Diversity of Butterfly species (Lepidoptera: Rhopalocera) attracted to Carrion Trap at Harau Valley Nature Reserve

E Bibas¹, H Herwina¹, Dahelmi¹, M N Janra¹, A K Amanda¹

¹Animal Taxonomy Laboratory, Biology Department, Faculty of Mathematics and Sciences, Universitas Andalas, Indonesia

Corresponding author’s e-mail address: hennyherwina@sci.unand.ac.id

Abstract. Butterflies are important insect used as bioindicator in addition to their attractiveness in nature. In the wild, butterflies actually use broad spectrum of food sources rather than just sipping nectar as commonly known. This study aimed to collect butterflies that may use substances produced by decaying carrion. It used Carrion Bite Traps baited with decaying fishes or shrimps and set at Harau Valley Nature Reserve areas from April to June 2019. The traps were checked every 24 hours for seven consecutive days at valley site, conservation site sites and plantations site. A total 35 butterfly species that belong to 24 genera and four families identified from 90 collected individuals. Nymphalidae became butterfly family with the highest species number observed (30), while three other families with few species recorded, i.e. Hesperidae with three species, Lycaenidae and Pieridae with one species each. This result might suggest specific trophic of Nymphalidae compared to other butterfly families. Species diversity for butterflies in relation to decaying carrion was high (3.24), indicating the effectiveness of carrion as bait for butterflies in biodiversity rapid assessment.

Keywords: Butterflies; Carrion Trap; Diversity; Family; Nature Reserve

1. Introduction

Indonesia is one of the countries that included in the areas for conservation priority as it has high species diversity and endemism [1]; one of this biodiversity is butterfly [2,3,4,5]. Butterflies in Indonesia are continuously threatened due to habitat destruction resulting from land change severely impacting into fragmented, degraded and decreased of butterfly habitat [6,7,8,9,10,11]. Threats to butterfly’s habitats and diversity can be minimized by carrying out conservation management which designed after monitoring on diversity, abundance and distribution. In addition, condition of habitat and bieology of butterflies are also important factors to know prior to conservation efforts [12,13,14,15,16,17,18].

The diversity of butterflies can be raised by increasing the variability and availability of nectar plants and forage plants for larvae. The disappearance of larval food plants can lead to the extinction of butterflies [19,20,21,22,23]. Abiotic factors such as temperature, humidity and light intensity greatly affect the diversity of butterflies in the tropics. The increasing of temperature and light intensity positively affect diversity, abundance and distribution of butterflies [24,25,26,27,28]. Light intensity and humidity determine puddling behaviour of butterflies, as more butterflies gathered when these two factors increased [29].

Traps are frequently used to collect and study tropical butterflies, including the carrion baited trap [30,31]. Carrion used as bait commonly made from decaying shrimp and fish. Butterflies sampling used carrion-baited trap was said to be better in describing species diversity and richness, as it is effective to
lure out species that are sensitive to disturbance [32,31,33]. Harau Valley has been subjected for many butterfly researches, yet none that use carrion trap. Therefore, applying this method may result in different perspective regarding butterfly diversity at Harau Valley Nature Reserve and its surroundings. Hence, it gives contribution in laying foundation for planning butterfly conservation efforts and managing Harau Valley Nature Reserve area in general.

2. Methods

2.1 Study Area and Sampling Methods

Butterflies sampling had been conducted from April to June 2019 at Harau Valley Nature Reserve, Lima Puluh Kota Regency, West Sumatra. General topography of this area is hilly, with sloping and steep cliffs, interspersed with valley area designated for tourism attraction. It has non-dipterocarp mixed rainforest ecosystem, dominated by highland plants. Portion around the protected area have been converted into plantations by local residents, especially for gambier.

The research used bait traps, cameras, compass, GPS, thermohygrometers, luxmeters, plastic collections for plant sampling, triangle papers for storing butterfly samples, stationery and rope. The traps used decaying carrion made from fishes and shrimps. Fishes and shrimps were mashed before mixed with water (ratio 1: 1) and let decomposed for 13-18 days prior to use [34]. The baited traps were set along the 1 km transects established in three types of area, namely valley area, protected area and gambier plantations (Figure 1). Ten carrion traps were set along the transect line with approximate distance of 100 meters from one to another, each placed 1-2 meters above ground level. At protected area, couple traps were placed 16 meters above the ground at canopy level [35]. Approximately 200 ml bait was put in each trap, replaced with new bait in every morning at 09.00. The checking was started after 24 hours, repeated daily for seven days.

