



Species diversity of small mammals at Gunung Stong State Park, Kelantan, Malaysia

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See end of this article.

Abstract: A recent small mammal survey was conducted in Gunung Stong State Park. Standard mist nets, harp traps and cage traps were used to document diversity of small mammals in this new protected area. This study reports five new distributional records of bats in Gunung Stong State Park and a first record of *Myotis muricola* in Kelantan. The study also shows that Gunung Stong State Park is one of the three areas in Peninsular Malaysia where all four *Cynopterus* species that can be found in Peninsular Malaysia coexist. This protected area also has *Maxomys rajah*, *M. whiteheadi* and *Niviventer cremoriventer* which are currently listed as Vulnerable, highlighting this location as an important conservation area for small mammals. Continuous surveys are needed as information of small mammal diversity in Kelantan is still scarce, and this study is a part of a series of small mammal surveys that have been carried out in Kelantan.

Keywords: Gunung Stong State Park, Kelantan, new record, small mammals, species diversity.

INTRODUCTION

Gunung Stong State Park, Malaysia which covers an area of 21,950ha, is situated north west of Kelantan in the district of Kuala Krai (Maseri & Mohd-Ros 2005). This state park is strategically positioned as part of a large forest block that includes the Titiwangsa Range, the Belum-Temenggor and the Ulu Muda forests in Malaysia, and connects with the stretch of forests in Hala Bala Wildlife Sanctuary and the Bang Lang National Park in southern Thailand (Maseri & Mohd-Ros 2005). This positioning, coupled with the buffering effect of various forests reserves around the area, is most suitable for fauna conservation as many iconic large mammals such as tigers, elephants, deer and leopards are found there (Zafir et al. 2005).

Gunung Stong State Park is also a good area for ecotourism. Its center of attraction is the Jelawang waterfall which is hailed as the highest waterfall in Southeast Asia (Yusoff et al. 2005). This state park also has iconic flora and fauna, that appeal to nature photographers, such as hornbills, banded leaf monkeys, colugo, the endemic Fan Palm *Licuda stongensis*, the endemic Bamboo *Holtumochloa pubescens* and *Rafflesia kerrii* (Latiff & Faridah-Hanum 2005). Together with several mountain peaks such as Gunung Ayam, Gunung Tera and Gunung Stong, this place is suitable for a variety of recreational activities and has been listed in the 2006 Malaysian National Economic Plan as one of the top 10 special places for ecotourism.

According to Bourliere (1975), small mammals have adult weights



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ranging from 2gm to 5kg. The majority of species in this category are from the high diversity orders Rodentia and Chiroptera, and Lagomorpha, Insectivora and Scandentia are also in this group. The importance of Rodentia and Chiroptera in the ecology of the tropical rainforest in Southeast Asia is recognized, yet the small mammals of Kelantan are not well known, with records of surveys from EIA surveys on certain development projects such as the Pergau, Lebir and Negiri Dam Project (see Pue & Latiff 2005) and surveys conducted by Zafir et al. (2005), Shukor et al. (2005) and Mariana et al. (2005). The objective of this study was to survey the diversity and abundance of small mammals in Gunung Stong State Park and add further information on the biodiversity of small mammals in Kelantan, Malaysia.

MATERIALS AND METHODS

The main sampling areas of this study were the Gunung Stong State Park headquarters and Gua Ikan (Image 1). Two trails near the park headquarters were chosen as sampling stations for bats. The first sampling station was Stong Trail 1 ($5^{\circ}20.352'N$ & $101^{\circ}58.503'E$, elevation 100–200 m) and the second sampling station was Stong Trail 3 ($5^{\circ}20.353'N$ & $101^{\circ}58.505'E$, 100–200 m). The vegetation at the first sampling station was hill vegetation with some bamboo plots, and the second sampling station was in the vicinity of the forest ecotone. A total of 10 mist nets and two harp-traps were used to capture bats. These nets and traps were placed in presumed flyways of bats at the sampling stations for four consecutive nights (2–4 March 2011). We also set up four additional nets near in Gua Ikan ($05^{\circ}21.268'N$ & $102^{\circ}1.5483'E$, 97m) which are limestone caves that are found near the forest reserve.

