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Small Mammals from Kuala Atok, Taman Negara Pahang, Malaysia

(Mamalia Kecil dari Kuala Atok, Taman Negara, Pahang, Malaysia)

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ABSTRACT

A faunal survey aimed to document small mammals was conducted at Nature Study Centre of Kuala Atok, Taman Negara Pahang from 16th to 23rd May 2008. This survey was part of the Biodiversity Inventory Programme that was organised by the Department of Wildlife and National Parks (DWNP). On average, ten mist nets, two four-bank harp traps, 100 cage traps and 40 Sherman traps were set for six trapping nights. A total of 79 individuals from three orders, seven families and 23 species were caught in this study. Of the 23 species, three were frugivorous bats, 15 were insectivorous bats, four were rodents and one was treeshrew. Our sampling site was bounded by Pahang River and mainly covered with lowland secondary forest. This is evidence by the highest abundance of Long-tailed Giant Rat (Leopoldamys sabanus) *for non-volant small mammals, and Fawn Roundleaf Bat* (Hipposideros cervinus) *for volant small mammals that are adapted to disturbed habitat. The increasing species cumulative curve for Chiropteran indicates that there may be more species yet to be recorded from this study site compared to rodents and treeshrews. Preliminary analysis on the species similarity between our study site to other survey reports in Peninsular Malaysia, positioned Kuala Atok with Krau Wildlife Reserve and Bukit Fraser Forest Reserve that are located adjacent to our study site. This similarity further indicate the importance of future survey in Kuala Atok especially for Chiropterans to properly document the species diversity in this site that may be as rich as other well studied area e.g. Krau Wildlife Reserve.*

Keyword: Biodiversity; Chiroptera; inventory; rodentia; Scandentia

ABSTRAK

*Satu survei mamalia kecil telah dijalankan di Pusat Pendidikan Alam Semula jadi Kuala Atok, Taman Negara Pahang dari 16hb hingga 23hb Mei 2008. Survei ini adalah sebahagian daripada Program Inventori Biodiversiti yang dianjurkan oleh Jabatan Perlindungan Hidupan Liar dan Taman Negara (PERHILITAN). Sebanyak sepuluh jaring kabus, dua perangkap '4-bank harp trap', 100 perangkap tikus biasa dan 40 perangkap tikus Sherman telah digunakan sepanjang survei tersebut. Sebanyak 79 individu daripada tiga order, tujuh famili dan 23 spesies telah ditangkap sepanjang survei ini. Daripada 23 spesies, tiga spesies adalah daripada kelawar jenis pemakan buah, 15 spesies kelawar jenis pemakan serangga, empat spesies tikus dan satu spesies tupai. Kawasan cerapan kami adalah bersebelahan dengan Sungai Pahang dan diliputi oleh hutan sekunder tanah rendah. Kelimpahan yang tinggi Tikus Mondok Ekor Panjang (*Leopoldamys sabanus*) dan Kelawar Ladam Bulat Gua (*Hipposideros cervinus*), menunjukkan bahawa kawasan kajian ini merupakan kawasan hutan yang terganggu. Graf kumulatif spesies yang masih meningkat menunjukkan potensi penemuan banyak lagi spesies yang masih belum direkodkan di kawasan ini, terumatanya bagi spesies kelawar berbanding tikus dan tupai. Analisis peringkat awal bagi kesamaan spesies di Kuala Atok berbanding kawasan lain yang telah dijalankan kajian menunjukkan kesamaan spesies di antara kawasan Kuala Atok dengan Hutan Simpanan Hidupan Liar Krau dan Hutan Bukit Fraser. Kesamaan ini sekaligus menunjukkan kepentingan survei di kawasan Kuala Atok terutamanya bagi spesies kelawar kerana berpotensi untuk mempunyai kepelbagaian spesies yang setara dengan kawasan kajian lain yang terkenal seperti Hutan Simpanan Hidupan Liar Krau.*

Kata kunci: Biodiversiti; Chiroptera; inventori; rodentia; Scandentia

INTRODUCTION

Taman Negara Pahang is situated at the centre of Peninsular Malaysia and it covers three states, namely Pahang (2,477 km^2), Terengganu (853 km^2) and Kelantan (1,013 km^2), giving a total of approximately 4,343 km^2 (DWNP, 2000a). The highest peak in Taman Negara Pahang is Mount Tahan with 2,187 m above sea level (a.s.l.) and known to be the highest mountain in Peninsular Malaysia. It has wide range of habitats including lowland that consists of riverine vegetation as well as freshwater swamp, hill dipterocarp forest, lower montane forest and upper montane forest, heath forest and riparian forest. This national park supports large mammals which include elephants, Malayan tapir, gaur, tiger, and sun bear as well as small mammals such as bats, rodents, pangolin and tree shrews (Siti-Hawa et al. 1985). With the presence of such diverse fauna, the primary

function of Taman Negara Pahang is to protect these biological resources for scientific research, education, new discovery and ultimately for the future generations (DWNP 2000b; Siti-Hawa et al. 1985).

