Journal of Tropical Biology and Conservation 16: 9–24, 2019 ISSN 1823-3902
E-ISSN 2550-1909

Research Article

A Preliminary Assessment of Insect Diversity in Imbak Canyon – Batu Timbang

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Abstract

This insect diversity survey by the Sabah Forestry Department team was carried out from 16th to 20th of August, 2017 in Imbak Canyon – Batu Timbang area. Nocturnal insect diversity was assessed through light-trapping while diurnal insects were documented through fruit-baited traps, sweep nets and forceps. The mean nocturnal insect species richness was 48 species while the mean abundance was 55 individuals. These values were affected by the presence of many wild honeybees, *Apis dorsata* and the unexpectedly wet weather. Some Bornean endemic species were recorded, which included moths, beetles, dragonflies and a butterfly species. The Bornean endemic butterfly, *Papilio acheron*, is a rare species documented during the survey. Interesting and iconic species recorded are the Malaysia national butterfly, *Trogonoptera brookiana* and the world's largest bush cricket, *Macrolyristes imperator*. These insect data provide salient information to enhance the conservation of the Batu Timbang forest. They will serve as baseline information for other insect research work in future. Threats, such as forest fire, fragmentation, illegal clearing of vegetation and poaching are likely to indirectly affect the insect fauna. As such, continuous monitoring and enforcement at strategic locations are important to minimize these threats.

Keywords: Insect diversity, Batu Timbang, Imbak Canyon, light trapping, fruit-baited traps, sweep nets, endemic species

Received 01 April 2019
Reviewed 26 June 2019
Accepted 02 July 2019
Published 15 October 2019

Introduction

Imbak Canyon Conservation Area (ICCA) is located to the north of Maliau Basin in central Sabah. The canyon, about 30,000 ha / 300 km^2 in size, consists of lowland rainforest vegetation with some lower montane vegetation, from 250-1,000 m a.s.l. Most, but not all, of the steep outer ridges are protected as Virgin Jungle Reserve (VJR), while the biodiversity-rich valley has been a Class I (Protection) Forest Reserve since 2009, set within the Yayasan Sabah Concession Area. The VJR and Forest Reserve combined, form the ICCA, with Gunung Kuli at 1,527 m as the highest point in the conservation area. Three expeditions have been organized in the past, in 2000 (Tampoi), 2004 (Kapur) and 2010 (Gg Kuli) respectively. These resulted in the discovery of new species, including *Dipterocarpus megacarpus*, a timber species from the Dipterocarpaceae family, and *Ceriscoides imbakensis*, a rare tree from the Rubiaceae family (Yayasan Sabah 2014). A new stick insect species, *Baculofractum shelfordi*, was discovered adjacent to the Imbak Waterfall (Bragg 2005).

Much is still unknown about this conservation area. As underscored in the ICCA Strategic Management Plan (2014-2023), biodiversity conservation and research are important components that should be given priority. Hence, a scientific expedition was organized from 16th to 26th of August 2017 to explore the biodiversity in the southern part of the conservation area, focusing on Batu Timbang Forest Reserve and its adjacent area. Batu Timbang is a VJR Forest Reserve, with limestone caves inhabited by swiftlets, encompassing 261 ha that was formerly gazetted under Gg Rara FR. Under the Sabah forest classification, VJR and Class VI FR are conserved strictly for forestry research purposes, including biodiversity and genetic conservation. Batu Timbang is one of the locations within the ICCA that has been earmarked for the establishment of a research station as specified in the ICCA Strategic Management Plan.

The base camp (N 05°00'14.8", E 117°04'36.4" at 375 m a.s.l.), was located beside Sg Lanap adjacent to Batu Timbang Forest Reserve on the south-eastern part and Gunung Kuli on the west. The vegetation in the base camp area is mainly lowland mixed dipterocarp forest. The entomology team from the Sabah Forestry Department participated in the first week of the expedition from 16th to 20th of August 2017. The insect diversity study carried out by Sabah Forestry Department was divided into three parts:

1. Nocturnal insect diversity as assessed through light-trapping.
2. Insects sampled through fruit-baited traps.
3. Diurnal insects sampled using sweep nets and forceps.

