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Diversity of Butterflies (Lepidoptera: Rhopalocera) in The Gunung Raya Wildlife Reserve, Sub District Warkuk Ranau, South Sumatra

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Abstract

This study aims to determine the diversity of butterflies at the Gunung Raya Wildlife Reserve, South Sumatra. The research was conducted in January-February 2018. The research sites were 4 different habitat types, namely primary forest, secondary forest, riparian area, and bush and plantation. Data collection uses direct observation and capture techniques along the transect line (linear transect counting) along 1000 m in each habitat type using insect nets. The results of the study obtained 55 butterfly species belonging to 5 families (there were 13 species of Papilionidae, 30 species of Nymphalidae, 7 species of Pieridae, one species of Riodinidae, and four species of Lycaenidae). The highest Shannon diversity index (H') is in primary forest habitat (Manduriang) with $H' = 3.5$; followed by shrubs and plantations (Pasir Bintang) with $H' = 3.45$, and riparian areas (Talang Lebong) with $H' = 3.23$; while the lowest is secondary forest (Mesagih) with $H' = 2.94$. Distribution of species in all locations is relative ($E > 0.9$) and high species richness ($R > 4$). 2 butterfly species protected by Regulations of the Environment and Forestry Ministers No 20 of 2018, namely *Troides helena* and *Trogonoptera brookiana* has been found in this study.

Keywords: distribution, habitat type, species richness

Received: 14 September 2018, Accepted: 28 November 2018

1. Introduction

Butterflies are one of the most numerous species of insects that are very easy to find in various types of habitat. In Indonesia it is known that more than 2500 species of butterflies are spread in various regions [1], while in the Sumatran island are estimated 500 species of butterflies although there is no definite data [2]. Butterflies are classified into 3 super families namely Hesperioidea, Papilionoidea and Hedyloidea. Hesperioidea and Hedyloidea each have one family, namely Hesperidae and Hedyliidae, while Papilionoidea is divided into 5 families namely Papilionidae, Nymphalidae, Pieridae, Riodinidae and Lycaenidae [3].

The existence of butterflies in nature has a very important role, including being a pollinating to the flowering plants, maintaining the balance of ecosystems and bio-indicators for environmental change. Some butterflies are

very selective in choosing host plants so that their presence in nature can be a marker of the diversity of vegetation in a region [4]. In addition to the ecological role, butterflies are known to become handicraft items that play a role in the economy of the community [5]. However, large-scale hunting along with the increasing demand to be used as collections also reduce the population of butterflies in nature so that the government has set several types of butterflies as protected animals such as butterflies from the Genus *Troides* and *Trogonoptera* as stated in Minister of Environment and Forestry Regulation PP No 7 of 1990 concerning protected plants and animals [6]. In addition, the establishment of protected areas is also quite efficient in suppressing the hunting of protected animals.

The loss of the natural habitat of butterflies due to land conversion and habitat fragmentation is one factor that causes a decline in population [7]. Forest encroachment and monoculture increasingly suppress the presence of butterflies in their natural habitat. The remaining primary for-

ests in Indonesia are mostly in areas that are included in the highlands, so that most of the exotic and protected butterflies are commonly found in this region [8].

Gunung Raya Wildlife Reserve located in the southern sub-district of the Ogan Komering Ulu (OKU) is based on the Minister of Agriculture Decree No. 55 / Kpts / Um / 1/1978 January 26, 1978 with an area of 39.500 ha. However, the area continues to grow until now based on SK. Minister of Forestry No. 76 / Kpts-II / 2001 dated on March 15, 2001 the area was 50.950 Ha. Gunung Raya Wildlife Reserve is a conservation area that is geographically located between 104°01-104°4 East Longitude and 4°40-4°55 South Latitude. Gunung Raya Wildlife Reserve consists of highland tropical rainforest ecosystems with humidity between 50-80%, which is dominated by Dipterocarpaceae families, including Meranti (*Shorea* spp.), Merawan (*Hopea mangarawan*), Jelutung (*Dyera* sp.), and Pulai (*Alstonia* sp) [9]. The total area of forest in this area continues to decline due to the conversion of functions to plantation land and residential areas as well as illegal logging resulting in habitat fragmentation.

Research on butterflies has been carried out in various locations in South Sumatra, such as at Sriwijaya University, which is known 40 species [10] and Sukarame sub-districts with 10 species [11], but in the Gunung Raya Wildlife Reserve area, research on the diversity of butterflies has never been done and published. For this reason, this research was carried out as a first step in the preparation of a butterfly database, especially in the Gunung Raya Wildlife Reserve area.

2. Materials and Methods

2.1 Site Area

This research has been conducted in January - February 2018. The research was located at Gunung Raya Wildlife Reserve, Warkuk Ranau sub-district, South Sumatra, divided into 4 points, namely Mesagih (M), Pasir Bintang (PB), Manduriang (MG) and Talang Lebong (TL). The research map can be seen in Figure 1. These locations were chosen to represent 4 types of habitat (primary forest, secondary forest, riparian area and shrubs and plantations (Table 1). All location can be seen in Figure 1.

