Checklist of butterflies (Lepidoptera: Papilionoidea and Hesperioidea) in Gunung Pulai Forest Reserve, Johor

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Abstract. This survey was done to provide a checklist of butterflies in Gunung Pulai Forest Reserve, Johor Darul Takzim. Sampling were done between October 2017 to March 2018 for nine sampling days. Butterflies were caught using aerial net and baited traps. The traps were baited with a mixture of rotten bananas and pineapples. A total of 101 individuals comprising 61 species were obtained from this survey. Family Nymphalidae recorded the highest number of species with 30 species, followed by Lycaenidae with 16 species. The most dominant species was Ypthima horsfieldii humei (Nymphalidae) with eight individuals followed by Lexias pardalis dirteana (Nymphalidae) with six individuals. Out of the 61 species, 45 were singletons which accounts for 73.8% of the sample. The Shannon Diversity Index for the butterflies in this area is 3.884 with an Evenness value of 0.941. Three species are considered as new records for the state of Johor. Based on the high value of Shannon Diversity Index and the abundance of singletons, it can be concluded that Gunung Pulai Forest Reserve holds a high diversity of butterflies in the region.

1. Introduction

Gunung Pulai Forest Reserve is a hill dipterocarp forest located in Johor, the southern-most state in Peninsular Malaysia. This granite-based forest covers an area of approximately 5,300 ha with the highest peak of 654 m. The forest is under the jurisdiction of Johor State Forestry Department which oversees forests for the state’s socioeconomic benefits. Biodiversity studies that have been done here include benthic macroinvertebrates [1,2], frogs [3], gliding lizard [4], and trees [5,6]. Like most forests in Johor, Gunung Pulai Forest Reserve is threatened by the rapid development that surrounds the area. As of now, the forest is already bordered by the district of Kulai township from the eastern side. The only buffer between the forest reserve and urban developments are the vast oil palm plantations. Based on the 2030 Structural Development Plan of Johor (RSNJ 2030), the areas north and south of Gunung Pulai Forest Reserve will be developed. Hence it is important to obtain as much information on the biodiversity that exist here before they are lost to human interference.

Lepidoptera is one of the most studied insect group, second only to Coleoptera. Their taxonomic hierarchy is relatively stable, making them a great surrogate taxon for flora and fauna within their habitat. They are also well-known as bio-indicator for ecosystem health. These are phytophagous organisms, where their presence is largely dependent on the availability of their host plants. The existence of forest species may indicate that the forest is still in good health, while the presence of urban species may indicate otherwise. The purpose of this study is to provide a preliminary checklist of...
butterflies in Gunung Pulai Forest Reserve. Hopefully, this information will help conservation managers make well-informed decisions when it comes to the managing the forest reserve.

2. Methods
Gunung Pulai Forest Reserve was accessed through the amenity forest (Figure 2). Sampling was done on October 2017, January and July 2018 for a total of nine sampling days. The butterflies were collected manually using aerial net and traps. The traps were baited with a mixture of rotten banana and pineapples to attract fruit-feeding butterflies such as the nymphalids. A 100 m sampling transect was set up along the forest trail. Butterflies were observed and identified from 9 am to 5 pm as this is the time when they are the most active. Identification was done using keys from [7] and field guide by [8].

![Figure 1](image_url)

**Figure 1.** Gunung Pulai Forest Reserve is marked by the boundaries in grey. Sampling area was accessed through the amenity forest as pin pointed in the map.

3. Result and Discussion
A total of 101 individuals comprising of 61 species were identified throughout the sampling period (Appendix A). For comparison, a similar sampling routine was done in Gunung Belumut which obtained 64 species [9] Bukit Soga with 42 species [10] and Taka Melor with 60 species [11]. Based on these previous studies, the species richness in Gunung Pulai Forest Reserve is quite similar to other forest patches in Johor.

