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Butterfly as bioindicator for development of conservation areas in Bukit Reban Kambing, Bukit Belading and Bukit Tukau, Johor, Malaysia

NORRADIHAH ISMAIL[1], AQILAH AWG ABDUL RAHMAN[1], MARYATI MOHAMED[1,♥], MOHD FADZELLY ABU BAKAR[1], LILI TOKIMAN[2]

[1]Centre of Research for Sustainable Uses of Natural Resources (CoR-SUNR), Faculty of Applied Sciences and Technology, Universiti Tun Hussein Onn Malaysia, Campus Pagoh, KM 1, Jalan Panchor, 84000 Muar, Johor, Malaysia. ♥email: maryatihayati52@gmail.com

[2]Johor National Parks Corporation, Level 1, Dato' Mohamad Salleh Perang Building, Kota Iskandar, 79100, Nusajaya, Johor, Malaysia

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Abstract. *Ismail N, Rahman A A A, Mohamed M, Abu Bakar M F, Tokiman L. 2020. Butterfly as bioindicator for development of conservation areas in Bukit Reban Kambing, Bukit Belading and Bukit Tukau, Johor, Malaysia. Biodiversitas 21: 334-344.* Butterflies are often used as indicator surrogates to evaluate the quality of ecosystems. This is made possible due to their sensitive responses toward environmental fluctuations and habitat changes. Butterflies were collected opportunistically using aerial nets at three hill dipterocarp forests; Bukit Reban Kambing (BRK), Bukit Belading (BB) and Bukit Tukau (BT) of Johor, Malaysia from 8th to 11th March 2016. The objectives of this study are to provide a checklist of butterflies of the hills and evaluate habitat suitability in an effort to support the proposal to gazette the hills as part of the Gunung Ledang protected area. A total of 60 individuals belonging to 23 species, 21 genera, and five families were recorded. Comparing the three hills, BRK recorded the greatest individual and species numbers, followed by BT and BB. BRK recorded the highest Shannon diversity index, H' (2.272) value, whereas BB presented the highest value of species evenness index, E' (0.945). MaxEnt modeling of the butterflies in BRK, BB, and BT showed a network of high habitat suitability areas connecting Gunung Ledang and our sampling locations. Despite limited sampling effort, this baseline data could possibly strengthen the effort for gazettement and prevent further pressure from mining activity and land conversion.

Keywords: Butterfly, gazettement, hills, habitat suitability

INTRODUCTION

One of the uses of rapid biodiversity assessment (RBA) is to collect the baseline inventories such as species list, community structure (diversity and distribution pattern) and significant species for conservation (protected and endemic species) of that particular area using the indicator surrogates (Gopal 2015). This RBA data could then be used to indicate the overall biodiversity of the site, reflecting the health of the current environmental condition there. Butterflies are often used as monitoring tools to value the biodiversity of forests and ecosystem functions due to their sensitive responses toward environmental fluctuations and habitat changes (Gerlach et al. 2015). Apart from that, they are highly diverse, easy to identify, suitable for quantitative sampling, could be found in many habitat and indicators for endemism (Foottit and Adler 2009). Many reports showed that the richness, abundance, and distribution of butterfly communities were greatly affected by the different land uses (Nkongolo and Bapeamoni 2018), seasonal changes (Hill et al. 2003; Ramesh et al. 2013), forest fragmentation (Vu and Vu 2011), forest disturbance (Lien and Yuan 2003), forest types (Widhiono 2015) and human activities such as logging (Cleary et al. 2005; Hamer et al. 2005) and mining (Kyerematen et al. 2018).

Therefore, a Johor Nature Heritage Expedition 2016 was held for five consecutive days from 7 till 12 March 2016 and organized by Johor National Parks Corporation (JNPC). The expedition covered the areas of Bukit Tukau (BT), Bukit Belading (BB) and Bukit Reban Kambing (BRK) at Ledang district with a total area of 320.21 ha. Besides act as important water catchment for Tangkak district of Johor state and Asahan of Malacca, the areas are also habitat for an endemic and critically endangered cycad species, *Cycas cantafolia* Jutta, K.L. Chew & Saw (Jutta et al. 2010) and also a newly described and critically endangered flowering plant, *Senyumia granitica* (Kiew and Lau 2019). These areas, however, are located outside the network of Totally Protected Area and severely threatened by the presence of mining and agricultural activities (Kiew and Lau 2019). Thus, this expedition aimed to inventory flora and fauna including orchids, tree flora, macrofungi, ants, odonates, termites, fish, anurans and rocks to support the proposal to gazette the three hills as part of Gunung Ledang National Park (BERNAMA 2016).

Particularly, this study was conducted; (i) to assess the biodiversity of the three hills specifically the butterfly communities, in turn providing a baseline data of butterfly diversity for those hills, (ii) to evaluate habitat suitability for wildlife and (iii) to update the checklist of butterfly fauna in Gunung Ledang and its vicinity. Then, this RBA data could support and strengthen the gazettement of those areas.

MATERIALS AND METHODS

Study area

This study was conducted at three different hill dipterocarp forests consists of Bukit Reban Kambing (BRK, N 02°20.11’; E 102°32.50’), Bukit Belading (BB, N 02°19.32’; E 102°31.59’) and Bukit Tukau (BT, N 02°18.634’; E 102°32.217’). The elevations range of the areas between 118 to 515 m a.s.l. The areas are adjacent to Gunung Ledang, one of the national parks in Johor and indigenous settlement (Figure 1). The forest areas are fragmented by the agricultural areas such as orchard, oil palm and rubber plantations. An active quarry is also located at the foot of BB and BT. In fact, the area of BT had been logged as dominated by few big trees and other common plants such as bamboo (*Dinochloa* sp. and *Gigantochloa ligulata*), rattan (*Daemonorops* sp.), palm (*Arenga westerhoutii*) and *Pandanus* sp. (Lau and Saw 2010; Kiew and Lau 2019). Based on finding from Johor Nature Heritage Expedition 2016, a total of 155 tree species belonging to 108 genera and 50 families were recorded from those hill forests, which comprising the largest family (Annonaceae), vulnerable species (*Anisoptera laevis*, *Dipterocarpus fagineus* and *Aquilaria malaccensis*) and endemic species (*Cyathocalyx pruniferus*, *Dacryodes longifolia*, *Diospyros argentea*, *D. nutans*, *Syzygium politum* and *Gordonia concentricicatrix*) (Lau et al. 2017). The uniqueness of BRK and BT came from metamorphic rock which originated from Gemas formation and the rock dated at least 200 million years ago, meanwhile, the granitic covers the area of BB (Madun et al. 2017).

