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Research Article

Butterfly (Lepidoptera: Papilionoidea) fauna of Kangkawat Research Station, Imbak Canyon Conservation Area, Sabah, Malaysia

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Abstract

Forty-three species of butterflies from 36 genera and six families are reported for Kangkawat Research Station, Imbak Canyon Conservation Area (ICCA). This accounts for 4.6 percent of the 944 species reported in Borneo. Compared to studies from other localities in ICCA, the butterfly fauna in Kangkawat Research Station is diverse and evenly distributed with a Shannon's index of Diversity (H') value of 3.636 and Simpson's index of Species Evenness ($E_{1/D}$) value of 0.776.The most dominant family is Nymphalidae with 27 species recorded followed by Lycaenidae with 11 species. Seven species are new records for ICCA: *Eurema blanda*, *Mycalesis dohertyi*, *Nacaduba berenice*, *Arhopala aedias agnis*, *Arhopala agesias*, *Drupadia cineas* and *Taractrocera ardonia*. Three species: *Mycalesis kina*, *Acytolepis ripte* and *Drupadia cineas*, which are endemic to Borneo are also recorded here. The presence of the butterfly species of high conservation value highlights Kangkawat Research Station as an important area for conservation of these species.

Keywords: butterfly, Kangkawat Research Station, endemic, new records

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Introduction

In 2009, Imbak Canyon was classified as a Class I (Protection) Forest Reserve by the Sabah State Government (Suleiman et al., 2011; Sabah, 2017). The conservation area consists of 30,000 hectares of virgin rainforest and is part of the Danum Valley-Maliau Basin-Imbak Canyon forest complex (Reynolds et al., 2011; Jaini et al., 2015), and known as Imbak Canyon Conservation Area (ICCA). In ICCA, the forest vegetation consists of lowland dipterocarp forest and lower montane heath forest.

Butterfly fauna has been surveyed throughout several scientific expeditions conducted since 2000 at different parts of ICCA. The first expedition in 2000 was conducted in Sungai Imbak Forest Reserve and recorded 174 butterfly species (Jalil et al., 2008). The second expedition in 2004 covered the central part of ICCA and had successfully listed 72 butterfly species and 133 individuals (Hasegawa & Chey, 2009). This was followed by a third expedition in 2010 in the southern region, Gunung Kuli and recorded 50 butterfly species and 79 individuals (Sulaiman et al., 2011). Subsequently, the Borneo Geographic Expedition 2018 was carried out in the south eastern part of ICCA, Kangkawat Research Station from 28 September till 9 October 2018. During the expedition, this study was conducted to determine the faunal composition of butterfly in Kangkawat Research Station and make notes of notable butterfly species (i.e. endemic, rare and protected species) occurring in the area.

Methodology

The survey was conducted daily from 29th September to 2nd October 2018 between 09:00h to 17:00h at the vicinity of Kangkawat Research Station (05° 04' North and 117° 03' East; Figure 1). Manual collection using aerial net was done at lowland dipterocarp forest (along the Kawang, South Rim and Nepenthes trail, secondary forest along the logging track (Pelajau trail) and along the riverbank of Sg. Kangkawat (as shown in Appendix 2). At the same time, ten traps were installed along the Kawang trail with rotten bananas used as bait.
Each captured specimen was sacrificed by gently pressing the thorax and stored in a glassine envelope. Specimens were then brought back to the laboratory for identification to species level using keys by Otsuka (1988), Corbet & Pendlebury (1992) and Otsuka (2001) and recent taxonomic hierarchy and classification by Kirton (2014).