Previous study in Taman Negara by Siti Hawa et al. (1985) documented 42 species of mammals. Of these, 14 species were non-volant and five species were volant small mammals. Siti-Hawa et al. (1985) covered four sites in Taman Negara Pahang which include Kuala Atok, Kuala Tahan, Kuala Terenggan and Sungai Gagau. Later, Lim et al. (1989) conducted faunal survey in Taman Negara Pahang and documented 67 species of mammals. Recent small mammals survey at Krau Wildlife Reserve (Krau WR), an adjacent locality from Taman Negara Pahang was recorded with 51 species of bats or about 47.5% of total bats known from Peninsular Malaysia. This site was listed with the highest bat species diversity found in a single site in the world along with sites in South America (Kingston et al. 2006). This further indicates that Krau WR and its surrounding area is a suitable habitat, that able to provide a variety of food resources as well as roosting sites for different species of small mammals.

Given the close proximity of our study site to Krau WR, we found the importance in documenting the small mammals from Kuala Atok. The objectives of current study were to document and inventory the small mammals in Kuala Atok, Taman Negara Pahang.

Materials and Methods Study Sites

Kuala Atok (N 04° 16.281' E 102°22.316') is situated at the lowest aspect of Taman Negara Pahang of approximately 75 m a.s.l (Figure 1). It is mainly covered with primary lowland dipterocarp forest. This Nature Study Centre was designed for conservation education programme to nurture school children concerning the importance of biodiversity and the ways to conserve them.

Field Methods

A sampling survey of small mammals was conducted from 16th until 23rd May 2008. There were 10 mist nets, two four-bank harp traps, 100 cage traps and 40 Sherman traps set throughout the sampling period. Mist nets were

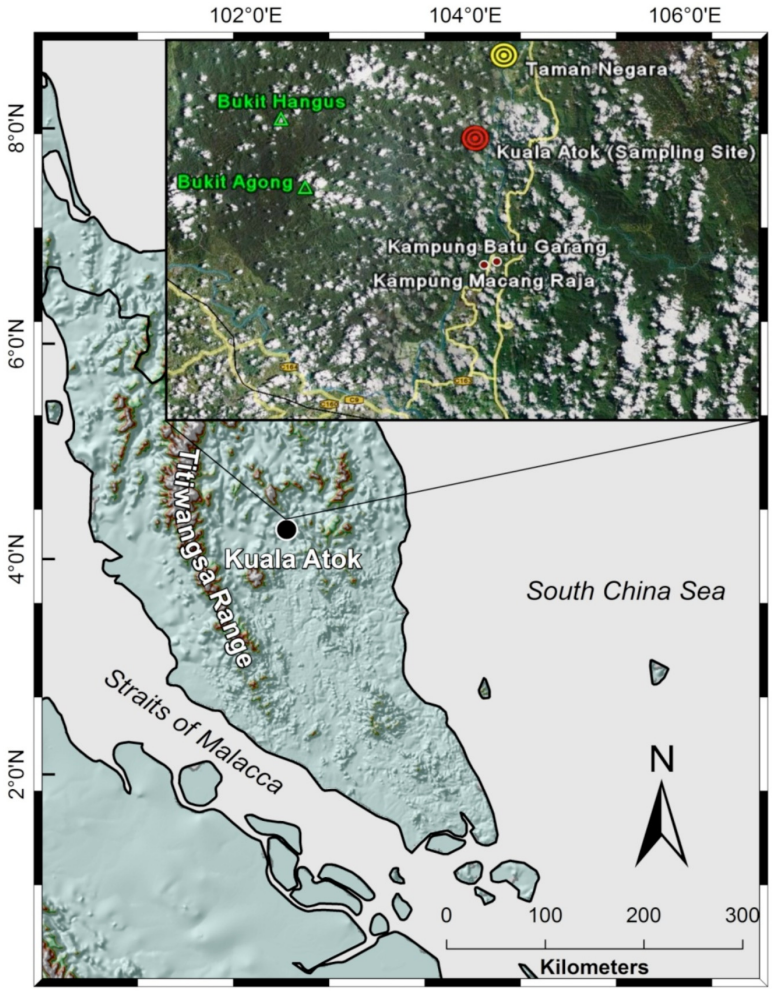

FIGURE 1. Study area of Kuala Atok, located South to Taman Negara, Pahang. (A larger map was produced using ArcGis 9.2 and locality map was produced using Google Earth)

deployed across small cliffs and along the forest trail whereas harp traps were fixed between two trees with narrow pathways. Nets and harp traps were checked for every two hours from 1830 until 2400 hours. Cage traps and Sherman traps were set about every 5 m of distance along forest transect. These traps were checked twice and rebaited if necessary. The first checking was done in the morning around 0630 hours and the next one was done around 1830 hours in the evening. Banana and oatmeal-peanut butter mixture were used as baits in the cage traps and Sherman traps respectively.

