

Diversity of bats at two contrasting elevations in a protected dipterocarp forest in Sarawak, Borneo

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ABSTRACT

We present an assessment of the diversity of Bornean bats at two contrasting elevations (119 m and 787 m) in Kubah National Park surveyed between August and December 2006. Three hundred and eighty-two individuals of bats from 26 species representing six families were recorded using 20 mist nets and three harp traps. The most commonly caught bat was *Hipposideros cervinus* (Gould, 1863) ($n = 168$) followed by *Penthetor lucasi* (Dobson, 1880) ($n = 55$), and they were also the most commonly detected species at low and high elevation sites, respectively. This survey yielded the first recorded specimen of *Pipistrellus cuprosus* Hill and Francis, 1984 for Sarawak. Analysis of daily cumulative capture rates indicated that further effort at these sites might not yield additional species if sampling techniques and locations were maintained. The species diversity index of Megachiroptera was higher at high elevations ($H' = 0.567$ versus $H' = 0.466$), whereas the species diversity index of Microchiroptera was greatest at low elevations ($H' = 0.905$ vs $H' = 1.225$).

KEYWORDS: Borneo, Chiroptera, bat diversity, elevation.

INTRODUCTION

Bats play a major role in ecosystem processes including pollination, seed dispersal and forest insect regulation (Davidson and Zubaid 1992; Tan *et al.* 1998; Payne *et al.* 2005). The importance of bats in these processes is particularly significant in tropical rainforests where chiropteran richness and diversity is high. Malaysia is renowned for these attributes of its bat fauna, however they vary with location and forest type. For example, Francis (1990) recorded 44 chiropteran species including nine species of fruit bats and 35 microbats in a primary lowland dipterocarp forest at Pasoh Forest Reserve, peninsular Malaysia, while Hall *et al.* (2002) recorded 23 species of bats (six Megachiroptera, 17 Microchiroptera) in a primary mixed dipterocarp forest (lowland mixed dipterocarp forest and tall mixed dipterocarp forest) at Niah National Park, Sarawak, Borneo. Despite tropical rainforests supporting high levels of bat diversity (Corbett and Hill 1992; Payne *et al.* 2005), studies on Bornean diversity are lacking (Struebig *et al.* 2006) although such basic information is important and plays a vital role for species conservation management, especially of rare and cryptic species (Frey 2006). Regional degeneration, fragmentation and deforestation pose a major threat to bats in South-east Asia (Lane *et al.* 2006). In light of this, we report the findings of our survey of Kubah National Park in Sarawak, Borneo.

METHODS

Study area. Kubah National Park (Fig. 1) is situated 20 km from Kuching city and covers an area of 2742 ha. This protected area consists of mixed dipterocarp forest, riverine forest, montane forest and heath forest. Several longhouses around this National Park have caused intrusion into, and excision of, forest produce. The terrain throughout this Park is steep with high ridges. The emergent tree species in the Park are forest species of the genera *Shorea*, *Dryobalanops* and *Dipterocarpus*. Other dominant tree species include *Calophyllum* sp., *Cotylelobium malayanum* v. Slooten and *Litsea resinosa* Blume. Details on the vegetation composition have been described by Hazebroek and Abang Morshidi (2000). Bennet and Walsh (1988) only recorded 18 terrestrial mammal species, suggesting this Park has relatively low large mammal diversity compared to other protected areas in Sarawak (Mohd-Azlan *et al.* 2007). Sampling was concentrated at two elevations, 119 m and 787 m above sea level, for 14 non-consecutive days between August and December 2006. The lower elevation site consisted mostly of lowland dipterocarp forest with a mixture of primary and old secondary forest, while the higher elevation site was a mixture of primary hill dipterocarp forest and lower montane forest.

Sampling Methods. Each night, twenty mist nets and three two band-harp traps were set up at each elevation for



Fig. 1. Montane forest in Kubah National Park provides habitat for bats. Photograph by J. Mohd-Azlan.

