PRELIMINARY CHECKLIST OF RHOPALOCERA (LEPIDOPTERA) IN LIBIKI BAMBOO RESORT, BAU, SARAWAK, MALAYSIA

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ABSTRACT

A preliminary study was conducted on the diversity of Rhopalocera (lepidopterans) butterfly fauna present in secondary forest of Libiki Bamboo Resort (LBR), Bau, Sarawak, Malaysia, due to the anthropogenic effect of human disturbance. The objectives of this study are to establish with a preliminary checklist of Rhopalocera and their species diversity in the mentioned resort and recorded its conservation status. Furthermore, this study work was performed to narrow the gap of knowledge regarding the diversity of Rhopalocera in Bau area, as no survey had been conducted in LBR previously. Twenty baited traps (passive method) and five ariel nets (active method) were used to collect Rhopalocera. Baited traps were placed along the trail and set up 100 m from each other with pineapple as bait, where aerial nets were used during day time, once in the morning and once in the evening, with a total sampling effort of 240 hours. A total of 183 butterflies from six families (Hesperiidae, Lycaenidae, Nymphalidae, Papilionidae, Pieridae and Riodinidae) belonging to 63 species under 35 genera were successfully collected and recorded. The most abundance individuals collected and identified were from the family Nymphalidae (75.4%, n = 138), whereas family Hesperiidae was the least family collected (0.5%, n = 1). Based on International Union for Conservation of Nature (IUCN) Red List status, one species, *Euploea mulciber* was found to be a vulnerable species, while most of the species recorded were categorised as data deficient status (84.13%, 53 species). Hence, it is recommended to conduct multiple similar studies to provide more adequate information for a more accurate update on the conservation status of Rhopalocera species in Malaysia.

Keywords: (IUCN) Red List, Borneo, Secondary Forest, Vulnerable Species, Conservation, Diversity

ABSTRAK

Kajian awal telah dijalankan terhadap kepelbagaian fauna kupu-kupu Rhopalocera (lepidopterans) yang terdapat di hutan sekunder Libiki Bamboo Resort (LBR), Bau, Sarawak, Malaysia, disebabkan oleh kesan antropogenik gangguan manusia. Objektif kajian ini adalah untuk mewujudkan senarai semak awal Rhopalocera dan kepelbagaian spesies mereka di resort tersebut dan merekodkan status pemuliharaannya. Tambahan pula, kajian ini dilakukan untuk mengecilkan jurang pengetahuan berhubung kepelbagaian Rhopalocera di kawasan Bau, kerana tiada tinjauan dilakukan di LBR sebelum ini. Dua puluh perangkap berumpan (kaedah pasif) dan lima jaring ariel (kaedah aktif) digunakan untuk mengumpul Rhopalocera. Perangkap berumpan diletakkan di sepanjang laluan dan dipasang 100 m antara satu sama lain dengan nanas sebagai umpan, manakala jaring ariel digunakan pada waktu siang sekali pada waktu pagi dan sekali pada waktu petang, dengan jumlah usaha pensampelan selama 240 jam. Sebanyak 183 kupu-kupu daripada enam famili (Hesperiidae, Lycaenidae, Nymphalidae, Papilionidae, Pieridae dan Riodinidae) kepunyaan 63 spesies di bawah 35 genus berjaya dikumpul dan direkodkan. Individu yang paling banyak dikumpul dan dikenal pasti adalah daripada keluarga Nymphalidae (75.4%, n = 138), manakala keluarga Hesperiidae adalah keluarga yang paling sedikit dikumpulkan (0.5%, n = 1). Berdasarkan status Senarai Merah Kesatuan Pemuliharaan Alam Semula Jadi Antarabangsa (IUCN), satu spesies iaitu *Euploea mulciber* didapati merupakan spesies yang terdedah kepada kepupusan, manakala kebanyakan spesies yang direkodkan dikategorikan sebagai status kekurangan data (84.13%, 53 spesies). Oleh itu, adalah dicadangkan untuk menjalankan beberapa kajian yang serupa untuk menyediakan maklumat yang lebih mencukupi untuk maklumat terkini yang lebih tepat mengenai status pemuliharaan spesies Rhopalocera di Malaysia.