Table 1. Coordinate points of research locations

Habitat type	Location	Coordinate point	Elevation (m.a.s.l)
Riparian area	Talang Lebong	S: 04°53'03.3" E: 104°03'33.7"	1288
Shrubs and plantation	Pasir Bintang	S: 04°49'14.8" E: 104°04'18.8"	950-1000
Secondary forest	Mesagih	S: 04°53'53.83" E: 104°08'01.23"	1570
Primary forest	Manduriang	S: 04°43'01.9" E: 104°02'36.4"	870- 1022

Figure 1. Map of Research Location

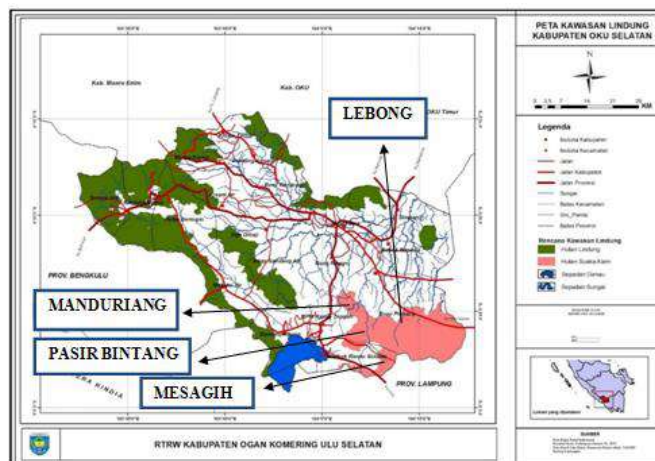


Figure 1. Habitat type of each research location: Riparian (A), Secondary forest (B), Primary forest (C) and Shrubs and plantation (D)

2.2 Collecting Technique

Data retrieval using direct observation techniques along the transect line (Linear transect count) along 1000 m. Every 100 meters the observer will stop and make observations and calculations including the left and right sides of each transect as far as 20 m [12]. Data collection was carried out at the active time of the butterfly at 08.00-15.00 p.m. Butterflies are caught using insect nets to identify. Species that can identified immediately will be released, while the unknown will be turned to death by pressing the thoracic part, put into papilot paper and then taken to the animal taxonomy laboratory of the Department of Biology Math and Sciences Faculty, Sriwijaya University be identified.

2.3 Data Analysis

Data analysis use the (Krebs 2002; Odum 1998) in [12] formula, below:

a. Diversity Index Shannon-Wiener

Diversity was determined using the Shannon-Wiener diversity index with the formula below:

$$H' = - \sum \left[\frac{ni}{N} \right] \text{Log} \left[\frac{ni}{N} \right]$$

H' is Shannon diversity index, ni: number of species, N: total number of individuals of all types

Criteria: $H' < 1$ (low), $1 \leq H' \leq 3$ (moderate), $H' \geq 3$ (high)

b. Evenness Index

$$E = \frac{H'}{\text{Ln } S}$$

E: Evenness index, H': Shannon-Wiener diversity index, Ln: logarithma natural, dan S: species
 Criteria: E < 0.3 (low), E: 0.3 – 0.6 (moderate) and E > 0.6 (high)

c. *Species Richness Margaleff*

$$R = \frac{(S - i)}{\ln N}$$

S: Total species location N, with criteria R < 2.5 (low), 2.5 < R < 4 (moderate), R > 4 (high)

3. Results and Discussion

Composition of Butterflies Species

We found 55 species of butterflies with a total of 314 individuals consisting of 5 families: Papilionidae (13 species), Nymphalidae (30 species), Pieridae (7 species), Riodinidae (one species), and Lycaenidae (4 species) at Gunung Raya Wildlife Reserve. The complete data regarding species, conservation status, and locations found are presented in (Table 2). The composition of butterfly in each habitat type show differences of species composition. According to [13] state that, differences in plant vegetation in an area determine the diversity of species of butterflies found in the area. This is due to the specifications in the selection of host plants for butterflies in the larval stage.

Percentage of butterflies followed by Family can be seen at Figure 3. Nymphalidae have total 30 species (54.54%), Papilionidae 13 species (23.63%), Pieridae 7 species (12.72%), Lycaenidae 4 species (7.27%) and Riodinidae one species (1.81%). While viewed from the composition of individuals in each family showed that Nymphalidae remained the highest with a total of 170 individuals (53.9%), followed by Pieridae 70 individuals (22.2%), Papilionidae 47 individuals (14.9%), Lycaenidae 22 individuals (6.9%) and Riodinidae 6 individuals (1.9%). *E. hecabe* has the highest number of species (30 individuals) and was found in all study locations, while there were 9 species found in only one individual namely *C. scylla*, *P. aspasia*, *P. delphis*, *I. gaura*, *E. core*, *D. genutia*, *A. violae* and *G. sarpedon*.

Based on the data above, Family Nymphalidae has the most species among other families. There are 30 species of butterflies, 8 of which can be found in all locations. Butterflies from the family Nymphalidae are more recorded during observations at 09:30 to 11:00 a.m. Approaching the middle of the day, butterflies will be found less and return to their activities on late afternoon (crepuscular). According to [14], skippers and browns butterflies are more active in early morning and early evening, or in the hour leading up to dusk. Their most active in flight at

dawn and dusk and tend to be reclusive at the rest of the day, referred to as crepuscular habit.

Papilionidae ranks second in the family with the most species, namely 13 species consisting of the genus *Graphium* (4 species), *Papilio* (4 species), and *Atrophaneura*, *Lamproptera*, *Pachliopta*, *Troides* and *Trogonoptera*. Each genus has an extension on the hindwing so that it resembles a tail except *G. doson*, *G. sarpedon* and *A. nox*. The samples recorded in size vary from small to large. [15] Butterflies from the same genus usually have the same hostplant with each other as the Genus *Graphium* which chooses the Annonaceae family as its hostplant or *Papilio* with Rutaceae. However, the selection of the same host plant can lead to interspecies and intra-species competition so that it can suppress the population.

Some butterfly species appear to have morphological differences between males and females, especially in the style and color of the wings. In this study found butterflies that have different morphology between males and females as in *Junonia orithya* and *Hypolimnas bolina*. [16] The wings of Nymphalidae butterflies vary greatly in color and wing patterns, generally in brown, orange, yellow and black with varying sizes. Many types are "sexual dimorphic" which is different from the male and female wing patterns [17]. In species where males and females look similar, females are usually larger with more rounded wings [3]. Some documented butterfly species can be seen in Figure 4.

Diversity, evenness, and species richness index of butterflies in research location.