Data collection

Butterflies were sampled opportunistically along the tracking trails of each hill forests between 09: 00 to 17: 00. The collection was conducted manually using aerial nets with two-man efforts. All butterfly specimens were identified using keys and illustrations in Fleming (1975), Corbet and Pendlebury (1992) and Kirton (2014).

Data analysis

The data were analyzed to determine the biodiversity values in terms of species richness, species abundance, species diversity and pattern of distribution at each forest hills. Several indices were used such as Shannon diversity index (H’) to describe diversity of butterfly, species evenness index (E’) to determine species distribution pattern and Jaccard similarity index (J) to describe the similarity of butterfly species occurred at those three hills (Magurran 2004; Magurran and McGill 2011). Also, the composition of butterfly communities was assessed based on species accumulation curve and rank abundance curve. Overall, the species richness estimation of butterfly fauna in Gunung Ledang was measured based on incidence data, using non-parametric estimators such as first-order Jackknife (Jack1), second-order Jackknife (Jack2), Chao2 and ICE.

Species distribution modeling

The potential distribution of the butterflies in the vicinity of BB, BRK, and BT were determined using MaxEnt (Phillips et al. 2006). MaxEnt is a modeling method that has gained traction in popularity over recent years due to its simplicity, reliability and user-friendly interface (Elith et al. 2011). It estimates the density of occurrence of a species across an environmental space. In this study, the model used distribution data of butterflies obtained from this study and other inventory works in Johor. The variables used include distance to forest, temperature fluctuations, precipitation and distance to road. A plot of suitable habitat with values ranging from 0 to 1 was produced by the model. A value close to 0 indicates low habitat suitability, while a value close to 1 indicates high habitat suitability. Further description of the methods and data used in this study can be obtained from Aqilah (2019).

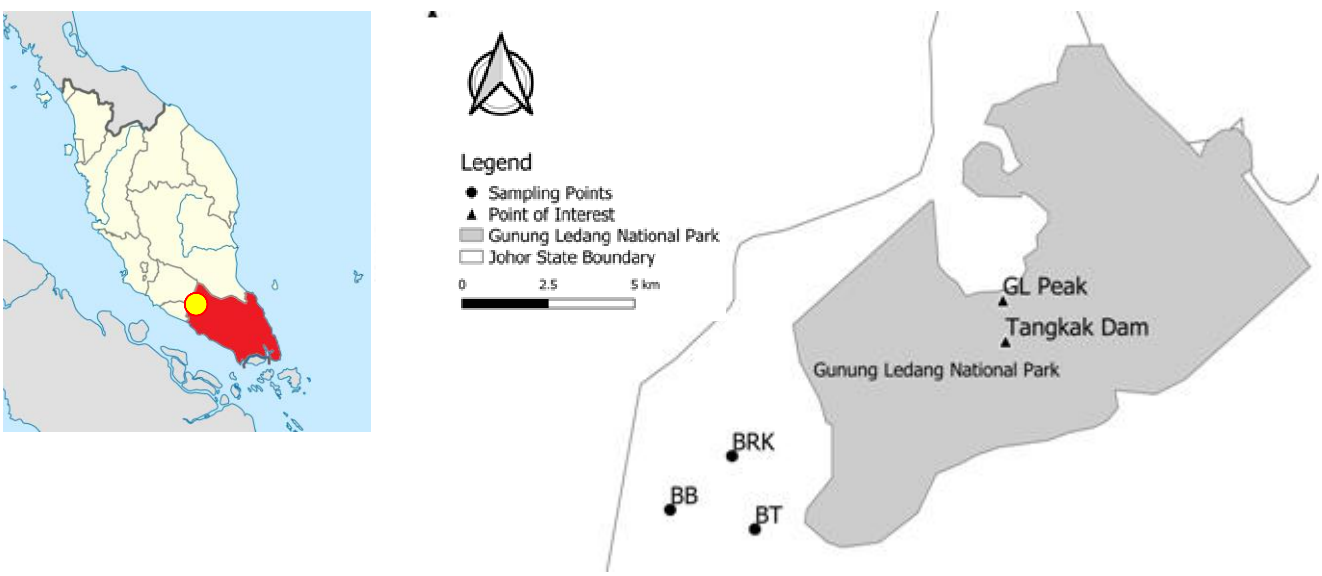

Figure 1. Map of sampling location at Bukit Reban Kambing (BRK), Bukit Belading (BB) and Bukit Tukau (BT) in Johor, Malaysia

RESULTS AND DISCUSSION

Species composition and diversity of butterfly

A total of 60 individuals belonging to 23 species in 21 genera representing five families were recorded during four days sampling period (as listed in Table S1). This included two protected species under Wildlife Conservation Act 2010 [Act 716], which are *Charaxes bernardus crepax* Fruhstorfer (Figure 4.D) and *Charaxes durnfordi durnfordi* Distant (Figure 4.E).

Overall, Nymphalidae was the most speciose (12 species) and abundant (38%) family. Followed by Pieridae (4 species; 35% of individuals), Lycaenidae (3; 10%) and Hesperiidae (3; 5%). Lastly, Papilionidae being the least diverse family (1; 6.7%) (Figure 2). Family composition reported in Bukit Soga (Aqilah et al. 2018) also showed similar distribution patterns. The collections were dominated by nymphalids as they are known as the most varied family with the largest subfamilies (Corbet and Pendlebury 1992). In fact, they are easily found as they are active fliers and polyphagous. Thus, enable them to forage into larger area and inhabit in different forest ecosystems (Abang and Fauzi 2004). On the other hand, papilionids are the least presented and difficult to capture in flight as they are large, strong fliers and typically hovering higher (Kirton 2014).

Overall, the Shannon diversity index (H') indicated only 2.698 and species evenness index (E') was 0.646. In fact, the species richness and diversity recorded in this study were moderate as considering the limited sampling period, area and method covered. Species recorded in this study was relatively low when compared to collections from other parts of Malaysia such as Gunung Ledang (129 species, H’= 3.405; Ismail et al. 2018), Gunung Kuli (51 sp., H’= 3.83; Sulaiman et al. 2010) and Bukit Soga (43 sp., H’=4.78; Aqilah et al. 2018). However, substantially comparable with figures recorded for other hill forests such as Fraser’s Hill (32 species; Ghazali et al. 2018) and Cameron Highlands (11 sp., Aris et al. 2017). The fragmentation and disturbance of these forests due to agricultural (oil palm plantation and small scale orchard) and quarry activities could affect the butterfly assemblages especially butterfly species which has poor dispersal ability and habitat specialization (Mattila et al. 2011). The isolated forests of BRK, BB, and BT surrounded by non-forest habitat would restrict the movement of butterflies especially forest-dependent species as the larval food sources are largely the forest herbs and trees (Scriven et al. 2017).