For non-volant small mammals, two sites were

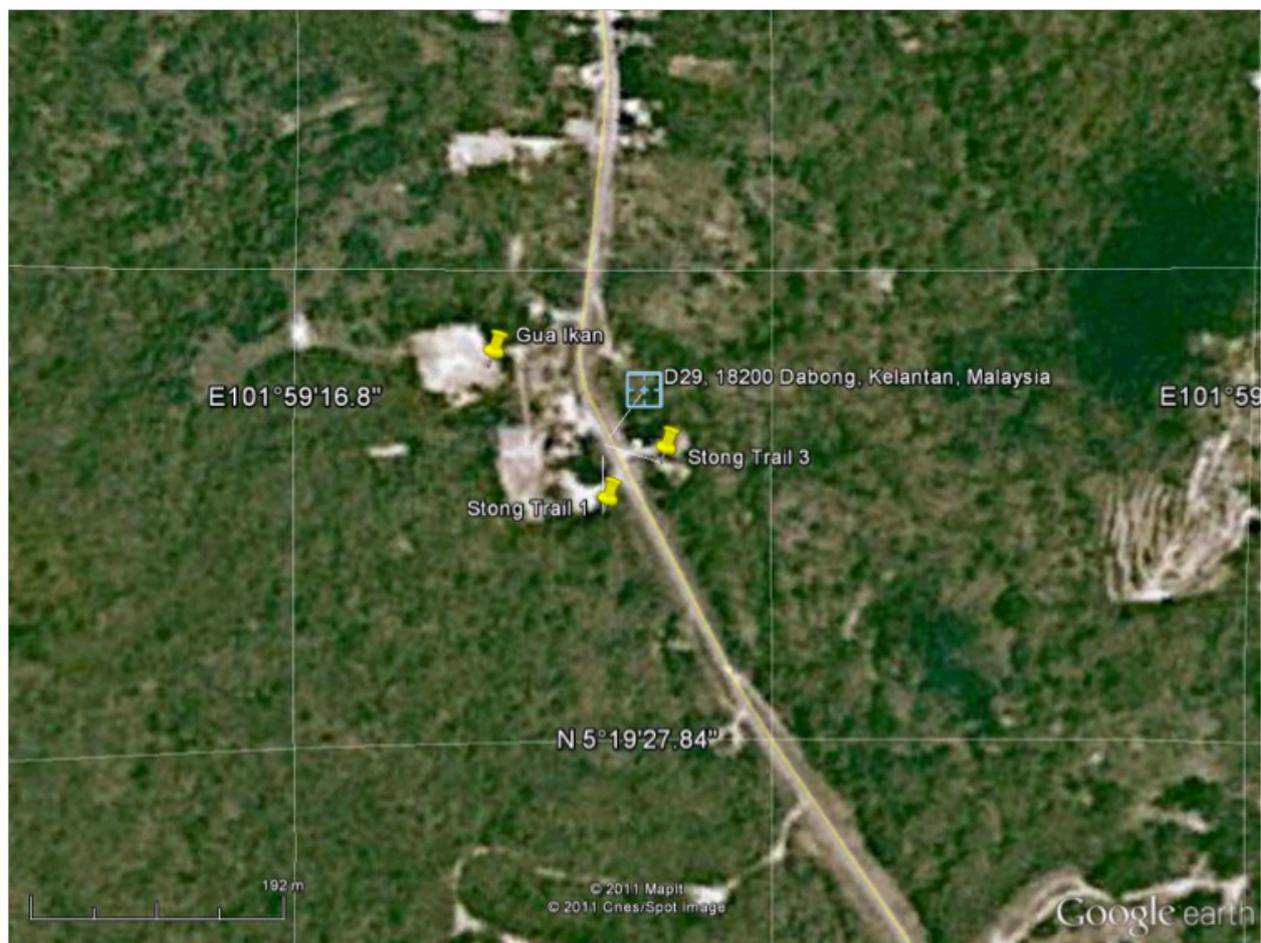


Image 1. Map of the study area (Source: Google Earth, 2011)

chosen in the vicinity of the park headquarters (5°20.352'N & 101°58.503'E, 100–200 m) and Gua Ikan (5°21.268'N & 102°1.5483'E, 97m). The vegetation at the sampling stations were: site A) hill vegetation with some bamboo plots and river vegetation (park headquarters), and site B) limestone area (Gua Ikan). Non-volant small mammals were captured using cage traps and all traps were placed on the ground to target forest floor small mammals. A total of 100 cage traps baited with pineapple were used for this purpose and all traps were placed for four consecutive days (2–4 March 2011).

