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Original Article

Diversity and conservation status of small mammals in Kelantan, Malaysia

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Abstract

There is little information and research on the diversity of the small mammals in Kelantan. Thus, a series of wildlife surveys were done at five localities in Kelantan to further elucidate the diversity of small mammals in this state. There were 39 species of small mammals recorded, 13 of these are new records for Kelantan. This significantly increased the known diversity of small mammals from 71 to 84 species. However, the diversity of small mammals in Kelantan is still underrepresented and further surveys are needed to add more information to the current knowledge.

Keywords: small mammals, Kelantan, new records, conservation

1. Introduction

Kelantan is an unexplored frontier in terms of vertebrate biodiversity. The positioning of this state at the northern part of the west coast coupled with the isolative effect of the Titiwangsa Range, lush with forests, makes up various forest reserves, national parks, and state parks in the state. This large block of forest is a valuable asset for biodiversity conservation in Peninsular Malaysia as it also connects with protected areas in Thailand forming a large interconnecting network of protected areas (Maseri and Mohd-Ros, 2005).

Small mammals are the most diverse group of mammals but yet little information is known about them as compared to larger enigmatic mammals. Thus, there is a big gap of knowledge on the distribution and abundance and conservation status of small mammals in this state and it is imperative that this lack of knowledge on small mammals is addressed. Hence, this study aims to document the distribution and diversity of small mammals in Kelantan.

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2. Study Area

Samplings small mammals were carried out at Gunung Chamah, Gunung Reng, Gua Musang, Pasir Mas, and Lojing Highlands. Gunung Chamah is a secondary forest, Gunung Reng and Gua Musang are limestone areas, whereas in Pasir Mas we sampled in an orchard plantation. In Lojing Highlands, the sampling was done in an isolated patch of forest surrounded by agricultural plots (Figure 1). Table 1 lists all the GPS location of all sampling sites. Anthropogenic activities were moderate in both limestone areas with rivers nearby ad at Pasir Mas orchard while high in Lojing Higlands. The area with the lowest anthropogenic activities was Gunung Chamah, as this area was only accessible via a logging road through a four wheel car.

3. Materials and Methods

Mist nets and harp-traps were used to capture bats and cage traps baited with banana were used to capture non-volant small mammals. These traps and nets were deployed for at least three consecutive days and captured animals were identified following description in Francis (2008) with their standard measurements recorded. All specimens collected (three individual per species) were euthanized using chloroform and preserved as voucher specimens deposited in UMK Zoological Museum.

The species richness for small mammal in each area was assessed by total number of species caught and trappings success was determined by calculating the percentage of total number of individuals caught from the total effort. Species rarefaction curve analysis was carried out using EcoSim 700 (Ensminger, 2012) with the inclusion of data from previous surveys at Gunung Stong State Park (see Shukor *et al*., 2005; Jayaraj *et al*., 2012). The analysis was run with individual-based rarefaction selection method because this study compared the species diversity based on sampling sites. The conservation status of mammals in this survey was obtained from the Red List of Mammals for Peninsular Malaysia (DWNP 2010).

We also compiled known mammal records from Lim *et al*. (1970), Davison and Kiew (1990), Shabrina (1991), Mariana *et al*. (2005), Pue and Latiff (2005), Ahmad Zafir *et al*. (2005). Shukor *et al*. (2005) and most recently Jayaraj *et al*. (2012) and Noor *et al*. (2012) to generate the full list of small mammals known to Kelantan. This result was then used to generate a bar chart of IUCN Red List Status of small mammals of Kelantan (DWNP 2010 and IUCN Red List, 2013; Figure 3 and 4) and different categories of protection under Wildlife Conservation Act 2010.