Butterfly ecology in relation to different hill forests

Based on Table 1, it shows that BRK was found to be the richest and most abundant, followed by BT and BT. The diversity index, H’ also showed the same pattern, highest at BRK and least at BB. In contrast, BB presented much higher value of evenness index, E' than BRK, which indicating more even species distribution patterns. Though low diversity was expected in BB since this area was a disturbed forest and affected by the nearby quarry, each butterfly species was occurring here in equal proportion in term number of individuals.

Among three hills, the butterfly assemblages of BRK and BT were more similar, recording the highest similarity index, Jaccard (17.4%), followed by comparison between BB and BT (16.7%) and the least similar between BRK and BB, only 10.5%. While only two species such as *Papilio iswara iswara* White and *Delias hyparete metarete* Butler (Figure 4.A) were common in all three hills, there are 11 species only found in BRK, four species in BT and two species were recorded only from BB. However, BRK and BT shared four same species including *Cyrestis cocles earli* Distant (Figure 4.G), *Hypolimnas bolina jacintha* (Drury) (Figure 4.B), *C. bernardus crepax* and *Jamides bochus nabonassar* (Fruhstorfer).

The differences in species richness and abundance between hills suggest that vegetation types, environmental conditions, host plant resources, and disturbance are most likely to influence the butterfly population and distribution. BRK is located at the forest edge, which is adjacent to orchards and plantations could provide more food sources and host plants (banana, lime and oil palm trees). The forest edge has a butterfly assemblage consisting of both forest species and open species that result in high number of butterfly species and abundance recorded (Vu 2009). Meanwhile, the condition of BB was too dry due to active quarry activities nearby and the rock formation comprising granite rock that mostly porous and coarse could result in habitat deterioration, in turn naturally affect butterfly population. The extreme forest disturbance and environmental conditions are likely to result in loss of many species (Bonebrake et al. 2016). Despite those conditions and disturbance, a few coupled pairs of butterflies were observed in flight especially at denser forest areas of BRK and BT during the survey. It shows that the vegetation in those areas is still able to support butterfly food sources.

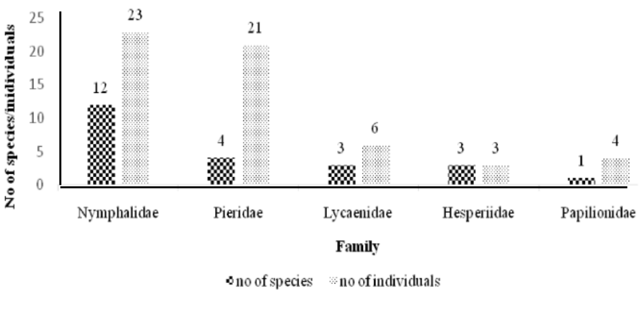

Figure 2. Species composition according to families at BRK, BB and BT in Johor, Malaysia

Table 1. Quantitative index of butterfly species diversity at three hill forests

	BRK	BB	BT
No of species	17	4	10
No of individuals	38	6	16
Shannon diversity index, H’	2.272	1.33	2.155
Species evenness index, E’	0.5705	0.9449	0.8625

Distribution pattern of butterfly communities

Rank abundance in Figure 3 was used to rank species by abundance, then, could identify commonness and rarity of the species (Magurran and Henderson 2011). The most abundant butterfly recorded was *Leptosia nina nina* (Fabricius) (Figure 4.C) with 15 individuals and generally found at open, grassy patch and orchard areas at the foot of BRK. This common species is easily seen flying low at the forest clearing, forest edges and parks from lowland to moderate elevations (Kirton, 2014). Mostly the larvae feed on the cultivated plants (Corbet and Pendlebury 1992) and herbaceous weed (*Cleome rutidosperma* DC. as abundantly found at the foot of BRK) (Butterfly Circle 2019). Followed by *H. bolina jacintha* (6) and *C. bernardus crepax* (6). They were easily sighted in flight as coupled pairs at the forest areas of BRK and BT, mostly at the opening area in the canopy.

The species represented by small number of individuals occurring in the study area could impart the impression of rarity of a species (Abu Zarim and Ahmad 2014). During this study, the butterfly collection was mainly reported by singletons, which accounts for 61% (14 species). The species are *Ideopsis gaura perakana* Fruhstorfer (Figure 4.F), *Euploea sylvester harrisii* C. & R. Felder, *Junonia orithya wallacei* Distant and *Plastingia naga* (de Niceville) (Figure 4.I). However, the singleton species are quite prevalent in insect assemblages especially in the tropics (Hamer et al. 2005). For example, 34% of singletons species of butterflies also were reported in a lowland dipterocarp rainforest in New Britain (Miller et al. 2011). Therefore, prevalence of singleton specimens could be related by low sampling intensity, sampling time, environmental condition and some species might appear occasionally contributing to low abundance (Magurran and McGill 2011).

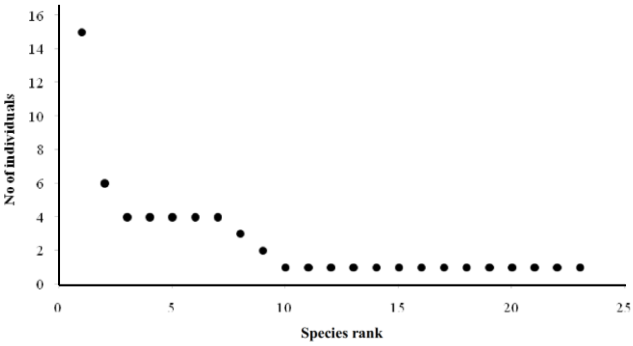

Figure 3. Rank abundance curve of butterfly at BRK, BB, and BT in Johor, Malaysia