The species were identified following Payne and Francis et al. (1985), Francis (2008) and Kingston et al. (2006). For each individual, standard external measurements were recorded. Samples were then prepared as museum voucher specimens either as skin, skull and skeletal or as fluid wet specimen. Muscle and liver tissue were preserved in lysis buffer and 95% ethanol whereas blood was collected using Nobuto blood filter strips. Specimens were deposited in Universiti Malaysia Sarawak Zoological Museum.

Statistical Analyses

Species cumulative curve were plot for volant (Chiroptera) and non-volant (Rodentia and Scandentia) mall mammals. Relative abundance was calculated based on the ratio of total number of individual of the calculated species to the overall total number of individuals collected. This ratio was calculated separately for volant and non-volant small mammals.

In this study, we generated phenogram for comparison on species richness of small mammals (bats, rodents, shrews and treeshrews) documented at six different sites in Peninsular Malaysia. The comparisons for the cluster analysis was constructed on the absence and presence matrix of species documented in all the locality. The selected sites includes Krau WR, Pahang (Anan et al. 2000), Bukit Kutu WR, Selangor (Lim et al. 1999), Gua Musang, Kelantan (Shariff et al. 1991), Bukit Fraser Forest Reserve (FR), Pahang (Mohd-Ridwan et al. 2008), Royal Belum WR, Perak (Nur-Aida et al. 2008), and Endau Kluang WR, Johor (Hanif-Ridzuan et al. 2010) to our study site (Table 1). These sites were selected mainly because most of these surveys were conducted by our team (Hanif-Ridzuan et al. 2010; Mohd-Ridwan et al. 2008; Nur-Aida et al. 2008) that used similar trapping effort. The rest were chose based on the availability and relevant of data (e.g. habitat type, trapping effort) to our study site

Results

A total of 72 individuals from Order Chiroptera, Rodentia and Scandentia were caught during the sampling period.

TABLE 1. Comparisons between Kuala Atok and other sites in Peninsular Malaysia. T= trapping, O= observation, MN=mist-net, HT=harp trap, CG=cage trap, ST=dherman trap, na=fata not available, ** excluding the unidentified species

	Present study Kuala Atok (Pahang)	Gua Musang (Kelantan)	Bukit Kutu WR (Selangor)	Krau WR (Pahang)	Bukit Fraser FR (Pahang)	Royal Belum FR (Perak)	Endau Kluang WR (Johor)
Methodology	T	T	T, O	T	T	T	T
Total traps	10MN, 2HT, 100CG, 40ST	100CG, MN (na)	13MN, 200CG	na	10MN, 3HT, 100CG	10MN, 3HT, 150CG,	10MN, 3HT, 100CG
Sampling site	Kuala Atok	Near Deer Breeding Farm of Gua Musang	Bukit Kutu	Sungai Chenderoh	Pine tree trail	Sungai Kejar	Surrounding water fall of Endau Kluang
Habitat/type of vegetation	Lowland secondary forest, riverine forest	Secondary logged forest, plantation, abandon gold mines, caves	Primary lowland and hill dipterocarp forest	Lowland dipterocarp forest	Highland dipterocarp forest	Riverine mixed dipterocarp forest	Lowland secondary forest
Sampling period (nights)	6	15	21	5	3	5	5
Total species**	23	25	71	24	17	14	12
Total individuals**	79	102	na	160	40	25	59

TABLE 2. Taxonomic list of bats species, percentage of relative abundance and mean measurements (maximum and minimum ranges) were taken in millimeters (mm), body mass in grams (g). N=total individuals, FA=forearm, E=ear, HF=hind foot, farger=tail ventral length, Tr=tragus, ATr=anti-tragus, TL=total length, Wt=weight, RA=relative abundance

