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## Research Article

# **Insect Diversity of Sg. Kangkawat Research Station in Imbak Canyon Conservation Area (ICCA), Sabah**

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## **Abstract**

The nocturnal insect diversity was very high, with more than 100 insect species in a square metre in all light-trapping sites. The mean Shannon Index was 4.60 while Simpson Index was 176.72. It is interesting to note that Sg. Kangkawat insect richness appears to be the second highest after Crocker Range, when compared with 25 other forest reserves in Sabah. There were more than 13 endemic species and a subspecies recorded during the survey, including an undescribed species of moth (Geometridae, *Plutodes* sp.). In view of the high diversity and intriguing insect fauna, Sg Kangkawat Research Station has potential in promoting nature tourism for special interest tourists. Encroachment is among the threats within this forest reserve. For the general public, the boundary of some parts of the forest reserve is still not clear. Hence, it is important to have more signages to denote the forest reserve boundary. Public awareness and environmental education have to be enhanced among the local communities so that they are aware of the significance of biodiversity conservation of forest resources. The threats and issues have indirectly affected the insect fauna. As such, the forest quality would have to be enhanced in order to maintain the interesting and endemic insect fauna for biodiversity conservation. On-going cooperation with the relevant authorities, such as Sabah Forestry Department and Sabah Wildlife Department, will enhance conservation efforts and curb future encroachment. Further biodiversity research with relevant agencies should be encouraged.

**Keywords:** Insect, nocturnal insect, diversity, light-trap, Bornean endemic.

## **Introduction**

Sungai Kangkawat Research Station is located within the famous Imbak Canyon Conservation Area (ICCA). ICCA serves as a vital gene bank or seed source for forest rehabilitation, and an ideal site for research in its lowland dipterocarp forest. Besides research related activities, ICCA is ideal for wilderness recreation such as jungle-trekking, bird-watching, nature or outdoor photography, camping, and night-walks to observe wildlife.

Among the studies conducted were in the areas of biodiversity, entomology, botany, forestry, herpetology, ichthyology, eco-tourism and other related fields. The expedition was part of Yayasan Sabah Group's conservation efforts that includes providing a platform for scientists and academicians to conduct research.

## **Methodology**

### ***Light-trapping***

Light trap 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. It was powered by a portable Yamaha 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).

To evaluate diversity of the sampling area, insect species and individuals ( $\geq 5$  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. This method is simple, fast and can be carried out by non-insect specialist. To avoid compounding human error, the same staff was assigned to count the species and individual numbers throughout the sampling period, and also for other sampling sites. The sampling was carried out for three nights at three different sites.

### ***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. The sampling was conducted from 9 a.m. until 1 p.m. for three days.

### ***Insect specimens and identification***

In this survey, focus was given to certain insect groups, i.e., butterflies, moths, beetles, dragonflies and damselflies. Only selected insects for further research work were sampled, as to minimize the workload at the laboratory in preparing the specimens for identification. Photographs were taken to facilitate identification. Common insects were not sampled but photographs were taken for record purposes.

Selected specimens were dry-mounted and sorted to family and some to the genus and species level. 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, e.g. Otsuka (1988 & 2001) for butterflies; Holloway (1983, 1985, 1986, 1988, 1989, 1993, 1996, 1997, 1998a & b, 1999, 2001, 2003, 2005, 2008, 2009 & 2011) and Robinson et al. (1994) for moths; Fujita (2010), Makihara (1999) and Tung (1983) for beetles; Seow-Choen (2016) for stick insects; Orr (2003) and Tang et al. (2010) for dragonflies and damselflies. Some other insects were identified based on Hill & Abang (2005).

### ***Diversity indices***

The diversity indices, namely Shannon Wiener and Simpson were calculated through a diversity analysis software by Seaby & Henderson (2007), based on Magurran (2004), and Southwood & Henderson (2000).

## **Results and Discussion**

### ***Nocturnal insect diversity as assessed through light-trapping***

The nocturnal insect diversity is shown in Table 2. Data were not available for Site C because of a heavy downpour before the enumeration could be conducted. A mean 118 species of nocturnal insects were recorded from one-square-metre of the light-trapping cloth, with an average of individuals. The mean Shannon Index was 4.60 while Simpson Index was 176.72.

During light-trapping, the temperature was 24<sup>o</sup>C - 25<sup>o</sup>C with humidity reaching 88% (Table 1). The distribution of insect species from the light-trapping sites is reflected in the species-rank abundance curves in Figure 1. Simpson's Index shows lower value in Site A because of a more dominant species with 18

individuals, which is *Apis dorsata* (Hymenoptera: Apidae), compared to Site B. This is also reflected in the higher staggered slope of the species-rank abundance curve of Site A.