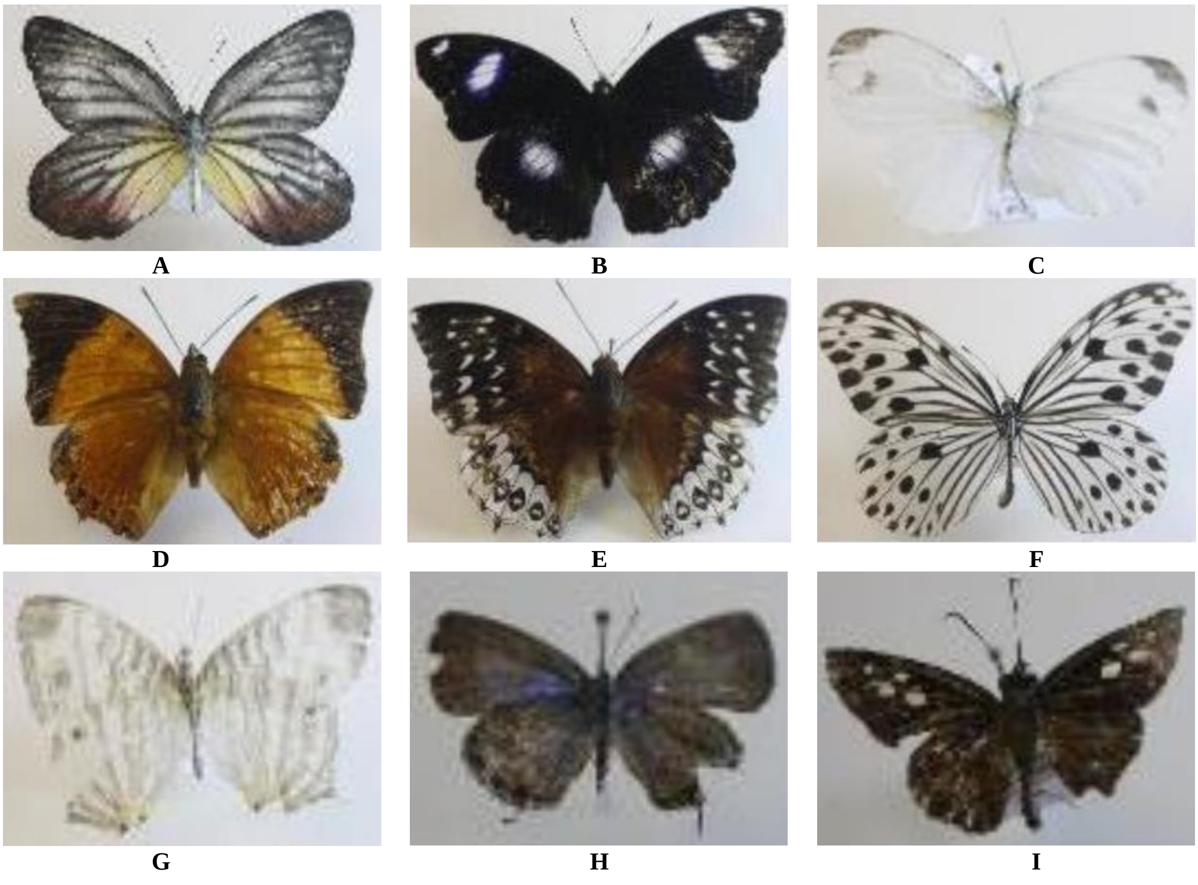

Figure 4. Some butterfly species were collected in the three hill forests at BRK, BB, and BT in Johor, Malaysia. A. *Delias hyparete metarete* Butler, B. *Hypolimnas bolina jacintha* Drury, C. *Leptosia nina nina* (Fabricius), D. *Charaxes bernardus crepax* Fruhstorfer, E. *Charaxes durnfordi durnfordi* Distant, F. *Ideopsis gaura perakana* Fruhstorfer, G. *Cyrestis cocles earli* Distant, H. *Chilades pandava pandava* Horsfield, I. *Plastingia naga* de Nicéville

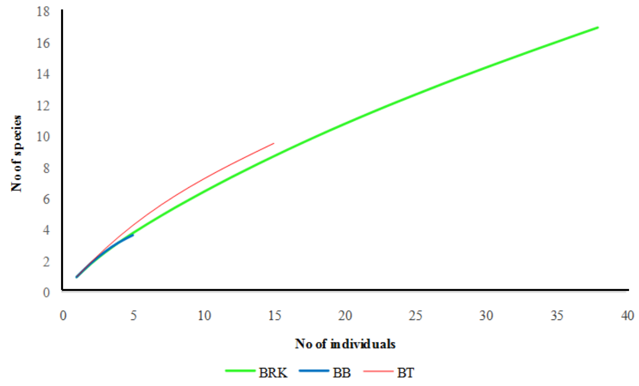

Figure 5. Species accumulation of butterfly species at BRK, BB, and BT in Johor, Malaysia

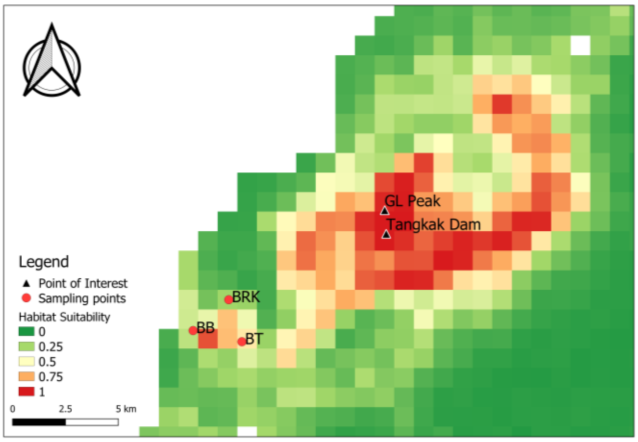

Figure 6. Species distribution modeling map of butterflies in BRK, BB and BT using MaxEnt

Butterfly communities are expected to discover more species if the sampling efforts continue as the curves of species accumulation graph are still steeply increasing and not reaching an asymptote in neither of those three hills (Figure 5).

Based on habitat and distribution, this study significantly recorded about 14 forest species, whereas nine are considered as common species (Kirton 2014; Corbet and Pendlebury 1992). In general, both forest and common or generalist species were captured, indicating the availability of food sources, changes in vegetation structure and level of disturbance in these forests. The overall assemblage of butterfly species also could allow evaluating the habitat quality in these forests. Higher number of forest species recorded might indicate the forest resources and plant diversity are still diverse and able to support more forest-dependent butterfly species (Joshi and Arya 2007).

Notable and indicator species

Another species encountered in this study was the Cycad Blue, *Chilades pandava pandava* Horsfield (Figure 4.H), which was found associated with cycad tree, *Cycas cantaforlia* at the peak of BRK. This species has become a pest for cycad and Sago palm trees as the caterpillars feed on the young leaves or soft tissues (Li et al. 2010). In terms of conservation status, three nymphalids including *C. durnfordi, C. bernardus,* and *Cyrestis cocles earli* Distant are considered rare. According to Fleming (1975), Corbet and Pendlebury (1992) and Kirton (2014), they are known as uncommon species due to their secretive habit, well-camouflage and localizing in forested area or dense forest. Meanwhile, two species namely *C. bernardus* and *C. Durnfordi* also protected under Malaysia's Wildlife Protected Species Act 2010 [ACT 716] (Wildlife Conservation Act 2010). The presence of these notable species in BRK and BT would develop strong support for the implementation of those areas as protected forest.