Kata Kunci: Senarai Merah (IUCN), Borneo, Hutan Sekunder, Spesies Terdedah, Pemuliharaan, Kepelbagaian

INTRODUCTION

Rhopalocera is commonly known as butterfly, which is a member of insects, together with Heterocera (moth) belonging to order Lepidoptera. Gullan and Cranston (2010) reported that after order Coleoptera (beetle), Lepidoptera is the second-largest order in term of species richness, with more than 28,000 Rhopalocera species recorded worldwide (Zarikian & Kalashian 2016). An interesting study by Aqilah et al. (2018) has successfully highlighted several species of Rhopalocera from Johor that were listed under Wildlife Conservation Act 2010 for conservation purposes in Johor. On the other hand, Borneo is the home to approximately 1,000 known species of Rhopalocera and this number may increase in a year (Christharina & Abang 2014; Hauser et al. 1997; Ismail et al. 2020; Otsuka 2001). According to Gohun et al. (2021), 81 species of Rhopalocera have been recorded as Bornean endemic butterfly species and one of example is *Mycalesis kina*, known as one of the nymphalid species that is endemic to Borneo Island (Christharina & Abang 2014; Ismail et al. 2020). Rhopalocera and Heterocera share many aspects of appearance and behaviour, but it can generally be recognized by their bright colour and clubbed antennae (Abang 2006). Rhopalocera is diurnal, brightly coloured insects that are always associated with sunshine and flowers during day time. Meanwhile, Heterocera are nocturnal insects and mostly small, unobtrusive, and brownish in colour (Abang 2006).

The nature of Borneo is a rich tropical rainforest and is considered as one of the biodiversity hotspots of the world (Mohd-Azlan et al. 2018). Rhopalocera are harboured more

in tropical regions (Ismail et al. 2018) because they are important pollinators in growth, development, and distribution of the host flora (Bonebrake et al. 2010). In addition, many studies on Rhopalocera have been conducted, including in Borneo, because they play many important roles in the environment as herbivores, pollinators, and environmental quality indicators (Braby 2006; Christharina & Abang 2014; Tati-Subahar et al. 2007). Moreover, the type of vegetation area are vital in Rhopalocera diversity, abundance, and evenness (Aris et al. 2017), including for modified vegetation by humans. Changes in lower plant diversity at higher elevation and vegetation structure can reduce the number of lepidopterans as well (Brehm & Fiedler 2005; Cavieres et al. 2000; Pyrcz et al. 2009). Moreover, Clark et al. (2007) reported that Rhopalocera has decreased in number, especially rich, rare, and specialized species which were most affected in areas that have high human activities. Hence, Rhopalocera are deemed to be a good indicator of human landscape transformation and urbanization because they are sensitive to changes in temperature, microclimate, humidity, and luminosity level (Blair 1999; Kremen 1994).

Libiki Bamboo Resort (LBR) is located in Bau, Borneo. It is a newly developed resort for the visitors and tourists who enjoy a stay close to nature. This resort has a secondary forest that was formed due to anthropogenic effects of human disturbance on forest land, including plantations (Brown & Lugo 1990). This forest is also rich with flora and fauna; however, there are many groups of insects that are still under study in this resort, as the area remains to be discovered. Thus, the objectives of this study are to establish a preliminary checklist and species diversity of Rhopalocera in Libiki Bamboo Resort (LBR) from Bau District, as well as on the importance of its conservation status in Sarawak, Malaysia.

MATERIALS AND METHODS

Study Area

The sampling was conducted in Libiki Bamboo Resort (01° 33.2752’ N, 110° 10.6129’ E) located at Kampung Bijuray Mongag, Bau, Sarawak (Figure 1). Libiki Bamboo Resort is a recreational place inside Kampung Bijuray Mongag, where the local residence is of Bidayuh native. The ecosystem in LBR is a secondary forest that plays an important role in Rhopalocera species. The secondary forest vegetation is simple as compared to mature forest due to age, climate, and soil types (Brown & Lugo 1990). According to Brown and Lugo (1990), the secondary forest is a forest that resulted from human disturbance, such as forest logging. This research was carried out along a 2-km trail, stretching from the riverside to the hill area.