12 hours, from 1830 hr until 0630 hr. Bats were captured by using 36 mm mesh mist nets measuring 9 m and 12 m in length. These nets were erected in the forest understorey (up to 1 m above the ground), across major trails, rivers and clearings in the forest and at the forest edge. Nets and traps were relocated to new sites every two to four days. Identification was based on Payne *et al.* (2005). Bats caught were identified and released immediately. To examine and compare species diversity, the H' values of the Shannon-Weiner Index (ranging from 1 for high species diversity to 0 for low species diversity) were calculated for both Megachiroptera and Microchiroptera at lower and higher elevation. We also used Zars T-test (Zars 1996) to test the difference in species abundance between high and low elevation.

RESULTS AND DISCUSSION

Twenty-six species, representing 28.0% of the 92 chiropteran species recorded in Borneo (Payne *et al.* 2005), were captured during our survey (Table 1). This included eight species of Megachiroptera (47.1% of Bornean species) and 18 species of Microchiroptera (24.0% of Bornean species) representing six families. The most commonly encountered bat at lower elevation was *Hipposideros cervinus* (Gould, 1863) ($n = 168$, or 63.8% of total capture), while *Penthetor lucasi* (Dobson, 1880) dominated captures at higher elevation ($n = 55$, or 45.1% of total capture). Most of the adult female *P. lucasi* captured were either pregnant or lactating. Significantly, our survey also obtained the first recorded capture of *Pipistrellus cuprosus* Hill and Francis, 1984 for Sarawak (Fig. 7).

The total number of Megachiroptera caught at the lower elevation was 57 ($H' = 0.466$), while at the higher elevation the total number captured was 107 ($H' = 0.567$). Whereas the total number of captures of Microchiroptera at the lower elevation was 203 ($H' = 1.225$), we only recorded 15 ($H' = 0.905$) at the higher elevation. The Zar's (1996) t-test on H' value of Shannon-Weiner Index had been calculated for both Megachiroptera and Microchiroptera at both the lower and the higher elevations, resulting in $\alpha_{0.025, 2} = 299 =$

2.44 ($t = -2.4409$, $df = 300$, $p < 0.025$) and showing that there are significantly less species present at higher elevations compared to lower elevations. However, due to the short sampling periods, and without involving replicates, our comparative results are limited, but they do provide baseline data for future studies.

In general, highland areas in tropical rainforests support relatively low chiropteran species diversity compared to lowland forests (Tuen *et al.* 2002). For example, Salleh *et al.* (1999) recorded only five species of bats from Kelabit Highlands, whereas Mohd-Azlan *et al.* (2003) recorded 11 species at Kayan Menterang National Park, East Kalimantan. In addition to this, the species accumulation curve (Fig. 2) reaches an asymptote after 10 nights suggesting that almost all of the understorey chiropteran species subject to these trapping methods in this area were recorded. However, the overall species diversity may not represent the bat fauna of the entire Kubah National Park due to the limited number of sampling methods, duration of the study, and types and structure of forest. These factors directly affect the number of species and individuals that are likely to be captured (Kingston *et al.* 2003). Further surveys targeting open spaces, forest edges and the canopy are likely to record species of other foraging guilds (Struebig *et al.* 2006). In view of this, rapid assessment of the bat fauna (especially the Microchiroptera) using conventional capture methods alone may not provide comprehensive information on the chiropteran diversity in tropical rainforests, thus underrepresentation of microchiropteran faunal diversity can be expected in the majority of environmental assessments in Malaysia.

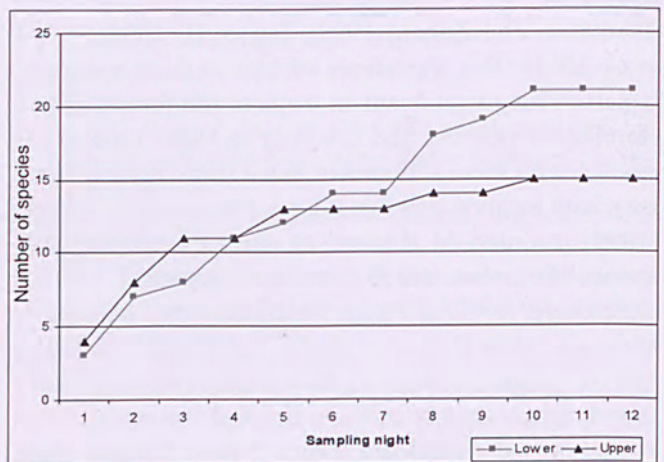


Fig. 2. Species accumulation curve of species richness against sampling night in Kubah National Park, Sarawak.