Captured animals were identified using keys from Francis (2008), and standard measurements were recorded. The diversity of small mammals for this survey was presented as list of species recorded and abundance was characterized by the capture rate of each species during this survey.

RESULTS

The cumulative species graph over days for bats is shown in Fig. 1. The graph is yet to reach an asymptotic level indicating that in-terms of sampling, there may still be species that are yet to be recorded. This also indicates that the netting effort of 52 net-nights was not adequate to sample the total chiroptera community in Kelantan. Table 1 shows the list of species caught, net-nights and capture rate of bats in this study and further comparison with the data from Mariana et al. (2005) and Shukor et al. (2005). This survey recorded 11 species of bats and the highest number of individuals caught was *Cynopterus horsfieldii*, followed by *C. sphinx* and the lowest capture rate were from *Rhinolophus affinis*, *Tylonycteris robustula* and *Myotis muricola*.

The species graph over days for non-volant mammals is shown in Fig. 2. The graph reached an asymptotic level on the 2nd day – 3rd day but the number of species trapped increased on the 4th day of sampling indicating that the total trapping effort was

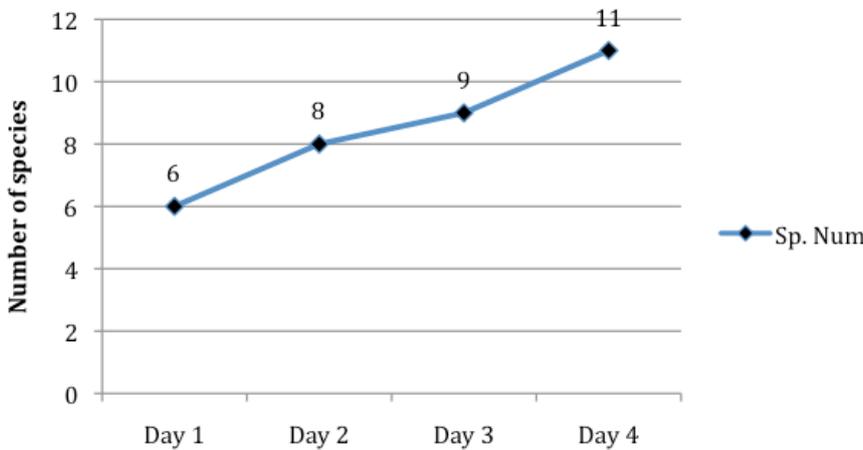


Figure 1. Cumulative frequency graph of bats in Mount Stong and Gua Ikan

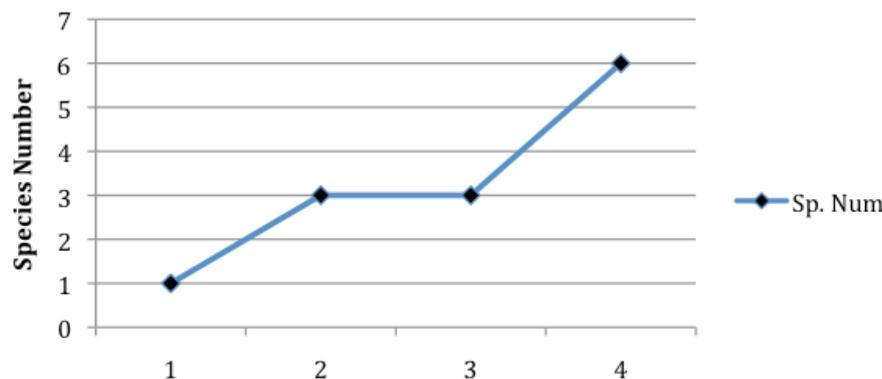


Figure 2. Cumulative Frequency Graph of Non-volant Small Mammals in Mount Stong and Gua Ikan

Table 1. List of species caught, net nights and capture rate of bats in this study