Materials and Methods

Insect sampling methods

Light trapping was used to sample nocturnal insects while fruit-baited traps, sweep nets and forceps were used to sample diurnal insects.

Light-trapping

Light trapping was used to sample nocturnal insects. The trap consists of a vertical white sheet (2 X 2 m) illuminated by a 250W mercury-lithium bulb (Figure 1). It was powered by a portable Yamaha ET950 generator. The trap was set up in an open area facing the forest reserve, from 7:00 to 9:00 p.m. A GPS (Model: Garmin GPSMAP 60CSx) was used to determine the coordinates of each sampling site. Temperature and humidity were taken with a digital hygrometer from Extech Instruments (model no. 445702) at 8:30 pm.

To evaluate diversity of the sampling area, insect species and individuals (≥ 5 mm) within the 1 X 1 m square of the white cloth were enumerated from 8:30 to 9:00 pm. This is a rapid biodiversity assessment method because by the end of the sampling time, species and individual numbers can be obtained, and the data can be used to calculate diversity indices, i.e. Shannon Wiener, Simpson and Fisher Alpha. This was done using the Species Diversity & Richness version IV (SDR 2006). This method is simple, fast and can be carried out by non-insect specialist. To avoid differences in sampling between nights, the same researcher was assigned to count the species and individual numbers throughout the sampling period, and across different sampling sites. Due to the rain, light-trapping was conducted at the base camp area for only two nights (Table 1).

Table 1. Light-trapping site at the base camp of Imbak Canyon – Batu Timbang.

Sampling site	Coordinates	Elevation (m)	Temp. (ºC)	Humidity (%)	Sampling date	Remarks
A	N 05°00'11.3" E 117°04'34.4"	363	24.7	75	18 August	Cloudy night
B	N 05°00'17.4" E 117°04'38.0"	364	22.7	86	19 August	Clear sky after rain in the late afternoon

Sampling using fruit-baited traps

The fruit-baited trap was about 100 cm in height and 30 cm in diameter, made of a nylon fabric cylinder with a plastic plate on top and another plate at the bottom baited with rotting bananas. Each trap was suspended from a tree branch (Figure 2). A total of six traps were set up along the Rafflesia Trail (Table 2). Traps were spaced at 80 m intervals along the trail. This sampling

Table 2. Fruit-baited traps (FBT) set up along the Rafflesia Trail in Batu Timbang.

FBT no.	Coordinates	Elevation (m)
1	N 05° 00'12.4" E 117° 04'32.4"	361
2	N 05° 00'10.5" E 117° 04'35.0"	359
3	N 05° 00'08.3" E 117° 04'35.7"	383
4	N 05° 00'04.4" E 117° 04'36.4"	416
5	N 05° 00'00.1" E 117° 04'36.4"	414
6	N 04° 59'55.9" E 117° 04'35.5"	388

method was based on the same apparatus used by Chey et al. (2014 & 2015). The traps were checked the next day (after 24 hours), and all the butterflies, moths and beetles within the traps were recorded.

Figure 1. Insect light-trapping in progress.

Figure 2. Setting-up a fruit-baited trap.

Sweep net and manual collection

Sweep nets were used to collect flying insects while other insects were sampled using fine forceps. Butterflies were put in triangle papers while other specimens were put in vials with 75% ethanol solution. Sampling was conducted along the trails established for the expedition. Three people were involved in this sampling from 8:00 am until 1:00 pm. Details of the daytime sampling sites are listed in Table 3.

Table 3. Daytime sampling sites in Batu Timbang.

Sampling site	Starting point coordinates	Ending point coordinates	Elevation (m)
1 (Rafflesia Trail)	N 05°00'11.3" E 117°04'34.4"	N 04°59'55.9" E 117°04'35.5"	363-388
2 (Sg Lanap Trail)	N 05°00'17.4" E 117°04'38.0"	N 05°00'09.8" E 117°04'34.4"	364-391

Insect specimens and identification

In this survey, we focussed on certain insect groups, i.e., butterflies, moths, beetles, dragonflies and damselflies. Only selected insect groups for further research work were sampled, so as to minimize the workload at the laboratory in preparing the specimens for identification. This is also one of the best practices adopted to minimize stress and disturbance to biodiversity, as pointed out by Costello et al. (2016) on field work ethics in biological research. Photographs were taken with DSLR Nikon D800E and other compact cameras to facilitate identification. Common insects were not sampled but photographs were taken as a record.