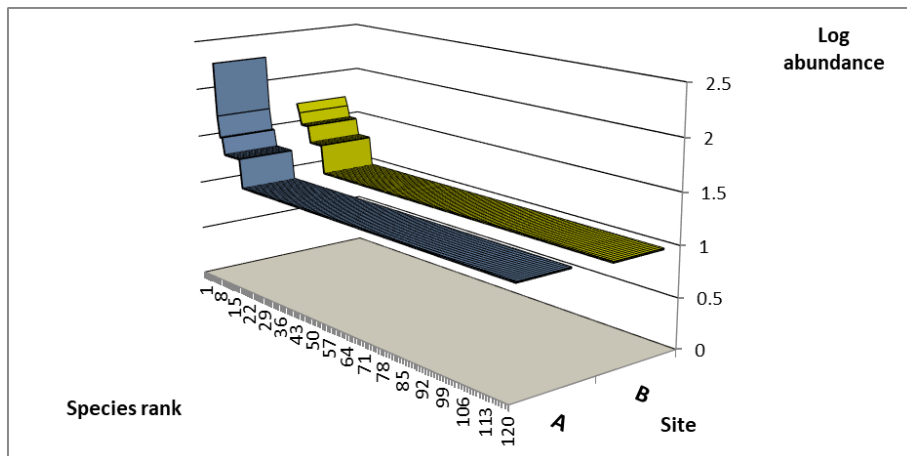


Figure 1: Species-rank abundance curves of the light-trapping in Sg. Kangkawat Research Station.

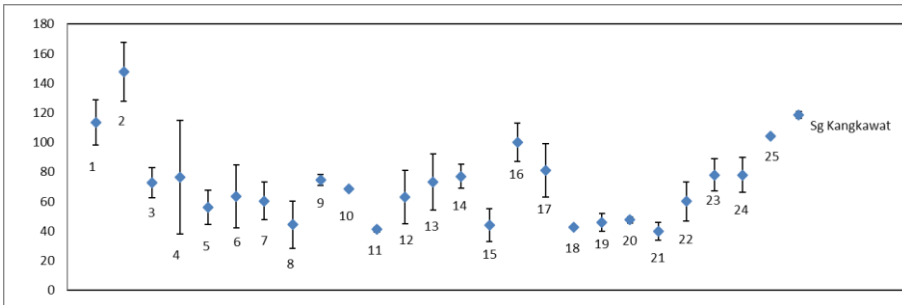
Table 1: Light-trapping sites in Sg. Kangkawat Research Station.

Sampling site	Coordinates	Elevation (m)	Temp. (°C)	Humidity (%)	Sampling date	Remarks
A	N 05°04'41.8" E 117°03'38.3"	244	25.3	84	29 Sept	No moon with clear sky.
B	N 05°04'39.8" E 117°03'30.2"	220	24.5	88%	30 Sept	No moon with clear sky.
C	N 05°04'39.5" E 117°03'30.5"	212	n.a	n.a	01 Oct	Heavy downpour at 7:30 pm. Hence, light-trapping was cancelled.

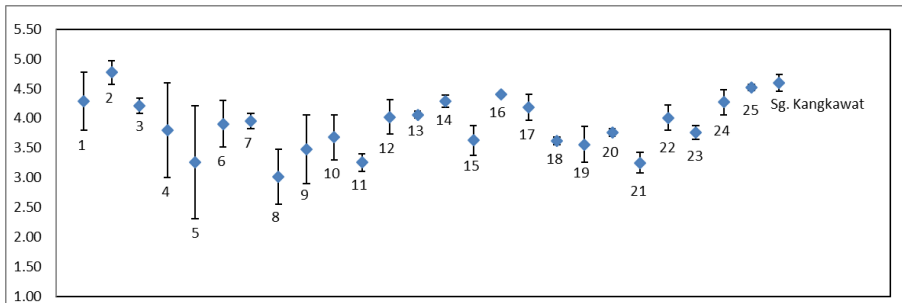
Table 2: Insect diversity within a one-square-metre, as sampled through light-trapping in Sg. Kangkawat Research Station.

No.	Sampling site	Species	Ind.	Shannon	Simpson
1.	A	117	150	4.49	64.14
2.	B	141	126	4.70	290.29
3.	C	-	-	-	-
	Mean	118.5±2.12	145.5±6.36	4.60±0.14	176.72±160.61

When the nocturnal insect richness is compared with 25 other forest reserves in Sabah, it is interesting to note that Sg. Kangkawat insect richness appears to be the third highest after Crocker Range and almost similar to Bukit Hampuan FR, as shown in Figure 2. In terms of nocturnal insect diversity as reflected by Shannon Index, it is the second highest after Crocker Range FR (Figure 3).