4. Results and Discussion

Overall we manage to record 39 species of small mammals classified under four orders (Insectivora, Scandentia, Chiroptera, and Rodentia) and nine families (Soricidae, Tupaidae, Pteropididae, Emballonuridae, Rhinolophidae,

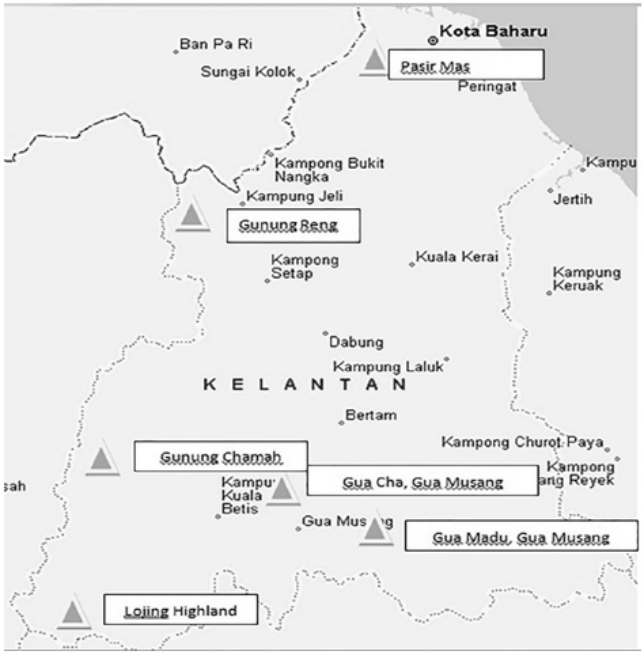

Figure 1. Map of five localities of sampling in Kelantan.

Table 1. GPS readings, elevation and date of sampling period of all sites sampled.

No.	Sampling Site	GPS		Elevation (m)	Date of sampling
		N reading	E reading		
1	Gunung Reng	05°42.811'	101°44.818'	100	18/6/2011 - 22/6/2011
2	Gua Cha, Gua Musang	04°50.614'	101°57.840	112	22/6/2011 - 29/6/2011
3	Gua Madu, Gua Musang	04°36.346'	101°57.868'	180	22/6/2011 - 29/6/2011
4	Lojing Highlands	04°36.340'	101°27.866'	1,097	29/6/2011 - 2/7/2011
5	Gunung Chamah	05°12.020'	101°46.199'	690	26/7/2011- 29/7/2011
6	Pasir Mas	06° 1.503'	102° 8.911'	13	17/2/2011-20/2/2011 24/2/2011- 27/2/2011 10/3/2011-13/3/2011

Hipposideridae, Vespertilionidae, Sciuridae, and Muridae) from 246 individuals with 13 new distributional records for Kelantan (Table 2).

Ten out of 13 new records for this survey were bats which one species from family Pteropodidae and Emballonuridae, two species from family Rhinolophidae and Hipposideridae and four species from family Vespertilionidae. The remaining species were two rodents of the family Muridae and one shrew (Soricidae). Vespertilionidae was the most diverse family of small mammal recorded in this survey with nine species. The most abundant small mammal in this study was *Rattus rattus* (25 individuals) followed by *H. cineraceus* and *H. larvatus* (23 individuals for both species). *Rattus rattus* was the most abundant non-volant small mammal in this study because majority of the capture was from Gunung Reng, where traps were placed near a small scale banana plantation. This caused high capture rates of this species as it was a pest in the banana plantation.

Figure 2 shows the rarefaction curve of species diversity in five localities. Although Gunung Stong had more captures (317 individuals) compared to all the sites surveyed in this study, Gua Musang showed the highest species diversity as it had the steepest curve among the other sites (including Gunung Stong) at the 70th individual. Our sampling effort of 153 net- nights and 1,694 trap-days was still inadequate to document the total diversity of small mammals in this state as the cumulative curve for all mammals species recorded (Figure 2) was still exponential. Previous studies in Kuala Lompat, Krau Wildlife Reserve, Pahang indicate that a total net effort of 837 harp-trap nights and 1573 net hours were required to document total chiropteran diversity (Kingston *et al*., 2003). For non-volant small mammals, 6,000-7,200 trap-days were