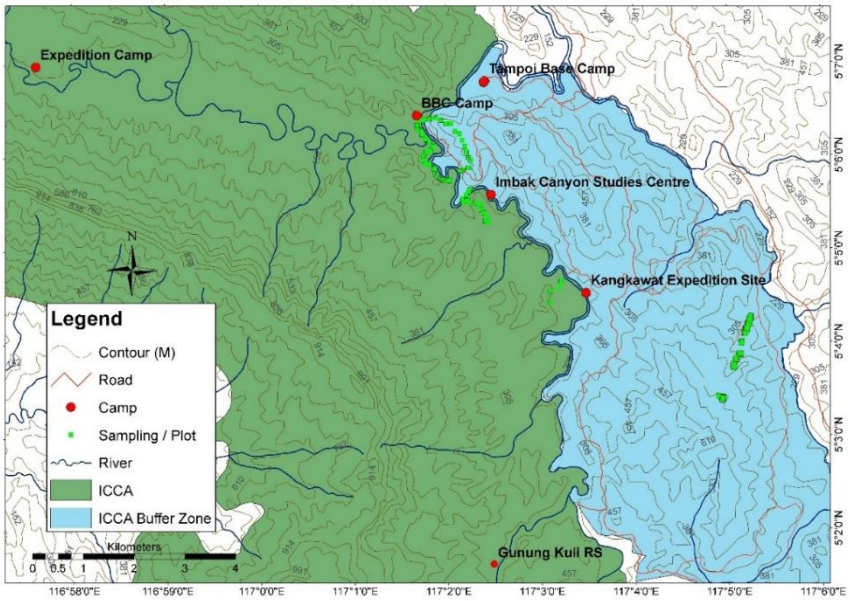

Figure 1. The sampling trail at the vicinity of Kangkawat Expedition site
(Source: Conservation & Environmental Management Division, Yayasan Sabah)

Data Analysis

Following reccommendations by Magurran (2004), several indices were used such as Shannon's diversity index (H') to measure diversity of butterfly and Simpson's evenness index ($E_{1/D}$) to describe the pattern of species distribution and evenness in the assemblage. All data were analysed using statistical software; Paleontological Statistics version 1999-2013 (PAST).

Results and Discussion

Species composition

A total of 43 butterfly species comprising of 79 individuals from six families was recorded during the inventory (listed in Appendix 1). The six families were: Nymphalidae (27 spp.), Lycaenidae (11 spp.), Papilionidae (2 spp.), Pieridae (1 sp.), Riodinidae (1 sp.) and Hesperiidae (1 sp.). The collection was dominated by Nymphalidae, which contributed about 70% of the butterfly abundance. The least represented family were Pieridae (1%) and Hesperiidae (1%) (Figure 2). Nymphalid species were easily found as they are active fliers and polyphagous

that feed on flower nectar, pollen, juices of rotten fruits, carrion and dung (Fiedler, 1998). This makes them forage in larger areas and inhabit different forest ecosystems (Majumder et al., 2013). The use of traps, baited with rotten fruits had successfully added to a higher number of nymphalid species such as species of subfamilies Satyrinae and Charaxinae to the collection, enhancing the sampling effort by 26%. On the other hand, hesperiids were least represented and difficult to spot when in flight since they are fast fliers and naturally well camouflaged due to their morphological resemblance to moths (Kirton, 2014). Typically, pierid species are often found congregated on puddles or riverbanks on a sunny day and locally abundant in lowland forest especially on secondary plant associates and are found in open areas (Corbet & Pendlebury, 1992; Abang, 2006). Therefore, Pieridae was only represented by a single species and individual during this study. This might be influenced by several environmental factors; diversity of vegetation (limited host plants and blooming of flowers), weather conditions (rainy and wet season) and canopy openness (more shaded area).