The family Nymphalidae recorded the highest number of species with 30 species, followed second by Lycaenidae with 16 species recorded (Figure 1).
Since fruit baited traps were used in this study, the bias towards nymphalids are to be expected. Most of the fruit feeding butterflies that are otherwise too cryptic to seen, were caught in the traps. The most dominant species caught were were *Ypthima horsfieldii humei* with eight individuals and *Lexias pardalis dirteana* with six individuals. *Y. horsfieldii* or the Malaysian Five Ring is a common butterfly species found in vegetated areas. Their hostplants include *Axonopus compressus* [12] and *Ottochloa nodosa* (Kwatrina 2018) which are common in oil palm plantations and human dwellings [13]. This makes sense since part of Gunung Pulai Forest Reserve is an amenity forest which is open to public while being surrounded by oil palm plantations.

Out of the 61 species, 45 were singletons which accounts for 73.8% of the sample. This can be seen in the rank abundance curve in Figure 2.

![Richness and abundance of butterflies in Gunung Pulai Forest Reserve](image1)

**Figure 2.** A graph of species richness and abundance of butterflies in Gunung Pulai Forest Reserve

![Rank-abundance curve of butterflies in Gunung Pulai Amenity Forest](image2)

**Figure 3.** Rank abundance curve of butterflies in Gunung Pulai Forest Reserve
The high proportion of singletons is common in insect communities of tropical rainforest [14]. Three of these species are new records for Johor. These species are *Potanthus confucius dushta* (Hesperidae), *Arhopala major major* (Lycaenidae), and *Junonia almana javana* (Nymphalidae). Prior to this study, *P. confucius* were also recorded in Universiti Kebangsaan Malaysia, Bangi [15]. In Singapore, this species was previously considered extinct [16] before being rediscovered by local butterfly enthusiasts. On the other hand, *A. major* and *J. almana* are considered rare in Singapore [16]. The genus *Arhopala* is well known to be myrmecophilous and feeds on *Macaranga* myrmecophytes [17]. The Shannon Diversity Index (H) for this site is 3.884 with an evenness (E) value of 0.941. The H value for this site is relatively high compared to other forested areas in Johor that is subjected to a similar sampling regime. For instance, Soga Forest Reserve in Batu Pahat has a H value of 3.54 [10]. However, when compared with Endau Rompin National Park with an H value of 4.78 [18], the diversity of butterflies in Gunung Pulai Forest Reserve can be considered average.

4. Conclusion
Our results demonstrate that the diversity of butterflies in Gunung Pulai Forest Reserve is relatively high for a forest of its type. Since the forest patch is highly fragmented and at risk of disturbance due to the surrounding development, it is important to obtain as much biodiversity data from it as possible.

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Appendix A

| No | Species |
|----|---------|
| 1  | *Graphium evemon eventus* (Fruhstorfer, [1908]) |
| 2  | *Papilio memnon agenor* Linnaeus, 1758 |
| 3  | *Eurema andersonii andersonii* (Moore, 1886) |
| 4  | *Eurema hecabe contubernalis* (Moore, 1886) |
| 5  | *Gandaca harina distanti* Moore, [1906] |
| 6  | *Appias cardena perakana* (Fruhstorfer, 1902) |
| 7  | *Appias libythea olferna* Swinhoe, 1890 |
| 8  | *Leptosia nina nina* (Fabricius, 1973) |
| 9  | *Charaxes bernardus crepax* Fruhstorfer, 1913 |
| 10 | *Chersonesia peraka peraka* Distant, 1884 |
| 11 | *Ideopsis gaura perakana* Fruhstorfer, [1899] |