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Table 1. Number of individuals and relative abundance of bats captured at both elevations at Kubah National Park between August and December 2006.

No.	Species	Lower (n)	Relative abundance (%)	Upper (n)	Relative abundance (%)
Family Pteropodidae					
1.	<i>Cynopterus brachyotis</i> (Müller, 1838)	36	13.68	21	17.22
2.	<i>Megaerops ecaudatus</i> (Temnick, 1837) (Fig. 3)	1	0.38	20	16.40
3.	<i>Balionycteris maculata</i> (Thomas, 1893)	4	1.52	5	4.10
4.	<i>Penthetor lucasi</i> (Dobson, 1880)	13	4.94	55	45.10
5.	<i>Eonycteris spelaea</i> (Dobson, 1871)	2	0.76	0	0
6.	<i>Chironax melanocephalus</i> (Temnick, 1825) (Fig. 5)	1	0.38	0	0
7.	<i>Macroglossus minimus</i> (E. Geoffroy, 1810)	0	0	1	0.82
8.	<i>Cynopterus horsefieldi</i> Gray, 1843	0	0	5	4.10
Family Emballonuridae					
9.	<i>Emballonura alecto</i> (Eydoux and Gervais, 1836)	1	0.38	1	0.82
10.	<i>Emballonura monticola</i> Temnick, 1838	0	0	1	0.82
Family Nycteridae					
11.	<i>Nycteris tragata</i> (K. Andersen, 1912)	1	0.38	0	0
Family Rhinolophidae (Fig. 4)					
12.	<i>Rhinolophus borneensis</i> Peters, 1861	1	0.38	0	0
13.	<i>Rhinolophus arcuatus</i> Peters, 1871	0	0	1	0.82
14.	<i>Rhinolophus affinis</i> Horsfield, 1823	2	0.76	3	2.46
15.	<i>Rhinolophus sedulus</i> K. Andersen, 1905	2	0.76	2	1.64
Family Hipposideridae					
16.	<i>Hipposideros ater</i> Templeton, 1848	10	3.80	1	0.82
17.	<i>Hipposideros bicolor</i> (Temnick, 1834)	1	0.38	0	0
18.	<i>Hipposideros dyacorum</i> (Temnick, 1834)	1	0.38	0	0
19.	<i>Hipposideros ridleyi</i> Robinson and Kloss, 1911	6	2.28	0	0
20.	<i>Hipposideros cervinus</i> (Gould, 1863)	168	63.84	1	0.82
21.	<i>Hipposideros galeritus</i> Cantor, 1846	1	0.38	2	1.64
Family Vespertilionidae					
22.	<i>Myotis ridleyi</i> Thomas, 1898	1	0.38	0	0
23.	<i>Pipistrellus cuprosus</i> Hill and Francis, 1984 (Fig. 7)	0	0	3	2.46
24.	<i>Kerivoula papillosa</i> (Temnick, 1840) (Fig. 6)	3	1.14	0	0
25.	<i>Kerivoula hardwickii</i> (Horsfield, 1824)	4	1.52	0	0
26.	<i>Murina suilla</i> (Temnick, 1840)	1	0.38	0	0
Total records		260	100	122	100
Number of species		21		15	
Number of families		6		5	
Net / trap-hour		6624		6624	
Bats/ effort (Net/trap hour)		0.039		0.018	
S-W Index (Megachiroptera)		0.467		0.567	
S-W Index (Microchiroptera)		0.369		0.905	
Simpson (1-D) (Megachiroptera)		0.848		0.841	
Simpson (1-D) (Microchiroptera)		0.938		0.943	
Evenness (Megachiroptera)		0.528		0.399	
Evenness (Microchiroptera)		0.733		0.081	



Figs 3–7. Representatives of bats captured in Kubah National Park: 3, *Megaerops ecaudatus*; 4, *Rhinolophus* sp; 5, *Chironax melanocephalus*; 6, *Kerivoula papillosa*; 7, *Pipistrellus cuprosus*. Photos: 3, 4, J. Mohd-Azlan; 5, 6, 7, S. H. Taha.

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