Table 2. Species diversity and abundance of small mammals in 5 localities

Species	Gunung Chamah	Gunung Reng	Gua Musang	Loging Highlands	Pasir Mas	Total
Insectivora						
Soricidae						
Suncus etruscus (Savi, 1822)*	1	0	0	0	0	1
Scandentia						
Tupaidae						
Tupaia glis (Diard, 1820)	0	4	1	0	8	13
Chiroptera						
Pteropodidae						
Cynopterus brachyotis (Müller, 1838)	0	2	9	3	0	14
Cynopterus sphinx (Vahl, 1797)	0	1	0	2	0	3
Cynopterus horsfieldii (Gray, 1843)	0	2	0	0	0	2
Chironax melanocephalus (Temminck, 1825)	4	0	0	0	0	4
Eonycteris spelaea (Dobson, 1871)	0	11	3	4	0	18
Megaerops ecaudatus (Temminck, 1837)*	0	0	3	0	0	3
Macroglossus sobrinus, K. Andersen, 1911	6	1	1	5	0	13
Macroglossus minimus (E. Geoffroy, 1810)	4	4	3	3	0	14
Emballonuridae						
Emballonura monticola, Temminck, 1838*	0	0	1	0	0	1
Rhinolophidae						
Rhinolophus acuminatus, Peters, 1871*	0	2	0	0	0	2
Rhinolophus affinis, Horsfield, 1823	0	13	4	0	0	17
Rhinolophus lepidus, Blyth, 1844	0	1	2	0	0	3
Rhinolophus robinsoni, K. Andersen, 1918*	0	0	1	0	0	1
Rhinolophus stheno , K. Andersen, 1905	0	0	7	0	0	7
Hipposideridae						
Hipposideros armiger (Hodgson, 1835)*	0	8	0	0	0	8
Hipposideros bicolor (Temminck, 1834)	0	0	0	1	0	1
Hipposideros cineraceus, Blyth, 1853*	0	11	12	0	0	23
Hipposideros diadema, Geoffroy, 1813	0	0	2	0	0	2
Hipposideros galeritus, Cantor, 1846	0	2	0	0	0	2
Hipposideros larvatus (Horsfield, 1823)	0	11	12	0	0	23

Table 2. Continued

Species	Gunung Chamah	Gunung Reng	Gua Musang	Loging Highlands	Pasir Mas	Total
Vespertilionidae						
Myotis horsfieldii (Temminck, 1840)*	0	2	0	0	0	2
Glischropus tylopus (Dobson, 1875)	0	0	1	0	0	1
Scotophilus kuhlii, Leach, 1821*	0	2	0	0	0	2
Tylonycteris robustula, Thomas, 1915	0	2	0	0	0	2
Tylonycteris pachypus (Temminck, 1840)	0	1	1	0	0	2
Murina peninsularis, Hill, 1964[b]	0	0	0	1	0	1
Kerivoula hardwickii (Horsfield, 1824)	0	0	1	0	0	1
Kerivoula minuta, Miller, 1898	0	0	1	0	0	1
Kerivoula papillosa (Temminck, 1840)*	0	0	1	0	0	1
Rodentia						
Sciuridae						
Callosciurus caniceps (sighted)(Gray, 1842)	1[a]	0	0	0	1, 2[a]	4
Muridae						
Rattus rattus (Linnaeus, 1758)	0	13	3	0	9	25
Rattus exulans (Peale, 1848)*	0	3	0	0	0	3
Rattus tiomanicus (Miller, 1900)	0	0	0	0	9	9
Sundamys muelleri (Jentink, 1879)	2	0	1	0	0	3
Niviventer cremoriventer (Miller, 1900)	0	0	0	1		1
Niviventer fulvescens (Gray, 1847)*	0	0	0	7	0	7
Maxomys rajah (Thomas, 1894)	1	0	1	0	0	2
Maxomys surifer (Miller, 1900)	0	0	1	0	3	4
Total no. of individuals	19	96	72	27	32	246
No. of species	7	20	23	9	5	39
No. of family	4	6	7	4	3	9
Net and harp trap nights	21	48	48	36	0	153
Trap days	150	400	400	300	444	1694
Total effort	171	448	448	336	444	1847
Capture rates	**11.1%**	**21.4%**	**16.1%**	**8.6%**	**7.2%**	**14.5%**

* = new record for Kelantan, [a] = Sighted, [b] = Taxonomic revision has elevated *M. c. peninsularis* to *M. peninsularis*.