The research locations with the most butterfly species are Manduriang with a total of 46 species (H' = 3.58), followed by Pasir Bintang 37 species (H' = 3.45) and 34 species of Talang Lebong (H' = 3.23) the three locations are categorized as having high diversity, while the least species are Mesagih with 24 species (H' = 2.94) and categorized as moderate diversity. Based on the calculation of evenness index, all locations are almost uniformly categorized (E = 0.76-0.95), while the species richness index of each location is high (R > 4).

Manduriang as the location of highest diversity index is located at an altitude of 950 meters to 1022 meters above sea level, the average temperature and humidity during the research ranged from 26.5 - 29.3°C and 65.6 - 73.9%. There is some species of plants that host plants for butterflies such as *Aristolochia* sp, *Asystasia intrusa*, *Mangifera* sp and *Passiflora* sp. [18] Butterflies indulge in humidity around 60% because it can reduce the risk of losing water (dehydration) due to the sun. The position of the host plant (topography), plus the associated temperature regime, has a direct influence on larval growth[15]. So that it can be said that the temperature and humidity and vegetation in this location can support the life of butterflies that live in it. At this location, there are protected butterflies called *Troides*

helena with 5 individuals.

Table 2. Butterflies taxonomy, conservation status, and their location.

No	Butterflies Taksonomy		Conservation status		Habitat type			
	Famili	Species	IUCN	PP	1	2	3	4
1.	Papilionidae	<i>Atrophaneura nox</i>	NE	NP	0	1	0	1
2.	Papilionidae	<i>Graphium agamemnon</i>	NE	NP	0	2	1	2
3.	Papilionidae	<i>Graphium antiphates</i>	NE	NP	0	0	2	0
4.	Papilionidae	<i>Graphium doson</i>	NE	NP	0	3	1	1
5.	Papilionidae	<i>Graphium sarpedon</i>	NE	NP	0	0	1	0
6.	Papilionidae	<i>Lamproptera meges</i>	NE	NP	1	0	0	1
7.	Papilionidae	<i>Pachliopta aristolochiae</i>	NE	NP	0	1	1	1
8.	Papilionidae	<i>Papilio demoleus</i>	NE	NP	0	1	1	0
9.	Papilionidae	<i>Papilio demolion</i>	NE	NP	0	1	0	1
10.	Papilionidae	<i>Papilio memnon</i>	NE	NP	2	3	5	2
11.	Papilionidae	<i>Papilio polytes</i>	NE	NP	0	2	2	1
12.	Papilionidae	<i>Troides helena</i>	LC	P	1	0	3	0
13.	Papilionidae	<i>Trogonoptera brookiana</i>	LC	P	2	0	0	0
14.	Nymphalidae	<i>Acraea violae</i>	NE	NP	0	0	1	0
15.	Nymphalidae	<i>Athyma nefte</i>	NE	NP	0	2	1	1
16.	Nymphalidae	<i>Argyreus hiperbius</i>	NE	NP	1	0	0	0
17.	Nymphalidae	<i>Cirrochroa orisa</i>	NE	NP	0	2	0	1
18.	Nymphalidae	<i>Cupha erymanthis</i>	NE	NP	2	3	3	0
19.	Nymphalidae	<i>Danaus genutia</i>	NE	NP	0	0	2	0
20.	Nymphalidae	<i>Danaus melanippus</i>	NE	NP	0	2	3	1
21.	Nymphalidae	<i>Elymnias penanga</i>	NE	NP	0	1	2	0
22.	Nymphalidae	<i>Euploea mulciber</i>	NE	NP	0	2	2	1
23.	Nymphalidae	<i>Euploea Eunice</i>	NE	NP	0	0	2	0
24.	Nymphalidae	<i>Euploea core</i>	NE	NP	0	0	1	0
25.	Nymphalidae	<i>Euthalia aconthea</i>	NE	NP	0	2	2	1
26.	Nymphalidae	<i>Hypolimnas bolina</i>	NE	NP	2	0	3	0
27.	Nymphalidae	<i>Ideopsis gaura</i>	NE	NP	0	0	1	0
28.	Nymphalidae	<i>Ideopsis juvena</i>	NE	NP	0	1	0	1
29.	Nymphalidae	<i>Ideopsis vulgaris</i>	NE	NP	1	0	1	0
30.	Nymphalidae	<i>Junonia atlites</i>	NE	NP	2	0	4	0
31.	Nymphalidae	<i>Junonia orithya</i>	NE	NP	0	0	3	1
32.	Nymphalidae	<i>Melanitis leda</i>	NE	NP	1	2	3	1
33.	Nymphalidae	<i>Mycalasis fusca</i>	NE	NP	6	5	4	2
34.	Nymphalidae	<i>Mycalasis mineus</i>	NE	NP	1	2	9	1
35.	Nymphalidae	<i>Neptis hylas</i>	NE	NP	0	1	4	2
36.	Nymphalidae	<i>Orsotriaena medus</i>	NE	NP	8	5	6	3
37.	Nymphalidae	<i>Parantica Aspasia</i>	NE	NP	0	1	0	0
38.	Nymphalidae	<i>Polyura delphis</i>	NE	NP	0	1	0	0
39.	Nymphalidae	<i>Polyura hebe</i>	NE	NP	0	1	2	1
40.	Nymphalidae	<i>Ragadia makuta</i>	NE	NP	2	1	1	0
41.	Nymphalidae	<i>Terinos terpander</i>	NE	NP	1	1	1	2
42.	Nymphalidae	<i>Ypthima baldus</i>	NE	NP	3	4	4	2
43.	Nymphalidae	<i>Ypthima pandocus</i>	NE	NP	5	2	7	1
44.	Pieridae	<i>Appias libythea</i>	NE	NP	0	0	3	1
45.	Pieridae	<i>Catopsilia scylla</i>	NE	NP	0	0	1	0
46.	Pieridae	<i>Delias belisama</i>	NE	NP	2	1	1	1
47.	Pieridae	<i>Eurema alitha</i>	NE	NP	3	2	2	4
48.	Pieridae	<i>Eurema hecabe</i>	NE	NP	4	2	13	11
49.	Pieridae	<i>Eurema sari</i>	NE	NP	2	2	5	3
50.	Pieridae	<i>Leptosia nina</i>	NE	NP	1	1	3	2
51.	Riodinidae	<i>Zemeros flegyas</i>	NE	NP	1	2	2	1
52.	Lycaenidae	<i>Caleta roxus</i>	NE	NP	1	0	2	0
53.	Lycaenidae	<i>Jamides celeno</i>	NE	NP	0	6	4	1
54.	Lycaenidae	<i>Hypolicaena erylus</i>	NE	NP	0	2	1	1
55.	Lycaenidae	<i>Tagiades japetus</i>	NE	NP	0	1	1	2
Individuals number					55	74	127	59
Species number					24	37	46	34