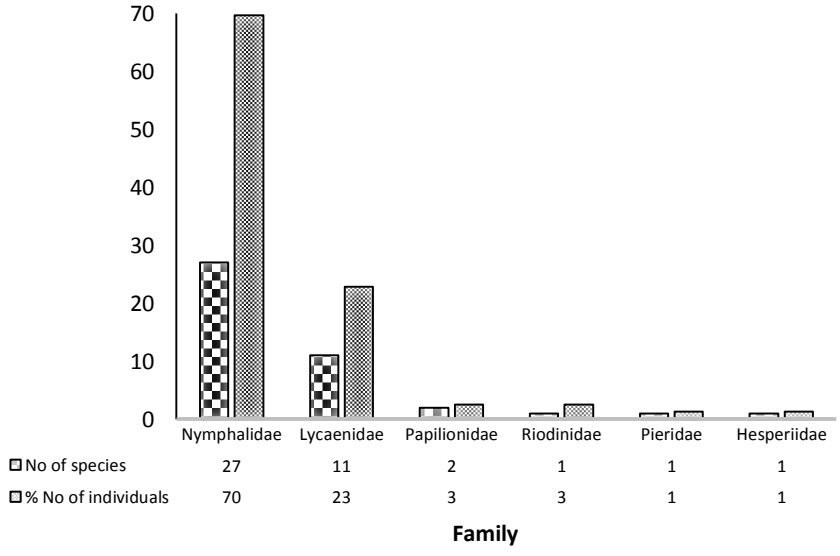

Figure 2. Faunal composition of butterfly species in Kangkawat Research Station, ICCA

Rank abundance curve as in Figure 3 shows two species were dominant; *Mycalesis kina* having the highest abundance (5 individuals), followed by *Drupadia theda* with 4 individuals recorded, while species ranked between 3rd to 23rd were classified as intermediate such as the fruit-feeding nymphalids (*Mycalesis dohertyi, Neorina lowii* and *Zeuxidia amethystus*) and the common species (*Ypthima baldus, Parthenos sylvia, Moduza procris* and *Prosotas nora* (species shown in Appendix 2). The common species could easily be found at the forest clearing, open area, secondary forest and moist spot especially at the logging track in Pelajau trail. Some species were singletons such as *Trogonoptera brookiana, Prothoe franckii, Charaxes bernadus, Acytolepis ripte* and *Arhopala agesias*. Some singleton species were considered uncommon as most of them are fast fliers and strictly confined to forested areas. Some of them are also cryptic as they are well camouflaged and rarely seen flying (Kirton, 2014). In addition, the thoroughness of the sampling effort and weather condition could contribute to low abundance of butterflies in the sampling area (Magurran & McGill, 2011).

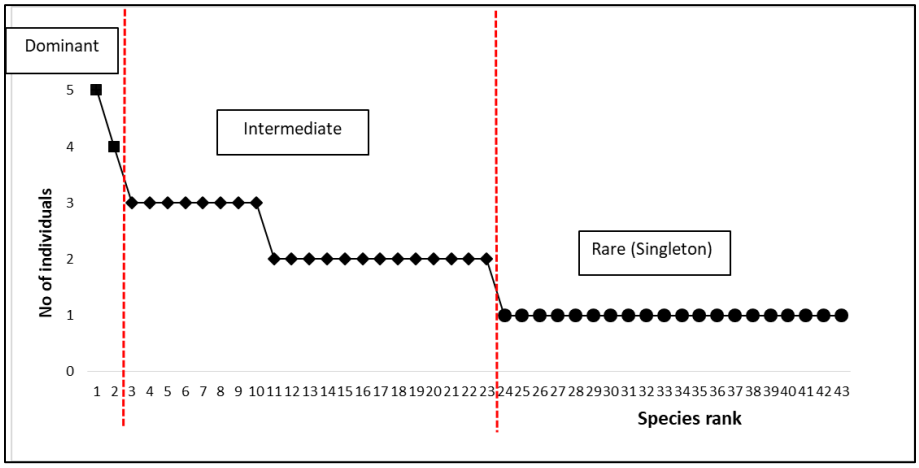

Figure 3. Rank abundance curve of butterfly in Kangkawat Research Station

In terms of species diversity and distribution, the values of Shannon Diversity Index (H') is 3.636 and Simpson Evenness Index (E') is 0.776. This indicated a high diversity of butterfly species that are evenly distributed in the area. This is comparable to the diversity of butterfly reported in the southern part of Imbak Canyon, Gunung Kuli with H'= 3.83 and E'= 0.97 respectively (Sulaiman et al., 2011).