Species	Site A	Site B	Gua Ikan	total	Shukor et al. 2005	Mariana et al. 2005
Family Pteropodidae						
<i>Cynopterus horsfieldii</i> *	5	30	3	38	0	
<i>Cynopterus brachyotis</i>	6	4	1	11	6 ^a	6 ^a
<i>Cynopterus cf. brachyotis</i> Forest	3	4	3	10		
<i>Cynopterus sphinx</i> *	1	12	1	14	0	0
<i>Balionycteris maculata</i>	0	0	0	0	2	3
<i>Penthetor lucasi</i> *	1	0	0	1	0	0
<i>Eonycteris spelaea</i> *	0	0	5	5	0	0
<i>Macroglossus sobrinus</i>	0	5	0	5	19	19
<i>Macroglossus minimus</i>	0	0	0	0	4	3
Family Nycteridae						
<i>Nycteris javanica</i>	0	0	0	0	1	1
Family Rhinolophidae						
<i>Rhinolophus trifolius</i>	0	0	0	0	1	1
<i>Rhinolophus stheno</i>	0	0	0	0	9	9
<i>Rhinolophus refulgens</i>	0	0	0	0	1	1
<i>Rhinolophus affinis</i>	0	0	1	1	21	29
Family Hipposideridae						
<i>Hipposideros bicolor</i>	0	0	0	0	70	74
<i>Hipposideros larvatus</i>	0	0	0	0	16	13
Family Vespertilionidae						
<i>Kerivoula hardwickii</i>	0	0	0	0	15	15
<i>Kerivoula minuta</i>	0	0	0	0	6	6
<i>Kerivoula papilosa</i>	0	0	0	0	17	16
<i>Kerivoula pellucida</i>	0	0	0	0	2	2
<i>Murina cylcotis</i>	0	0	0	0	3	3
<i>Murina suilla</i>	0	0	0	0	4	4
<i>Murina aenea</i>	0	0	0	0	1	0
<i>Myotis ater</i>	0	0	0	0	2	3
<i>Myotis muricola</i> **	0	1	0	1	0	0
<i>Tylonycteris pachypus</i>	0	4	0	4	2	2
<i>Tylonycteris robustula</i>	0	1	0	1	4	4
Total no. of individuals	16	61	13	91	216	214
No. of species	5	7	6	11	21	20
No. of family	2	2	2	3	5	5
Net-nights	24	24	4	52	55	33
Capture rate	1	3	3	2	4	7

* - new record at Gunung Stong State Park; ** - New record for Kelantan based on Pue & Latiff (2005), Mohd Zafir et al. (2005) and Mariana et al. (2005);

^a - Note that Shukor et al. (2005) and Mariana et al. (2005) did not distinguish *C. brachyotis* from *C. cf. brachyotis* Forest.

not adequate to document non-volant small mammals diversity on the forest floor in the sampling stations.

We recorded a total of six species of non-volant small mammals in this study with the highest number of individuals caught were *Leopoldamys sabanus* (six

individuals) followed by *Maxomys whiteheadi* (two individuals).

Species accounts

Cynopterus brachyotis (Müller, 1838): This

species has been recorded in open areas and agricultural plots in southern Thailand, Peninsular Malaysia and Borneo (Abdullah 2003; Abdullah et al. 1997a,b, 2000; Anwarali et al. 2007; Hall et al. 2002, 2004; Karim et al. 2004; Azlan et al. 2005; Jayaraj et al. 2011, 2012). In Borneo *C. brachyotis* is one of the most successful and dominant fruit bat in terms of capture rate and distribution. We netted this species near the forest fringe and near a small stream. This species is listed as Least Concern in the IUCN Red List of Threatened Species (Csorba et al. 2008) and Red List of Mammals for Peninsular Malaysia (DWNP 2010).

There has been ongoing research on the presence of several distinct lineages in this species and in southern Thailand, Peninsular Malaysia and Borneo a smaller form tentatively assigned as *C. cf. brachyotis* Forest has been identified (Abdullah 2003; Campbell et al. 2004, 2006, 2007; Jayaraj 2009; Fong 2011; Jayaraj et al. 2012). We took the liberty of separating the new form *C. cf. brachyotis* Forest as a separate account for future reference using methods described by Jayaraj

et al. (2012).

***Cynopterus cf. brachyotis* Forest:** This undescribed species has been known to occur in primary forests and old secondary forests in contrast with the habitat of *C. brachyotis* (Abdullah 2003). We caught *C. cf. brachyotis* Forest in the forest fringes in the same nets that netted *C. brachyotis*, indicating that these two species although occurs in contrasting habitats but may meet at forest fringes. This undescribed species (see Simmons 2005) is not listed in IUCN's Red List of Threatened Species (2008) and Red List of Mammals for Peninsular Malaysia (DWNP 2010).

