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Short Communication

A report on bats survey at Air Panas-GuaMusang, Kelantan, Malaysia

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ABSTRACT. A short survey was conducted during the BanjaranTitiwangsa (Titiwangsa Range) expedition organised by the Department of Wildlife and National Parks to assess bat species diversity. The survey was conducted for seven trapping-nights from 29 May to 4 June 2007 at Air Panas, near Gua Musang division in Kelantan. A total of 112 individuals from 28 species of bats were captured using mist-nets and harp traps.*Cynopterus brachyotis* and *Hipposideros bicolor* were recorded as the most abundant species with 21.4 % of total captures for each. Lowest relative abundance was recorded in 12 species which were only represented by one individual for each species. An increasing trend of species cumulative curve suggested additional trapping effort could result in more bat species records in this remote area. A long term study focused at various localities along the Titiwangsa Range would greatly increase the discovery of bat species diversity.

Keywords: Air Panas, Gua Musang, bats, diversity, Kelantan, Titiwangsa Range

INTRODUCTION

BanjaranTitiwangsa (Titiwangsa Range) forms the backbone of a mountainous area located in the centre of Peninsular Malaysia. The range starts in the north of Peninsular Malaysia, or southern Thailand, running towards a southeast direction and ending in the south near Jelebu, Negeri Sembilan. Stretching about 500 km in length, the range is also the largest with eight continuous mountain ranges in Peninsular Malaysia (Soh *et al.,* 2006). The highest elevation for this range is recorded at Gunung Korbu (2,183 m). With an estimate area of 12, 000 km^2, the mountainous geography of this area acts as a natural divider, splitting Peninsular Malaysia into the east and west coast regions. Difficulty in accessing inner forests at these mountains is a major reason for limited floral and faunal surveys in Titiwangsa Range.

Most of the studies in Peninsular Malaysia have focused on either established field research stations, e.g. Krau Wildlife

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Reserve (Saharudin Anan *et al.*, 2000; Kingston *et al.*, 2006) or national parks and reserves, e.g. eight different reserves and parks (Siti Hawa *et al.*, 1986) including Bukit Kutu Wildlife Reserve (Lim *et al.*, 1999), Sungai Lalang and Bukit Kemandul Forest Reserves (Azmin & Lim, 1999). Such surveys and continuous inventories provide the basis for the recognition of biodiversity in Malaysia, e.g. new species of bats: *Rhinolophus convexus* (Csorba *et al.*, 1997), *Rhinolophus chiewkweeae* (Yoshiyuki & Lim, 2005), and *Kerivoula krauensis* (Francis *et al.*, 2007). There is an urgency to document and understand biodiversity through faunal surveys aimed at areas that have not previously been surveyed using a variety of techniques targeted at specific taxa (Anwarali *et al.*, 2008a). In view of this importance, we conducted a fauna survey primarily to inventory bat species diversity that occur at Air Panas, GuaMusang in the Titiwangsa Range. This study will serve as the baseline inventory for future monitoring and long-term changes, especially with current agricultural development around this area that has converted much of the forest.

MATERIALS AND METHODS

Study area

"Air Panas" or Hot Spring of Gua Musang (04°42.577' N, 101°34.082') is a local tourist attraction located about two hours from Gua Musang, Kelantan and one hour from Cameron Highlands (Figure 1). Air Panas is located on the northern part of the Titiwangsa Range, located along a river called Sungai Ber. The