![Figure 1. Map of Research Location in Harau Valley Nature Reserve (Google earth, 2020)](image)

Observations were only taken during sunny weather conditions. Collected butterflies were recorded for their species and total individual number. Specimen then brought to the Research Laboratory of Invertebrate Animal Taxonomy to be stretched, preserved and photographed. Upon the identification finalized, the butterflies stored in the repository of laboratory.
2.2 Identification Samples
Species identification was guided with relevant literatures for Sumatra [36,37,38,39,40,41]. Identification was keyed by looking into specific signs in butterflies and typical for species determination.

2.3 Data Analysis
Identified butterflies were then grouped according to their taxonomical orders, i.e. species, genus and family, with number of collected individual was also detailed. Butterfly diversity was calculated using the Shannon diversity index with the formula below:

\[ H' = -\sum (p_i \ln p_i) \]  

\( H' \): species diversity index, \( p_i \): the proportion of individuals of species-i to all species \( (p_i = n_i/N) \), ln: natural logarithm, \( n_i \): number of individuals-i and \( N \): total individuals of all species [42]. The result was then presented descriptively using tables.

3. Results and Discussion
This study listed a total of 35 butterfly species through the use of carrion trap method. These species belong to 23 genera and 4 families; all of which identified from 90 vouchered specimens. Nymphalidae became the most common family with 30 species identified from this study, while the other three families represented by much less species; Hesperidae with 3 species, Lycaenidae and Pieridae with one species respectively. Nymphalidae is known as family with numerous members and widely distributed [4,37,43,44]. Aside from using flowering plants as source of nectar, food that is commonly associated with butterflies, some species also use resource on rotten fruit [32,34,45,46]. Decaying carcasses, as seen used as bait in this study, also became food source for many butterflies, especially those of Nymphalids.

Table 1. Taxonomy of butterflies collected with carrion bait method at Harau Valley Nature Reserve, West Sumatra. VA: Valley Area, PA: Protected Area, GA: Gambier Plantation, * = Species recently observed in study, after compared with previous studies in Sumatra.

| No | Family    | Genus | Species                        | Number of Individuals | Total |
|----|-----------|-------|--------------------------------|-----------------------|-------|
|    |           |       |                                | VA | PA | GA |       |
| 1  | Hesperida | Bibasis | Bibasis etelka (Hewitson, 1871)* | 2 | 1 |     | 3     |
| 2  |           |        | Bibasis harisa (Moore, 1866)*    | 1 |     | 1   |       |
| 3  | Lycaenida | Udaspes | Udaspes folus (Cramer, 1775)*    | 1 |     | 1   |       |
| 4  |           | Nacabuda | Nacaduba heroe (C.&R. Felder, 1865) | 1 |     |     | 1     |
| 5  | Nymphalida | Agatasa | Agatasa calydonia (Hewitson, 1855)* | 2 |     | 2   |       |
| 6  |           |        | Athyma asura Moore, 1858         | 2 |     | 2   |       |
| 7  |           |        | Athyma nefte (Cramer, 1780)      | 3 | 2 | 1 | 6     |
| 8  | Charaxes  |        | Charaxes bernardus (Fabricius, 1793) | 1 |     |     | 1     |
| 9  | Dichorragia |        | Dichorragia nesimachus (Doyere, 1840) | 2 | 1 | 3 |       |
| 10 | Discophora |        | Discophora necho C.&R. Felder, 1867 | 3 | 6 |     | 9     |
| 11 |           |        | Discophora sondaica Boisduval, 1836* | 2 |     | 2   |       |
12. **Elymnias**  
   *Elymnias panthera* (Fabricius, 1787)  
   *Elymnias penanga*  
   (Westwood, 1851)  

13. **Laringa**  
   *Laringa castelnaui* (C.&R. Felder, 1860)  

14. **Lethe**  
   *Lethe chandica* (Moore, 1858)  
   *Lethe europa* (Fabricius, 1775)  
   *Lethe minerva* (Fabricius, 1775)*  