Species distribution modeling

A map was generated based on the plot developed by the MaxEnt model used in this study (Figure 6). The warmer color in the map represents higher habitat suitability, while the opposite color signifies lower habitat suitability. The map shows that the warmer color forms a network between Gunung Ledang, BRK, BB, and BT. This further proves that Gunung Ledang, BRK, BB, and BT is an interconnected ecosystem suitable for wildlife habitats such as butterflies. A similar case that involves a network of important conservation areas that are partially gazetted can be seen in Ulu Jelai Forest Reserve and Taman Negara National Park (Mohd Taher et al. 2018). Their modeling results show that both forests, which are located next to each other, have high habitat suitability for *Tragulus napu*, the Greater Mouse Deer. This further stresses the need to connect any forests that are located close to each other to form a greater network of natural habitat for its wildlife. In this study, the areas in green are deemed unsuitable due to several reasons. This may be due to the location being oil palm plantations, surrounded by roads and unsuitable overall temperature and precipitation. This shows that the forest butterfly species within the vicinity of BRK, BB and BT and confined to the forested areas in the area. An effort to gazette this area as part of Gunung Ledang protected area would be one of the best options to conserve the valuable natural resources and guarantee a bigger area for the wildlife to roam and thrive.

Updating checklist of butterflies in Gunung Ledang

The butterfly collections were periodically conducted at several vicinities of Gunung Ledang from 2012 to 2019. The collection areas included Gunung Ledang Johor National Park, covering two transects; Lagenda and Empangan trails (Maryati et al. 2014; Siddiki, 2015; Ismail et al. 2018) as well as Gunung Ledang Resort (Aqilah 2019; on-going surveyed by Hasnizan (2019)). Meanwhile, this study was shortly surveyed at three hills including BT, BRK, and BB during scientific expedition in 2016. Overall, the current number of species recorded in Gunung Ledang and its vicinity is 178 species, representing 17% of the total butterfly fauna in Peninsular Malaysia (1038 sp.; Eliot and Kirton 2000). Species recorded in Gunung Ledang are comparable with other highland forests in Malaysia such as Gunung Stong (146 species, Zaidi et al. 2005), Gunung Serambu (97 species, Pang et al. 2016) and Gunung Panti (83 species, Sulaiman et al. 2009), but substantially less than Gunung Tahan (248 species, Kirton et al. 1990) and Gunung Mulu (276 species, Hazebroek and Morshidi 2006).

The species cumulative graph shows the trend of butterfly species discovery from 2012 to 2019 still increasing and continuous addition of new records (Figure 7.A), indicating that high probability to discover new additional species if more sampling be conducted (Badli-Sham 2018). The estimation of species richness was also measured using non-parametric estimators, such as first-Jack1, Jack2, Chao2, and ICE. The graph curves of all estimators lied outside the 95% confidence interval of the observed species (S_{est}) and overestimated the species richness with a total of 282 to 436 species are expected to be found in Gunung Ledang (Figure 8). The presence of many unique and duplicate species in the assemblages could influence the performance of the estimators that leads to higher number of species estimation (Figure 7.B) (Ahmad-Zaini 2017). The unique species only occurred in one sample, while duplicate occurred in two samples (Foggo et al. 2003). Thus, it is presumed that more samples are needed to reach an asymptote and sampling completeness.

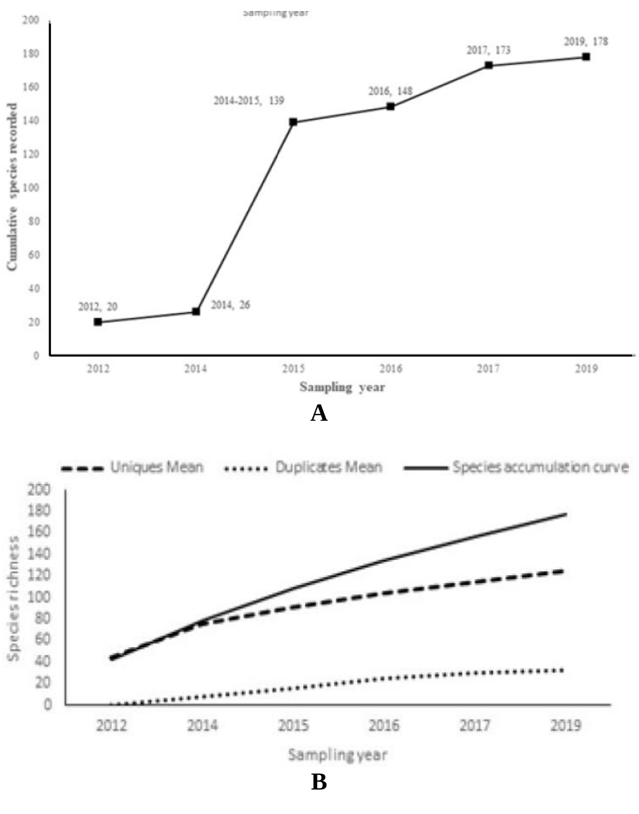

Figure 7. The cumulative graph of butterfly species recorded in Gunung Ledang and its vicinity from 2012 to 2019 (A) and graph of species accumulation curve and estimation of unique and duplicate species (B)

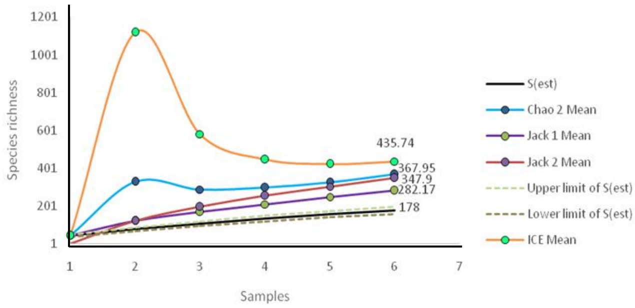

Figure 8. Observed species and species richness estimation using non-parametric estimators

In conclusion, though this short survey could not justify the actual diversity of butterflies in BRK, BB, and BT, this report presents an empirical and baseline survey of the butterfly fauna in those three hills to facilitate the authorities for the conservation and better management actions of the proposed areas. Moreover, the records of protected and rare species during this survey could justify the need to put more effort in conserving these hills. In a way to protect the butterfly communities especially these significant species from any further forest fragmentation and disturbance. In fact, the curve of species accumulation graph reported is far to level off, suggesting more butterfly species has yet been to be discovered. Thus, intensive sampling efforts in term sampling period, areas and methods are recommended for further rapid biodiversity assessment of the areas.