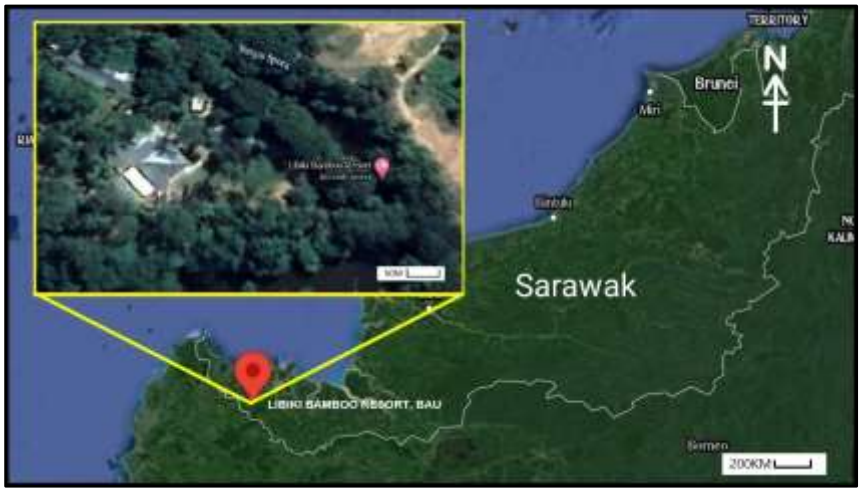

Figure 1 Sampling location at Libiki Bamboo Resort, Bau, Sarawak

Sampling Methods

The sampling was conducted for six days continuously, beginning from 25 March until 30 March 2019. Two methods were used in this study to collect butterfly samples, which were active and passive methods. Figure 2 shows five aerial nets were used as an active method for a total of 240 hours, once in the morning (8 a.m. to 12 p.m.) and evening (1 p.m. to 5 p.m.). The aerial nets were used at all LBR areas and mostly along the trail when passive method was adopted for sampling purposes.

The passive method used was baited trap (Figure 3), where a total of 20 baited traps were set along the trail of the study site. The baited traps were placed approximately 100 m from each other and placed one meter above the ground. Pineapple is the only bait used for this passive method. All baited traps were checked twice a day, from 8 to 10 a.m. and 3 to 5 p.m., respectively, to observe the occurrence of the Rhopalocera. All of the individuals collected were placed in separate triangular envelopes after squeeze the thorax using thumb and forefinger. Each envelope was marked with the date, collector's name, type of method used, and locality.

Figure 2. Aerial net (active method)

Figure 3. Baited trap (passive method)

Preservation and Identification

The preservation and identification of Rhopalocera specimens were conducted at LBR and Faculty of Resource Science and Technology, Universiti Malaysia Sarawak (UNIMAS). All specimens were preserved in an insect box for data collection. The individual data was recorded and identified in detail through stereo microscope according to their taxonomic classification and morphological characteristics such as wing patterns, colour and shape by referring the specimen to a book of Butterflies of Borneo by Otsuka (2001) and Butterflies of Malaysian Borneo by Abang (2006). The status of the species was identified by referring the data from IUCN Red List website (IUCN 2021).

Data Analysis

The collected data were compiled and analyzed by using excel and species accumulation curve to determine whether the data collected are sufficient or otherwise. The species abundance was determined based on the number of individuals of each encountered species. Diversity indices such as Shannon-Wiener diversity index (H') to identify the diversity status of the recorded data and species evenness index (E') to indicate the pattern of species distribution in relation to other species in the sampling location. All of the data were computed using the statistical software Paleontological Statistics Software (PAST) (version 3.14).