15. **Lexias**  
   *Lexias dirtea* (Fabricius, 1793)  

16. **Melanitis**  
   *Melanitis phedima* (Cramer, 1780)  

17. **Mycalesis**  
   *Mycalesis horfieldii* Moore, 1892  
   *Mycalesis janardana* Moore, 1857  
   *Mycalesis mnasicles*  
   Hewitson, 1864  
   *Mycalesis orseis* Hewitson, 1864  

18. **Neorina**  
   *Neorina lowii* (Doubleday, 1849)  

19. **Polyura**  
   *Polyura athamas* (Drury, 1773)  
   *Polyura hebe* (Butler, 1866)  
   *Polyura schreiber* (Godart, 1824)  

20. **Prothoe**  
   *Prothoe franck* (Godart, 1824)  

21. **Ragadia**  
   *Ragadia makula* (Horsfield, 1829)  

22. **Vindura**  
   *Vindula dejone* (Erichson, 1834)  

23. **Ypthima**  
   *Ypthima pandocus*  
   Moore, 1857  

24. **Zeoxydia**  
   *Zoeuxidia amethystus* Butler  
   1865  
   *Zoeuxidia doubledayii*  
   Westwood, 1851 *  

25. **Pieridae**  
   *Eurema*  
   *Eurema hecabe* (Linnaeus, 1758)  

| Number of Individuals | 33 | 45 | 12 | 90 |
|-----------------------|----|----|----|----|
| Number of Species     | 17 | 19 | 9  | 35 |
| Number of Genus       | 14 | 14 | 9  | 23 |
| Number of Family      | 3  | 2  | 3  | 4  |
| Shannon-Wiener Index  | 2.72 | 2.63 | 2.09 | 3.24 |

*Prothoe franck* (Nymphalidae) was recorded with most individuals (10). This species was collected from protected area (9 individuals) and gambier plantation (1 individual). Morphologically, *Prothoe franck* has dark coloration on wings which thought to be an adaptation to its preferred habitat. Hence,
this species was found at shaded area like protected forest, where the temperature and light intensity were low [47]. This type of habitat help it camouflaged well.

There were seven butterfly species that need to be highlighted in this study, as they were not recorded from previous studies in Sumatra (Table 1). These species were observed existing in current study, probably as result from the typicality of current location and habitat [48]. The diversity of butterfly species was influenced by the presence of factors that support reproduction and development of butterflies. These include variety of host plants favorable to butterflies as well as environmental factors such as temperature and humidity. As diurnal organisms, which were active during the day, these factors are prominent during the daylight and therefore significantly affect the life of butterflies.

Valley area was indicated as habitat with the highest butterfly species diversity (2.72), followed by protected area (2.63) and gambier plantation (2.09). The high species diversity at valley area might hint the high suitability of this area for butterflies. Harau Valley, in general, has been enriched with various flowering plants to support its main function as tourism destination [21,49]. Some spots, such as ones near waterfalls and along the rivers are heavily shaded with thick canopy and connected to forest edge, providing protection to butterflies within the considerable open valley area [49].