**Figure 2:** Species number ( $\pm$ standard deviation) within one square metre as assessed through light-trapping in various forest reserves in Sabah (1 = Bkt Hampuan, 2 = Crocker Range, 3 = Rafflesia, 4 = Gn. Lumaku, 5 = Gunong Lumaku, 6 = Milian Labau, 7 = Kawag, USM Office, 8 = Sg. Kapur, 9 = Sg. Siliawan, 10 = Nurod Urod, 11 = Punggol & Sansiang, 12 = Gg Tinkar, 13 = Sg Imbak 2a&2b, 14 = Tim-Bot, 15 = T. Bohangin, 16 = Sg Imbak 2c&2d, 17 = Kungkular, 18 = Pensiangan, 19 = Nuluhon Trusmadi, 20 = Batu Timbang, 21 = Tambulanan, 22 = Trusan Sugut, 23 = IJM SG, 24 = Ulu Kalang & 25= Sg. Rawog).



**Figure 3:** Shannon Index ( $\pm$ standard deviation) within one square metre as assessed through light-trapping in various forest reserves in Sabah (For sites 1-25, refer to details in Figure 2).

### ***Bornean endemic insect species from the survey***

One undescribed moth species and at least 13 Bornean endemic species and a Bornean endemic subspecies were recorded during the survey, as listed in Table 3. This information provides input towards recommendations on high conservation values (HCV) of the area, based on HCV 1 as stipulated in HCVRN (2013).

**Table 3.** Bornean endemic insect species recorded from Sg. Kangkawat Research Station

No.	Species	Author	Order	Family
1	<i>Eulichas fasciolata</i>	Fairmaire	Coleoptera	Eulichadidae
2	<i>Dorcus thoracicus</i>	Moellenkamp	Coleoptera	Lucanidae
3	<i>Chalcosoma moellenkampii</i>	Kolbe	Coleoptera	Scarabaeidae
4	<i>Amata egenaria</i>	Walker	Lepidoptera	Erebidae
5	<i>Barsine lucibilis</i>	Swinhoe	Lepidoptera	Erebidae
6	<i>Amblychia cavimargo</i>	Prout	Lepidoptera	Geometridae
7	<i>Plutodes evaginata</i>	Holloway	Lepidoptera	Geometridae
8	<i>Plutodes</i> sp. (undescribed)		Lepidoptera	Geometridae
9	<i>Acytolepis ripte</i>	Druce	Lepidoptera	Lycaenidae
10	<i>Caleta elna elvira*</i>	Fruhstorfer	Lepidoptera	Lycaenidae
11	<i>Ugia disjungens</i>	Walker	Lepidoptera	Noctuidae
12	<i>Haaniella echinata</i>	Redtenbacher	Phasmatodea	Phasmatidae
13	<i>Lonchodes nr abbreviatus</i>	Brunner	Phasmatodea	Phasmatidae
14	<i>Phobaeticus kirbyi</i>	Brunner	Phasmatodea	Phasmatidae

\*subspecies endemic to Borneo

The undescribed moth species is from the genus *Plutodes* of the family Geometridae. It did not match any of the species featured in Holloway (1993), and Roger Kendrick (pers. comm.) suggested that it is a species that is close to *Plutodes cyclaria*. Unfortunately, the specimen was not collected and only photographs were taken.

At least five Bornean endemic moth species were recorded in this expedition, namely a wasp-like moth (*Amata egenaria*), and a *Barsine lucibilis* of family Erebididae, two Geometrid Moth (*Amblychia cavimargo* and *Plutodes evaginata*) and a Noctuid Moth (*Ugia disjungens*). Apart from these, there were a Bornean

Lycaenid Butterfly (*Acytolepis ripte*) and an endemic subspecies of Lycaenid Butterfly (*Caleta elna elvira*). For beetles, three Bornean endemic species were recorded. *Eulichas fasciolata* is a Forest Stream Beetle which was attracted to the light trap. Although it is endemic, this species is locally common. The other beetles are black Stag Beetle (*Dorcus* nr *thoracicus*) and Three-horned Rhinocheros Beetle (*Chalcosoma moellenkampii*). Three Bornean endemic stick insect were recorded, namely a *Lonchodes* nr *abbreviatus*, a *Phobaeticus kirbyi* and a *Haaniella echinata*. The *Lonchodes* nr *abbreviatus* was featured in Soew-Choen (2016). The *kirbyi* is the common species among the *Phobaeticus* and also was featured in Soew-Choen (2016). The *Haaniella echinata* is the common stick insect that can be spotted in most of the lowland forest reserves in Sabah.

