specialist species (Habel et al., 2016). This is clearly evident in the study's results in

Mataram City. Conversely, the low number of Lycaenidae species may be linked to more specific ecological requirements; many species within this family depend on particular host plants and interact with other organisms (Schär, 2018).

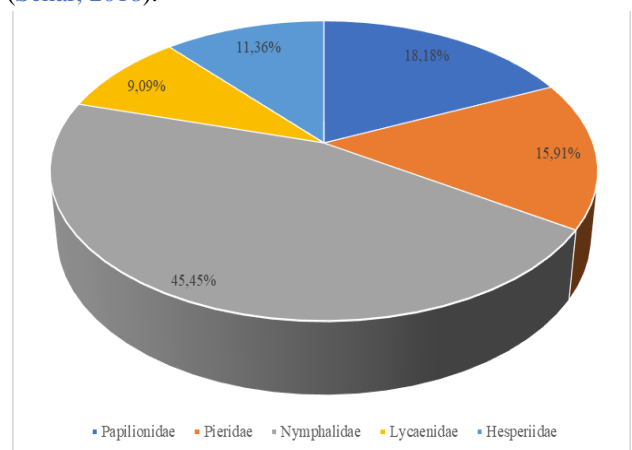


Figure 1. Percentage of butterfly families in Mataram City

This dependence makes them more sensitive to habitat changes and declines in vegetation heterogeneity. Compared with natural ecosystems, the community composition in the study area shows a tendency toward the dominance of tolerant species, leading to community homogenization in urban and intensively farmed environments (Elia et al., 2022). This situation is a key consideration for conservation, as high diversity does not necessarily reflect stable habitat quality (Rivest & Kharouba, 2024). These findings highlight the importance of managing more diverse green open spaces; vegetation must not only be present but also capable of supporting the needs of specialist species, including providing host plants and diverse habitat structures (Naik et al., 2022). This approach can maintain the balance of butterfly communities and preserve their function as environmental bioindicators.

The composition and dominance of butterflies in Mataram City reveal a pattern that is not entirely uniform across species (Figure 2). The highest dominance value was recorded for *Leptosia nina* at 19%, followed by *Parnara* sp. at 6.99% and *Catopsilia pomona* at 5.68%. This pattern suggests that a single species does not dominate the community to an extreme degree. However, it still indicates a tendency for certain species to be more successful in utilizing the habitat. Upon closer examination, most species with high dominance belong to groups known to be adapted to open and disturbed environments. Conversely, many other species have low dominance values, even below 1%. This suggests that the butterfly community at the study site comprises a mix of common species and less common ones. The presence of species such as *Troides helena*, with its low dominance, reinforces the finding that certain habitats can still support more sensitive species, albeit in limited numbers.