FAMILY		Measurements							
Species	N	FA	E	HF	TVL	Tr/ATr	TL	Wt	RA
PTEROPODIDAE									
Cynopterus brachyotis	5	62.91 (61.01-66)	10.30 (14.69-18)	12.57 (10.21-14.05)	11.25 (10-12.31)		91.06 (81.96-100)	27 (22-23)	7.58
Cynopterus horsfieldii	2	73.94 (73-74.87)	20.54 (20-21.08)	15.34 (15-15.67)	12.3 (10.6-14)		112.88 (112.75-113)	53.5 (50-57)	3.03
Balionycteris maculata	1	41.71	10.48	7.14	-		58.04	13	1.52
RHINOLOPHIDAE									
Rhinolophus affinis	7	53.09 (50.39-57)	20.20 (17-22)	9.55 (8-11)	21.32 (20-29)	10	85.76 (80-88.99)	13.33 (12-15)	10.61
Rhinolophus lepidus	4	40.22 (39.75-41)	15.97 (14.81-17)	6.81 (6-7.67)	22.40 (21-23.88)	9	67.72 (64-73.19)	6 (5-7)	6.06
Rhinolophus sedulus	1	40.76	20.61	10.04	23.63		72.05	8	1.51
Rhinolophus trifoliatus	7	51.17 (47-57)	25.26 (21.82-28)	10.56 (8-13)	33.79 (25.5-38)	12.5 (12-13)	95.83 (81.78-100)	12.86 (11-16)	10.61
HIPPOSIDERIDAE									
Hipposideros bicolor	5	44.15 (40.49-49)	17.92 (16.23-19)	7.15 (5.84-9)	30.03 (24.76-33)		80.66 (71.72-86)	7.5 (6-8.5)	7.58
Hipposideros cervinus	9	49.16 (46.2-51.03)	14.53 (13-16.2)	6.82 (5.7-8.67)	25.66 (21.42-27.42)		78.98 (69.68-81.95)	8.67 (8-10)	13.64
Hipposideros galeritus	1	47	15	7	37		87	6.5	1.52
Hipposideros larvatus	4	58.18 (55.85-59.95)	20.47 (19.95-21.43)	8.75 (7.58-9.31)	32.57 (27.84-34.55)		97.82 (93.81-101.14)	16 (12-18)	6.06
Hipposideros ridleyi	7	49.38 (47.85-50.67)	25.55 (23.84-26)	16.99 (6.24-9.03)	30.53 (29.13-34.54)		82.3 (68.81-89.51)	8.5 (7-10)	10.61
NYCTERIDAE									
Nycteris tragata	1	54	30	10	72		137	16	1.52
VESPERTILIONIDAE									
Murininae									
Murina cyclotis	2	36.82 (36.63-37)	14.05 (13-15.1)	7.36 (6.71-8)	38.31 (37-39.61)	9	92.31 (88.61-96)	7.25 (6-8.5)	3.03

cont.

Table 2 (cont.)

Murina suilla	2	28 (26-30)	11 (10-12)	6	28 (27-29)	7 (6-8)	67 (66-68)	3.25 (3-3.5)	3.03
Kerivoulinae									
Kerivoula minuta	4	27.12 (26-28)	9.96 (9.85-10)	5.43 (4.72-6)	36.48 (33.93-40)	7.67 (7-8)	70.34 (68.34-74)	2.63 (2-3)	6.06
Kerivoula papillosa	1	28	10	5	40	8	74	3	1.52
Kerivoula pellucida	3	30.67 (30-31)	16.33 (15-17)	6.33 (6-7)	46.67 (45-49)		88.67 (88-90)	4.33 (4-5)	4.55
Total Family	5								
Total Species	18								
Total Individuals	66								

TABLE 3. Taxonomic list of Rodentia and Scadentia, percentage of relative abundance and mean measurements (maximum and minimum ranges) were taken in millimeters (mm), body mass in grams (g). N=total number of individuals, E=ears, HF=hindfoot TVL=tail length, TL=total length, Wt=weight and RA=relative abundance

ORDER: FAMILY		Measurements					
Species	N	E	HF	TVL	TL	Wt (g)	RA
Rodentia: Muridae							
Leopoldamys sabanus	6	27.53 (26-28.17)	43.58 (38-49.46)	374.17 (350-400)	610.5 (586-655)	338.33 (250-425)	46.15
Maxomys rajah	3	22.23 (20.87-23.25)	35.7 (34.11-38)	167 (154-175)	335.33 (315-365)	115 (90-130)	23.08
Maxomys surifer	2	22	42	189	367	160	15.38
Maxomys white headi	1	18	27	150	218	40.5	7.69
Scandentia: Tupaiidae							
Tupaia glis	1	18.89	42	129	339	230	7.69
Total Family	2						
Total Species	5						
Total Individuals	13						

From the six nights of trapping, 23 species of small mammals were recorded. These were three frugivorous bats, 15 insectivorous bats, four rats and a treeshrew (Tables 2 and 3). The frugivorous bats were *Cynopterus brachyotis*, *C. horsfieldii* and *Balionycteris maculata* from the family Pteropodidae, whereas the insectivorous bats were from the family Hipposideridae Megadermatidae, Nycteridae, Rhinolophidae, and Vespertilionidae (Subfamily: Murininae and Kerivoulinae). As for the rodents, all rats were from the family Muridae and a single treeshrew from the family Tupaiidae were captured.

