The diversity and abundance of butterfly (Lepidoptera) in several urban green spaces of Malang city

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Abstract. Urban green spaces have become one of the butterfly habitat remnants, which decreased by the expansion of cities and urbanization. In this study, we analyze the diversity and abundance of butterfly communities in several urban green spaces of Malang City. We used a scan sampling method along the transect line in five study sites, namely, Taman Singha Merjosari, Kebun Bibit Mojolangu, Taman Slamet, and Alun-Alun Malang. The composition of butterfly communities was analyzed regarding the number of individuals, species richness, Shanon Wiener diversity index, importance value index, similarity cluster and analysis of CCA to determine the correlation of abiotic factor and butterfly community. A total of 1284 individuals, 38 species which belong to 4 families with Leptosia nina as the most dominant species. The highest diversity index was found in Taman Singha Merjosari. According to the diversity index, all four urban green spaces in Malang city were on a moderate level (index value between 1 to 3). This attributed to the fact that butterfly diversity in urban green spaces still had not been completely disturbed yet.

Keywords: Diversity, Habitat, Lepidoptera, Urbanization

1. Introduction

Urbanization has always been adversely affected biodiversity. The expansion of urban areas will increase along with the population growth [1]. One of the organisms that under threat due to urbanization is butterfly [2]. Some studies have found the diversity and abundance of butterflies in urban areas is 10% less than in rural areas [1] [3]. A case study of monitoring butterfly abundance from 1996-2016 in Ohio City found a decrease in abundance by 2% per year [2]. Another study found that around 40% of Jakarta city forest area was converted to recreational and shopping areas, which led to a decrease in the number of butterfly species [4].

Malang is one of the largest cities in East Java. In 2017, the population of Malang City which was recorded by the Central Bureau of Statistics was 820.243 people with a density of up to 7453 people / km² [5]. The high rate of urbanization in Malang potentially leading to butterfly habitat degradation.
Urban green spaces become the habitat remnant for butterfly in urban ecosystems. However, the existence of urban green spaces is currently decreasing due to urban expansion. Several urban green spaces in Malang have previously researched on butterfly diversity, such as in the campus area of Universitas Brawijaya ($H' = 1.518$), Jalan Veteran ($H' = 2.161$), Jalan Jakarta ($H' = 2.176$) and Jalan Velodrom ($H = 199$). Overall, the diversity of butterflies in the four green open spaces in Malang City is at an intermediate level ($1 < H' < 3$) and has not been completely disturbed [6]. However, there are still several other urban green spaces that are spread out in Malang City such as Kebun Bibit Mojolangu, Taman Singha Merjosari, Taman Slamet and Alun-Alun Malang. There is no research has been conducted particularly on the diversity and abundance of butterflies. Therefore, the importance of this research is to analyze the diversity and abundance of butterflies in those urban green spaces. Hence the current condition and the quality status of that urban green spaces as butterfly habitat in the urban ecosystem are known.

2. Methods

2.1 Study Sites
Butterfly observations were carried out in four study sites, namely Kebun Bibit Mojolangu, Taman Singha Merjosari, Taman Slamet and Alun-Alun Malang (Figure 1). Preliminary study was conducted from November to December 2019 and the research was conducted from January to April 2020.

![Figure 1. Map of Study Sites](image)

2.2 Butterfly Sampling Method
Observation of butterfly species was carried out using the Visual Encounter Survey (VES) method, by recording each number and type of butterfly species directly on a predetermined path. The observation path is determined based on the coverage of urban green spaces, which consist of open and covered areas. The open area contains herbaceous vegetation and ornamental plants while the covered area consists of trees with large canopies. Observations are made by walking along approximately 500
meters around a clockwise direction in both areas, then recording every type of butterfly encountered within 10 m \[7\] \[8\] \[9\]. This activity was carried out at 07.30-11.00 WIB and was repeated ten times.

2.3 Data Analysis
Data on butterfly species and abundance and abiotic factors obtained were analyzed consisting of an index Shannon Wiener diversity, importance value Index and Bray-Curtis similarity, correlation of abiotic factors with butterfly community structure was analyzed using Canonical Correspondence Analysis (CCA) using the PAST program.

The formula of Shanon Wiener diversity index is based on \[9\].

Index of species diversity:
\[H' = - \sum (ni/N. \ln ni/N)\]

\(H'\): Index of species diversity from Shannon Wiener

\(ni\): Abundance of i-species

\(N\): Total abundance of all species found

3. Results

3.1 Butterfly Community Structure
A total of 1284 individuals belonging to 38 species was found at four locations of urban green spaces of Malang City (Table 1). There are some dominant butterfly species in those areas in which abundance average is high overall such as Leptosia nina, Delias dorylaea, Eurema hacabe, Junonia atlites, and Appias indra (Figure 2). Species of Leptosia nina were the most common species found among all species. Butterfly species from the Nymphalidae and Pieridae families are mostly found in habitats in green open spaces such as species from the genus Eurema, Catopsilia, Junonia, Yphitima, Leptosia, Hypolimnas, Delias, Graphium and Appias \[5\] \[10\] \[11\] \[12\]. The Pieridae group generally likes flowering plants and grasses that are commonly found in city park areas \[12\].