RESULTS

A total of 183 individuals of Rhopalocera from six families, 14 subfamilies, 35 genera, and 63 species were recorded in LBR, Bau. Six families identified were Hesperiidae, Lycaenidae, Nymphalidae, Papilionidae, Pieridae, and Riodinidae. Based on IUCN (International Union for Conservation of Nature) Red List status, mostly butterfly species were found to be a data deficient (84.13%, 53 species). Meanwhile, seven species (11.11%) were of least concern and two species (3.17%) were not applicable. *Euploea mulciber* (Figure 9) was the only species recorded as vulnerable species (IUCN 2021).

Table 1. Checklist of Rhopalocera in Libiki Bamboo Resort, Bau, and the status according to the IUCN (International Union for Conservation of Nature) Red List

Family **Subfamily** **Species**	**Number of Individual**	**IUCN Status (2020)**
Hesperiidae		
Hesperiinae		
Notocrypta curvifascia	1	DD
Lycaenidae		
Miletinae		
Allotinus bidiensis	1	DD
Allotinus nicholsi	3	DD
Allotinus strigatus	1	DD
Theclinae		
Cheritra freja	1	LC
Drupadia ravindra	1	DD
Eooxylides etias	1	DD
Eooxylides tharis	4	DD
Polyommatinae		
Catochrysops strabo	2	DD

Euchrysops cnejus	2	DD
Jamides cyta	1	DD
Nymphalidae		
Danainae		
Euploea diocletianus	3	DD
Euploea mulciber	1	VU
Heliconiinae		
Cethosia hypsea	1	DD
Limenitidinae		
Athyma larymna	1	DD
Euthalia godarti	2	DD
Euthalia merta	1	LC
Lexias dirtea	1	DD
Neptis hylas	2	DD
Tanaecia aruna	2	DD
Tanaecia clathrata	1	DD
Tanaecia munda	4	DD
Tanaecia pelea	1	LC
Morphinae		
Amathuxidia amythaon	2	DD
Discophora necho	2	DD
Discophora sondaica	2	DD
Faunis stomphax	2	DD
Faunis kirata	1	DD
Xanthotaenia busiris	2	DD
Zeuxidia amethystus	2	NA
Nymphalinae		
Junonia atlites	3	DD
Junonia hedonia	1	DD
Junonia iphita	1	DD
Satyrinae		
Elymnias hypermnestra	1	DD
Elymnias panthera	1	DD
Erites argentina	4	DD
Erites elegans	4	LC
Lethe mekara	3	DD
Melanitis leda	1	DD
Melanitis zitenius	6	DD
Mycalesis anapita	9	DD
Mycalesis fusca	2	DD
Mycalesis horsfieldii	2	DD
Mycalesis maianeas	1	DD
Mycalesis mnasicles	13	DD
Mycalesis oroatis	1	DD
Mycalesis orseis	7	DD
Neorina lowii	18	DD
Orsotriaena medus	9	DD
Ragadia makuta	6	DD
Ypthima baldus	3	DD
Ypthima fasciata	3	DD

Ypthima pandocus	6	DD
Papilionidae		
Papilioninae		
Papilio demoleus	1	NA
Papilio memnon	1	DD
Pieridae		
Coliadinae		
Eurema andersonii	1	LC
Eurema blanda	5	DD
Eurema hecabe	12	DD
Eurema lacteola	1	DD
Pierinae		
Delias hyparete	2	DD
Leptosia nina	1	DD
Riodinidae		
Riodininae		
Paralaxita damajanti	2	LC
Paralaxita orphna	1	LC
Total = 6 = 14	**Total = 183**	