Species Abundance and Similarity

The most abundant species (Tables 2 and 3) for volant small mammals is *H. cervinus* with nine individuals (13.64%) whereas for non-volant mammals is *Leopoldamys sabanus* with six individuals (46.15%). After six days of sampling, the total volant small mammals caught has yet to reach assymptote as there were still additional species added to the list on the last night compared to the total number of non-volant small mammals that has reached asymptote condition on the last two nights (Figure 2).

The comparisons of six different sites in cluster analysis resulted in three major grouping (Figure 3). Kuala Atok clustered together with Krau WR followed by Bukit Fraser FR. A cluster consists of Bukit Kutu WR and Gua Musang were are the second cluster closely grouped with Kuala Atok. Finally, a cluster consists of Royal Belum FR and Endau Kluang WR is the most distantly group cluster to the Kuala Atok site.

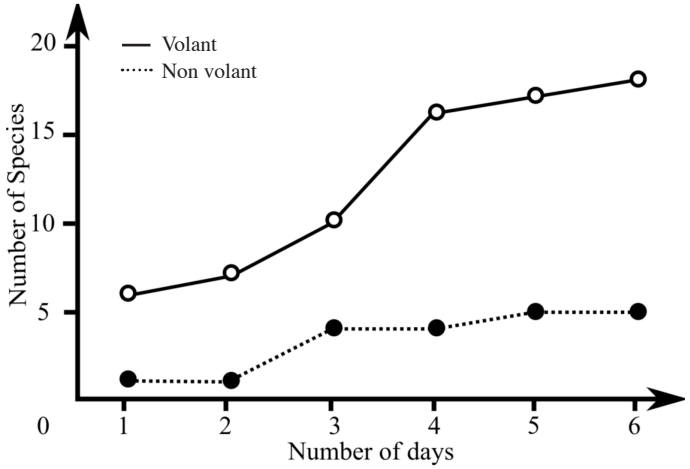

FIGURE 2. Species cumullative curve for volant and non-volant small mammals for six trapping nights

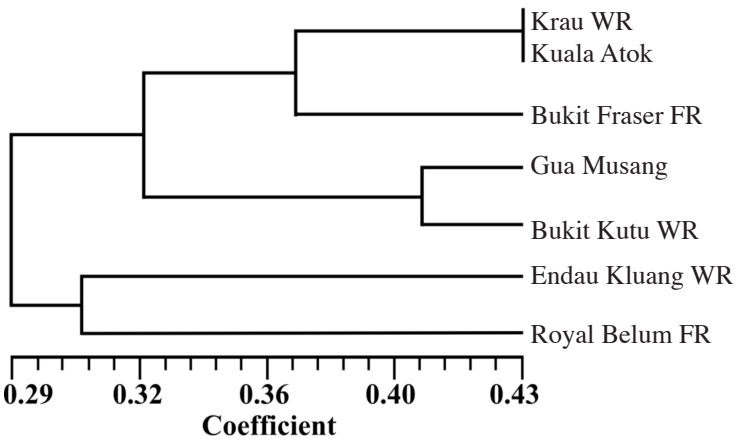

FIGURE 3. Phenogram of the comparison between Kuala Atok with other small mammals survey records (bats, rodents, shrews and treeshrews) in Peninsular Malaysia based on the species record only from each sites

Discussions

More insectivorous bats than frugivorous bats were captured in the present study (83.5% of the total bat captured). This is not only reflected in the number of species for that feeding guild but also in the number of individuals per species with this feeding guild (insectivorous). This can be mainly a result of insectivorous bats behavior that forage understorey in a lowland forest, and some of these bats is known to forage in groups (e.g. *Hipposideros cervinus*, Payne & Francis et al. 1985). Species from the family Hipposideridae, Rhinolophidae, and Vespertilionidae (Kerivoulinae and Murininae) that were caught in this study were the most common insectivorous families in the forest interior with high maneuverability in flight and good echolocators that allow them to efficiently avoid mist nets (Francis 1989). These insect bats are important for the balance of the ecosystem. Each night, these large colonies of insect bats is believed to consume of over 2000 tonnes of insects per year (Kingston et al. 2003). This natural biological control process provides free service mainly to the agricultural industry by reducing costly pesticides use that may also damage the crops (Cleveland et al. 2006). In Niah Cave, Sarawak, it was estimated 7, 500 kg of insects were consumed by these bats every day (MacKinnon et al. 1996). Nevertheless, these forest interior insectivorous bats are very susceptible towards the effects of changes in habitat (Kingston et al. 2003), such as forest loss or fragmentation that would likely reduce the population size of these species (Meijaard et al. 2005).