***Cynopterus horsfieldii* Gray, 1843:** This is a new record for Gunung Stong State Park. This species is known to be a forest dwelling *Cynopterus*, commonly caught at the ecotones and may occur sympatric with *C. cf. brachyotis* Forest but there are records of this species netted in oil palm plantations and in Pulau Tioman (Lim et al. 1999). The capture rate of this species was the highest in this study, which was highly in contrast when compared with trapping



Image 2. Female *C. horsfieldii* (left) with less prominent sagittal crest versus male *C. horsfieldii* with prominent sagittal crest (A)

results in similar vegetations in Borneo (see Jayaraj et al. 2011) whereas in Pahang the capture rate of this species is similar with *C. brachyotis* (see Lim et al. 2008). Individuals of this species were caught in all three forms of habitat (ecotones, hill forest and limestone areas). Sexual dimorphism of skulls was apparent, where in male skulls have more prominent sagittal crest compared to female skulls (Image 2). This species is listed as Least Concern in the IUCN Red List of Threatened Species (Bates et al. 2008a) and Red List of Mammals for Peninsular Malaysia (DWNP 2010).

***Cynopterus sphinx* (Vahl, 1797):** This is a new record for Gunung Stong State Park. The social structure of *C. sphinx* was previously studied by Storz et al. (2000) and they found out that this species exhibits a polygynous mating system, with males having varying harem size from six to 13 females. Lim et al. (2008) suggested that the distribution pattern of *C. sphinx* should be investigated as little is known about the current distribution of this species in Malaysia. Clinal variation in terms of size of this species was discussed by Storz et al. (2001) and our observations (unpublished data) indicate that *C. sphinx* is not highly adaptable in Peninsular Malaysia incongruent with observations of Bates et al. (2008b). Although widespread the abundance of this species is determined by the type of vegetation sampled (Campbell et al. 2006). In Gunung Stong State Park the forearm length of this species was 74.52 ± 3.87 mm and this species was netted in the hill vegetation and near bamboo plots beside the forest fringe. Struebig et al. (2005) netted this species near fruiting figs trees and this is commonly observed across Peninsular Malaysia with other Cynopterans. This species is listed as Least Concern in the IUCN Red List of Threatened Species (Bates et al. 2008b) and Red List of Mammals for Peninsular Malaysia (DWNP 2010).

***Penthetor lucasi* (Dobson, 1880):** This is a new record for Gunung Stong State Park. Only one individual was caught near the forest fringe throughout the survey. This cave dwelling species normally roosts in large numbers and may have a population size up to 70,845 individuals [mark recapture model estimates in Wind Cave Nature Reserve Sarawak, Malaysia by Barapoi (2004)]. A recent study by Rahman & Abdullah (2010) indicated that there are two or more morphologically distinct forms of *P. lucasi* from

different localities in Sarawak. It is quite possible that such a distinct form also existed in Peninsular Malaysia. This species is listed as Least Concern in the IUCN Red List of Threatened Species (Bates et al. 2008c) and Red List of Mammals for Peninsular Malaysia (DWNP 2010).

***Eonycteris spelaea* (Dobson, 1871):** This is a new record for Gunung Stong State Park. Five individuals of this species were caught near the limestone area throughout the survey. Daytime survey in the cave revealed that this species was abundant in the Gua Ikan. Previously, this species was netted at Gua Musang, Kelantan (Shabrina 1991). Mariana et al. (2005) and Shukor et al. (2005) did not record this species in their survey most probably because their nets were not placed near the cave. Anwarali et al. (2008) observed that individuals from Peninsular Malaysia versus Borneo had a genetic distance of 1%. This species is listed as Least Concern in the IUCN Red List of Threatened Species (Francis et al. 2008) and Red List of Mammals for Peninsular Malaysia (DWNP 2010).

***Macroglossus sobrinus* K. Andersen, 1911:** This species is common in many forest types in Malaysia but has been associated with flowering banana plots and mangrove areas. We collected five individuals of *M. sobrinus* near the river and similarly Shukor et al. (2005) and Mariana et al. (2005) collected 19 individuals of this species in their expeditions. This species is listed as Least Concern in the IUCN Red List of Threatened Species (Hutson et al. 2008).

