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SPECIES COMPOSITION OF NYMPHALID BUTTERFLIES IN MAINLAND (KUBAH NATIONAL PARK) AND ISLAND (SATANG BESAR ISLAND), SARAWAK

SHAHIDAN SURAYA[1], S. G., CHRISTHARINA[2]*, MAWAR STANLY MERUM[1], IDRIS MUHAMAD IKHWAN[2] AND GHAZALI RAZIMAN IMAM[2]

[1]Fakulti Sains dan Teknologi Sumber, Universiti Malaysia Sarawak, 94300, Kota Samarahan, Sarawak, Malaysia. [2]Pusat Pengajian Pra-Universiti, Universiti Malaysia Sarawak, 94300, Kota Samarahan, Sarawak, Malaysia.

**Corresponding author: sgchristharina@unimas.my*
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Abstract: Species diversity is a good measure of habitat quality. In order to gain this knowledge, bio-indicator species such as butterflies is among the species to be observed. In this study, nymphalids were recorded in mainland (Kubah National Park) and island (Satang Besar Island), Sarawak by using 20 baited traps in 20 days of sampling period. A total of 93 individuals representing 25 species were documented. Species diversity index was higher in the mainland (H'= 2.8639) with 87 individuals comprising 24 species. This could be due to the habitat homogeneity and thus less variety of food resources in the island. Species abundance in the mainland was dominated by the Nymphalinae (13.48%) of both *Bassarona dunya* and *Tanaecia aruna*. Meanwhile, *Melanitis leda* was the most abundant species recorded (67%) in the island. Mainland was more speciose in terms of butterfly composition as compared to island and distribution pattern of butterflies were also observed.

Keywords: Species composition, Nymphalidae, Satang Besar Island, Kubah National Park.
Abbreviations: Kubah National Park (KNP), metre (m), Mixed Dipterocarp Forest (MDF), Mount (Mt.), Satang Besar Island (SBI), hectares (ha).

Introduction

Butterflies play an important role as bio-indicators of terrestrial environments and habitat quality and have therefore established a role in biological monitoring and conservation (Koh, 2007). The topics about the roles of insects as indicators of forest disturbance have been previously discussed by many authors (Wilson, 1987; Brown, 1991; Sutton & Collins, 199; Kremen *et al.,* 1993) and butterflies are considered as an effective group for assessment studies (e.g., Brown, 1991; Kremen, 1992; Sparrow *et al.,* 1994; New *et al.,* 1995; New, 1997). Lepidopterans are one of the most familiar and easily recognised insects, due to their colouration that reached the highest degree of specialisation (Richards & Davies, 1977). They are also sensitive to habitat disruption including changes in floral and fruit diversity and also in habitat structure and therefore, play a very important role in ecosystem (Molleman *et al.,* 2006).

The adult nymphalids are known to be attracted to plant nectar as well as to the juice of rotting fruits and are also referred to as fruit-feeding nymphalids (DeVries & Walla, 2001; Christharina & Abang, 2014b). Butterfly species are more reliably identified (Schulze *et al.,* 2001) especially frugivorous nymphalids. This provides an opportunity to compare species composition in different selected forest habitats.

In order to compare the butterflies of island and mainland habitats, these two localities, Satang Besar Island (SBI) and Kubah National Park (KNP) were selected. Both study sites are located about 20 km apart, thus suitable to represent the two different targeted habitats. Kier *et al.* (2009) has stated that oceanic islands are known for their high percentage of endemic species, yet in terms of species richness it is in moderate levels. That brings to the question of their relative conservation value and thus, leads to the objectives of this study. This study was to

determine and compare the species diversity in the island and mainland habitats.

Materials and Methods

Study Site

This study was conducted in Satang Besar Island (SBI) (1.7918° N, 110.1656° E) and Kubah National Park (KNP) (01°36'48.43"N and 110°11 '5 1.59"E), Sarawak (Figure 1). SBI is an island that covers an area about 76.21 ha and the very first Marine National Park in Sarawak. This island consists mainly of planted vegetation, open shrub land, beach forest and secondary with little primary forest (Hazebroek & Abang Morshidi, 2000).