Based on the similarity dendrogram, it is possible to hypothesise that species richness in Kuala Atok is most similar to those in Krau WR which is followed by Bukit Fraser FR. Krau WR is known to support the highest diversity of insectivorous bats with more than 50 insectivorous bat species from a single site (Kington et al. 2003) and the insect bats caught from Kuala Atok has 29.4% similarity to the total insect bats of Krau WR. The similarity in species richness among Kuala Atok, Krau WR and Bukit Fraser FR can also be explained due to the close proximity of these sites to each other in Pahang. This also showed that species richness for lowland dipterocarp (Kuala Atok and Krau WR) was almost similar to highland dipterocarp (Bukit Fraser). Endau Kluang WR and Royal Belum FR were found to have high similarity of species caught especially from the Family Hipposideridae.

Species Account

Species account were compiled for all the specimens collected from Kuala Atok. For each family we reviewed the natural history and their species designations presented herein based on our field identifications. The taxonomic arrangement herein followed Simmons (2005) for Chiroptera, Carleton and Musser (2005) for Rodentia and Helgen (2005) for Scandentia. We included the total number of specimens examined, key diagnostics feature that separates them from their congeners, the habitat where there were captured and their conservation status.

Order: Chiroptera

family: pteropodidae

Three species of fruit bats were documented (12.1% of total bats captured) which were *C. brachyotis* (n=5), *C. horsfieldii* (n=2) and *B. maculata* (n=1). *Cynopterus brachyotis* can be separated from *C. horsfieldii* in the basis of their forearm size in which *C. horsefieldii* is larger than the former, whereas *B. maculata* can be easily identified based on the white to pinkish spotted wing morphology that is unique compared to other pteropodids. Recent molecular identification suggest that *B. maculata* from Borneo is genetically diverged from those in Peninsular Malaysia (*B. maculata seimundi*), whereas currently recognized *C. brachyotis* may include at least two dfferent species that is distributed both in Peninsular Malaysia and Borneo (Anwarali et al. 2008).

All the fruit bats were captured using mist-net along the Pahang river, around the open area in front of our camping site that have 3-4 fig trees. None of the fruit bats were netted in the forest. Our transect observations corroborate with this finding as no fruiting tree were found during our survey along our forest trails where we set out mist-nets and harp traps. The absence of the common nectar bats such as *Macroglossus* and *Eonycteris* further indicate that the study site may have low flowering and fruiting trees during our sampling period. In other studies that had been done in Peninsular Malaysia (Nur-Juliani et al. 2011), both *C. brachyotis* and *C. horsfieldii* were also commonly caught in secondary forest surrounded by secondary vegetation at upper stream of sungai Bayor, Perak. As stated by Medway (1983) these bats can be found commonly in oil palm plantations, orchards and also opens areas. Fruit and nectar bats play an essential role in pollination and seed dispersal (Mickleburgh et al. 1992). Such interaction between bats and plants are indeed a fundamental element of all tropical ecosystems (Neuweiler 2000). Compared to previous records (Lim et al. 1989; Siti Hawa et al. 1985), only three species out of eight fruit bat species were successfully caught in the present study. Other possible reason that could have cause to low capture of fruit bat is too many of human disturbance mainly, tourism at present. Conservation status for *C. brachyotis*, *C. horsfieldii* and *B. maculata* were listed as least concern (IUCN 2010).

family: rhinolophidae

A total of 19 specimens or 28.8% of total bat captured were trapped from four species of *Rhinolophus*. These includes *R. affinis* (n=7), *R. lepidus* (n=4), *R. sedulus* (n=1) and *R. trifoliatus* (n=7). *Rhinolophus affinis* can be distinguished from other species within *megaphyllus* species group by the broadly rounded connecting process, as well as the tall and triangular noseleaf with a straight-sided lancet (Csorba et al. 2003). *Rhinolophus lepidus* from the *pusillus* species group is the smallest *Rhinolophus* species found in Peninsular Malaysia (Forearm, FA=40-41 mm) with the

tip of triangular shaped connecting process that is broadly rounded off (Csorba et al. 2003). *Rhinolophus lepidus* has two forms of colour phases which are dark blackish-grey and reddish-brown. Specimens from Kuala Atok are reddish-brown. According to Francis (2008), populations in Thailand and Malaysia may appear to be a separate species, *R. refulgens*. *Rhinolophus sedulus* has a dark coloured trilobated sella with the smallest forearm length (40-44 mm) within the *trifoliatus* species group, whereas *R. trifoliatus* within the same species group can be easily identified based on the unique yellowish noseleaf colour (Csorba et al. 2003).