Conservation status

There are some notable species among the collection from Kangkawat Research Station. Three butterfly species recorded are endemic to Borneo, namely *Mycalesis kina* Staudinger, 1892, *Acytolepis ripte* (Druce, 1895) and *Drupadia cineas* (Grose-Smith, 1889):

Mycalesis kina Staudinger, 1892

This species was originally found in Kinabalu, Lawas (Fruhstofer 1908; NHM, 2018). Despite being noted as endemic species to Borneo (Otsuka, 1988), this species was widely recorded in all forest habitats and easily found in the sun-lit sections of the forest (Otsuka, 2001). It was abundantly recorded in Danum Valley, Sabah (Hamer et al., 2003), Kubah National Park, Sarawak (Christhina & Abang, 2014) and Kuala Belalong, Brunei (Orr & Haeuser, 1996). In fact, this species was previously recorded in ICCA by Jalil *et al.* (2008) and Hasegawa & Chey (2009). In this study, this species is considered as the most dominant species recorded and found at several sampling transects (Kawang, Nephenthus and Pelajau trail). It was collected both manually using aerial net and baited trap.

Acytolepis ripte (Druce, 1895)

This species is also known as *Cyaniris ripte* H.H. Druce (NHM, 2018) and *Lycaenopsis ripte* (Druce) (Chapman, 1909) and firstly collected by Sir Hugh Low in Labuan (Druce, 1895). It could be found in lowland forest and previously reported in Kuala Belalong, Brunei (Orr & Hauser, 1996) and central part of ICCA during the Imbak Canyon Scientific Expedition 2004 (Hasegawa & Chey, 2009).

Drupadia cineas (Grose-Smith, 1889)

This species was previously known as *Sithon cineas* Grose-Smith, firstly recorded by J. Whitehead in Mount Kinabalu. It is also a synonym for *Biduanda hewitsonii* Druce, which was recorded in Sarawak (Cowan, 1974). Previously, it was recorded in Poring Hot Spring at the southeastern part of Mount Kinabalu (Hauser et al., 1997) and Lambir Hill, Sarawak (Itioka et al., 2009). This species was not recorded in ICCA from previous expeditions of 2000, 2004 and 2011. During this study, a single individual was collected manually at the logging track, Pelajau trail and thus added a new record for ICCA.

In term of conservation status, there are five species listed in Wildlife Protected Species Act 2010 [Act 716] which are *Trogonoptera brookiana* (Wallace, 1855), *Troides amphrysus* (Cramer, [1779]), *Idea stolli* (Moore, 1883), *Charaxes bernadus* (Fabricius, 1775) and *Prothoe franckii* (Godart, [1824]). The last two species are shown in Appendix 2. Due to their aesthetic appeal and striking colouration, both *T. brookiana* and *T. amphrysus* are vulnerable to specimen trade for souvenir purpose. In turn, they are also listed in Appendix II of Convention on International Trade in Endangered Species of Wild Flora and Fauna (UNEP-WCMC, 2012; CITES, 2016).

Addition to the butterfly fauna in ICCA

The documentation of butterfly fauna in ICCA was periodically reported in 2008, 2009 and 2011 following several scientific expeditions. When compared to the previous reports, this study has added 7 new records for ICCA. They are *Eurema blanda* (Boisduval, 1836), *Mycalesis dohertyi* Elwes, 1891, *Nacaduba berenice* (Herrich-Schaffer, 1869), *Arhopala aedias agnis* C. & R. Felder, [1865], *Arhopala agesias* (Hewitson, 1892), *Drupadia cineas* (Grose-Smith, 1889) and *Taractrocera ardonia* (Hewitson, 1868) (Appendix 1). Overall, the current number of species recorded in ICCA is 222, representing 24% of the total butterfly fauna in Borneo (944 sp.; Otsuka, 2001).

Conclusion

In spite of limited time, manpower and survey area, also unpredictable weather conditions, this study has provided a significant contribution in recording the diversity of butterflies in ICCA. Based on results of this study, Kangkawat Research Station holds a comparable diversity of butterflies making the conservation of the area even more important than ever. The presence of seven new records for ICCA from such a short expedition proves that there is still more to be discovered here. The endemic and protected species found in the area will hopefully encourage deeper studies on their assemblage in future.