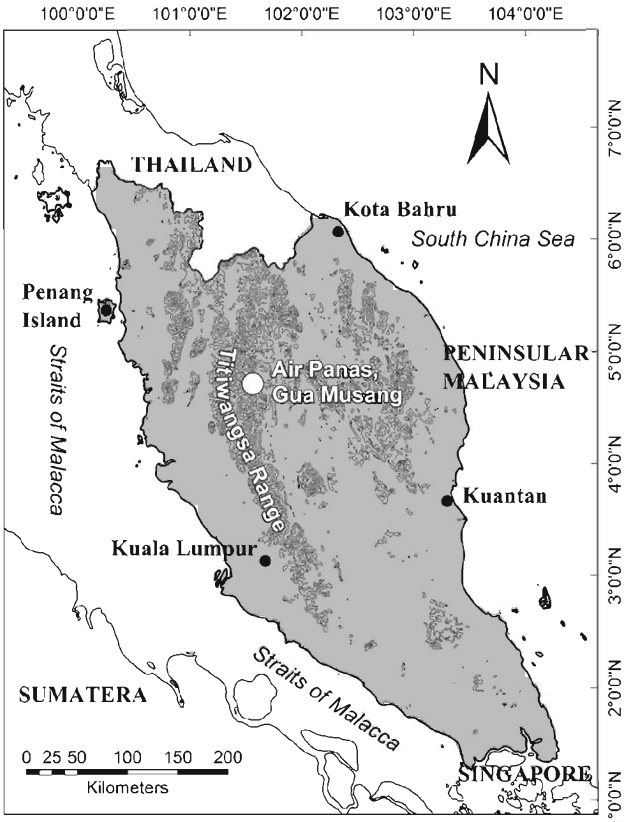

Figure 1. Study area Air Panas, in GuaMusang division of Kelantan, located on the northern part of the Titiwangsa Range (Produced using ArcGis 9.2).

surrounding area comprises of dipterocarp and hill forests which are believed to be less disturbed habitats. However, the nearby forest which is only a short distance away from Air Panas has been turned into agricultural land. This can be observed along the trip from Air Panas to Cameron Highlands.

Field methods

The survey was carried out using 10 standard mist-nets and three sets of four-bank harp traps for seven trapping nights. Nets and traps were set across streams, a hot spring, narrow pathways in the forest, trails, cleared areas in the forest and at the forest edge. Most of the nets and traps were set to capture bats that occupy the forest understorey (up to four meters from the ground). Both nets and traps were checked frequently from 1900 hrs to 2200 hrs, and finally at 0600 hrs in the morning.

Bat identification, samples processing and preservation

Bats were identified in the field following the identification key proposed by Payne *et al.* (1985). Juveniles were determined by the amount of diaphyseal fusion on the third, fourth and fifth metacarpals. After assigning species identification, three individuals per species were taken as voucher specimens. An additional three specimens were collected for species that exhibited substantial morphological variation suggesting more than a single species existed within the sampled population. Additional bats were released after measurements and were marked by ear notching technique for recapture data.

A standard morphological measurement of each bat was taken using a digital caliper (Mitutoyo) and weighed using the Pesola spring balance for future morphometric studies. Specimens were then prepared as museum voucher specimens, either as skin or skeleton or a fluid preserved form. Liver and muscle tissues were minced and preserved into a lysis buffer (Longmire *et al.*, 1997). Additionally, muscle tissues were also preserved in 95% alcohol. Blood samples were collected using Nobuto blood filter strips (Advantec Inc.). Ectoparasites found on the specimens were preserved in 70% ethanol. Skull and skeleton were soaked in 70% ethanol, subsequently basked until dry for further scull extraction process in the museum. Wet specimens were dissected exposing the stomach and intestine before being preserved in 95% alcohol as voucher specimens. Voucher specimens and duplicates of tissue samples were deposited at the UNIMAS Zoological Museum. Photographs of the selected bats were taken and kept for future reference.

RESULTS AND DISCUSSION

One hundred and twelve individuals from 28 species representing five of the Chiropteran families, Pteropodidae, Nycteridae, Rhinolophidae, Hipposideridae and Vespertilionidae, were recorded from the seven trapping nights (Table 1). The species cumulative curve for seven trapping nights showed an increasing pattern of species number accumulated throughout the trapping nights (not shown). This may indicate the possibility that more species are yet to be discovered from additional trapping nights.