***Rhinolophus affinis* Horsfield, 1823:** Only one individual was caught in this survey near Gua Ikan. This highly adaptable and common species can be found in most protected areas in Malaysia and are generally abundant in most sites sampled. However, Lim et al. (2008) and Kingston et al. (2008) stated that this species is a common under-storey forest bat that is confined to caves. Shukor et al. (2005) collected 21 individuals of this species while Mariana et al. (2005) collected 29 individuals indicating high abundance of this species in Gunung Stong State Park. Approximately 4% in cyt-b genetic distance observed between Bornean individuals and a single individual from Thailand in Anwarali et al. (2008) and this may have some significance in this study as this individual from Gunung Stong State Park may have similar genetic difference with Bornean samples. This species is listed as Least Concern in the IUCN Red List of

Threatened Species (Walston et al. 2008) and Red List of Mammals for Peninsular Malaysia (DWNP 2010).

***Myotis muricola* (Gray, 1846):** This is a new record for Gunung Stong State Park and Kelantan. We netted this species near the bamboo plots but this species is generally netted in open areas, heath forest, peat swamps, streams and rivers near forest, and agricultural plots (Struebig et al. 2006; Francis 2008). The Red List of Mammals for Peninsular Malaysia (DWNP 2010) indicates that this species is widely distributed in peninsular Malaysia. Francis (2008) mentioned that this species maybe a complex species based on genetic analyses but diagnostic characters and appropriate names have yet to be assigned (see Anwarali et al. 2008). Only one individual was recorded throughout the survey and this species is listed as Least Concern in the IUCN Red List of Threatened Species (Bates et al. 2008d) and Red List of Mammals for Peninsular Malaysia (DWNP 2010).

***Tylonycteris pachypus* (Temminck, 1840):** This species was netted near bamboo plots and a total of four individuals were collected throughout the survey. Shukor et al. (2005) collected only two individuals in their survey but we believe that this species maybe more abundant in Gunung Stong State Park based on the presence of many bamboo plots and observations of slit in the internodes of the bamboos. This species is listed as Least Concern in the IUCN Red List of Threatened Species (Bates et al. 2008e) and Red List of Mammals for Peninsular Malaysia (DWNP 2010).

***Tylonycteris robustula* Thomas, 1915:** This is a species of bat associated with bamboos (Anwarali et al. 2008; Francis 2008) and is a sister species with *T. pachypus* (Francis 2008). We collected only one individual of *T. robustula* in this survey, whereas Mariana et al. (2005) and Shukor et al. (2005) collected four individuals in their surveys. Similarly this species was netted in the same net as *T. pachypus*, reinforcing the idea that this species does share roosting sites with *T. pachypus* (Francis 2008). Francis (2008) did mention that there are differences in roost site selection of both species; *T. robustula* prefer large and dead bamboos whereas *T. pachypus* prefer live bamboo stems, but both species may share the same roost hole. This species is listed as Least Concern in the IUCN Red List of Threatened Species (Bates et al. 2008f) and Red List of Mammals for Peninsular Malaysia (DWNP 2010).

***Maxomys surifer* (Miller, 1900):** We collected only one individual of *M. surifer* near Gua Ikan, but previously Shukor et al. (2005) collected three individuals of this species near the vicinity of site A (sampling site of present study). This species is the most abundant small mammal trapped in Huai Kha Khaeng Wildlife Sanctuary, central Thailand (Walker & Rabinowitz 1992). *M. surifer* and *M. rajah* have rarely been caught in the same area but Shukor et al. (2005) collected one *M. rajah* in this state park, indicating that both species may co-occur in the same area but this needs further confirmation. This species is listed as Least Concern in the IUCN Red List of Threatened Species (Aplin et al. 2008a) and Red List of Mammals for Peninsular Malaysia (DWNP 2010).