Selected specimens were dry-mounted and sorted to family and some to the genus and species level. Some of the identifications are still tentative. The specimens sampled from this study are deposited at the Forest Research Centre, Sepilok, Sabah. Dry-mounted specimens were identified based on the FRC Entomology Collection and various reference materials.

Specimens of dragonflies and damselflies were handed over to the expert, Dr Choong Chee Yen of Universiti Kebangsaan Malaysia, Bangi who also participated in the expedition while some butterfly specimens were given to students of Dr Homathevi Rahman of Universiti Malaysia Sabah who were documenting the butterfly fauna of Batu Timbang.

Results and Discussion

Nocturnal insect diversity as assessed through light-trapping

The nocturnal insect diversity is shown in Table 4. The mean nocturnal insect species richness was 48 species while the mean abundance was 55 individuals. The mean Shannon Index was 3.76 while Simpson Index was 99 and Fisher Alpha Index was 167.30. The value for the diversity indices was affected by the presence of many wild honeybees, *Apis dorsata*, at Site A. There was a *Koompassia excelsa* tree with wild honeybee nests near the camp. The

presence and aggressive behaviour of the bees may have adversely affected the numbers of other insects. In enumerating the diversity values, honeybee abundance was not included as this species is social, and hence, individuals are not independent from each other, biasing calculation of diversity metrics. At Site B, the night wasp, *Provespa anomala*, was the most abundant species, with six individuals recorded during the enumeration time. Logistically, it was not feasible to carry out sampling far from the camp at night because of the extreme muddy road conditions.

During light-trapping, the temperature was between 22°C and 25°C with humidity relatively high, between 75 and 86% (Table 1). The distribution of insect species from the light-trapping sites (excluding wild honeybees) is reflected in the species-rank abundance curves in Figure 3.

Table 4. Insect diversity within a one-square-metre, as sampled through light-trapping in Imbak Canyon – Batu Timbang.

No.	Sampling site	Species	Ind.	Shannon	Simpson	Fisher Alpha
1.	A	49	56	3.81	118.46	187.47
2.	B	46	54	3.71	79.50	147.18
	Mean	47.5±2	55±1.4	3.76±0.07	99±27.60	167.30±28.50

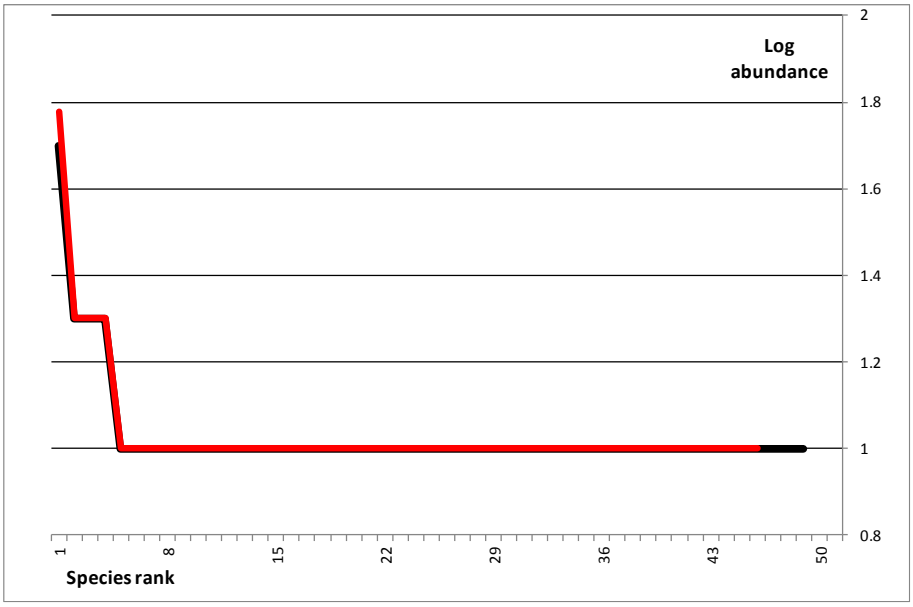

Figure 3. Species-rank abundance curves of light-trapping insect data in Imbak Canyon – Batu Timbang (Site A = black, Site B = red).