Information : IUCN (International Union for Conservation of Nature Redlist), NE: Not evaluated, LC: Least concern, PP: Protection status of Indonesian Government (PP number 7, 1999), (P: Protected, NP: Not Protected), 1: secondary forest, 2: shrubs and plantation, 3: primary forest, 4: riparian area

The location with the lowest diversity index value but still in the medium category is Mesagih. This location has a height of 1570 meters above sea level, temperature and humidity between 23.5 - 26.3°C and 72.4 -81.1% and the weather changes so quickly and often misty. There are still many large trees, but the littered forest floor makes the vegetation below quite a bit at this location. According to [16] state that, more diverse vegetation in a habitat has the potential for more available feed compared to habitats with less diverse vegetation [19]. The low source of feed in this area resulted in several types of butterflies migrating to other areas with more food sources. However, at this location visible the rare butterflies *Trogonoptera brookiana*, *Troides helena* and *Lamproptera meges*.

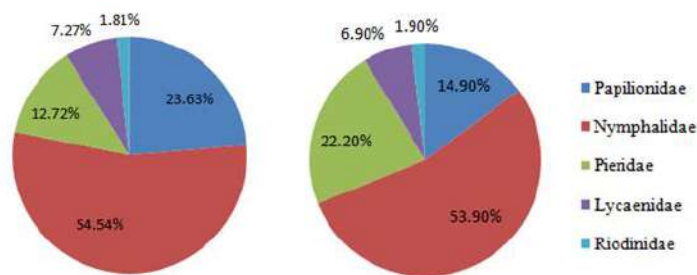


Figure 3. Butterflies families percentage based on species and individuals.



Figure 4. Some species of butterflies of the Gunung Raya Wildlife Reserve: *Graphium agamemnon agamemnon* (A), *Papilio memnon agenor* (B), *Atrophaneura nox erebus* (C), *Polyura hebe chersonesus* (D), *Danaus melanippus hegesippus* (E), *Ideopsis gaura perakana* (F), *Delias belisama belisama* (G), *Zemerus flegyas flegyas* (H), and *Calta elna elvira* (I).

Pasir Bintang and Talang Lebong both have high diversity categories. Pasir Bintang is located at 950-1000 masl, representing habitat types that are directly adjacent to coffee plantations. There is a lot of vegetation that becomes a butterfly hostplant among them such as *Asystasia intrusa*, *Imperata cylindrica*, *Mangifera indica*, *Nephlium* sp, *Cinamomum* sp, and *Flacourtia* sp. While the talang lebong represent habitat types that are close to water sources. At this location there is a large waterfall where many flowering plants grow around it. [20] These results may be due to invasion of disturbed areas by generalized

T. helena and *T. brookiana* that are seen when collecting data are types of butterflies whose existence is rare and threatened with extinction in Indonesia, so that it is protected in PP No 7 of 1999 about concerning the preservation of protected species of plants and animals; and Regulations of Environment and Forestry ministres No 20 of 2018 about protected species of plants and animals . In International Union For Conservation Nation (IUCN), the two species of butterflies are Least concern (LC). While 53 other species are not protected and Not evaluated (NE) in the IUCN.

Table 3. Ecological indices at different habitat type

Ecological indices		Habitat types			
		Mesagih	Pasir Bintang	Manduriang	Talang Lebong
Diversity	Shannon-	2.94	3.45	3.58	3.23
	Wiener (H')	(moderate)	(high)	(high)	(High)
	Pielou's Evenness (E)	0.92	0.95	0.93	0.91
		(almost uniformly)	(almost uniformly)	(almost uniformly)	(almost uniformly)
Margaleff	Species	5.98	8.59	9.49	8.33
Richness (R)		(high)	(high)	(high)	(high)

and widespread herb and shrub species such as *Lantana camara* etc which act as a rich nectar source for butterflies. Plant species which act as rich source of nectar influence the occurrence of butterfly species.

The four study sites have an index of more than 4, indicating that species richness is high. In addition, all locations also show that completing species is almost uniform. Environmental carrying capacity affects the evenness of species. According to [21] state that the size of the balance between a community with one another is largely determined by the value of the evenness index and this value is influenced by the number of species contained in one community.

In all study locations it was seen that Nymphalidae became a family whose species were always found. The abundance of species and individuals of Nymphalidae when research may occur due to the selection of butterfly larvae hostplants that are not too selective ,so that there are more than one host plant species. As with the *Hypolimnas bolina* during the study, they were carrying out oviposition on the *Asystasia intrusa* and *Sida acuta* plants at one time. [22] The largest proportion of the family Nymphalidae is due to the tendency of the nature of the polyphag (having more than one type of food). Polyfag properties allow Nymphalidae to still be able to meet their needs for host plants even though the main host plants are not available. An alternative host search usually takes into account the chemical content (water and nitrogen) and the level of butterfly competition from the same genus [23].

4. Conclusion

There are 55 species of butterflies consisting of 5 families at Gunung Raya Wildlife Reserve. The diversity of butterflies were relatively high Shannon diversity index ($H' > 3$), and 1 habitat type has Shannon diversity index ($H'=2.94$). Indonesian protected butterflies *T. helena* and *T.brookiana* can be still found in the Gunung Raya Wildlife Reserve area.