***Maxomys whiteheadi* (Thomas, 1894):** We trapped two individuals of this species near Gua Ikan (limestone area) but Francis (2008) stated that generally, this species can be found in tall and old secondary forests and occasionally encroaching disturbed areas in the vicinity of these forests. Wilson et al. (2006) trapped this species in an acacia plantation and a fragmented forest in Borneo. There was also a record of this species occurring in mangrove swamp and secondary forest at Kuala Selangor State Park (Chuluun et al. 2005). This species is listed as Vulnerable in the IUCN Red List of Threatened Species (Aplin et al. 2008b) due to significant population decline for the past 10 years but is listed as Least Concern in the Red List of Mammals for Peninsular Malaysia (DWNP 2010).

***Sundamys muelleri* (Jentink, 1879):** This species has a wide distribution and was normally caught near rivers (Francis 2008). Incidentally, this big rodent was caught in the limestone area of Gua Ikan where there is a river flowing into the cave. Previously this species was caught by Lim (1970) at Sungai Durian Forest Reserve and Mariana et al. (2005) in Gunung Stong State Park. In Borneo this species was caught on the ground or low trees (Wilson et al. 2006). Zakaria et al. (2011) found that this species can survive in disturbed habitats. Ruedas et al. (2008a) assigned the status Least Concern for this species in the IUCN Red List of Threatened Species which was congruent with the Red List of Mammals for Peninsular Malaysia (DWNP 2010).

***Niviventer cremoriventer* (Miller, 1900):** Only one *N. cremoriventer* was caught in this survey at Site A. This species has been recorded in tall and secondary

forests, forest area and lightly wooded areas (Francis 2008). Lim et al. (2008) trapped this species in a disturbed secondary forest at Lakum Forest Reserve, Pahang. In Mount Nuang Hulu Langat, this species has been recorded right up to 1350m asl (Shukor et al. 2001; Batin et al. 2002) and Francis (2008) mentioned that this species can be found up to 1900 m asl. This species is listed as Vulnerable in the IUCN Red List of Threatened Species due to significant population decline for the past 10 years (Ruedas et al. 2008b) and is listed as Least Concern in the Red List of Mammals for Peninsular Malaysia (DWNP 2010).

***Leopoldamys sabanus* (Thomas, 1887):** We collected a total of six individuals from both trapping sites, dominating non-volant small mammal captures in this study. This species is common in many types of forests in Malaysia and is threatened by clearing of forests (Lim et al. 2008). Individuals of this species were found to be highly infested with ectoparasites and previously Mariana et al. (2005) recorded ticks, Mesostigmatid mites and chiggers on individuals trapped in this same area. It is listed as Least Concern in the IUCN Red List of Threatened Species (Lunde et al. 2008) and Red List of Mammals for Peninsular Malaysia (DWNP 2010).

DISCUSSION

This survey recorded 11 species of bats and six species of non-volant small mammals with one new record for Kelantan (*Myotis muricola*) and four additional distributional records for Gunung Stong State Park (*Cynopterus horsfieldii*, *C. sphinx* and *Penthetor lucasi*). Bats from the family Pteropodidae dominated the captures as compared to Shukor et al. (2005) and Mariana et al. (2005) who recorded more insectivorous bats. *Leopoldamys sabanus* (six individuals) dominated the captures for non-volant small mammals followed by *Maxomys whiteheadi* (two individuals), while the remaining species (*M. surifer*, *S. muelleri*, *N. cremoriventer* and *Callosciurus* sp.) recorded only one individual each. This in-turn increased the total number of small mammals known to occur in Gunung Stong State Park from 28 species to 35 species.

The sampling effort for this survey was not adequate in documenting total chiropteran community at Gunung Stong State Park as the graph is yet to reach and asymptotic level. In Kuala Lompat, Krau Wildlife Reserve, a total of 837 harp-trap nights and 1573 net hours (786 hours for ground nets, 606 hours for stacked nets, 147 hours for canopy nets and 34 hours for river nets) were needed to document total insectivorous bat diversity (Kingston et al. 2003). Hall et al. (2004)

Table 2. List of species caught, net nights and capture rate of non-volant small mammals in this study