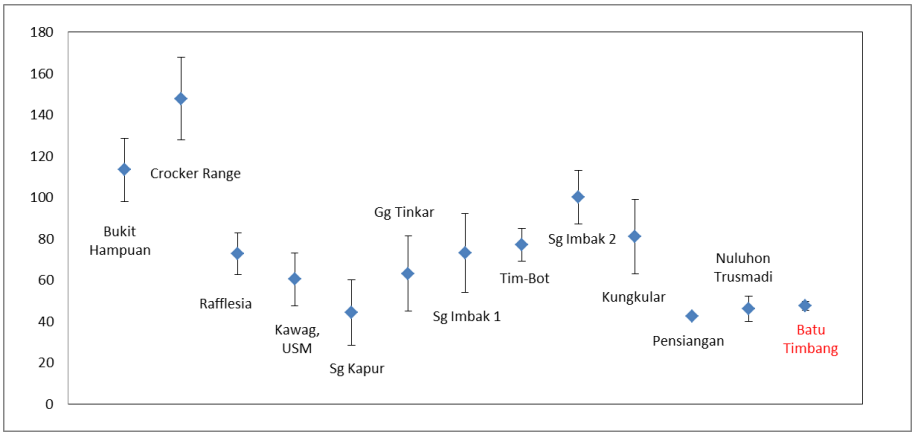

Figure 4a. Species number (±standard deviation) per night within one square metre as assessed through light-trapping in various forest reserves in Sabah.

When the nocturnal insect richness is compared with other forest reserves (Sabah Forestry Department's entomology data), Imbak Canyon – Batu Timbang insect richness (in red) appears to be low as shown in Figure 4a. In terms of nocturnal insect diversity, it is also moderately low (Figure 4b). Again, this could be due to the proliferation of the wild honeybees and the wet weather during the sampling period.

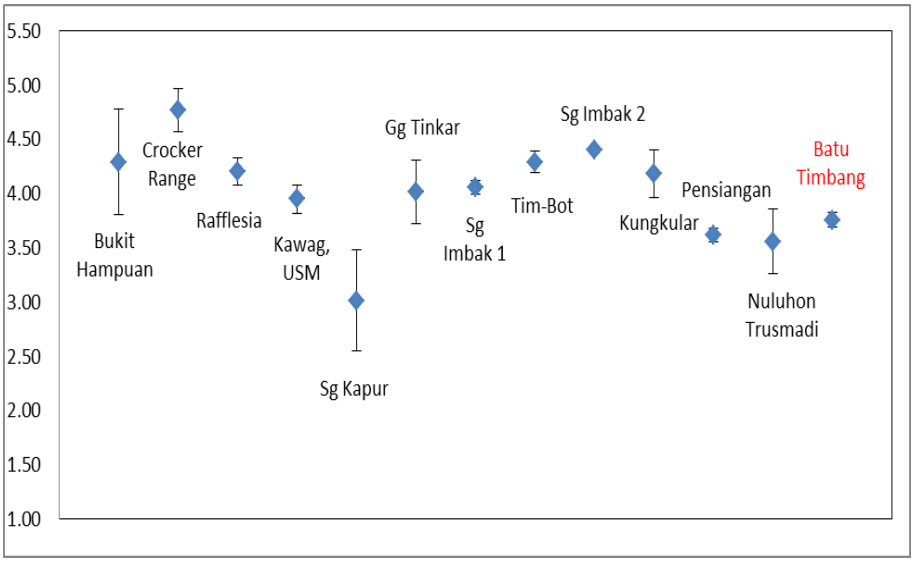

Figure 4b. Shannon Index (±standard deviation) per night within one square metre as assessed through light-trapping in various forest reserves in Sabah.

Table 5. Bornean endemic insect species from light-trapping in Imbak Canyon –Batu Timbang.