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DIVERSITY OF BUTTERFLIES
(LEPIDOPTERA: RHOPALOCERA) IN
THE GUNUNG RAYA WILDLIFE
RESERVE, SUB DISTRICT WARKUK
RANAU, SOUTH SUMATERA

By Arum Setiawan



Diversity of Butterflies (Lepidoptera: Rhopalocera) in The Gunung Raya Wildlife Reserve, Sub District Warkuk Ranau, South Sumatra

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Abstract

This study aims to determine the diversity of butterflies at the Gunung Raya Wildlife Reserve, South Sumatra. The research was conducted in January-February 2018. The research sites were 4 different habitat types, namely primary forest, secondary forest, riparian area, and bush and plantation. Data collection uses direct observation and capture techniques along the transect line (linear transect counting) along 1000 m in each habitat type using insect nets. The results of the study obtained 55 butterfly species belonging to 5 families (there were 13 species of Papilionidae, 30 species of Nymphalidae, 7 species of Pieridae, one species of Riodinidae, and four species of Lycaenidae). The highest Shannon diversity index (H') is in primary forest habitat (Manduriang) with $H' = 3.5$; followed by shrubs and plantations (Pasir Bintang) with $H' = 3.45$, and riparian areas (Talang Lebong) with $H' = 3.23$; while the lowest is secondary forest (Mesagih) with $H' = 2.94$. Distribution of species in all locations is relative ($E > 0.9$) and high species richness ($R > 4$). 2 butterfly species protected by Regulations of the Environment and Forestry Ministers No 20 of 2018, namely *Troides helena* and *Trogonoptera brookiana* has been found in this study.

Keywords: distribution, habitat type, species richness

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1. Introduction

Butterflies are one of the most numerous species of insects that are very easy to find in various types of habitat. In Indonesia it is known that more than 2500 species of butterflies are spread in various regions [1], while in the Sumatran island are estimated 500 species of butterflies although there is no definite data [2]. Butterflies are classified into 3 super families namely Hesperioidea, Papilionoidea and Hedyloidea. Hesperioidea and Hedyloidea each have one family, namely Hesperidae and Hedyidae, while Papilionoidea is divided into 5 families namely Papilionidae, Nymphalidae, Pieridae, Riodinidae and Lycaenidae [3].

The existence of butterflies in nature has a very important role, including being a pollinating to the flowering plants, maintaining the balance of ecosystems and bio-indicators for environmental change. Some butterflies are

very selective in choosing host plants so that their presence in nature can be a marker of the diversity of vegetation in a region [4]. In addition to the ecological role, butterflies are known to become handicraft items that play a role in the economy of the community [5]. However, large-scale hunting along with the increasing demand to be used as collections also reduce the population of butterflies in nature so that the government has set several types of butterflies as protected animals such as butterflies from the Genus *Troides* and *Trogonoptera* as stated in Minister of Environment and Forestry Regulation PP No 7 of 1990 concerning protected plants and animals [6]. In addition, the establishment of protected areas is also quite efficient in suppressing the hunting of protected animals.

The loss of the natural habitat of butterflies due to land conversion and habitat fragmentation is one factor that causes a decline in population [7]. Forest encroachment and monoculture increasingly suppress the presence of butterflies in their natural habitat. The remaining primary for-

ests in Indonesia are mostly in areas that are included in the highlands, so that most of the exotic and protected butterflies are commonly found in this region [8].

Gunung Raya Wildlife Reserve located in the southern sub-district of the Ogan Komering Ulu (OKU) is based on the Minister of Agriculture Decree No. 55 / Kpts / Um / 1/1978 January 26, 1978 with an area of 39.500 ha. However, the area continues to grow until now based on SK. Minister of Forestry No. 76 / Kpts-II / 2001 dated on March 15, 2001 the area was 50.950 Ha. Gunung Raya Wildlife Reserve is a conservation area that is geographically located between 104°01-104°4 East Longitude and 4°40-4°55 South Latitude. Gunung Raya Wildlife Reserve consists of highland tropical rainforest ecosystems with humidity between 50-80%, which is dominated by Dipterocarpaceae families, including Meranti (*Shorea* spp.), Merawan (*Hopea mangarawan*), Jelutung (*Dyera* sp.), and Pulai (*Alstonia* sp.) [9]. The total area of forest in this area continues to decline due to the conversion of functions to plantation land and residential areas as well as illegal logging resulting in habitat fragmentation.

Research on butterflies has been carried out in various locations in South Sumatra, such as at Sriwijaya University, which is known 40 species [10] and Sukarame sub-districts with 10 species [11], but in the Gunung Raya Wildlife Reserve area, research on the diversity of butterflies has never been done and published. For this reason, this research was carried out as a first step in the preparation of a butterfly database, especially in the Gunung Raya Wildlife Reserve area.

2. Materials and Methods

2.1 Site Area

This research has been conducted in January - February 2018. The research was located at Gunung Raya Wildlife Reserve, Warkuk Ranau sub-district, South Sumatra, divided into 4 points, namely Mesagih (M), Pasir Bintang (PB), Manduriang (MG) and Talang Lebong (TL). The research map can be seen in Figure 1. These locations were chosen to represent 4 types of habitat (primary forest, secondary forest, riparian area and shrubs and plantations (Table 1). All location can be seen in Figure 1.