Both *Cynopterus brachyotis* and *Hipposideros bicolor* recorded the highest relative abundance with 24 individuals each (21.4 %). This was followed by *H. cervinus* with 11 individuals (9.8 %) and *C. horsfieldi* with nine individuals (8.0 %). The least captured species with one individual (0.9 %) was recorded for 12 species: *Penthetor lucasi, Chironax melanocephalus, H. doriae, H. galeritus, Myotis muricola, Glischropus tylopus, Tylonycteris pachypus, Murina suilla, Kerivoula hardwickii, K. pellucida, K. minuta* and *Phoniscus atrox* (Table 1).

Table 1 shows the taxonomic list with mean measurements of external morphological measurements of bat species captured. Forearm length is used as the main species identification key, and other additional

Table 1. Taxonomic list of bats species, percentage relative abundance and mean measurements (maximum and minimum ranges) of selected chiropterans observed at Air Panas, Gua Musang.

Family Species	N	% total capture	Forearm (mm)	Tail length (mm)	Ear length (mm)	Weight (g)
Pteropodidae						
Cynopterus brachyotis	24	21.4	59.6 (53.6-64.4)	8.7 (7.0-11.7)	15.0 (13.6-16.8)	30.9 (20.0-57.0)
Cynopterus horsfieldii	9	8.0	70.3 (36.5-76.6)	12.3 (10.0-15.1)	19.0 (17.2-20.4)	55.8 (46.0-62.0)
Penthetor lucasi	1	0.9	62.0	10.0	15.0	29.0
Chironax melanocephalus	1	0.9	47.6	-	14.9	19.5
Eonycteris spelaea	2	1.8	58.5 (56.0-61.0)	17.5 (17.0-18.0)	13.5 (12.0-15.0)	30.5 (29.0-32.0)
Macroglossus minimus	2	1.8	na	na	na	na
Macroglossus sobrinus	5	4.5	44.7 (41.3-46.9)	-	13.6 (12.3-14.9)	19.2 (14.0-22.0)
Nycteridae						
Nycteris tragata	3	2.7	50.1 (50.0-50.3)	70.3 (68.0-72.0)	29.0 (26.0-30.8)	14.3 (14-15)
Rhinolophidae						
Rhinolophus affinis	2	1.8	45.2 (38.4-52.1)	na	na	14.0 (13.0-15.0)
Rhinolophus trifoliatus	3	2.7	49.8 (49.0-51.0)	30.0	26.0	13.0 (11-15)
Rhinolophus luctus	2	1.8	63.9 (62.9-65.0)	48.0	33.0	29.0 (27.0-31.0)
Rhinolophus stheno	4	3.6	46.2 (45.9-46.5)	na	na	11.5 (10.0-14.0)
Rhinolophus lepidus	2	1.8	42.8 (41.5-44.1)	na	na	6.5 (6.0-7.0)
Hipposideridae						
Hipposideros bicolor	24	21.4	46.1 (27.5-51.0)	na	na	10.1 (9.0-12.0)
Hipposideros doriae	1	0.9	36.9	na	na	6.0
Hipposideros cervinus	11	9.8	46.2 (27.5-51.0)	na	na	10.1 (9.0-12.0)

Hipposideros galeritus	1	0.9	46.6	na	na	8.0
Hipposideros larvatus	2	1.8	57.0 (56.6-57.5)	na	na	18.0 (16.0-21.0)
Hipposideros diadema	3	2.7	82.6 (77.7-88.5)	38.1 (27.9-49.7)	28.14 (26.7-29.4)	45.8 (32.0-51.5)
Vespertilionidae						
Myotis muricola	1	0.9	37.3	47.0	13.0	4.0
Glischropus tylopus	1	0.9	29.8	na	na	6.0
Tylonycteris pachypus	1	0.9	26.0	30.0	9.0	4.5
Murina suilla	1	0.9	44.4	na	na	3.0
Kerivoula hardwickii	1	0.9	35.1	na	na	4.0
Kerivoula pellucida	1	0.9	30.9	na	na	4.0
Kerivoula intermedia	2	1.8	38.4 (27.9-48.9)	na	na	2.0
Kerivoula minuta	1	0.9	28.6	35.8	8.8	3.0
Phoniscus atrox	1	0.9	34.2	na	na	5.0

* na – data not available

measurements were used to distinguish morphologically similar species. Genetic studies on the specimens are still in progress. Results from the genetic analyses will allow for better species delineation which may not be easily distinguished through morphological identification alone due to cryptic morphology (Anwarali *et al.*, 2008a).