No.	Species	Author	Order	Family	Individuals
1	*Eulichas fasciolata*	Fairmaire	Coleoptera	Eulichadidae	1
2	*Chalcosoma moellenkampi*	Kolbe	Coleoptera	Scarabaeidae	2
3	*Amata prepuncta*	Holloway	Lepidoptera	Erebidae	1
4	*Panacra psaltria*	Jordan	Lepidoptera	Sphingidae	1

At least four Bornean endemic species were recorded from the base camp during light-trapping, as listed in Table 5. This information provides input towards recommendations on High Conservation Value Forest (HCVF) of the area, namely HCV 1.3 (WWF-Malaysia 2009). Endemism is one of the criteria that is highlighted as providing significant biodiversity values, hence, contributing towards forest conservation.

Eulichas fasciolata known as the Forest Stream Beetle, is common in the lowland mixed dipterocarp forests. However, not much is known about its ecology. It looks somewhat similar to a click beetle, with a distinctive scutellum with fine white hairs forming a circle and saw-toothed antennae (Bosuang et al. 2017). *Chalcosoma moellenkampi* or the Three-horned Beetle, is among the largest beetles in Borneo, measuring up to 115 mm in length. Although endemic, it is locally common in the lowlands, up to 1500 m in montane forests. *Amata prepuncta* is a wasp-like moth that normally prefers the understory of the lowland rainforest. *Panacra psaltria*, is one of the two hawkmoth species endemic to Borneo (Holloway 1998). It is found in dipterocarp forests, up to 900 m a.s.l.

Apart from endemic insects, the world's largest bush cricket, *Macrolyristes imperator*, was attracted to the light trap at Site A. This species has a wingspan of up to 274 mm and a body length (head to the tip of the forewings) of 150 mm (Chung 2002). The specimen sighted at Site A was a male, identified by a stridulatory organ at the base of the forewings. Four species of *Macrolyristes* have been described and all are found in the Malay Archipelago. The broad and serrated pronotum of the bush cricket is used in identification to differentiate among the four species.

Insects sampled using fruit-baited traps

Insects that were recorded feeding on rotting bananas in the fruit-baited traps are listed in Table 6. Some moths, butterflies and beetles were found in the

Table 6. Insects recorded from the fruit-baited traps in Imbak Canyon – Batu Timbang.

FBT no.	Species	Order, Family	Individuals
1	*Mycalesis orseis*	Lepidoptera, Nymphalidae	1
	Erebus caprimulgus	Lepidoptera, Erebidae	3
2	*Mycalesis orseis*	Lepidoptera, Nymphalidae	3
3	Curculionidae 5931	Coleoptera, Curculionidae	1
	Bocana 5933	Lepidoptera, Erebidae	2
4	*Ixorida* (*Mecinonota*) *regia bicolor*	Coleoptera, Scarabaeidae	1
	Erebus caprimulgus	Lepidoptera, Erebidae	1
5	*Ixorida* (*Mecinonota*) *regia bicolor*	Coleoptera, Scarabaeidae	1
	Sypnoides infernalis	Lepidoptera, Erebidae	1
	Bocana sp. 1 (5920)	Lepidoptera, Erebidae	1
	Bocana sp. 2 (5921)	Lepidoptera, Erebidae	1
6	*Erebus caprimulgus*	Lepidoptera, Erebidae	2

traps that were left overnight. One Bornean endemic subspecies of Flower Beetle, *Ixorida* (*Mecinonota*) *regia bicolor*, was recorded in two of the traps (FBT 4 & FBT5) while a Bornean endemic moth species, *Synoides infernalis*, was recorded from FBT5. The Purple Bushbrown butterfly, *Mycalesis orseis*, was the only butterfly sampled while *Erebus caprimulgus* was the commonest moth species recorded. Both *Mycalesis orseis* and *Erebus caprimulgus* are frequently attracted to rotting bananas (Chey 2015).