On the other hand, KNP is one of the most accessible national parks in Sarawak (Figure 1). It consists of five forest types which are alluvial, lowland mixed dipterocarp, kerangas, submontane and secondary forest (Lee, 1987; Pearce, 1994). This 2,230 ha national park is largely covered with mixed dipterocarp forest (MDF) and very paramount for about 86 palms species, 16 of which are endemic to Borneo (Hazebroek & Kashim, 2000).

Sampling Method

Data collection was carried out for five continuous days in SBI (1st – 5th September 2019 and 15th – 18th March 2020) and KNP (10th – 15th November 2019 and 28th – 2nd January 2020), respectively. 20 baited traps were installed along the man-made trails using line transects technique. Two baited traps were used in each of the sampling plot (tree). Trees was approximately 10 m apart. Baited traps were hung at the canopy level (8 – 15 m) and ground level (1 m from the ground) with the Single Rope Technique (Christianus, 2012; Christharina & Abang, 2014b) (Figure 2).

A mixture of mashed rotting banana and pineapples were used as bait and were replenished twice a day. All baited traps were run concurrently and were checked twice daily. Species identification was conducted by referring to Otsuka (2001) and Abang (2006), as well as comparison with the available voucher specimen in the Unimas Insect Reference Collection. All statistical tests were performed with the Palaeontological Statistics (PAST) Version 4.0 (Hammer *et al.,* 2001).

Results

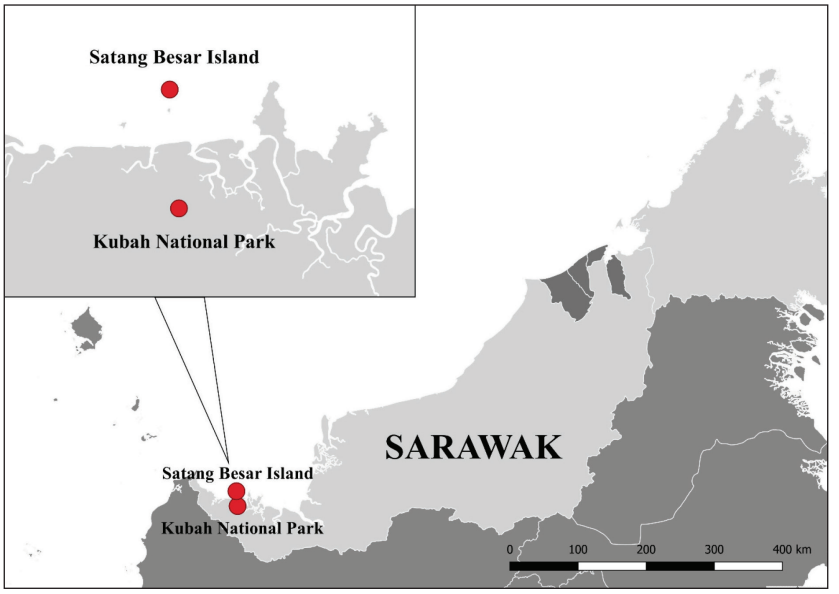

Figure 1: Modified map of Satang Besar Island and Kubah National Park, Sarawak (Source: Created with QGIS software)