The study successfully recorded 28 species of bats from five families at Air Panas, Gua Musang, Kelantan. Made up of lowland dipterocarp and hill forests, it appears that bat diversity within the area was relatively high compared to a similar study by Mohd-Azlan *et al.* (2000) on species diversity of the understorey bats at Air Hitam Forest Reserve, Selangor and the study by Mohd-Nor (2001) on small mammals at Tasik Meranti, Taman Negeri Perlis. Each study recorded 15 and four species, respectively. Zubaid (1993) captured 32 species of bats at Krau Wildlife Reserve, Pahang, whereas Anwarali *et al.* (2008a) only recorded 18 species of bats in the same reserve. Overall, the major technical differences observed between these studies are linked to trapping efforts (number of harp traps and mist nets used, duration of study), number of sites in a single locality (frequency of changing traps position), weather (rain or full moon) and forest type (e.g. disturbed or undisturbed).These factors may dictate the differences in species spectrum captured in the abovementioned studies which further suggest the importance of different forest vegetation as habitat for different bat species that evolve specific roosting ecology and foraging behaviour (Mohd-Azlan *et al.*, 2000).

There are seven species of bats recorded from the Pteropodidae family, with *Cynopterus brachyotis* having the highest species abundance. Most of these species were caught using mist-nets erected up to three meters from the ground at the forest edge. From a total of 24 individuals of *C. brachyotis*, 10 were recorded as larger sized (FA>60.0 mm) individuals and the remaining 14 individuals were recorded as being of small size (FA<60.0 mm) (Abdullah *et al.*, 2001). According to Abdullah *et al.* (2001), the large sized individuals were known to inhabit open areas and have adapted to powerful flight against predators such as owls whereas the small sized individuals have adapted themselves for flight between forested or dense habitats. Abdullah *et al.* (2001) also showed that the difference in size of *C. brachyotis* is reflected in high cytochrome-*b* genetic divergence that merit species level distinction.

As for the insectivorous bats, 21 species were recorded suggesting that the forest maintains high species richness and food abundance to accommodate a large community of mammals (Mackinnon *et al.*, 1996; Hazebroek & Abang Kashim, 2000). Murdoch *et al.* (1972) also stated that insect diversity is closely related to plant diversity in the forest. Hence, high species abundance of plants holds high insect diversity that supports the abundance of insectivorous bats in this forest. *Hipposideros bicolor* have the highest relative abundance of the insectivorous bats followed by the *H. cervinus*. This may be due to the availability of suitable roosting sites such as crevices on large boulders found in the study site for both of these species (Kingston *et al.*, 2006). Additionally, this is also primarily due to their foraging behaviour as they forage in a group in the forest understorey (Payne *et al.*, 1985), optimising their capture using harp traps (Mohd-Azlan *et al.*, 2000). The capture rate of insectivorous bats may be improved by increasing harp trap numbers in the study site (Laval & Fitch, 1977; Tidemann & Woodside, 1978; Francis, 1989; Mohd-Azlan *et al.*, 2000, 2005; Anwarali *et al.*, 2007).

CONCLUSION AND RECOMMENDATIONS

Our study provides a baseline for bat species for future monitoring within Air Panas-Gua Musang, Kelantan. This study suggests that additional trapping efforts will increase the number of species known from this area as the species cumulative curve is still increasing. A sampling initiative on various localities along the Titiwangsa Main Range would definitely enhance our understanding on bats species diversity along Titiwangsa Range. This should include sampling at the canopy and the sub-canopy levels to reduce biases. The sampling period should be lengthened and should include various sampling methods such as bat detector and line transect surveys (Anwarali *et al.*, 2008b) that could provide additional insights on other mammals in the area.

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