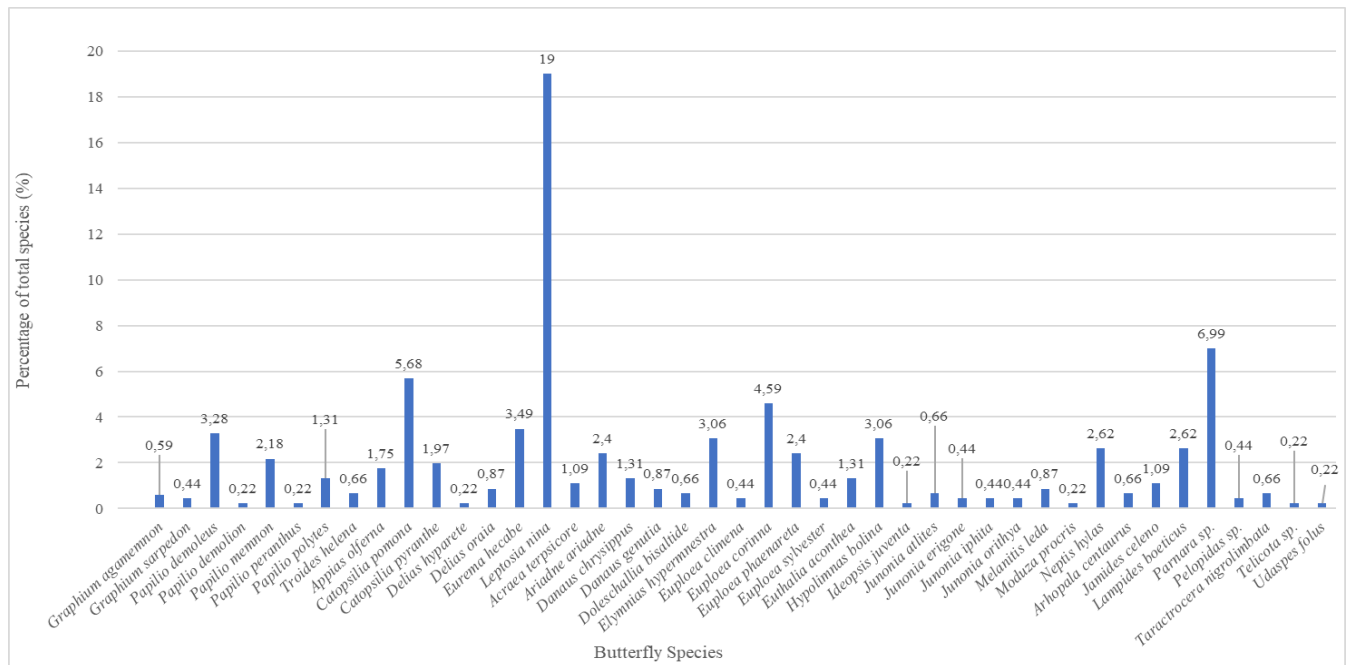


Figure 2. Percentage of butterfly species in the city of Mataram

A community ecology approach, along with findings from previous research, can explain this pattern of dominance. Species such as *Leptosia nina*, *Catopsilia pomona*, and *Eurema hecabe* are known to be generalists that utilize a wide variety of host plants, making them better able to adapt to urban areas (Sari et al., 2023; Lestari et al., 2021). This aligns with research indicating that urban habitats are dominated by disturbance-tolerant, ecologically flexible species (Pignataro et al., 2020). Conversely, species with low dominance, such as *Troides helena*, depend on specific host plants, particularly those in the genus *Aristolochia*, resulting in a restricted distribution (Irsa et al., 2022; Ilhamdi et al., 2018). These findings are also consistent with studies from other regions, which indicate that high diversity is not always accompanied by balanced species distributions, particularly in habitats

under anthropogenic pressure (Nuraini et al., 2020; Hermawan, 2024). A key difference from natural ecosystems is the increasing dominance of generalist species, leading to community homogenization.

This indicates that the butterfly community structure in Mataram City remains fairly stable yet is beginning to show signs of environmental selection favoring certain species. This situation cannot be directly interpreted as indicative of optimal habitat quality. High diversity must still be considered alongside patterns of dominance and the presence of sensitive species. The presence of low-dominance species, such as *Troides helena*, indicates that habitat fragments still support specific ecological needs. A limitation of this study is the lack of a detailed analysis of the direct relationship between host plant distribution and species dominance patterns.

These findings point to the need for more targeted management of green open spaces. An approach that focuses not only on area size but also on vegetation diversity is crucial for maintaining the balance of butterfly communities. Such efforts can preserve butterflies' role as environmental bioindicators while supporting biodiversity conservation in urban areas (Azahra et al., 2025).

**Analysis of the Butterfly Ecology Index**

The results of the ecological index analysis indicate that the butterfly community in Mataram City has a relatively stable structure. The Shannon–Wiener diversity index ( $H'$ ) value of 3.081 indicates a high level of diversity. The species richness index ( $R$ ) value of 7.018 further

confirms that the number of species is substantial. Taken together, these two values suggest that the community is not only species-rich but also capable of sustaining multiple species within a single habitat. The evenness index ( $E$ ) value of 0.814 indicates that the distribution of individuals across species is relatively balanced. No single species dominates to an extreme degree. This is supported by the Simpson's dominance ( $D$ ) value of 0.077, which falls within the low category. This combination of values suggests that the butterfly community at the study site remains in good ecological condition, despite being located in an urban area. The results of the ecological index calculations in this study are presented in **Table 2**.

**Table 2.** Ecological Index of the Butterfly Community in Mataram City

Indeks Ekologi	Nilai	Interpretasi
Richness Index ( $R$ )	7.03	High species richness
Diversity Index Shannon–Wiener ( $H'$ )	3.081	High diversity
Evenness Index ( $E$ )	0.814	High equality (relatively even distribution of individuals)
Simpson's Dominance Index ( $D$ )	0.077	Low dominance (no species dominates significantly)

These results can be explained by community ecology and are supported by previous research. The Shannon–Wiener index is commonly used to assess ecosystem stability because it integrates species richness and relative abundance (Fardian, 2021). The high  $H'$  value in this study indicates that environmental pressures have not yet caused a significant decline in biodiversity. This finding aligns with studies showing that green open spaces in urban areas can still serve as important habitats for butterflies (Sukma et al., 2021). A high evenness value also suggests that interspecific competition remains balanced, preventing excessive dominance (Destaranti et al., 2017). However, a low dominance value does not imply the absence of a superior species. Generalist species such as *Leptosia nina* still show higher abundance than other species. This pattern suggests environmental selection favoring species with high adaptive capacity, as reported in previous research (Nuraini et al., 2020). Compared with natural ecosystems, community structure in urban areas tends to be more influenced by disturbance-tolerant species.