Table 1. List of species and its total abundance

| Species              | Mjg | Mjs | Slm | Alm | Total |
|----------------------|-----|-----|-----|-----|-------|
| Leptosia nina        | 31  | 41  | 35  | 30  | 137   |
| Delias dorylaea      | 25  | 36  | 29  | 24  | 114   |
| Eurema hacabe        | 26  | 36  | 28  | 19  | 109   |
| Junonia atlites      | 33  | 31  | 20  | 20  | 104   |
| Appias indra         | 28  | 32  | 19  | 14  | 93    |
| Catopsilia pyranthe  | 27  | 20  | 18  | 21  | 86    |
| Eurema harina        | 15  | 16  | 26  | 4   | 61    |
| Delias belisama      | 20  | 32  | 0   | 0   | 52    |
| Appias lyncida       | 22  | 27  | 0   | 0   | 49    |
| Hypolimnas bolina    | 0   | 18  | 15  | 0   | 33    |
| Parantica albata     | 20  | 8   | 14  | 0   | 42    |
| Euploea eleusina     | 0   | 13  | 19  | 0   | 32    |
| Priomeris philonome  | 14  | 9   | 5   | 8   | 36    |
| Euploea mulciber     | 24  | 14  | 0   | 0   | 38    |
| Appias paulina       | 0   | 16  | 16  | 0   | 48    |
| Elymnias casiphone   | 11  | 0   | 13  | 24  |
| Graphium euryalus    | 0   | 7   | 0   | 7   |
| Yphitima baldus      | 17  | 0   | 0   | 17  |
| Troides cuneifera    | 4   | 11  | 0   | 6   | 21    |
| Danaus affinis       | 19  | 0   | 0   | 19  |
| Hypolimnas misippus  | 3   | 11  | 0   | 14  |
| Graphium bathyleus   | 0   | 17  | 0   | 17  |
| Heliochorus epicule  | 0   | 5   | 0   | 5   |
| Danaus melanippus    | 15  | 0   | 0   | 15  |
| Neptis hylas         | 0   | 8   | 0   | 16  |
| Graphium doson       | 2   | 0   | 22  | 24  |
| Species                        | a  | b  | c  | d  | e  | f  | g  | h  |
|-------------------------------|----|----|----|----|----|----|----|----|
| *Papilio nephelus*            | 0  | 13 | 0  | 0  | 13 | 0  | 0  | 0  |
| *Euploea modesta*             | 0  | 12 | 0  | 0  | 12 | 0  | 0  | 0  |
| *Hypolimnas anomala*          | 0  | 12 | 0  | 0  | 12 | 0  | 0  | 0  |
| *Zizeeria maha serica*        | 0  | 0  | 0  | 0  | 12 | 0  | 0  | 0  |
| *Yphitima pandocus*           | 0  | 0  | 0  | 0  | 18 | 0  | 0  | 0  |
| *Euripus nictalus*            | 0  | 9  | 0  | 0  | 0  | 0  | 3  | 3  |
| *Arhopala alitaeus*           | 4  | 0  | 0  | 3  | 7  | 0  | 0  | 0  |
| *Arhopala centaurus*          | 3  | 0  | 0  | 0  | 3  | 0  | 0  | 0  |
| *Hebomoia glaucippe*          | 0  | 3  | 0  | 3  | 6  | 0  | 0  | 0  |
| *Phalanta phalanta*           | 0  | 6  | 0  | 0  | 0  | 0  | 5  | 0  |
| *Prioneris autothisbe*        | 5  | 0  | 0  | 0  | 5  | 0  | 0  | 0  |
| **Grand Total**               | 368| 391| 300| 225| 1284|

(Note: Mjg: Mojolangu; Mjs: Merjosari; Slm: Slamet; Alm: Alun-Alun Malang)

**Figure 2.** Some species found in Malang Urban Green Spaces, (a) *Leptosia nina*, (b) *Delias dorylaea*, (c) *Appias indra*, (d) *Eurema hecabe*, (f) *Hypolimnas bolina*, (g) *Papilio memnon* (h) *Catopsilia pyranthe*

### 3.2 Diversity and Abundance of Butterfly

The highest number of species was found in Kebun Bibit Mojolangu, but the highest individual abundance and diversity index was found in Taman Singha Merjosari (Figure 3). Based on the Shannon Wiener diversity index obtained, Taman Singha Merjosari has the highest diversity index value (2.47) but it is not significantly different from the diversity index of butterflies in Kebun Bibit Mojolangu and Taman Slamet. Otherwise, the diversity index of Alun-Alun Malang has the lowest value (1.77) and it is significantly different from other urban green spaces. Overall, the diversity index value at the four green open spaces ranged from 1 to 3.