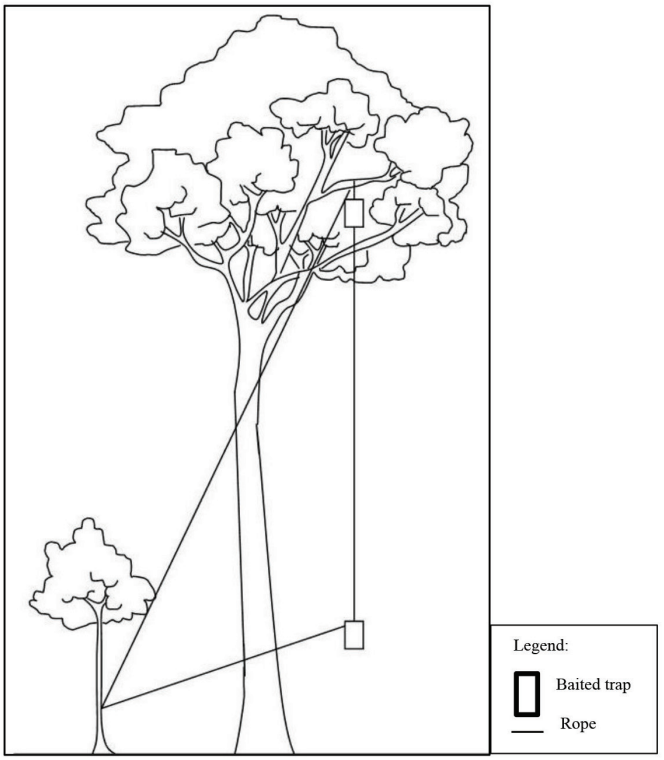

Figure 2: The vertical trap setting of baited traps by using Single Rope Technique in each sampling plot (Source: Christianus, 2012) (Sketch is not up to scale)

Six individual butterflies representing two species were sampled at SBI (Table 1). The two species were *Melanitis leda* (71.43%) and *Amathusia phidippus* (28.57%). Satyrinae was the most abundant subfamily in SBI. Overall diversity index recorded for the butterflies was H' = 0.6365 (Table 2). On the other hand, 87 individuals comprising 25 species of Nymphalidae from four subfamilies were recorded in KNP (Table 1). An average of eight individuals were recorded per day throughout the study in KNP. The most abundant species were *Bassarona dunya* and *Tanaecia aruna* with 12 individuals sampled respectively (13.79%). Another abundant species was *Dophla evelina* with nine individuals which contributed to 10.47% of the total individuals recorded.

Nymphalinae was the most diverse (H': 1.823) and abundant subfamily with 56.98% (49 individuals) of the total nymphalid species recorded, followed by Satyrinae with 25.58% (22 individuals), Morphinae with 15.12% (13 individuals) and lastly Charaxinae with 2.32% (two individuals). Most of the nymphalid species recorded in KNP were satyrine butterflies (10 out of 25 species).

In total, 93 individuals belonging to 25 species of Nymphalidae were recorded in SBI and KNP. Two species (6 individuals) were sampled in SBI and 25 species (86 individuals) in KNP (Figure 3). Two species, *A. phidippus* and *M. leda* were sampled in both sites (Table 3).

Table 1: A list of nymphalids butterfly species (Lepidoptera: Nymphalidae) collected by using baited traps in Satang Besar Island (SBI) and Kubah National Park (KNP), Sarawak