Table 1. Coordinate points of research locations

Habitat type	Location	Coordinate point	Elevation (m.a.s.l)
Riparian area	Talang Lebong	S: 04°53'03.3" E: 104°03'33.7"	1288
Shrubs and plantation	Pasir Bintang	S: 04°49'14.8" E: 104°04'18.8"	950-1000
Secondary forest	Mesagih	S: 04°53'53.83" E: 104°08'01.23"	1570
Primary forest	Manduriang	S: 04°43'01.9" E: 104°02'36.4"	870- 1022

Figure 1. Map of Research Location

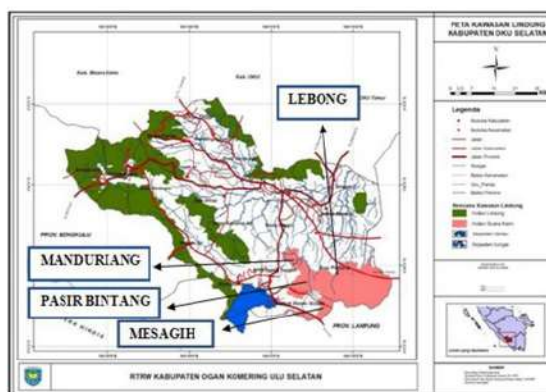


Figure 1. Habitat type of each research location: Riparian (A), Secondary forest (B), Primary forest (C) and Shrubs and plantation (D)

2.2 Collecting Technique

Data retrieval using direct observation techniques along the transect line (Linear transect count) along 1000 m. Every 100 meters the observer will stop and make observations and calculations including the left and right sides of each transect as far as 20 m [12]. Data collection was carried out at the active time of the butterfly at 08.00-15.00 p.m. Butterflies are caught using insect nets to identify. Species that can identified immediately will be released, while the unknown will be turned to death by pressing the thoracic part, put into papilot paper and then taken to the animal taxonomy laboratory of the Department of Biology Math and Sciences Faculty, Sriwijaya University be identified.

2.3 Data Analysis

Data analysis use the (Krebs 2002; Odum 1998) in [12] formula, below:

a. Diversity Index Shannon-Wiener

Diversity was determined using the Shannon-Wiener diversity index with the formula below:

$$H' = - \sum \left[\frac{n_i}{N} \right] \log \left[\frac{n_i}{N} \right]$$

H' is Shannon diversity index, n_i : number of species, N : total number of individuals of all types

Criteria: $H' < 1$ (low), $1 \leq H' \leq 3$ (moderate), $H' \geq 3$ (high)

b. Evenness Index

$$E = \frac{H'}{\ln S}$$

E: Evenness index, H': Shannon-Wiener diversity index, Ln: logarithma natural, dan S: species
 Criteria: E < 0.3 (low), E: 0.3 – 0.6 (moderate) and E > 0.6 (high)

c. *Species Richness Margaleff*

$$R = \frac{(S - i)}{\ln N}$$

S: Total species location N, with criteria R < 2.5 (low), 2.5 < R < 4 (moderate), R > 4 (high)

3. Results and Discussion

Composition of Butterflies Species

We found 55 species of butterflies with a total of 314 individuals consisting of 5 families: Papilionidae (13 species), Nymphalidae (30 species), Pieridae (7 species), Riodinidae (one species), and Lycaenidae (4 species) at Gunung Raya Wildlife Reserve. The complete data regarding species, conservation status, and locations found are presented in (Table 2). The composition of butterfly in each habitat type show differences of species composition. According to [13] state that, differences in plant vegetation in an area determine the diversity of species of butterflies found in the area. This is due to the specifications in the selection of host plants for butterflies in the larval stage.

Percentage of butterflies followed by Family can be seen at Figure 3. Nymphalidae have total 30 species (54.54%), Papilionidae 13 species (23.63%), Pieridae 7 species (12.72%), Lycaenidae 4 species (7.27%) and Riodinidae one species (1.81%). While viewed from the composition of individuals in each family showed that Nymphalidae remained the highest with a total of 170 individuals (53.9%), followed by Pieridae 70 individuals (22.2%), Papilionidae 47 individuals (14.9%), Lycaenidae 22 individuals (6.9%) and Riodinidae 6 individuals (1.9%). *E. hecabe* has the highest number of species (30 individuals) and was found in all study locations, while there were 9 species found in only one individual namely *C. scylla*, *P. aspasia*, *P. delphis*, *I. gaura*, *E. core*, *D. gemutia*, *A. violae* and *G. sarpedon*.

Based on the data above, Family Nymphalidae has the most species among other families. There are 30 species of butterflies, 8 of which can be found in all locations. Butterflies from the family Nymphalidae are more recorded during observations at 09:30 to 11:00 a.m. Approaching the middle of the day, butterflies will be found less and return to their activities on late afternoon (crepuscular). According to [14], skippers and browns butterflies are more active in early morning and early evening, or in the hour leading up to dusk. Their most active in flight at

dawn and dusk and tend to be reclusive at the rest of the day, referred to as crepuscular habit.

Papilionidae ranks second in the family with the most species, namely 13 species consisting of the genus *Graphium* (4 species), *Papilio* (4 species), and *Atrophaneura*, *Lamproptera*, *Pachliopta*, *Troides* and *Trogonoptera*. Each genus has an extension on the hindwing so that it resembles a tail except *G. doson*, *G. sarpedon* and *A. nox*. The samples recorded in size vary from small to large. [15] Butterflies from the same genus usually have the same hostplant with each other as the Genus *Graphium* which chooses the Annonaceae family as its hostplant or *Papilio* with Rutaceae. However, the selection of the same host plant can lead to interspecies and intra-species competition so that it can suppress the population.

Some butterfly species appear to have morphological differences between males and females, especially in the style and color of the wings. In this study found butterflies that have different morphology between males and females as in *Junonia orithya* and *Hypolimnas bolina*. [16] The wings of Nymphalidae butterflies vary greatly in color and wing patterns, generally in brown, orange, yellow and black with varying sizes. Many types are "sexual dimorphic" which is different from the male and female wing patterns [17]. In species where males and females look similar, females are usually larger with more rounded wings [3]. Some documented butterfly species can be seen in Figure 4.

Diversity, evenness, and species richness index of butterflies in research location.

The research locations with the most butterfly species are Manduriang with a total of 46 species (H' = 3.58), followed by Pasir Bintang 37 species (H' = 3.45) and 34 species of Talang Lebong (H' = 3.23) the three locations are categorized as having high diversity, while the least species are Mesagih with 24 species (H' = 2.94) and categorized as moderate diversity. Based on the calculation of evenness index, all locations are almost uniformly categorized (E = 0.76-0.95), while the species richness index of each location is high (R > 4).