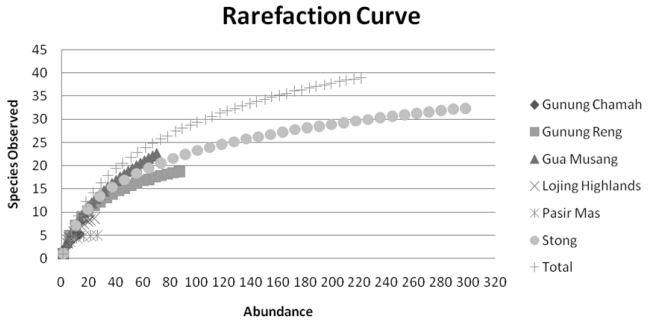

Figure 2. Rarefaction curve for species diversity in five sampling site and comparison with Stong species diversity (Jayaraj *et al*., 2012).

required to document the diversity of these fauna at Mount Jerai, Kedah (Rayan and Shahrul Anuar, 2006; Shahrul Anuar *et al*., 2006). Nonetheless, 13 new records and baseline data for five areas in this study is a significant addition to the knowledge of small mammals in Kelantan. Together with the data from this study, Kelantan now have records of 84 small mammals occurring in the state.

The majority of mammals recorded in Gua Musang were bats and this highlights the importance of karst areas in the conservation of bats in Malaysia. Similarly, a previous study on the diversity of bats in Sangkulirang limestone karst formations highlighted the importance of such geological formation as the key habitat for many species of bats (Struebig and Suyanto, 2007). Coupled with several remaining forests in the area, Gua Musang should be prioritized as a key area to conserve bats in Kelantan. As for the other sites, although the species diversity are lower than Gua Musang, but these areas has several new records of small mammals in the state and should be monitored for conservation purposes.

4.1 Conservation of small mammals under Wildlife Conservation Act 2010

Out of 84 species of small mammals known to Kelantan, 63 species (75%) were listed as *least concern,* whereas eight species (9.5%) were *near threatened* and another eight species were *vulnerable* in the IUCN Red List. Four species (4.7%) were not evaluated as these were unidentified (*Chimarrogale* sp. and *Callosciurus* sp.), probable typo error in the literature (*Ratufa glis*) and a newly described species that its conservation status has yet to be evaluated; *M. peninsularis,* see Francis and Eger (2012) and Soisook *et al.* (2013). These 84 species does not include the locally extinct Indian Grey Mongoose *Herpestes edwardsii.* Figure 3 and 4 shows the number of species of small mammals in Kelantan categorized under four different conservations status, Figure 3 after IUCN (2013) and Figure 4 after DWNP (2010), and their status in the Wildlife Conservation Act 2010. Out of 64 species categorized as *least concern* in the IUCN Red List of Threatened Species 2013; 48 are not protected under Wildlife Conservation Act 2010, but 15 species are categorized as either *protected* or *totally protected* under the same law.

Only three out of eight species (*Viverra zibetha, Ratufa bicolor and R. affinis*) categorized under *near threatened* are protected under the Wildlife Conservation Act 2010. The remaining species of bats and rodents are not protected under this legislation and was categorized as *least concern* in the DWNP (2010). Two out of eight species categorized under *vulnerable* were totally protected (*Nycticebus coucang* and *Lutrogale perspicillata*) and the remaining six species are not protected under the Wildlife Conservation Act 2010. DWNP (2010) classified these six species as *least concern* (*Nycteris tragata, Murina aenea, Niviventer cremoriventer, Maxomys rajah, M. whiteheadi, Kerivoula intermedia*). *Prionailurus planiceps* was listed as *endangered* (EN C1+ 2a (i)) under IUCN (2013) but listed as *least concern* in DWNP (2010). This species was *totally protected* under the Wildlife Conservation Act 2010. The only extinct small mammal in DWNP (2010) *Herpestes edwardsii* was *totally protected*, but at a global scale this species was classified as *least concern* in IUCN (2013).