Species	Site 1	Site 2	Total	Shukor et al. 2005	Mariana et al.2005
Muridae					
<i>Rattus tiomanicus</i>	0	0	0	0	8
<i>Maxomys whiteheadi</i>	0	2	2	4	7
<i>Maxomys surifer</i>	0	1	1	3	1
<i>Maxomys rajah</i>	0	0	0	1	3
<i>Sundamys muelleri</i>	0	1	1	0	3
<i>Niviventer cremoriventer</i>	1	0	1	6	6
<i>Leopoldamys sabanus</i>	5	1	6	6	6
Sciuridae					
<i>Callosciurus nigrovittatus</i>	0	0	0	1	0
<i>Callosciurus</i> sp. (sighted)	1	0	1	0	0
Total no. of individuals	7	5	11	21	34
No. of species	3	4	6	6	7
No. of family	2	1	2	2	1
Trap-days	150	150	300	525	225
Capture rate	1	1	1	1	1

showed that generally a total effort of 30 net nights was needed to document total fruit bat composition in most areas in southern Thailand, Peninsular Malaysia and Borneo. In this study, the 54 net nights were not adequate in documenting total chiropteran fauna and to compensate this inadequacy, further surveys can be done on a long term basis.

The low trapping rate of harp traps in this study (averaging one individual per night) contributed to the overall low diversity of insect bats captured in this study. Nonetheless our positioning of the harp traps near the forest edge and beside the river may not be effective if the bats do not use the presumed flyways. The low capture rate of non-volant small mammals and the absence of treeshrews and squirrels may be caused by the choice of bait used and trap placement in this study. Previous studies on non-volant small mammals do indicate bait selection by small mammals, as Bernard (2003) mentioned that the local banana variety 'pisang emas' (*Musa acuminata*) generally produces the best capture rate. In this study, we used pineapples as bait and the traps were placed on the forest floor which may be selective for trapping rats and treeshrews.

The importance of Gunung Stong State Park for conservation of small mammals is yet to be explored but this recent survey revealed some major findings; First, Gunung Stong State Park is the second known protected area in Malaysia where all four species of *Cynopterus* that can be found in Peninsular Malaysia (*C. brachyotis*, *C. cf. brachyotis* Forest, *C. horsfieldii* and *sphinx*) co-exist. Previous records of such occurrences in Malaysia were only in Perlis State Park and Taiping, Perak (Campbell et al. 2004, 2006). Sungai Dusun may be another area where all four species co-exist but this needs to be confirmed (Abdullah 2003; Hall et al. 2004). Other records of such observations include Thaleban National Park, Thailand (Abdullah 2003; Hall et al. 2004; Abdullah et al. 2007). Abdullah et al. (2007) stated that having three species of *Cynopterus* netted in the same area was unusual, and they relate their observation way back in 1997 as due to lack of resource partitioning, diet overlap, or similar roosting, emergence time and flight behavior of the species.

The results of this study show that all four species of *Cynopterus* meet at the ecotones (based on netting results) and such area may be the place where lack of space partitioning between these congenics occur.

The habitat use of these four species can also be divided into open areas and forested areas, thus we speculate that the existence of such areas together with the ecotones in the vicinity and in Gunung Stong State Park may contribute to the conservation of these fruit bats. Second, this area also recorded three species of *Maxomys*, with *M. rajah* and *M. whiteheadi* listed as Vulnerable in the IUCN Red List of Threatened Species (Aplin et al. 2008 a,b). *N. cremoriventer* also joins the list of Vulnerable species that can be found in this protected area making Gunung Stong State Park an important area for the conservation of these rodents in peninsular Malaysia. These animals are primarily forest dependent species and are not found outside of forested areas (Aplin et al. 2008a,b; Ruedas et al. 2008b) and are threatened by clearing of forests (Lim et al. 2008), thus protected areas are the only areas where significant conservation planning and effort can be put in place.

The conservation of bats and small mammals are generally overlooked in many protected area management plans in this country except enigmatic species such as the large flying fox *Pteropus vampyrus* and naked bats *Chiromeles torquatus* which have some form of economic or aesthetic value. Conservation of small mammals primarily depends on the establishment of protected areas and controlling human activities or disturbance in the vicinity and the protected area itself with good enforcement of local wildlife protection laws. Thus, it is important that knowledge on the diversity of small mammals in protected areas are known for monitoring and management purposes. Gunung Stong State Park as a newly established protected area which requires more data on the diversity and abundance of various taxa including small mammals and it is imperative that relevant institutions such as Universiti Malaysia Kelantan (UMK) support such work by contributing local knowledge on biodiversity in Kelantan. This study is a part of a series of three papers about Kelantan small mammals that will be published based on recent small mammal surveys in the state.

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