Manduriang as the location of highest diversity index is located at an altitude of 950 meters to 1022 meters above sea level, the average temperature and humidity during the research ranged from 26.5 - 29.3°C and 65.6 - 73.9%. There is some species of plants that host plants for butterflies such as *Aristolochia* sp, *Asystasia intrusa*, *Mangifera* sp and *Passiflora* sp. [18] Butterflies indulge in humidity around 60% because it can reduce the risk of losing water (dehydration) due to the sun. The position of the host plant (topography), plus the associated temperature regime, has a direct influence on larval growth [15]. So that it can be said that the temperature and humidity and vegetation in this location can support the life of butterflies that live in it. At this location, there are protected butterflies called *Troides*

helena with 5 individuals.

Table 2. Butterflies taxonomy, conservation status, and their location.

No	Butterflies Taksonomy		Conservation status		Habitat type			
	Famili	Species	IUCN	PP	1	2	3	4
1.	Papilionidae	<i>Atrophaneura nox</i>	NE	NP	0	1	0	1
2.	Papilionidae	<i>Graphium agamemnon</i>	NE	NP	0	2	1	2
3.	Papilionidae	<i>Graphium antiphates</i>	NE	NP	0	0	2	0
4.	Papilionidae	<i>Graphium doson</i>	NE	NP	0	3	1	1
5.	Papilionidae	<i>Graphium sarpedon</i>	NE	NP	0	0	1	0
6.	Papilionidae	<i>Lamproptera meges</i>	NE	NP	1	0	0	1
7.	Papilionidae	<i>Pachioptera aristolochiae</i>	NE	NP	0	1	1	1
8.	Papilionidae	<i>Papilio demoleus</i>	NE	NP	0	1	1	0
9.	Papilionidae	<i>Papilio demolion</i>	NE	NP	0	1	0	1
10.	Papilionidae	<i>Papilio memnon</i>	NE	NP	2	3	5	2
11.	Papilionidae	<i>Papilio polytes</i>	NE	NP	0	2	2	1
12.	Papilionidae	<i>Troides helena</i>	LC	P	1	0	3	0
13.	Papilionidae	<i>Trogonoptera brookiana</i>	LC	P	2	0	0	0
14.	Nymphalidae	<i>Acraea violae</i>	NE	NP	0	0	1	0
15.	Nymphalidae	<i>Athyma nefte</i>	NE	NP	0	2	1	1
16.	Nymphalidae	<i>Argyreus hiperbius</i>	NE	NP	1	0	0	0
17.	Nymphalidae	<i>Cirrochroa orisa</i>	NE	NP	0	2	0	1
18.	Nymphalidae	<i>Cupha erymanthis</i>	NE	NP	2	3	3	0
19.	Nymphalidae	<i>Danaus genutia</i>	NE	NP	0	0	2	0
20.	Nymphalidae	<i>Danaus melanippus</i>	NE	NP	0	2	3	1
21.	Nymphalidae	<i>Elymnias penanga</i>	NE	NP	0	1	2	0
22.	Nymphalidae	<i>Euploea mulciber</i>	NE	NP	0	2	2	1
23.	Nymphalidae	<i>Euploea Eunice</i>	NE	NP	0	0	2	0
24.	Nymphalidae	<i>Euploea core</i>	NE	NP	0	0	1	0
25.	Nymphalidae	<i>Euthalia aconthea</i>	NE	NP	0	2	2	1
26.	Nymphalidae	<i>Hypolimnas bolina</i>	NE	NP	2	0	3	0
27.	Nymphalidae	<i>Ideopsis gaura</i>	NE	NP	0	0	1	0
28.	Nymphalidae	<i>Ideopsis juvena</i>	NE	NP	0	1	0	1
29.	Nymphalidae	<i>Ideopsis vulgaris</i>	NE	NP	1	0	1	0
30.	Nymphalidae	<i>Junonia athles</i>	NE	NP	2	0	4	0
31.	Nymphalidae	<i>Junonia orithya</i>	NE	NP	0	0	3	1
32.	Nymphalidae	<i>Melanitis leda</i>	NE	NP	1	2	3	1
33.	Nymphalidae	<i>Myccalesis fusca</i>	NE	NP	6	5	4	2
34.	Nymphalidae	<i>Myccalesis mineus</i>	NE	NP	1	2	9	1
35.	Nymphalidae	<i>Neptis hylas</i>	NE	NP	0	1	4	2
36.	Nymphalidae	<i>Orsotriaena medus</i>	NE	NP	8	5	6	3
37.	Nymphalidae	<i>Parantica Aspasia</i>	NE	NP	0	1	0	0
38.	Nymphalidae	<i>Polyura delphis</i>	NE	NP	0	1	0	0
39.	Nymphalidae	<i>Polyura hebe</i>	NE	NP	0	1	2	1
40.	Nymphalidae	<i>Ragadia makuta</i>	NE	NP	2	1	1	0
41.	Nymphalidae	<i>Terinos terpander</i>	NE	NP	1	1	1	2
42.	Nymphalidae	<i>Ypthina baldus</i>	NE	NP	3	4	4	2
43.	Nymphalidae	<i>Ypthina pandocus</i>	NE	NP	5	2	7	1
44.	Pieridae	<i>Appias libythea</i>	NE	NP	0	0	3	1
45.	Pieridae	<i>Catopsilia scylla</i>	NE	NP	0	0	1	0
46.	Pieridae	<i>Delias belisama</i>	NE	NP	2	1	1	1
47.	Pieridae	<i>Eurema alitha</i>	NE	NP	3	2	2	4
48.	Pieridae	<i>Eurema hecabe</i>	NE	NP	4	2	13	11
49.	Pieridae	<i>Eurema sari</i>	NE	NP	2	2	5	3
50.	Pieridae	<i>Leptostia nina</i>	NE	NP	1	1	3	2
51.	Riodinidae	<i>Zemeros flegyas</i>	NE	NP	1	2	2	1
52.	Lycaenidae	<i>Caleta roxus</i>	NE	NP	1	0	2	0
53.	Lycaenidae	<i>Jamides celeno</i>	NE	NP	0	6	4	1
54.	Lycaenidae	<i>Hypolicaena erylus</i>	NE	NP	0	2	1	1
55.	Lycaenidae	<i>Tagiades japetus</i>	NE	NP	0	1	1	2
	Individuals number				55	74	127	59
	Species number				24	37	46	34