Study Site	Subfamily / Species	Sex		Total	Relative Abundance (%)
		Male	Female		
SBI	**Morphinae**				
	Amathusia phidippus phidippus Linnaeus 1763	0	2	2	33.33
	Satyrinae				
	Melanitis leda leda Linnaeus 1758	2	2	4	66.67
	Total (2 species)	**2**	**4**	**6**	
KNP	**Charaxinae**				
	Agatasa calydonia mahasthama Fruh 1913	1	0	1	1.15
	Prothoe franckii borneensis Fruh 1913	1	0	1	1.15
	Morphinae				
	Amathuxidia amythaon ottoman Butler 1869	2	3	5	5.75
	Amathusia phidippus phidippus Linnaeus 1763	0	2	2	2.30
	Zeuxidia amethystus wallacei Felder 1867	0	2	2	2.30
	Zeuxidia aurelius euthycrite Fruh 1913	1	0	1	1.15
	Zeuxidia doubledayii horsfieldii Felder 1867	5	0	5	5.75
	Nymphalinae				
	Bassarona dunya monara Fruhstorfer 1913	9	3	12	13.79
	Bassarona teuta bellata Distant 1886	5	2	7	8.05
	Dophla evelina magama Fruh 1913	5	4	9	10.34
	Dichorragia nesimachus derdas Fruh 1903	4	0	4	4.60
	Lexias dirtea chalcenoides Fruh 1913	2	0	2	2.30
	Tanaecia aruna aparasa Vollenhoeven 1862	10	2	12	13.79
	Tanaecia clathrata coerulescens Vollenhoeven 1862	1	0	1	1.15
	Tanaecia pelea djata Fruh 1913	2	0	2	2.30
	Satyrinae				
	Elymnias nesaea hypereides Fruhstorfer 1902	1	0	1	1.15
	Melanitis leda leda Linnaeus 1758	0	1	1	1.15
	Melanitis zitenius rufinus Fruh 1908	1	1	2	2.30
	Mycalesis sp.	0	1	1	1.15
	Mycalesis orseis borneensis Fruh 1906	1	2	3	3.44
	Mycalesis horsefieldi hermana Fruh 1908	3	0	3	3.44
	Mycalesis mnasicles mnasicles Hewitson 1864	4	0	4	4.60
	Mycalesis perseus Fabricius 1775	0	1	1	1.15
	Neorina lowii lowii Doubleday 1849	3	1	4	4.60
	Ragadia makuta umbrata Fruh 1911	1	0	1	1.15
	Total (25 species)	**62**	**25**	**87**	

Table 2: Diversity *t*-test and Shannon Index computed using PAST v.4.0 software

	Kubah National Park	Satang Besar Island
Number of Species	25	2
Shannon Index	2.8649	0.6365
t- test	11.047	
p-value	0.0030879	

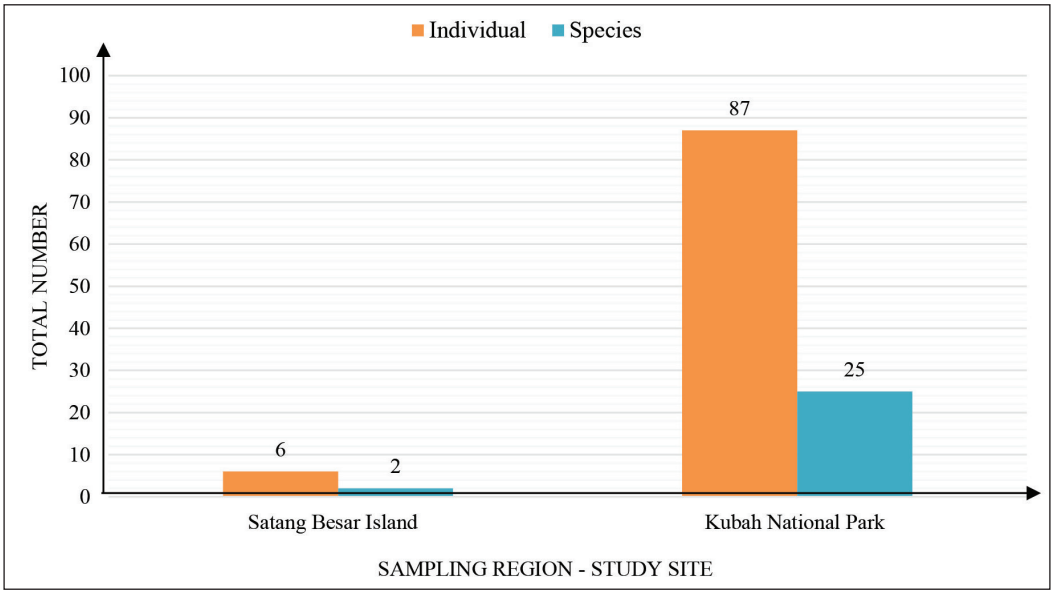

Figure 3: Total number of species and individuals of nymphalid butterflies collected in Satang Besar Island and Kubah National Park, Sarawak

Table 3: Number of species and individuals of nymphalid butterflies among subfamilies collected from Satang Besar Island and Kubah National Park, Sarawak