The results of this ecological analysis indicate that high diversity does not always reflect optimal habitat conditions. Even seemingly stable community structures still show signs of environmental pressures shaping species composition. The availability of host plants and food sources is a key factor determining butterfly abundance at each location. Habitats with diverse vegetation tend to support more species than homogeneous habitats (Syukur et al., 2018; Huang et al., 2024). A limitation of this study

is that the quantitative relationship between vegetation composition and ecological index values has not yet been analyzed. These results indicate that the management of green open spaces needs to focus on vegetation quality, not merely the area's size. Such an approach is vital for maintaining the long-term balance of butterfly communities and preserving their role as indicators of environmental conditions in urban areas.

**Research Environment in Mataram City**

Measurements of environmental factors revealed differences in microclimatic conditions at each observation site (Table 3). These differences had a direct impact on butterfly activity and abundance. The Pagutan Green Open Space emerged as the most favorable location. Temperatures averaged around 29°C, with humidity at 82% and relatively high light intensity. These conditions were associated with the highest number of individuals compared with other locations. Butterfly activity at this site was also more diverse. Behaviors such as oviposition and mating could be observed directly. This suggests that the environment at this location not only supports the presence of butterflies but also their life cycle. Conversely, locations such as the Bintaro Cemetery exhibited less favorable conditions. Humidity reaching 90% and very high light intensity appear to correlate with fewer individuals. This difference indicates that environmental factors play a significant role in shaping the distribution patterns of butterflies in the study area.

**Table 3.** Environmental Factors at Five Observation Sites in Mataram City

Environmental Factors	Location				
	UD	UN	BN	SG	PG
Temperature (°C)	29	30	32	28	29
Humidity (%)	75	70	90	85	82
Light intensity (lux)	9.142	8.842	70.150	7.790	10.480

Notes: UD (Udayana); UN (Unram); BN (Bintaro); SG : (Selagalas); PG (Pagutan)

Butterflies' ectothermic physiology can explain this phenomenon. Ambient temperature plays a decisive role in flight activity and metabolism. Warmer temperature ranges tend to increase butterflies' daily activity (Sukma et al., 2021). Excessively high humidity can hinder movement and increase the risk of pathogens, thereby reducing population abundance (Azahra et al., 2022). Light intensity also influences habitat preferences. Areas with sufficient light support foraging and reproductive activities. These findings align with previous research indicating that the combination of temperature, humidity, and light is the primary factor determining the presence of butterflies in a habitat (Muhelni, 2022). Nevertheless, some species are still found under less-than-optimal conditions. The presence of species such as *Ariadne ariadne*, *Danaus chrysippus*, and *Troides helena* in specific locations indicates adaptive capacity or the availability of specific resources. These conditions suggest that biotic factors, such as host plants, continue to play a significant role alongside abiotic factors.

The implications of these results suggest that microclimatic differences within urban areas can lead to variations in habitat quality for butterflies. Environments with temperatures ranging from 28–32°C and moderate humidity tend to be more conducive to the presence and activity of butterflies. Although all locations remain within physiological tolerance limits, they do not provide the same optimal conditions. A limitation of this study is the absence of a quantitative analysis of the relationship between environmental factors and species abundance. The results are still descriptive, based on field observations. These findings suggest that the management of green open spaces needs to take microclimatic factors into account. The provision of vegetation capable of regulating temperature and humidity is crucial. Such an approach can enhance habitat quality and support the sustainability of butterfly communities in urban areas.

**CONCLUSION**

This study recorded 44 butterfly species from five families in the city of Mataram, indicating high species richness in the urban area. Analysis of ecological indices showed that the butterfly community exhibited high diversity and evenness, with low dominance, reflecting a relatively stable community structure. The community composition is dominated by generalist species that can adapt to urban environmental conditions, although some specialist species, such as *Troides helena*, remain present in limited numbers. Environmental factors such as temperature, humidity, and light intensity were found to influence butterfly activity and distribution, with certain microclimatic conditions more conducive to their presence and abundance. The implications of this study underscore the importance of managing green open spaces with a focus on vegetation diversity and environmental conditions to support the conservation of butterflies as bioindicators of urban ecosystem quality.

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**AUTHOR’S CONTRIBUTION**

All authors contributed to the study design, data collection and analysis, and the drafting and revision of the manuscript.

**Table 4.** Table of Author Contributions

Contribution Indicator	Author			
	1	2	3	4
Conceptualization	✓			
Literature Review		✓		
Research Design / Methodology		✓		
Instrument Development	✓			
Data Collection		✓		✓
Data Curation			✓	
Formal Analysis	✓		✓	
Data Interpretation		✓		✓
Writing – Original Draft			✓	
Writing – Review & Editing	✓	✓		✓
Visualization / Tables			✓	
Supervision	✓			

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