All specimens were trapped under forest canopy using harp trap. In Peninsular Malaysia, 12 species of *Rhinolophus* were recorded from total of 15 species known from Malaysia (Corbet & Hill 1992; Hutson et al. 2001; Khan 1992; Payne et al. 1985 & Simmons 2005). *Rhinolophus* species were found to roost in hollow trees, caves, buildings, foliage including rock crevices and forest canopy (Csorba et al. 2003; Francis 2008). Both *R. trifoliatus* and *R. sedulus* are near threatened due to loss of forest (Francis 2008). Conservation status for *R. affinis*, *R. lepidus* and *R. trifoliatus* was listed as least concern whereas for *R. sedulus* was listed as near threatened (IUCN 2010).

FAMILY: HIPPOSIDERIDAE

There were five species and a total of 26 *Hipposideros* specimens or 39.4% of total bat capture were caught in this study using harp traps. These includes *H. bicolor* (n=5), *H. cervinus* (n=9), *H. galeritus* (n=1), *H. larvatus* (n=4), and *H. ridleyi* (n=7). *Hipposideros bicolor*, *H. cervinus*, *H. galeritus* and *H. ridleyi* belong to the *bicolor* species group. *Hipposideros bicolor* can be identified base on simple noseleaf, lacking leaflets, and a straight internarial septum. Recent taxonomic assesment suggest that this species consist of two cryptic species that can be identified based on echolocation calls (131 vs. 142 kHz) and genetics (Anwarali et al. 2008; Kingston et al. 2001). Those that echolocate at 142 kHz has been now recognised as *H. atrox* (Douangboubpha et al. 2010). Three of our specimen appear to be genetically similar to those with *H. atrox* (Anwarali pers. comm.) and we include them in *H. bicolor* until further morphological assessment being done.

Hipposideros cervinus can be easily distinguished from other species based on forearm size and two lateral leaflets except to *H. galeritus*. Both of these can be separated in the field base on their tail length (> 30 mm in *H. galeritus*; < 30 mm in *H. cervinus*) and a broader median than posterior noseleaf; whereas broader posterior noseleaf exists in *H. cervinus* (Francis 2008). *Hipposideros cervinus* set the highest capture record in Kuala Atok. *Hipposideros ridleyi* can be identified based on disc shaped structure on the nostril. Although *H. ridleyi* were listed to be extinct in Singapore (type locality), it is abundant throughout Peninsular Malaysia and Borneo (Anwarali et al. 2008). *Hipposideros larvatus* from the *larvatus* species group can be distinguished from other species based on the three lateral leaflets and forearm size. This species were caught in their roost inside Gua Telinga (Telinga Cave), Kuala Atok. Although only four specimens were collected for this species, a large colony of them were found roosting inside Gua Telinga. Conservation status for *H. bicolor*, *H. cervinus*, *H. galeritus*, and *H. larvatus* were listed as least concern whereas for *H. ridleyi* is listed as vulnerable (IUCN 2010).

FAMILY: NYCTERIDAE

A single specimen of *N. tragata* or 1.5% of total bat capture, was caught in this study using a harp trap under the forest canopy. *Nycteris* can be distinguished from *Megaderma* base on tail length and ears that are not joined at the base; and a slit that present in the middle of rostrum. *Nycteris tragata* occur throughout South Myanmar, Thailand, Peninsular Malaysia, Sumatra and Borneo (Francis 2008). The other congeners, *N. javanica* that was previously reported to occur in Borneo (Chasen 1940) has been revised. *N. javanica* is now known to be restricted to Java (van Cakenberghe & de Vree 1993; Kock & Dobat 2000). This is further supported in the low genetic divergence (<2%) between *Nycteris* species from Borneo and Peninsular Malaysia, indicating both of them are conspecifics (Anwarali et al. 2008). Conservation status of *N. tragata* was listed as near threatened (IUCN 2010).

FAMILY: VESPERTILIONIDAE

Specimens from two subfamilies of Vespertilionids (Kerivoulinae and Murininae) were captured. Two species of *Murina*: *M. cyclotis* (n=2), and *M. suilla* (n=2); and three species of *Kerivoula*: *K. minuta*, (n=4), *K. papillosa* (n=1), and *K. pellucida* (n=3) or 18.2% of total bat capture were caught using harp traps set across forest trail. *Murina cyclotis* can be distinguished from other species based on their size, with *M. cyclotis* being the largest and *M. suilla* being the smallest *Murina* in Peninsular Malaysia (*M. aenea*, *M. huttoni*, *M. rozendaali* and *M. suilla*). *Murina* is among the rare species of vespertilionids but has been recorded throughout Southeast Asia (Medway 1983). Based on a genetic analysis, Francis (2008) reported that *M. cyclotis* from Peninsular Malaysia (*M. c. Peninsularis*, FA=34-41 mm) may represent a separate species from the other forms found in Southeast Asia (FA=29-34 mm). Further studies are required to interpret these genetic variations. Conservation status of *M. cyclotis* and *M. suilla* were listed as least concern. It is hard to distinguish *K. minuta* from their larger counterpart *K. intermedia*, as the only discriminating character is their size that overlaps (FA=26-31 mm for *K. intermedia*, FA=25-29 mm for *K. minuta*, Anwarali et al. 2010). Genetic data is critical to discriminate this species as both of these occur in symptary. Comparison with a newly describe species, *K. krauensis* from Krau WR showed that *K. krauensis* has a conspicuous