Based on the Shannon Wiener diversity index category, the value of diversity index between 1 to 3 is classified as moderate level. This shows that the quality level of urban green spaces as butterfly habitats is still at intermediate rank. These results are similar to other studies in green urban spaces in other cities of Indonesia such as the cities of Kediri, Pontianak and Manado which obtained butterfly diversity index values ranging from 1 to 3, namely Taman Kediri (1.68), Taman Pontianak (2.02-2.74) and Taman Sam Ratulangi Manado (1.86-2.49) [10] [11] [12]. These results indicate that the diversity of butterfly in urban green spaces of Malang City has not been completely disturbed yet and the potential of urban green spaces is still supporting as butterfly habitat in urban ecosystems.

The diversity index of butterflies is influenced by abiotic factors such as light intensity, temperature, humidity and wind speed, as well as biotic factors such as vegetation and natural enemies. In this study, Taman Merjosari has the highest relative abundance and diversity index due to light intensity factors with moderate levels, high humidity and the high amount of vegetation, both...
herbs and trees. The highest number of species is found in Kebun Bibit Mojolangu, but this area has a lower abundance of butterflies than Merjosari Park, so the diversity index is not higher either. The high number of species in kebun Bibit Mojolangu is because this area is dominated by ornamental plants with brightly colored flowers. This resulted in the interest of butterflies to visit the plant. However, the area has little tree vegetation and some parts of the land cover have been covered with paving blocks. Mechanical structures in urban ecosystems such as roads, buildings, and paving blocks are several factors that support the loss of butterfly oviposition sites, causing a decrease in abundance [13]

![Figure 3. Diversity and Abundance of Butterfly in Four Urban Green Spaces of Malang City, (a) Relative Abundance, (b) Species Richness, (c) Shannon Wiener Diversity Index](image)

3.3 Important Value Index
The analysis of the importance value index on all butterfly species found in green open spaces resulted in Leptosia nina as the highest species in Taman Singha Merjosari and Taman Slamet. At Kebun Bibit Mojolangu the highest percentage of importance value index was found in the species of Eurema hacabe, while at Alun-Alun Malang the highest importance value index belongs to Junonia atlites. However, overall Leptosia nina almost dominate and have a quietly high percentage in each urban green space (Figure 4). Butterfly species that have a high importance value index percentage generally have a good survival rate.

Several factors that can affect the survival rate of butterfly species in a habitat include the availability of host plants, environmental abiotic factors, number of predators, and adaptability. Vegetation plays an important role in supporting the survival of butterflies related to its role as a host plant and a source of food [14]. Leptosia nina appear to have a significant role because they are
present in all locations and have a fairly high percentage, followed by Junonia atlites, Eurema hacabe, Delias dorylaea and Appias indra. The existence of a butterfly species that has a highly importance value index indicates that this species has an important role in the habitat so that it needs to be protected to keep the sustainability of the ecosystem [15].

![Figure 4. Important Value Index of Butterfly in Four Urban Green Spaces of Malang City](image)

### 3.4 Similarity Clustering

Butterfly communities found in all urban green spaces are visualized in the form of clusters, Alun-Alun Malang and Taman Slamet have the highest similarity, while Taman Singha Merjosari has the lowest similarity value with other urban green spaces. This indicates that there is a fairly high similarity in butterfly community structures in Taman Slamet and Alun-Alun Malang and a quite large difference in Taman Singha Merjosari with other urban green spaces (Figure 5). The Bray-Curtis similarity index depicts the similarity of community structures between two types of habitats in the same ecosystem based on certain variables such as species and abundance. The range of the Bray-Curtis index value is 0-1, if the index value tends to be close to 0, the similarity level of the community structure is low or has a higher difference. Meanwhile, if the index value approaches 1, the similarity of the community structure is high or almost similar [15].
3.5 Correlation of Abiotic Factors to Butterfly Community Structure

Analysis of CCA between butterfly community structure with measured abiotic factors found that *Eurema hacabe* and *Catopsilia pyranthe* have a positive correlation with abiotic wind speed and temperature (Figure 6). Besides *Troides cunifera* and *Eurema harina* also positively correlated with humidity, but a negative correlation with temperature. The group consisting of *Delias dorylæa*, *Graphium autothisbe*, *Hebomoia glaucippe*, and *Junonia atlites* had a positive correlation with light intensity. The other group which includes *Parantica albata*, *Elymnias casiphone*, *Appias indra* and *Prioneris philonome* are positively correlated with humidity and wind factor.

*Catopsilia phyranthe* has a positive correlation with wind and temperature. This result is similar to the previous study in Dakka urban green spaces, Bangladesh which found several genera of *C. pomona* and *C. etride* were positively associated with temperature, wind and humidity through CCA analysis. Besides the research also states that *Eurema hacabe* has a positive correlation with humidity, but has a negative correlation with temperature. This is different from the results in this study, where *E. hacabe* has a positive correlation with temperature, and *E. harina* is positively correlated with humidity factor [16].

![Figure 5. Similarity of Butterfly Community Structure in Four Urban Green Spaces of Malang](image)
4. Conclusions

A total of 38 species and 1284 individuals were found in four green urban spaces of Malang city with *Leptosia nina* as the most common species. The value of diversity index overall 1.77- 2.47 with Taman Singha Merjosari as the highest diversity. This indicated the diversity of butterflies in Malang Urban Green Spaces still in a moderate level and still not completely disturbed yet.

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