Diurnal insects sampled using sweep nets and forceps

Diurnal insects recorded from the base camp area include butterflies, dragonflies, damselflies and ants. However, they will not be discussed in depth in this report as Dr Choong Chee Yen of UKM reports on dragonflies and damselflies (Choong & Chung 2017) while Dr Homathevi Rahman and her students from UMS will report on the butterfly fauna. The Bornean endemic insect species recorded by the Forestry team while sampling along the trails at the base camp include the rare Bornean Mormon butterfly, *Papilio acheron* and a few damselfly species, namely *Rhinocypha aurofulgens*, *Drepanosticta actaeon* and *Devadatta tanduk*. The iconic Malaysia national butterfly, *Trogonoptera brookiana*, was sighted at the base camp and also along Sg. Lanap. A stick insect, *Acacus ?sarawacus*, was recorded from the Rafflesia Trail, adjacent to Sg. Lanap. Details of other insects recorded are listed in Appendices 1-5.

Threats and issues affecting insect diversity

Although ICCA is fully protected as Virgin Jungle Reserve (Class VI) and Protection Forest Reserve (Class I) under Sabah's forest classification, there are still various threats and issues which affect wildlife, including insects. Similar to that of other forest reserves, the major threats and issues that are affecting this reserve, as pointed out by Nilus et al. (2014), include forest fires, fragmentation, encroachment or illegal clearing of vegetation and poaching.

Of all these threats, forest fire is the most serious issue that can adversely affect insects within ICCA. A drought-induced fire on the forest may lead to the depletion of insect biomass, abundance and diversity that eventually changes species functions as well as alters the food chain. This has happened in the past in Sabah, e.g. Woods (1989) and reoccurs whenever there is a prolonged dry period. Therefore, monitoring during the dry season is crucial so that immediate action can be taken to reduce any forest fire incidences. Close cooperation and networking among relevant agencies, including capacity building, should be one of the main priorities in the management of any forest fire outbreak.

Forest fragmentation, encroachment or illegal clearing of vegetation and poaching are among threats that could indirectly affect the insect fauna in the long term. Having a ranger station in Batu Timbang would definitely enhance the enforcement in this part of the conservation area to curb any illegal activities. A station with radio communication and other basic facilities will also enable researchers to conduct long term research and monitoring work on wildlife, including insects.

A number of interesting Bornean endemic flora and fauna, including insects, were documented, even though this was just a two-week expedition. This indicates that the forest still harbours an interesting fauna, from the perspective of insects. Hence, the forest must continue to be protected and enhanced in terms of forest quality. Maintaining high forest quality is important for conserving rare taxa, especially for biodiversity conservation, while maintaining large forest areas is important for conserving common taxa, especially those that are important for conserving ecosystem functions.

Conclusion

Although the nocturnal insect diversity was not particularly high compared to other forest reserves, perhaps due to the proliferation of wild honeybees and unfavourable weather during the expedition, this pioneer data serves as baseline information for other research work in future. The endemic and interesting insect species recorded during the expedition provide information to enhance the conservation of this part of Imbak Canyon.

Any long-term threats are likely to indirectly affect the insect fauna. As such, continuous monitoring and enforcement at strategic locations are important to minimize these threats. Establishment of a ranger station and permanent research station would enable Yayasan Sabah and other relevant authorities to be more effective in managing this conservation area. This will ensure that the forest quality is improved in order to maintain the valuable biodiversity in the area, including insects.

Acknowledgements

Despite the unfavourable weather and logistical challenges, the expedition was successfully carried out, under the coordination of Dr Yap Sau Wai, who heads the Conservation and Environmental Management Division, Rita S. Galid, Dr Hamzah Tangki, Jadda Suhaimi and their team from Yayasan Sabah. We thank the then Chief Conservator of Forests, Datuk Sam Mannan, who was also the then chairman of the Imbak Canyon Management Committee; Deputy Chief Conservators, Frederick Kugan and Dr Lee Ying Fah, for their support in this expedition. We also wish to thank other entomologists who have contributed, namely Dr Choong Chee Yen, Dr Homathevi Rahman and Dr Francis Seow-Choen. Razy Japir, Nurul Aqidah and Dayang Fazrinah assisted in the insect list compilation. Dr Joan Pereira and Postar Miun provided some comments on the plants in this report. Viviannye Paul provided some insect photos from the second week of the expedition. The Sabah Forestry Department's participation in this expedition is an activity under the Heart of Borneo Initiative.