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Table S1. The species list collected in three forest hills during this study and also a compilation of butterflies' checklist recorded in Gunung Ledang and its vicinity from 2012 to 2019. The list is arranged according to incidence data (1= presence; 0= absence). The abbreviations for localities: BRK = Bukit Reban Kambing; BB = Bukit Belading; BT = Bukit Tukau; TNJGL = Taman Negara Johor Gunung Ledang and GLR= Gunung Ledang Resort.

Species name	2012	2014	2014-2015	2016	2017	2019	Localities
Papilionidae							
Chilasa clytia clytia (Linnaeus, 1758)	0	0	0	0	1	0	GLR
Graphium agamemnon agamemnon (Linnaeus, 1758)	0	0	1	0	1	1	TNJGL, GLR
Graphium eurypylus mecisteus (Distant, 1885)	0	0	0	0	1	0	GLR
Graphium evemon eventus (Fruhstorfer, [1908])	0	0	0	0	1	0	GLR
Graphium sarpedon luctatius (Fruhstorfer, 1907)	0	0	1	0	0	1	TNJGL, GLR
Papilio demoleus malayanus Wallace, 1865	0	0	0	0	0	1	GLR
Pachliopta neptunus neptunus (Guerin-Meneville, 1840)	1	0	0	0	0	0	TNJGL
Papilio nephelus sunatus Corbet, 1940	0	0	0	0	0	1	GLR
Papilio helenus helenus Linnaeus, 1758	0	0	1	0	1	1	TNJGL, GLR
Papilio iswara iswara White, 1842	1	0	1	1	0	0	TNJGL, BRK, BB, BT
Papilio iswaroides curtisi Jordan, 1909	0	0	0	0	1	0	GLR
Papilio memnon agenor Linnaeus, 1758	1	0	0	0	1	1	TNJGL, GLR
Papilio palinurus palinurus Fabricius, 1787	1	0	0	0	0	0	TNJGL
Papilio polytes romulus Cramer, [1775]	1	0	1	0	1	1	TNJGL, GLR
Pathysa antiphates itamputi (Butler, 1885)	0	0	1	0	0	0	TNJGL
Pathysa delessertii delessertii (Guérin-Méneville, 1839)	0	0	1	0	0	0	TNJGL
Pathysa macareus perakensis (Fruhstorfer, 1899)	0	0	1	0	0	0	TNJGL
Pieridae							
Appias indra plana Butler, [1879]	0	0	1	0	0	0	TNJGL
Appias libythea olferna Swinhoe, 1890	0	0	1	0	0	1	TNJGL, GLR
Catopsilia pomona pomona (Fabricius, 1775)	0	0	1	1	0	0	TNJGL, BRK
Delias hyparete metarete Butler, [1879]	0	0	1	1	0	0	TNJGL, BRK, BB, BT
Delias ninus ninus (Wallace, 1867)	0	1	1	0	0	0	TNJGL
Eurema ada iona Talbot, 1939	0	0	0	0	1	0	GLR
Eurema andersonii andersonii (Moore, 1886)	0	0	1	0	0	0	TNJGL
Eurema hecabe contubernalis (Moore, 1886)	1	0	1	1	1	0	TNJGL, BRK, GLR
Eurema lacteola lacteola (Distant, 1886)	0	0	1	0	0	0	TNJGL
Eurema sari sodalis (Moore, 1886)	0	0	1	0	0	0	TNJGL
Eurema simulatrix tecmessa (de Nicéville, [1896])	0	0	1	0	0	0	TNJGL
Leptosia nina nina (Fabricius, 1793)	1	0	1	1	1	0	TNJGL, BRK, GLR
Nymphalidae							
Danaus melanippus hegesippus (Cramer, [1777])	0	0	1	0	0	0	TNJGL
Euploea doubledayi evalida (Swinhoe, 1899)	0	0	1	0	0	0	TNJGL
Euploea eunice leucogonis (Butler, [1879])	0	0	1	0	0	0	TNJGL
Euploea mulciber mulciber (Cramer, [1777])	0	0	1	0	1	0	TNJGL, GLR
Euploea sylvester harrisii C. & R. Felder, [1865]	0	0	0	1	0	0	BT
Euploea radamanthus radamanthus(Fabricius, 1793)	0	0	1	0	1	1	TNJGL, GLR
Euploea tulliolus ledereri C. & R. Felder, 1860	0	0	1	0	0	0	TNJGL
Idea hypermnestra linteata (Butler, [1879])	0	0	1	0	0	1	TNJGL, GLR
Idea stolli logani (Moore, 1883)	0	0	1	0	0	0	TNJGL
Ideopsis gaura perakana Fruhstorfer, [1899]	0	1	1	1	0	0	TNJGL, BB
Ideopsis vulgaris macrina (Fruhstorfer, 1904)	0	0	1	0	0	0	TNJGL
Parantica aspasia aspasia (Fabricius, 1787)	0	1	1	0	0	0	TNJGL
Parantica melaneus sinopion Fruhstorfer, 1910	0	1	0	0	0	0	TNJGL
Elymnias casiphone saueri Distant, 1882	0	0	1	0	1	1	TNJGL, GLR
Elymnias hypermnestra tinctoria Moore, [1879]	0	0	1	1	0	0	TNJGL, BT
Elymnias panthera panthera (Fabricius, 1787)	0	0	1	0	0	1	TNJGL, GLR
Elymnias penanga penanga (Westwood, [1851])	0	0	1	0	0	1	TNJGL, GLR
Mycalesis fusca fusca (C. & R. Felder, 1860)	0	0	1	0	0	0	TNJGL
Mycalesis intermedia distanti (Moore, [1892])	0	0	1	0	0	1	TNJGL, GLR
Mycalesis maianeas maianeas Hewitson, [1864]	0	0	1	0	0	0	TNJGL
Mycalesis mineus marcomalayana Fruhstorfer, 1911	0	0	1	0	0	0	TNJGL
Mycalesis oroatis ustulata Distant 1885	0	0	1	0	0	0	TNJGL
Mycalesis orseis nautilus Butler, 1867	0	0	1	0	1	1	TNJGL, GLR
Mycalesis perseoides perseoides (Moore, [1892])	0	0	1	0	0	1	TNJGL, GLR
Mycalesis perseus cepheus Butler, 1867	0	0	1	0	0	0	TNJGL
Mycalesis visala phamis Talbot & Corbet, 1939	0	0	1	0	0	0	TNJGL