NA = Not Applicable, DD = Data Deficient, LC = Least Concern, VU = Vulnerable

More species were discovered throughout six consecutive sampling days, as indicated in the species accumulation curve (Figure 4). Family Nymphalidae (Figure 5) is the most dominant family of Rhopalocera contributing more than half of total individuals collected with 138 individuals (75.41%) comprises six subfamilies, namely, Danainae, Heliconiinae, Limenitidinae, Morphinae, Nymphalinae and Satyrinae (Table 1), followed by family Pieridae (12.02%), Lycaenidae (9.29%), Riodinidae (1.64%), Papilionidae (1.09%), and Hesperiidae (0.55%) being the least abundant. Meanwhile, subfamily Satyrinae from family Nymphalidae is the most common subfamily, which recorded a total of 100 individuals and 20 species. *Neorina lowii* (Figure 6) and *Mycalesis mnasicles* (Figure 7) (Nymphalidae) dominated the Rhopalocera assemblage with 18 and 13 individuals, respectively. This is followed by *Eurema hecabe* (Pieridae), as shown in Figure 8, with a total of 12 individuals collected. Shannon-Wiener diversity index (H') and species evenness index (E') for this study were 3.73 and 0.90, respectively.

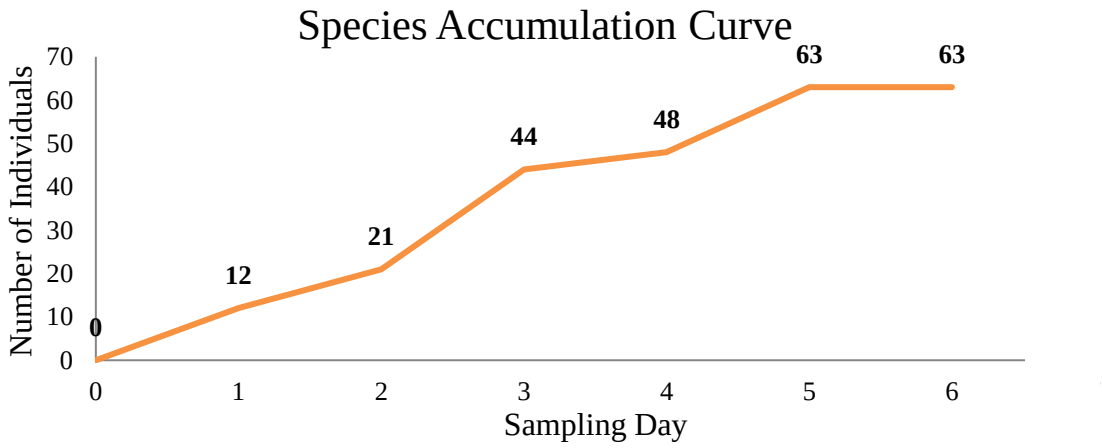

Figure 4 Species accumulation curve for six days of sampling in Libiki Bamboo Resort