This simple analysis shows that the species listing in the five schedules in Wildlife Conservation Act 2010 does not address the need for species to be conserved according to IUCN (2010) but rather it supports the idea of managing commercially exploitable species in the CITES listing. Thus, the five different schedules in the Wildlife Conservation Act 2010 do not adequately address the conservation needs of small mammals in Malaysia, especially ground dwelling rodents and bats. These animals are generally less appreciated by the public or may be considered as pest. Lim *et al.* (2008) mentioned that as the common Bamboo rat *Rhizomys sumatrensis* population was declining for the last two decad es due to the hunting by *Orang Asli* (Malaysian aboriginals) for food and there is need to list this species as *totally protected* under Wildlife Conservation Act 2010 to conserve this species from extinction, but yet this has not be done due to the fact that this species was less prioritized for conservation.

The three rodent species *Niviventer cremoriventer, Maxomys rajah, M. whiteheadi* listed as *vulnerable* under IUCN (2013) are generally regarded as pest and would be killed in the rural areas for crop protection or control of other pests in the human settlements. This is because as rodents are generally controlled using rodenticides, this non-selective method may inevitably kill other rodents that feed on the poison. This in turn may threaten the survival of these species in areas near to human settlements. Nonetheless the Wildlife Conservation Act 2010 Schedules poor coverage on protection of small mammals is compensated by a wide variety of clauses in the Act that allows the establishment of wildlife reserves and sanctuaries, control of activities related to wildlife in wildlife reserves, protection of wildlife in salt licks, protection against cruelty to wildlife and young (Wildlife Conservation Act, 2010). Sodhi *et al*. (2004) outlined four main threats to biodiversity loss in Southeast Asia, 1) forest conversion, 2) forest fires, 3) hunting for bush meat, and 4) wildlife trade. They further projected extinction rates of mammals to be a minimum of 20% to a maximum of 50% by the year 2100. In Peninsular Malaysia especially in Kelantan, forest conversion and wildlife trade are the major threats to survival of mammals. However, for small mammals, the impact of forest conversion is the key threat to the conservation of

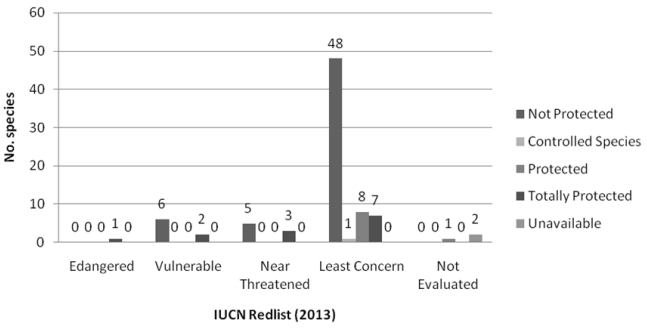

Figure 3. IUCN Red List (2013) status of small mammals of Kelantan and different categories of protection under Wildlife Conservation Act 2010.

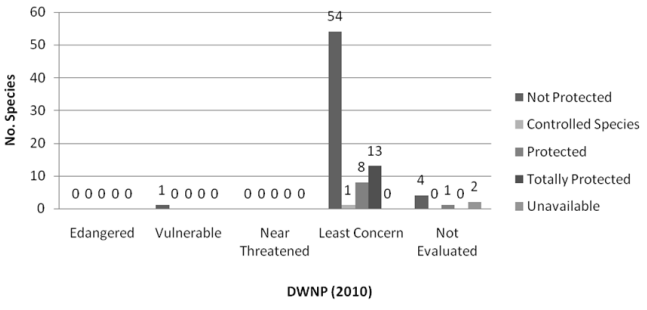

Figure 4. DWNP (2010) status of small mammals of Kelantan and different categories of protection under Wildlife Conservation Act 2010.