**Table 2. Inventory of flowering plants found along the sampling transects**

| Area        | # Transect point | Species                                                                 | Total |
|-------------|------------------|-------------------------------------------------------------------------|-------|
| Valley      | 1                | Melastoma malabathricum, Elephantopus tomentosus,                        | 7     |
|             |                  | Stachyapheta jamaicensis, Mikania micrantha, Spilanthes                  |       |
|             |                  | paniculata, Borreria laevis dan Clidemia hirta                           |       |
|             | 2                | Mikania micratha, Bidens pilosa, Ageratum conyzoides, Emilia sonchifolia, | 5     |
|             |                  | Stachyapheta jamaicensis dan Asystasia gangetica                         |       |
|             | 3                | Mikania micratha, Bidens pilosa, Ageratum conyzoides,                    | 7     |
|             |                  | Stachyapheta jamaicensis, Spilanthes paniculata, Asystasia gangetica dan |       |
|             |                  | Borreria laevis                                                           |       |
|             | 4                | Melastoma malabathricum, Bidens pilosa, Ageratum conyzoides,             | 12    |
|             |                  | Asystasia gangetica, Sphagneticola trilobata, Zinnia elegans,            |       |
|             |                  | Wedelia biflora, Cosmos caudatus, Tagetes erecta, Rosa hybrida,          |       |
|             |                  | Clerodendrum paniculatum dan Tagetes patula                              |       |
|             | 5                | Melastoma malabathricum, Mikania micrantha, Elephantopus tomentosus,     | 12    |
|             |                  | Ageratum conyzoides, Urena lobata, Solanum torvum,                       |       |
|             |                  | Crassocephalum crepidioides, Stachyapheta jamaicensis,                   |       |
|             |                  | Borreria laevis, Clidemia hirta, Leea sp. dan Clibadium surinamense      |       |
|             | 6                | Melastoma malabathricum, Chromolaena odorata, Elephantopus tomentosus,   | 8     |
|             |                  | Urena lobata, Crassocephalum crepidioides,                               |       |
|             |                  | Stachyapheta jamaicensis, Mikania micrantha dan Spilanthes paniculata   |       |
|             | 7                | Elephantopus tomentosus, Bidens pilosa Ageratum conyzoides,              | 10    |
|             |                  | Spilanthes paniculata, Borreria laevis, Clidemia hirta, Asystasia        |       |
|             |                  | gangetica, Sphagneticola trilobata, Hibiscus arceri dan Sirobilanthes sp.|       |
|             | 8                | -                                                                        | -     |
|             | 9                | Melastoma malabathricum, Mikania micrantha Elephantopus tomentosus,      | 9     |
|             |                  | Bidens pilosa Ageratum conyzoides, Emilia sonchifolia,                   |       |
|             |                  | Stachyapheta jamaicensis, Spilanthes paniculata dan Clibadium surinamense |       |
|             | 10               | Austroepaturium livolium, Ageratum conyzoides, Urena lobata, Emilia      | 8     |
|             |                  | sonchifolia, Mikania micrantha, Spilanthes paniculata, Clidemia hirta    |       |
|             |                  | dan Clibadium surinamense                                               |       |
The valley area had higher diversity of flowering plants compared to the monoculture gambier plantation, which mean more food resource available there. While at the protected area, the flowering plants were shifted with high trees that were not ideal as nectar source for butterflies. With total 29 species of flowering plants identified from the transect in valley area, averagely there were 8 plant species per 100 meter transect that became nectar source for butterflies (Table 2). Much less flowering plants were identified from transect in gambier plantation, with total 11 species gave it an average one species of flowering plant exist in this type of habitat. Butterflies may primarily use nectar as their main diet, but there are various minerals and substances that can only be supplied by non-plant source. Decaying process is essentially a breakdown of complex structures of animal carcass into much more simple substances (including minerals) that might be essential for some organisms, including butterflies. Hence, the use of carrion trap in an area that densely populated by flowering plants can still yield a prominent result.

### 4. Conclusion

Carrion traps effectively collected 35 butterfly species from four families at three locations in Harau Valley Nature Reserve. Nymphalidae became family with the most species collected. The valley area was observed to have higher species diversity than the protected area and gambier plantation due to higher diversity of flowering plants therein. The effectiveness of carrion trap for butterfly diversity study may encourage the use of this method along with insect net and fruit trap to improve the result.

### Acknowledgements

| Nature Reserve | Gambier plantation |
|----------------|--------------------|
|                | Melastoma malabathricum, Mikania micrantha | 2 |
|                | Melastoma malabathricum | 1 |
|                | Melastoma malabathricum, Mikania micrantha, Uncaria gambir, Polygala paniculata, Elephantopus tomentosus, Bidens pilosa, Ageratum conyzoides, Urena lobata, Solanum torvum dan Emilia sonchifolia | 10 |
|                | Melastoma malabathricum, Uncaria gambir dan Elephantopus tomentosus | 3 |
|                | Melastoma malabathricum dan Uncaria gambir | 2 |
|                | Melastoma malabathricum | 1 |
|                | Melastoma malabathricum | 1 |
|                | Melastoma malabathricum | 1 |
|                | Melastoma malabathricum, Mikania micrantha, Uncaria gambir, Polygala paniculata, Bidens pilosa, Ageratum conyzoides, Urena lobata, Emilia sonchifolia dan Stachytarpheta jamaicensis | 9 |
|                | Melastoma malabathricum | 1 |
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