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Appendix 1. Butterfly list from Imbak Canyon - Batu Timbang (16-20 August, 2017).

No.	Species	Author	Family	Photo (IMB)	Remarks
1	*Paralaxita telesia ines*	Fruhstorfer	Riodinidae	DSCN5175, 5177	
2	*Trogonoptera brookiana brookiana*	Wallace	Papilionidae	DSC 0431	
3	*Papilio memnon memnon*	Linne	Papilionidae	DSC 0432	
4	*Cethosia hypsea hypsea*	Doubleday	Nymphalidae	Spotted	
5	*Mycalesis orseis borneensis*	Fruhstorfer	Nymphalidae	5963	
6	*Papilio acheron*	Grose-Smith	Papilionidae	5994, 5991	Endemic
7	*Mycalesis anapita fucentia*	Fruhstorfer	Nymphalidae	5785	
8	*Eurema* sp. 1		Pieridae	5805	
9	*Eurema* sp. 2		Pieridae	5958	

Appendix 2. Selected moths recorded from Imbak Canyon - Batu Timbang (16-20 August, 2017).

No.	Species	Author	Family	Subfamily	Photo no. (IMB)	Remarks
1	*Glyphodes canthusalis*	Walker	Crambidae		6057	
2	*Sylepte* sp.		Crambidae		6056	
3	Unidentified		Crambidae		5848	
4	Unidentified		Crambidae		5899	
5	*Drapetodes matulata*	Felder & Rogenhofer	Drepanidae	Drepaninae	6032	
6	*Tridrepana* sp.		Drepanidae		5894	
7	*Amata prepuncta*	Holloway	Erebidae	Arctiinae	spotted	Endemic
8	*Barsine rubricostata*	Herrich-Schaffer	Erebidae	Arctiinae	5839	
9	*Cyana* nr. *constifimbria*		Erebidae	Arctiinae	5844	
10	*Ischyja manlioides*	Prout	Erebidae	Catocalinae	5880	
11	*Ischyja manlioides*	Prout	Erebidae	Catocalinae	5890	
12	*Sypnoides infernalis*	Berio	Erebidae	Catocalinae	5919	Endemic
13	*Erebus caprimulgus*	Fabricius	Erebidae	Erebinae	5914a (female), 5927(male)	
14	*Bocana* sp. 1		Erebidae	Herminiinae	5920	
15	*Bocana* sp. 2		Erebidae	Herminiinae	5921	
16	*Cyana conclusa*	Walker	Erebidae	Lithosiinae	5883	
17	*Cyana determinata*	Walker	Erebidae	Lithosiinae	6037	

18	*Cyana malayensis*	Hampson	Erebidae	Lithosiinae	6035	
19	*Cyanaperornata*	Walker	Erebidae	Lithosiinae	5882	
20	Unidentified		Erebidae		5842	
21	Unidentified		Erebidae		6055	
22	*Bracca maculosa*	Walker	Geometridae	Ennominae	5850	
23	*Heterostegane* sp.	Guenee	Geometridae	Ennominae	6058	
24	Unidentified		Geometridae	Ennominae	5852	
25	*Pingasa rubicunda*	Warren	Geometridae	Geometrinae	6054	
26	*Pingasa ruginaria*	Guenee	Geometridae	Geometrinae	6033	
27	*Pingasa ruginaria*	Guenee	Geometridae	Geometrinae	6039	
28	*Pingasa venusta*	Warren	Geometridae	Geometrinae	6061	
29	Unidentified		Geometridae		6036	
30	*Setora* sp.		Limacodidae		5888	
31	*Carriola ecnomoda*	Swinhoe	Lymantriidae	Ennominae	6040	
32	*Arctornis* sp.		Lymantriidae		5855	
33	*Toxoproctis cosmia*	Collenette	Lymantriidae		5900	
34	Unidentified		Pyralidae		5889	
35	*Eupanacra busiris*	Walker	Sphingidae		6029	
36	*Panacra psaltria*	Jordan	Sphingidae		5863	Endemic
37	Unidentified		Unidentified		6060	

Appendix 3. Beetle list from Imbak Canyon - Batu Timbang (16-20 August, 2017).