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Appendix 1. The checklist of butterfly recorded from the Borneo Geographic Expedition 2018 Sungai Kangkawat, Imbak Canyon is arranged systematically according to the current taxonomic classification by Kirton (2014). The sampling trails, where butterflies were recorded are abbreviated by KW (Kawang), SR (South Rim), NP (Nepenthes), PJ (Pelajau) and Sg. Kangkawat (SK). Notable species are preceded with '*****' to indicate endemic species to Borneo, '**x**' to represent protected species under Wildlife Conservation Act 2010) and '**+**' to mark a new record for Imbak Canyon Conservation Area.

Family/ Subfamily	Species Name	Sampling Trail				
		KW	SR	NP	PJ	SK
PAPILIONIDAE						
Papilioninae	X *Trogonoptera brookiana (Wallace, 1855)* -observation					
	X *Troides amphrysus* (Cramer, [1779])				/	
PIERIDAE						
Coliadinae	*+Eurema blanda* (Boisduval, 1836)					
NYMPHALIDAE						
Danainae	X *Idea stolli* (Moore, 1883)	/	/			/
Satyrinae	*Neorina lowii* (Doubleday, [1849])	/		/		
	Zeuxidia amethystus Butler, 1865	/				
	Coelites euptychiodes C.&R. Felder, [1867]	/			/	
	Ragadia makuta (Horsfield, [1829])	/	/			
	+Mycalesis dohertyi Elwes, 1891	/				
	Mycalesis fusca (C.&R.Felder,1860)	/			/	
	*****Mycalesis kina* Staudinger, 1892	/		/	/	
	Mycalesis maianeas Hewitson, [1864]	/				
	Mycalesis mineus (Linnaeus, 1758)				/	
	Mycalesis oroatis Hewitson, [864]	/	/			
	Mycalesis orseis Hewitson, [1864]				/	
	Ypthima baldus (Fabricius, 1775)		/		/	
	Ypthima pandocus Moore, [1858]					/
Charaxinae	*Polyura athamas* (Dury, [1773])					/
	X *Charaxes bernadus* (Fabricius, 1793)	/				
	X *Prothoe franckii* (Godart, [1824])	/				
Heliconiinae	*Cethosia hypsea* Doubleday, [1847]				/	
	Vindula dejone (Erichson, 1834)					
	Cirrochroa tyche (C.&R.Felder,1861)				/	
	Terinos atlita (Fabricius, 1787)					

	Cupha erymanthis (Drury, [1773])				
Limenitidinae	*Parthenos sylvia* (Cramer,[1775])			/	
	Moduza procris (Cramer, [1777])			/	/
	Bassarona dunya (Doubleday, [1848])	/			
	Tanaecia clathrata (Vollenhoeven,1862)	/			
Nymphalinae	*Rhinopalpa polynice* (Cramer,[1779])		/		
RIODINIDAE					
Nemeobiinae	*Paralaxita orphna* (Boisduval, 1836)	/			
LYCAENIDAE					
Miletinae	*Logania malayica* Distant,1884	/			
Polyommatinae	*Caleta elna* (Hewitson, [1876])				
	*****_Acytolepis ripte_ (Druce, 1895)				
	Celastrina lavenduralis (Moore,1877)	/	/	/	
	Jamides pura (Moore,1886)		/	/	
	+Nacaduba berenice (Herrich-Schaffer,1869)		/		
	Prosotas nora (C.Felder,1860)			/	/
Theclinae	*+Arhopala aedias agnis* C.&R.Felder, [1865]	/			
	+Arhopala agesias (Hewitson, 1892)	/			
	*****_+Drupadia cineas_ (Grose-Smith, 1889)			/	
	Drupadia theda (C.&R.Felder, 1862)	/	/		
HESPERIIDAE					
Hesperiinae	*+Taractrocera ardonia* (Hewitson, 1868)			/	

Total number of species	43
Total number of individuals	79
Number of families	6
Endemic species	3
New records for ICCA	7

Appendix 2. (A) The forest vegetation at Kawang, South Rim, (B) Sg. Kangkawat, (C) Pelajau trails, (D) male of *Prosotas nora* was seen sipping minerals on the bank of forest stream, and the protected species under Wildlife Conservation Act 2010 [716]; (E) *Prothoe franckii*, (F) *Charaxes bernadus*.