Information : IUCN (International Union for Conservation of Nature Redlist), NE: Not evaluated, LC: Least concern, PP: Protection status of Indonesian Government (PP number 7, 1999). (P: Protected, NP: Not Protected), 1: secondary forest, 2: shrubs and plantation, 3: primary forest, 4: riparian area

The location with the lowest diversity index value but still in the medium category is Mesagih. This location has a height of 1570 meters above sea level, temperature and humidity between 23.5 - 26.3°C and 72.4 -81.1% and the weather changes so quickly and often misty. There are still many large trees, but the littered forest floor makes the vegetation below quite a bit at this location. According to [16] state that, more diverse vegetation in a habitat has the potential for more available feed compared to habitats with less diverse vegetation [19]. The low source of feed in this area resulted in several types of butterflies migrating to other areas with more food sources. However, at this location visible the rare butterflies *Trogonoptera brookiana*, *Troides helena* and *Lamproptera meges*.

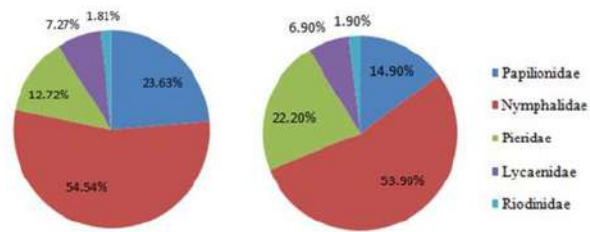


Figure 3. Butterflies families percentage based on species and individuals.



Figure 4. Some species of butterflies of the Gunung Raya Wildlife Reserve: *Graphium agamemnon agamemnon* (A), *Papilio memnon agenor* (B), *Atrophaneura nox erebus* (C), *Polyura hebe chersonesus* (D), *Danaus melanippus hegesippus* (E), *Ideopsis gaura perakana* (F), *Delias belisama belisama* (G), *Zemerus flegyas flegyas* (H), and *Calta elna elvira* (I).

Pasir Bintang and Talang Lebong both have high diversity categories. Pasir Bintang is located at 950-1000 masl, representing habitat types that are directly adjacent to coffee plantations. There is a lot of vegetation that becomes a butterfly hostplant among them such as *Asystasia intrusa*, *Imperata cylindrica*, *Mangifera indica*, *Nephlium* sp, *Cinamomum* sp, and *Flacourtia* sp. While the talang lebong represent habitat types that are close to water sources. At this location there is a large waterfall where many flowering plants grow around it. [20] These results may be due to invasion of disturbed areas by generalized

T. helena and *T. brookiana* that are seen when collecting data are types of butterflies whose existence is rare and threatened with extinction in Indonesia, so that it is protected in PP No 7 of 1999 about concerning the preservation of protected species of plants and animals; and Regulations of Environment and Forestry ministres No 20 of 2018 about protected species of plants and animals . In International Union For Conservation Nation (IUCN), the two species of butterflies are Least concern (LC). While 53 other species are not protected and Not evaluated (NE) in the IUCN.

Table 3. Ecological indices at different habitat type

Ecological indices		Habitat types			
		Mesagih	Pasir Bintang	Manduriang	Talang Lebong
Diversity	Shannon-	2.94	3.45	3.58	3.23
	Wiener (H')	(moderate)	(high)	(high)	(High)
Pielou's	Evenness (E)	0.92	0.95	0.93	0.91
		(almost uniformly)	(almost uniformly)	(almost uniformly)	(almost uniformly)
Margaleff	Species	5.98	8.59	9.49	8.33
Richness (R)		(high)	(high)	(high)	(high)

and widespread herb and shrub species such as *Lantana camara* etc which act as a rich nectar source for butterflies. Plant species which act as rich source of nectar influence the occurrence of butterfly species.

The four study sites have an index of more than 4, indicating that species richness is high. In addition, all locations also show that completing species is almost uniform. Environmental carrying capacity affects the evenness of species. According to [21] state that the size of the balance between a community with one another is largely determined by the value of the evenness index and this value is influenced by the number of species contained in one community.

In all study locations it was seen that Nymphalidae became a family whose species were always found. The abundance of species and individuals of Nymphalidae when research may occur due to the selection of butterfly larvae hostplants that are not too selective ,so that there are more than one host plant species. As with the *Hypolimnas bolina* during the study, they were carrying out oviposition on the *Asystasia intrusa* and *Sida acuta* plants at one time. [22] The largest proportion of the family Nymphalidae is due to the tendency of the nature of the polyphag (having more than one type of food). Polyfag properties allow Nymphalidae to still be able to meet their needs for host plants even though the main host plants are not available. An alternative host search usually takes into account the chemical content (water and nitrogen) and the level of butterfly competition from the same genus [23].

4. Conclusion

There are 55 species of butterflies consisting of 5 families at Gunung Raya Wildlife Reserve. The diversity of butterflies were relatively high Shannon diversity index ($H' > 3$), and 1 habitat type has Shannon diversity index ($H'=2.94$). Indonesian protected butterflies *T. helena* and *T.brookiana* can be still found in the Gunung Raya Wildlife Reserve area.

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DIVERSITY OF BUTTERFLIES (LEPIDOPTERA: RHOPALOCERA) IN THE GUNUNG RAYA WILDLIFE RESERVE, SUB DISTRICT WARKUK RANAU, SOUTH SUMATERA

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