No.	Species	Author	Family	Photo No. (IMB)	Remarks
1	*Rhabdoscelus* sp.		Curculionidae	DSCN5186	
2	*Alaus* sp.		Elateridae	5917	
3	*Lanelater* sp.		Elateridae	5856	
4	*Endomychus* sp.		Endomychidae	5696	
5	*Eumorphus* sp.		Endomychidae	5696	
6	*Eulichas fasciolata*	Fairmaire	Eulichadidae	5886	Endemic
7	*Pseudozaena orientalis*	Klug	Harpalidae	5847	
8	*Anomala* sp.		Scarabaeidae	5846	
9	*Chalcosoma atlas*	Linnaeus	Scarabaeidae	5579	
10	*Chalcosoma moellenkampi*	Kolbe	Scarabaeidae	spotted	Endemic
11	*Ixorida (Mecinonota) regia bicolor*	Kraatz	Scarabaeidae	DSCN5185a	Endemic subspecies

Appendix 4. Odonata list from Imbak Canyon - Batu Timbang (16-20 August, 2017)*.

No.	Species	Author	Family	Photo (IMB)	Remarks
1	*Vestalis* spp.	Selys, 1853	Calopterygidae	5630, 5750, 5753-5755, 5757-5758, 5770, 5959-5960, 5767	
2	*Rhinocypha aurofulgens*	Laidlaw, 1931	Chlorocyphidae	5773-5778	Endemic
3	*Rhinocypha humeralis*	Selys, 1873	Chlorocyphidae	5759-5760, 5995	
4	*Devadatta tanduk*	Dow et al., 2015	Devadattidae	5965-5966	Endemic
5	*Euphaea subcostalis*	Laidlaw, 1915	Euphaeidae	6006-6007, 5779-5780, 5822	
6	*Cratilla metallica*	Brauer,1878	Libellulidae	5824-5830	
7	*Neurothemis fluctuans*	Fabricus, 1993	Libellulidae	5799	
8	*Orthetrum chrysis*	Selys, 1891	Libellulidae	5807-5808	
9	*Orthetrum glaucum*	Brauer, 1865	Libellulidae	5637, 5640, 5804, 5981	
10	*Orthetrum pruinosum*	Burmeister, 1839	Libellulidae	5801, 5806, 56639(female)	
11	*Orthetrum testaceum*	Burmeister, 1839	Libellulidae	5802-5803	
12	*Trithemis festiva*	Rambur, 1842	Libellulidae	5809	
13	*Macromia* sp.		Macromiidae	5697-5699	
14	*Drepanosticta actaeon*	Laidlaw, 1934	Platystictidae	5795-5797, 5941	Endemic

*Choong Chee Yen has kindly identified some of the Odonata in this list.

Appendix 5. Other insects recorded from Imbak Canyon - Batu Timbang (16-20 August, 2017).

No.	Species	Author	Order	Family	Photo no. (IMB)	Remarks
1	*Leptogenys* nr *diminuta*	Smith	Hymenoptera	Formicidae	5814	
2	*Macrolyristes imperator*	Snellen van Vollenhoven	Orthoptera	Tettigoniidae	5872	
3	*Apis dorsata*	Fabricius	Hymenoptera	Apidae	5854	
4	*Provespa anomala*	Saussure	Hymenoptera	Vespidae	5840	
5	*Orientopsaltria padda*	Distant	Hemiptera	Cicadidae	6042	
6	*Dinomyrmex gigas*	Latreille	Hymenoptera	Formicidae	5861	
7	*Dundubia vaginata*	Fabricius	Hemiptera	Cicadidae	5857	
8	*Platylomia* nr *spinosa*	Fabricius	Hemiptera	Cicadidae	5892	
9	*Nevromus gloriosoi*	Liu, Hayashi & Yang	Megaloptera	Corydalidae	6051	
10	*Episyrphus?* sp.		Diptera	Syrphidae	6025	
11	*Neoperla* sp.		Plecoptera	Perlidae	5762	

12	*Acacus ?sarawacus*	Phasmida	Diapheromeridae	5790
13	*Calliphora* sp.	Diptera	Calliphoridae	5951