### ***The insect fauna (non-endemic) of Sg. Kangkawat Research Station***

During the expedition, the main insect groups that were documented were butterflies, moths, beetles, dragonflies and the rest were grouped as other insects.

#### ***Butterflies***

A total of 17 butterfly species were recorded. Interesting butterflies sighted during the expedition were the Rajah Brooke's Birdwing (*Trogonoptera brookiana*) and the Golden Birdwing (*Troides amphrysus flaviscolis*). The former is Malaysia's national butterfly while the latter is an iconic species which is often featured in Sabah's nature tourism promotion. Both are protected species under Schedule 2 of the Sabah Wildlife Conservation Enactment 1997. The male Rajah Brooke's Birdwing was spotted a number of times flying across the river near the base camp of Sg. Kangkawat. Another butterfly that was commonly sighted resting on the damp river bank was the Cruiser, *Vindula dejone dejone*.

#### ***Moths***

At least 32 moth species were documented during this expedition. The most interesting moth sighted was the Cossidae Moth, *Xyleutes mineus* (Cossidae), because of its striking red wings with their unusual blue-black patches. Other interesting moth species included the Geometrid Moth (*Pingasa tapungkanana*) and the black and white Swallowtail Moth, *Lyssa menoetius* (Uraniidae). From the family Cossidae, *Xyleutes strix* was the largest goat moth recorded, with a body length (including wings) up to 6 cm and wing span of 12 cm.

#### ***Beetles***

Twelve macro beetle species were recorded during the survey. *Chalcosoma moellenkampii* was the largest beetle recorded through light trap and it is known as one of the types of pests found in oil palm plantations. It is also one of the

largest beetles in Borneo. Other large beetles recorded included the Three-horned Rhinoceros Beetle, *Chalcosoma atlas*. Another interesting beetle recorded was the Click Beetle, *Alaus* sp., which can do an acrobatic jump when disturbed.

#### *Dragonflies and damselflies*

At least four Odonata common species were sighted in Sg. Kangkawat Research Station during the survey. The Odonata fauna is reported by Choong et al. (2019). It is also interesting to note that the Black Velvetwing Damselfly, *Dysphaea demidiata*, was found in abundance resting on the damp part of the riverine area.

#### *Other insects*

At least 11 species of other insects were recorded including termites, bugs, wasps, honeybees, ants, praying mantises, crickets, and stick insects. The most interesting insect was the Exploding Ant, *Camponotus (Colobopsis) saundersi*. It can rupture its abdomen and secrete yellowish fluid when attacked by intruders.

#### *Threats and issues affecting insect diversity*

Sungai Kangkawat Research Station is located within the Imbak Canyon Conservation Area. There are threats that may affect forest reserves such as forest fire, poaching, fragmentation, and encroachment as the study site is located near local villages and it is accessible by vehicles. These threats have been discussed and were similar to that of other forest reserves (Nilus et al. (2014); Chung & Lee (2009); Chung et al. (2018)).

In terms of insects, the forest harboured interesting fauna as well as Bornean endemic insects even though it was just a short expedition. Hence, the forest has to be protected and monitored to minimize encroachment and to enhance the forest quality.

## **Conclusion**

The data procured from the expedition serves as baseline information as there was no insect diversity survey in this research station in the past. Research findings have revealed that the nocturnal insect diversity was very high, second after the Crocker Range FR, in comparison with 25 other sites in Sabah. Hence, from the insect diversity perspective, this area is of utmost importance. The Bornean endemic insect species recorded provide salient information to enhance the conservation of Sg. Kangkawat Research Station.



It is important to conduct continuous monitoring and enforcement at strategic locations within the reserve to minimize threats and adverse issues. This will ensure the forest quality is improved in order to maintain the interesting biodiversity, including insects. On-going cooperation with the relevant authorities, such as Sabah Forestry Department and Sabah Wildlife Department, may curb future incidences of encroachment into the conservation area. Further biodiversity research with Universiti Malaysia Sabah to enhance the conservation of that area is needed.

### Acknowledgements

Authors would like to thank Universiti Malaysia Sabah for financial support (Grant No. SDK0043-2018), Sabah Biodiversity Council for the access license Ref. JKM/MBS.1000-2/1JLD.3 (246) and Imbak Canyon Management Committee for research permission. Chief Conservator of Forests (Datuk Mashor Hj. Mohd. Jaini), Deputy Chief Conservators (Frederick Kugan and Dr. Robert Ong). Dr. Choong Chee Yen assisted in Odonata identification while Dr. Francis Seow-Choen identified some stick insects. Dr. Roger Kendrick commented on an undescribed moth species. UMS volunteers, Marcella Gohun and Shah Rizan Ronne assisted in the field sampling and light trapping.

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