Table A1. Checklist of butterflies in Gunung Pulai Forest Reserve
| No | Species | Subfamily: |
|----|---------|------------|
| 12 | *Ideopsis similis persimilis* (Moore, 1879) | Heliconiinae |
| 13 | *Cirrochroa emalea emalea* (Guerin-Meneville, 1843) | |
| 14 | *Cirrochroa orissa orissa* C. & R. Felder, 1860 | |
| 15 | *Cupha erymanthis lotis* (Sulzer, 1776) | |
| 16 | *Bassarona teuta goodrichi* (Distant, 1886) | Limenitidinae |
| 17 | *Dophla Evelina compta* Fruhstorfer, 1899 | |
| 18 | *Lasippa tiga siaka* (Moore, 1881) | |
| 19 | *Lebadea martha malayana* Fruhstorfer, [1902] | |
| 20 | *Lexias pardalis dirteana* (Corbet, 1941) | |
| 21 | *Moduza procris milonia* (Fruhstorfer, 1906) | |
| 22 | *Neptis hylas papaja* Moore, [1875] | |
| 23 | *Neptis leucoporos cresina* Fruhstorfer, 1908 | |
| 24 | *Tanaecia flora flora* M. R. Butler, 1873 | |
| 25 | *Tanaecia iapis puseda* (Moore, [1858]) | |
| 26 | *Tanaecia pelea pelea* (Fabricius, 1787) | |
| 27 | *Faunis canens arcesilas* Stichel, 1933 | Morphinae |
| 28 | *Zeuxidia aurelius aurelius* (Cramer, [1777]) ** | Nymphalinae |
| 29 | *Junonia almana javana* C. Felder, 1862 + | Satyrinae |
| 30 | *Junonia hedonia ida* (Cramer, [1775]) | |
| 31 | *Mycalesis fusca fusca* (C. & R. Felder, 1860) | |
| 32 | *Mycalesis intermedia distanti* (Moore, [1892]) | |
| 33 | *Mycalesis mineus macromalayana* Fruhstorfer, 1911 | |
| 34 | *Mycalesis orseis nautilus* Butler, 1867 | |
| 35 | *Mycalesis perseus cepheus* Butler, 1867 | |
| 36 | *Ypthima baldus newboldi* Distant, 1882 | |
| 37 | *Ypthima horsfieldii humei* Elwes & Edwards, 1893 | |
| 38 | *Ypthima pandocus corticaria* Butler, [1879] | |

**RIODINIDAE**

Subfamily: Nemeobiinae

| No | Species | Subfamily: |
|----|---------|------------|
| 39 | *Paralaxita telesia lyclene* (de Niceville, 1894) | |

**LYCAENIDAE**

Subfamily: Miletinae

| No | Species | Subfamily: |
|----|---------|------------|
| 40 | *Allotinus horsfieldi permagnus* Fruhstorfer, 1913 | |
| 41 | *Allotinus leogoron leogoron* (Fruhstorfer, 1916) | |
| 42 | *Logania distantis masalia* Doherty, 1891 | Aphnaeinae |
| No | Species | Subfamily |
|----|---------|-----------|
| 43 | *Spindasis syama terana* (Fruhstorfer, [1912]) | Polyommatinae |
| 44 | *Caleta elna elvira* (Fruhstorfer, 1918) | |
| 45 | *Ionolyce helicon merguiana* (Moore, 1884) | |
| 46 | *Jamides elpis pseudelpis* (Butler, [1879]) | |
| 47 | *Jamides pura pura* (Moore, 1886) | |
| 48 | *Jamides virgulatus nisanca* (Fruhstorfer, 1915) | |
| 49 | *Arhopala abseus abseus* Hewitson, 1862 + | Theclinae |
| 50 | *Arhopala major major* Staudinger, 1889 + | |
| 51 | *Arhopala metamuta metamuta* (Hewitson, [1863]) | |
| 52 | *Drupadia ravindra moorei* (Distant, 1882) | |
| 53 | *Drupadia theda thesmania* (Hewitson, [1863]) | |
| 54 | *Horaga onyx sardonyx* Fruhstorfer, 1914 + | |
| 55 | *Loxura cassiopeia cassiopeia* Distant, 1884 | |
| 56 | *Hasora vitta vitta* (Butler, 1870) | HESPERIIDAE |
| 57 | *Iambrix stellifer* (Butler, [1879]) | |
| 58 | *Koruthaialos sindu sindu* (C. & R. Felder, 1860) | |
| 59 | *Notocrypta pria* (H. Druce, 1873) | |
| 60 | *Potanthus confucius dushta* (Fruhstorfer, 1911) + | |
| 61 | *Taractrocera archias quinta* Swinhoe, 1913 + | |

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