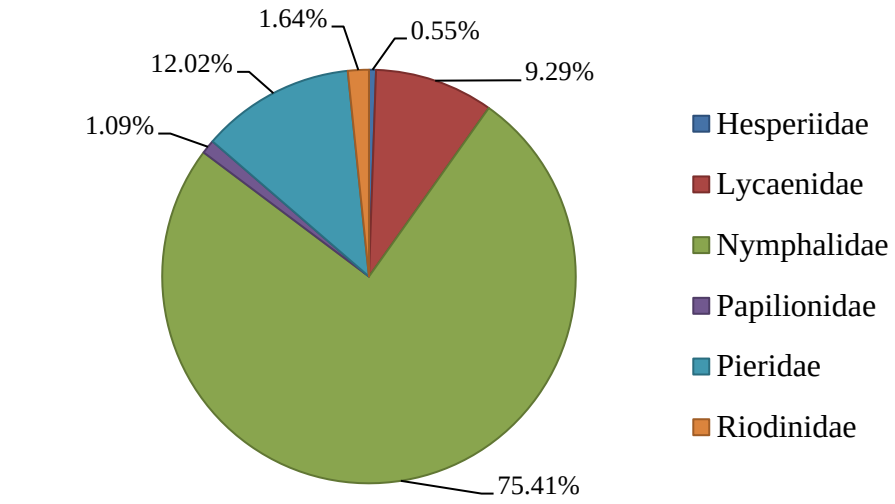

Figure 5. Pie chart percentage of individuals collected per family

Figure 6. *Neorina lowii*

Figure 7. *Mycalesis mnasicles*

Figure 8. *Eurema hecabe*

Figure 9. *Euploea mulciber*

DISCUSSION

Family Nymphalidae is the largest family of Rhopalocera (Heppner 2008) and is widely distributed, thus explaining their highest number of individuals recorded in this study. As such, they are deemed to have more easily adapted to new environment, such as a secondary forest, compared with other Rhopalocera families (Haneda & Kusuma 2018). This makes the findings of this work relevant, as Libiki Bambo Resort is known as secondary forest. Furthermore, since pineapple was used as bait, a high representative from the family Nymphalidae is expected in this study because the Rhopalocera from this family are mainly fruit feeders (Rahman et al. 2018). On the other hand, family Hesperiidae was poorly recorded because of their morphologically and behaviourally resembling moths, which are normally feed at night and would roll up inside the leaves of food pants during the day (Abang 2006). According to Ismail et al. (2018) and Pang et al. (2016), it is difficult to trap family Hesperiidae in flight, as they are fast fliers and might be overlooked due to their small body size. Lack of larvae host plant and adult nectar sources might be the possible explanation on the lowest count record of this family (Chia et al. 2011).

Neorina lowii is also known as Malayan owl, which were found as the most abundant species comprising 9.84% from the total of 183 individuals collected when flying and roosted

on plants during the survey. *Mycalesis mnasicles* or commonly called Cyclops bush brown are also common nymphalid species collected in this study. Their common characteristics include slow and low flying, and preference on fermented fruit, thus making them easy to catch (Pang et al. 2016). In addition, common grass yellow (*Eurema hecabe*) was a common species sampled, where they inhabit almost every habitat at all elevations, as noted by Laurence (2014). Most of them hover closely to the ground to avoid heat from the sun in the afternoon.

Based on species recorded throughout six sampling days continuously, only one species is currently categorized as vulnerable species (*Euploea mulciber*) by the IUCN Red List of Threatened Species in 1996, which was considered to be facing a high risk of extinction in the wild (IUCN 2021). The butterfly might be negatively affected by the anthropogenic of human disturbance because they are at risk from deforestation for the construction of the resort and plantation nearby. Further study on *E. mulciber* in this research area could be done to investigate the abundance of the species in secondary forest, where the result may be able to aid in updating the status of the species in IUCN Red List more accurately. Meanwhile, most species were categorized as data deficient and least concern were recorded. If the sampling duration is prolonged, research on Data Deficient species and Not Applicable species can be monitored and may be able to have their IUCN Red List status updated when sufficient data are observed.

Shannon-Wiener diversity index (H’ = 3.73) and species evenness index (E’ = 0.90) showed that the species diversity of Rhopalocera in LBR is high and Rhopalocera were distributed evenly in these secondary forests. As compared with the study by Ismail et al. (2018) in Endau-Rompin Johor National Park (ERJNP) that consisted of a homogeneous environment, this study also recorded high a number of total species and diversity (H’ = 4.123, E’ = 0.471). A total of 349 species were recorded in Ismail et al. (2018) study by using the same sampling methods but different sampling efforts. Hence, the result obtained from both studies was quite different in terms of the number of species due to the sampling duration where the study in ERJNP, the sampling was conducted for 17 months rather than only six days was conducted in LBR. This showed that the number of species diversity in LBR may be higher than the actual result if the sampling period is longer, which also depends on the size of the study area (Hardy & Dennis 1999).

Therefore, further study should be conducted to obtain more species composition of Rhopalocera in this study sites by prolong the collect time. This may also help to monitor and assess other Rhopalocera species performance. Sufficient amount of data may be able to update IUCN Red List status of the species in secondary forest and reference for future studies.

CONCLUSION

This study succeeded in identifying and providing the checklist of Rhopalocera in LBR, Bau, as a baseline reference for future studies of the same interest. Only 63 species were recorded in this study, demonstrating the need for a thorough survey of forest in Bau. A more in-depth study will aid in providing a detailed understanding of Rhopalocera population and its ecology. All information and a complete list of butterfly species are important to create alertness alert and for saving endangered and vulnerable species from extinction.

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