Ragadia makuta siponta Fruhstorfer, 1911	0	0	1	0	0	0	TNJGL
Ypthima baldus newboldi Distant, 1882	0	0	0	1	0	0	BRK
*Ypthima fasciata torane*Fruhstorfer, 1911	0	0	0	0	1	0	BT
Ypthima horsfieldii humei Elwes & Edwards, 1893	0	0	1	1	0	0	TNJGL
Ypthima pandocus corticaria Butler, [1879]/ *Y. pandocus tahanensis* Pendlebury, 1933	0	1	1	0	0	0	TNJGL
Amathusia binghami Fruhstorfer, 1904	0	0	0	0	0	1	GLR
Amathusia phidippus phidippus (Linnaeus, 1763)	0	0	0	0	1	1	GLR
Amathusia ochraceofusca ochraceofusca Honrath, [1888]	0	0	1	0	1	0	TNJGL, GLR
Amathuxidia amythaon dilucida (Honrath, 1884)	0	0	1	0	0	0	TNJGL
Faunis canens arcesilas Stichel, 1933	0	0	1	0	0	0	TNJGL
Zeuxidia amethystus amethystus Butler, 1865	0	0	1	0	1	0	TNJGL, GLR
Zeuxidia doubledayi doubledayi Westwood, [1851]	0	0	1	0	1	1	TNJGL, GLR
Athyma abiasa clerica Butler, [1879]	0	0	1	0	0	0	TNJGL
Athyma nefte subrata Moore, 1858	1	0	0	0	1	0	TNJGL
Bassarona teuta rayana (Morishita, 1968)/ *B. teuta goodrichi* (Distant, 1886)	0	0	0	0	1	1	TNJGL, GLR
Cethosia hypsea hypsina C. & R. Felder, [1867]	0	0	1	0	0	0	TNJGL
Chersonesia intermedia intermedia Martin, 1895	0	0	1	0	0	0	TNJGL
Chersonesia rahria rahria (Moore, [1858])	0	0	1	0	1	0	TNJGL
Cirrochroa emalea emalea (Guerin-Meneville, 1843)	1	0	0	0	0	0	TNJGL
Cirrochroa malaya malaya C. & R. Felder, 1860	0	0	1	0	0	0	TNJGL
Cirrochroa orissa orissa C. & R. Felder, 1860	1	0	1	0	0	0	TNJGL
Coelites epiminthia epiminthia Westwood, [1851]	0	0	0	0	1	0	GLR
Cupha erymanthis lotis (Sulzer, 1776)	0	0	1	1	1	0	TNJGL, BRK. GLR
Cyrestis cocles earli Distant, 1883	0	0	1	1	1	0	TNJGL, BRK, BT, GLR
Cyrestis nivea nivalis C. & R. Felder, [1867]	0	0	1	0	0	0	TNJGL
Cyrestis themire themire Honrath, [1884]	0	0	1	0	0	0	TNJGL
Discophora necho engamon Fruhstorfer, 1911	0	0	0	0	1	0	GLR
Dophla evelina compta Fruhstorfer, 1899	0	0	1	0	1	1	TNJGL, GLR
Eulacera osteria kumana Fruhstorfer, 1913	0	0	1	0	0	0	TNJGL
Euthalia alpheda langkawica Eliot, 1980	0	0	1	0	0	0	TNJGL
Euthalia eriphylae de Nicéville, 1891	0	0	1	0	0	0	TNJGL
Euthalia ipona Fruhstorfer, 1913	0	0	1	0	0	0	TNJGL
Euthalia kanda marana Corbet, 1937	0	0	1	0	0	0	TNJGL
Euthalia monina monina (Fabricius, 1787)	0	0	1	0	0	0	TNJGL
Hypolimnas bolina bolina (Linnaeus, 1758)/ *H. bolina jacintha* (Drury, 1773)	0	0	1	0	1	0	TNJGL, BRK, BT
Junonia hedonia ida (Cramer, [1775])	0	0	1	0	1	0	TNJGL, GLR
Junonia orithya wallacei Distant, 1883	0	0	0	1	0	0	BRK
Lasippa tiga siaka (Moore, 1881)	0	0	1	0	0	0	TNJGL
Lebadea martha malayana Fruhstorfer, [1902]	0	0	1	0	1	0	TNJGL, GLR
*Lethe mekara gopaka*Fruhstorfer, 1911	0	0	0	0	0	1	GLR
Lexias canescens pardalina(Staudinger, 1886)	0	0	0	0	1	0	GLR
Lexias dirtea merguia (Tytler, 1926)	1	0	0	0	0	0	TNJGL
Lexias pardalis dirteana (Corbet, 1941)	1	0	1	0	1	0	TNJGL, GLR
Moduza procris milonia (Fruhstorfer, 1906)	0	0	1	0	0	0	TNJGL
Neorina lowii neophyta Fruhstorfer, 1911	0	0	0	0	1	0	GLR
Neptis harita harita Moore, [1875]	0	0	1	0	0	0	TNJGL
Neptis leucoporos cresina Fruhstorfer, 1908	0	0	1	0	0	0	TNJGL
Neptis miah batara Moore, 1881	0	0	1	0	0	0	TNJGL
Neptis soma pendleburyi Corbet, 1937	0	0	1	0	0	0	TNJGL
Phaedyma columella singa (Fruhstorfer, 1899)	0	0	0	0	1	0	GLR
Phalanta alcippe alcesta Corbet, 1941	0	0	1	0	0	0	TNJGL
Polyura hebe chersonesus (Fruhstorfer, 1898)	0	0	0	0	1	0	GLR
Rhinopalpa polynice eudoxia (Guérin-Méneville, 1840)	0	0	1	0	0	0	TNJGL
Tanaecia aruna aruna (C. & R. Felder, 1860)	0	0	1	0	1	0	TNJGL, GLR
Tanaecia flora andersonii Moore, 1884	0	0	1	0	0	0	TNJGL
Tanaecia godartii asoka (C. & R. Felder, [1867])	0	0	1	0	0	0	TNJGL
Tanaecia iapis puseda (Moore, [1858])	0	0	1	0	0	0	TNJGL
Tanaecia palguna consanguinea Distant, 1886	0	0	1	1	0	0	TNJGL, BRK
Terinos atlita teuthras Hewitson, 1862	0	0	1	0	0	0	TNJGL
Terinos clarissa malayanus Fruhstorfer, 1906	0	0	1	0	0	0	TNJGL
Terinos terpander robertsia Butler, 1867	0	0	1	0	1	1	TNJGL, GLR
Vagrans egista macromalayana (Fruhstorfer, 1912)	0	0	1	0	0	0	TNJGL
Vindula dejone erotella (Butler, [1879])	0	0	1	0	0	0	TNJGL
Agatasa calydonia calydonia (Hewitson, [1854])	1	0	1	0	1	0	TNJGL, GLR