Subfamily	Satang Besar Island		Kubah National Park		Shared Species
	Number of Species	Number of Individuals	Number of Species	Number of Individuals	Number of Species
Charaxinae	0	0	2	2	0
Morphinae	1	2	5	15	1
Nymphalinae	0	0	8	49	0
Satyrinae	1	4	10	21	1
Total	**2**	**6**	**25**	**87**	**2**

Overall species richness in KNP was dominated by Satyrinae (10 species), followed by Nymphalinae (8 species), Morphinae (5 species) and Charaxinae (2 species). While in SBI, Morphinae and Satyrinae both listed one species (Table 3). In terms of abundance, Satyrinae was the most abundant subfamily in both habitats. The least nymphalid butterflies sampled in SBI was subfamily Morphinae and in KNP it was the Charaxinae. KNP was more diverse (H' = 2.8649) than SBI (H' = 0.6365) (p-value <0.05) (Table 2).

Discussion

Low diversity of frugivorous butterflies in SBI could be related to the dry condition and haze during the data collection. According to Hodkinson (2005), temperature employs an essential impact on species richness as it impacts ecological elements. This includes host plant quality, competition, predation, parasitism and abiotic elements such as net primary productivity (Rosenzweig, 1968). Temperature also has direct impact on butterfly species richness for example to their spatial arrangement along different altitudinal distributions (Wilson *et al.,* 2007; Chen *et al.,* 2009). Furthermore, humidity has been suggested to have an effect on the vegetation structure and therefore, it could influence the butterfly distribution along the elevation gradient (Brehm *et al.,* 2007; Axmacher *et al.,* 2009).

Due to the dry weather, the habitat quality was more or less affected. Butterflies are bioindicators of terrestrial habitat and environs quality, thus their established role in biological observance and conservation (Koh, 2007; McGeoch, 1998; Stork *et al.*, 2003). Butterfly communities would be sparse in areas with low temperature and food plant availability, especially those which rely on temperature and seasons (Nidup *et al.*, 2014). Butterflies often have close association with their specific larval host plants, also as their pollinating activities and thus butterflies can be strong indicators of the presence of explicit plant taxa (Sparrow *et al.,* 1994).

M. leda was sampled the most in SBI probably due to the presence of hostplant. Larsen (2005) stated that satyrine butterflies are often clearly appeared as "grass-feeding" including *M. leda* (Kalesh & Prakash, 2009; Kunte, 2012). This medium-sized butterfly is recorded throughout the tropics mostly in habitats ranging from dense wooded area to grassland (Larsen, 2005; Kunte, 2012). Data collected was generally similar with a previous study done by Catherine (2007) in SBI. Seven nymphalid butterflies were recorded in this study which were *A. phidippus* (5 individuals) and *M. leda* (2 individuals) (Catherine, 2007).

Data recorded in KNP has resulted to an average of eight individuals per day in KNP. Subfamily Nymphalinae was the most abundant with 56.98%. The most abundant subfamily, Nymphalinae (56.98%) attains various larval food plants, thus greater evenly disbursed throughout the strata (Schulze *et al*., 2001). Nymphalinae is also noted to be abundant in areas with increased light intensity (Hamer *et al*., 2003). According to Hill *et al.* (1999), many forest butterflies are sensitive to changes in moisture availability and humidity. This proves that the distribution of butterfly can also be affected by the modification in canopy cowl and light penetration especially on adult and larval survival. In contrast, Charaxinae was the least sampled (2.3%) probably due to being host-plant specific.

Conclusion

KNP showed more nymphalids species compared to SBI. This could be due to geographical distance and environmental dissimilarity that come from the inhospitable overwater dispersal barrier near the island. Subfamily Nymphalinae dominated the species abundance in KNP, with *B. dunya* and *T. aruna* among the abundant species. In contrast, *M. leda* was the most sampled nymphalid in SBI. The difference in terms of plant diversity could possibly be the nymphalids' host plant that could have also contributed to this finding. Longer sampling

period is recommended in the future to get a more extensive data.

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