dark band on the dorsal fur, for almost 90% of its length with golden-bronze tips (Francis et al. 2007). None of our specimens have these characteristics. *Kerivoula pellucida* can be distinguished easily from the rest of the congeners by having an orange to pinkish facial colouration and a unique translucent wing membrane. *Kerivoula papillosa* is the largest *Kerivoula* in Peninsular Malaysia (FA>38 mm). They were reported to occur in sympatry with recently recognised species, *K. lenis* (FA= mm), that used to be included as a subspecies of *K. papillosa* (Anwarali et al. 2010). A much larger *Kerivoula* that is genetically different from *K. papillosa* has been reported from Borneo, but yet to be found in the Southeast Asian Mainland (Anwarali et al. 2010). Due to the ambiguities in field identification within *Kerivoula*, all of the specimens from Kuala Atok has been genetically and morphologically identified in Anwarali et al. (2010). Conservation status of *K. minuta* and *K. pellucida* were listed as near threatened, whereas for *K. papillosa* was listed as least concern (IUCN 2010).

ORDER: RODENTIA

FAMILY: MURIDAE

A total of 12 specimens from one species of *Leopoldamys*: *Leopoldamys sabanus* (n=6), and three species of *Maxomys*: *M. rajah* (n=3), *M. surifer* (n=2), *M. whiteheadi* (n=1) were collected using cage traps and Sherman traps. Specimens of *L. sabanus* have a large body size with a long tail that typically 135% longer than their head to body size (HB=200-275 mm). *Leopoldamys sabanus* are the most abundant non-volant small mammals at Kuala Atok. This large bodied and long tailed arboreal rat was mainly collected in tall and secondary forest (Francis 2008). This further supports that habitat at Kuala Atok where these specimens were collected is a secondary forest.

Maxomys can be identified based on the bicoloured tail (T), and similar size to head and body length. *Maxomys rajah* (HB=165-225 mm, T=160-210 mm) can be differentiated from *M. surifer* (HB=160-210 mm, T=155-210 mm) with the later having brighter reddish coloration but no streak on underparts, orange colar under neck and orange band around leg (Francis 2008). Both of these species have been reported to rarely occur together in the same locations (Francis 2008). Given that there were a substantial overlaps in size between both of these species, genetic and cranial analysis between these specimens would accurately identify the specimens. *Maxomys whiteheadi* is smaller (HB=105-150 mm, T= 90-125 mm) and spiny, than either *M. rajah* or *M. surifer* (Francis 2008). This species can be distinguished based on reddish-brown to dark brown upperparts and grey to orange-grey underparts (Francis 2008). All the *Maxomys* species collected in this trip is known to occur in both primary and secondary forest. Conservation status of *M. rajah* and *M. whiteheadi* were listed as near threatened, whereas *L. sabanus* and *M. surifer* were listed as least concern (IUCN 2010).

ORDER: SCANDENTIA

FAMILY: TUPAIIDAE

A single specimen of the common treeshrew, *Tupaia glis* was collected in a cage trap. This large sized *Tupaia* (HB=135-205 mm, T=125-195 mm) has a dark and pale banded upperparts that appears speckled with a strong reddish tint (Francis 2008). This species is widely distributed throughout Southeast Asia. Conservation status of *T. glis* was listed as least concern (IUCN 2010).

CONCLUSIONS

The small number of individuals and low number of species caught among the rodents and treeshrew may indicate that our sampling site are less abundance with this terrestrial small mammals. This may be due to the lack of food resources and possible flooding near the river bank area that have forced them to move further inside the forest. In contrast, the study site seems to support high diversity of bats especially the insectivorous bats and our species cumulative graph indicate that there are possibilities that many species of bats is yet to be discovered in this area. This study also recorded two rare species of bat, from the genus *Murina* that typically are found in cluttered forest, indicating this area is best to be conserved. Although Kuala Atok has been logged in the past, our data indicate that the forest in Kuala Atok provide a suitable habitat for many different species of bats and any future planning around Kuala Atok should consider the conservation implication on these fauna.

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