Charaxes bernardus crepax Fruhstorfer, 1913	0	0	0	1	0	0	BRK, BT
Charaxes durnfordi durnfordi Distant, 1884	1	0	1	1	0	1	TNJGL, BRK, GLR
Prothoe franck uniformis Butler, 1885	0	0	1	0	0	0	TNJGL
Riodinidae							
Abisara kausambi kausambi C. & R. Felder, 1860	0	0	1	0	0	0	TNJGL
Abisara geza niya Fruhstorfer, 1914	0	0	1	0	0	0	TNJGL
Abisara savitri savitri C. & R. Felder, 1860	0	0	0	0	0	1	GLR
Laxita thuisto thuisto (Hewitsonn, [1861])	0	0	1	0	0	0	TNJGL
Paralaxita damajanti damajanti (C. & R. Felder, 1860)	0	0	1	0	0	0	TNJGL
Paralaxita orphna laocoon (de Niceville, 1894)	1	0	0	0	0	0	TNJGL
Taxila haquinus haquinus (Fabricius, 1793)	0	0	1	0	1	1	TNJGL, GLR
Zemeros emesoides emesoides C. & R. Felder, 1860	1	0	1	0	0	0	TNJGL
Lycaenidae							
*Allotinus horsfieldi permagnus*Fruhstorfer, 1913	0	0	0	0	1	0	GLR
Allotinus unicolor unicolor C. & R. Felder, [1865]	0	0	0	0	1	0	GLR
Arhopala athada athada (Staudinger, 1889)	1	0	0	0	0	0	TNJGL
Arhopala azinis azinis de Niceville, [1896]	0	0	0	0	1	0	GLR
Arhopala abseus abseus (Hewitson, 1862)	0	0	0	0	1	0	GLR
Arhopala achelous achelous (Hewitson, 1862)	0	0	1	0	0	0	TNJGL
Arhopala hypomuta hypomuta (Hewitson, 1862)	0	0	1	0	0	0	TNJGL
Arhopala metamuta metamuta (Hewitson, [1863])	0	0	0	0	1	0	GLR
Arhopala phaenops sandakani Bethune-Baker, 1896	0	0	1	0	0	0	TNJGL
Chilades pandava pandava (Horsfield, [1829])	0	0	1	1	0	0	TNJGL, BRK
Deramas nolens pasteuri Eliot, 1978	0	0	0	0	1	0	GLR
Drupadia ravindra moorei (Distant, 1882)	0	0	1	0	0	0	TNJGL
Drupadia theda thesmia (Hewitson, [1863])	0	0	1	0	1	0	TNJGL, GLR
Eooxylides tharis distanti Riley, 1942	0	0	1	0	0	0	TNJGL
Hypolycaena amabilis lisba (Corbet, 1948)	0	0	1	0	0	0	TNJGL
Jamides alecto ageladas (Fruhstorfer, 1915)	1	0	1	0	0	0	TNJGL
Jamides bochus nabonassar (Fruhstorfer, 1915)	0	0	0	1	0	0	BRK, BT
Jamides ferrari evansi Riley & Corbet, 1938	0	0	1	0	0	0	TNJGL
Jamides malaccanus malaccanus (Röber, 1886)	0	0	1	0	0	0	TNJGL
Jamides pura pura (Moore, 1886)	0	0	1	0	0	0	TNJGL
Jamides talinga (Kheil, 1884)	0	0	1	0	0	0	TNJGL
Jamides virgulatus nisanca (Fruhstorfer, 1915)	0	0	1	0	0	0	TNJGL
Jamides zebra lakatti Corbet, 1940	0	0	1	0	0	0	TNJGL
*Logania distanti massalia*Doherty, 1891	0	0	0	0	1	0	GLR
Megisba malaya sikkima Moore, 1884	0	0	1	0	0	0	TNJGL
Miletus biggsii biggsii(Distant, 1884)	0	0	0	0	1	0	GLR
Nacaduba berenice icena Fruhstorfer, 1916	0	0	1	0	0	0	TNJGL
Nacaduba hermus swatipa Corbet, 1938	0	0	1	0	0	0	TNJGL
Nacaduba kurava kurava Fruhstorfer, 1916	0	0	0	1	0	0	BB
Neocheritra amrita amrita (C. & R. Felder, 1860)	0	1	1	0	0	0	TNJGL
Prosotas nora superdates (Fruhstorfer, 1916)	0	0	1	0	0	0	TNJGL
Zizula hylax pygmaea (Snellen, 1876)	0	0	1	0	0	0	TNJGL
Hesperiidae							
Celaenorrhinus ladana (Butler, 1870)	1	0	0	0	0	0	TNJGL
Eetion elia(Hewitson, [1866]	1	0	0	0	0	0	TNJGL
Halpe insignis (Distant, 1886)	0	0	0	1	0	0	BRK
Hasora zoma Evans, 1934	0	0	1	0	0	0	TNJGL
Tagiades litigiosus litigiosus (Möschler, 1878)	0	0	1	0	0	0	TNJGL
Gangara thyrsis thyrsis (Fabricius, 1775)	0	0	1	0	0	0	TNJGL
Iambrix salsala salsala (Moore, [1886])	0	0	0	1	1	0	TNJGL, BRK
Idmon distanti (Distant, 1886)	0	0	1	0	0	0	TNJGL
Koruthaialos rucubela rucubela (Plotz, 1882)	0	0	0	0	1	0	GLR
Koruthaialos sindu sindu(C. & R. Felder, 1860)	0	0	0	0	1	0	GLR
Matapa sasivarna (Moore, [1866])	0	0	1	0	0	0	TNJGL
Notocrypta clavata clavata (Staudinger, 1889)	0	0	1	0	0	0	TNJGL
Plastingia naga (de Nicéville, [1884])	0	0	0	1	0	0	BT
Potantus mingo ajax (Evans, 1932)	0	0	1	0	0	0	TNJGL
Potantus omaha omaha (W. H. Edwards, 1863)	0	0	1	0	0	0	TNJGL
Taractrocera archias quinta Swinhoe, [1912]	0	0	0	0	1	0	GLR