Table 3. Number of species distributed in four different habitat niches and estimated local extinction due to impact of deforestation (in brackets).

Habitat Niches	Volant Mammals	Non-volant Mammals	Total No of Species	Estimated Mortality
Upper Air Community	16 (0)	0	14 (0)	0%
Canopy Community	11 (8)	4 (2)	15 (10)	67%
Middle Zone	14 (8)	14 (6)	28 (14)	50%
Terrestrial Zone	0	22 (9)	22 (9)	41%
Total No of Species	42(16)	39 (17)	81 (31)	39%

small mammals in this state as regional comparison shows that Kelantan's rate of forest loss is higher than the estimated forest loss in Malaysia (1.2%) and Southeast Asia (1%) (Sodhi *et al.,* 2004). Kelantan's high forest conversion rate - Kamaruzaman and Setiawan's (2003) estimated 2.3% per year within an 8-year span, 1989-1997 - will have a profound impact on the survival of small mammals once socioeconomic drivers push in and subsequently of environmental issues are marginalized (Sodhi *et al.,* 2004).

Lim *et al*. (2008) described the resultant of impact that may affect a mammal community when clear felling of forest happens based on four categories of habitat zonation. Following Lim *et al*. (2008) habitat zonation (Table 3), the most diverse mammals in Kelantan are found in the Middle Zone whereas the upper air community is the least diverse. The clear felling of forest would have the highest impact on the canopy community (67%) as mammals in this habitat niche are highly dependent on the forest canopy as roosting and foraging sites, whereas the highest loss of species would be on small mammals of the middle zone as most of these small mammals are forest dependent and roost in rock crevices and tree holes (Lim *et al*., 2008). Bats that roost in caves are least affected but may suffer some impact as some species forage in the canopy. In fact, Struebig *et al*. (2009) showed that significant limestone systems has the ability to maintain diversity of bats from gradual lost over time in adjacent forest patches. Vesper bats are the least impacted group when clear felling are done as many are upper air community members where they roost in caves and forage above the canopy (Lim *et al*., 2008).

The possibility of local extinction for 31 species of small mammals is severe and would have high impact on the natural ecosystems in the state. This 39% of small mammal local extinction is lower than the projected 50% total loss of species by Lim *et al*. (2008) and 20-48% projection for Southeast Asia by Brook *et al*. (2003), but our estimate does not include species that have yet to be recorded particularly the lowly represented rodents in this checklist. The extinction of small mammals will specifically hit the most on taxonomically small groups of forest dependent mammals, and this may result significant diversity loss at the higher taxonomic level (Russell *et al*., 1998). Struebig *et al*. (2009) noted that any forest patches < 300 ha are of poor bat assemblage and may lose it significance to support a more diverse bat assemblage. This change in fauna composition is permanent as the composition and diversity of fauna would not be replicated (Dunn, 2004, Gibson *et al*., 2011). In another instance, Shankar-Rahman *et al*. (1998) found that even 100 years regenerated forest do not recover the original species diversity of forest dependent species. Thus landscape changes due to deforestation in Kelantan should be of concern in the near future.

At present, the conservation of small mammals in the state needs detailed and careful planning in order to address the conservation needs of the animals but also strike a balance in managing human-wildlife conflict in the state. As deforestation is the key threat to the survival of these mammals, our estimate of 39% of loss of small mammalian diversity would be devastating and is irreplaceable if it were allowed to happen. Therefore it is imperative that the current protected areas are maintained and additional areas to be outlined in the near future.

5. Conclusions

Thirteen new records of small mammals in Kelantan together with rarefaction curve analysis indicates that diversity of small mammals in Kelantan is yet to be fully documented and further surveys with various techniques and more trapping effort may reveal higher diversity. Wildlife Conservation Act 2010's incomplete coverage on small mammals needs to be addressed as it is imminent that several species that needs protection have yet to be listed and these mammals may face immediate local extinction if nothing is done to control the current rate of deforestation.

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