Taxonomic Composition of Non-volant Small Mammal Assemblages in Tasik Kenyir, Hulu Terengganu, Terengganu

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Abstract A study was carried out in the area of Tasik Kenyir, Hulu Terengganu from July 2015 to April 2016. The aims of the study were to access the taxonomic composition of non-volant small mammal assemblages in Tasik Kenyir area and to investigate if the types of ecosystems influence the species richness and diversity of non-volant small mammal assemblages in that area. A total of 56 individuals comprising five orders, six families and 12 species of non-volant small mammals were recorded. The Common Treeshrew (*Tupaia glis*) was the most abundant species of non-volant small mammals recorded in Tasik Kenyir area. The highlights of this study included the Grey-cheeked Flying Squirrel (*Hylopetes platyurus*) and the world's smallest mammal, Savi's Pigmy Shrew (*Suncus etruscus*). In conclusion, Kampung Kemat recorded the highest diversity of small mammals with 13 individuals belonging to three orders, four families and six species. The types of habitat may influence the species richness and diversity of non-volant small mammals by their tendency to adapt to those types of habitat due to the fact that certain species are more adaptable to many kinds of habitats than the other species.

Keywords Composition · Habitat · Non-volant small mammals · Tasik Kenyir

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Introduction

Merritt (2010) stated that small mammals are mammalians weighing 5 kg or less. They are further categorized into volant and non-volant small mammals. Small mammals are not surveyed thoroughly in many areas in Southeast Asia (Francis 2001). The studies of the diversity and abundance of small mammals in Malaysia have been scarce (Ruppert et al. 2015). Small mammals are often caught at emergent, forest litter, rotting logs, seedlings or rough barks as these kinds of habitats are suitable for breeding and nesting sites for them as well as plenty of food resources being available (Zakaria et al. 2001; Zakaria and Nordin 1998; Medway 1983).

Tasik Kenyir is located at Hulu Terengganu and covers over 209,199 ha. It is the largest man-made lake in Southeast Asia. This lake is also surrounded by one of the oldest rainforests in the world, ranging from Kelantan to Pahang (Shaharom 2015). There was only one study carried out for studying the diversity of small mammals of Tasik Kenyir. The study only recorded 14 species of volant small mammals from four families of chiropteran and no non-volant small mammals captured due to the unattractiveness of the baits and inadequate sampling efforts (Mazlan et al. 2015).

The objectives of the study were to assess the taxonomic composition of non-volant small mammal assemblages in Tasik Kenyir and to determine if the types of habitat influence the species richness and diversity of non-volant small mammals in Tasik Kenyir.

The study was carried out at in Hulu Telemong Forest Reserve (5° 13′48.0″N, 102° 50′08.9″E), Kenyir Research Station, Universiti Malaysia Terengganu (5° 08′59.5″N, 102° 45′48.9″E), Kampung Kemat (5° 00′52.2″N, 102° 57′10.4″E) and Belukar Bukit (4° 53′37.4″N, 102° 59′23.4″E) (Fig. 1). All sampling sites mainly comprised lowland dipterocarp forests. Hulu Telemong Forest Reserve was also a riparian forest as there was a river present in the sampling site. Furthermore, it was disturbed by ongoing human activities. The forest located at Kenyir Research Station was a regenerated forest as the forest was logged previously. The forest located at Kampung Kemat was disturbed as there were human settlements nearby as well as ongoing human activities. Belukar Bukit was a riparian forest and recently became a disturbed forest due to human intrusion.

A total of 100 cage traps were set up for each study site in Tasik Kenyir area and its vicinity. Selecting suitable multiple microhabitats for trap placement at each station is important to increase the documentation of non-volant small mammals (Jayaraj et al. 2013). Bananas were used as baits as proposed by Bernard (2003) to be the most suitable baits used to capture small mammals. Other live trapping methods used were pitfall trapping and mist netting. Thirty pitfall traps and ten mist nets were set up during this study. The traps were checked daily between 8.00 a.m. until 10.00 a.m. and 3.00 p.m. until 5.00 p.m.

A line transect along 1 km trail was used to conduct visual encounter survey (VES) (Ramli and Hashim 2009; Crump and Scott 1994). Diurnal and nocturnal VES were carried out as frequently as possible during the sampling period. The Bushnell Powerview 20 × 50 Optics Green Film binoculars were used for diurnal VES and widebeam spotlight was used during nocturnal VES.

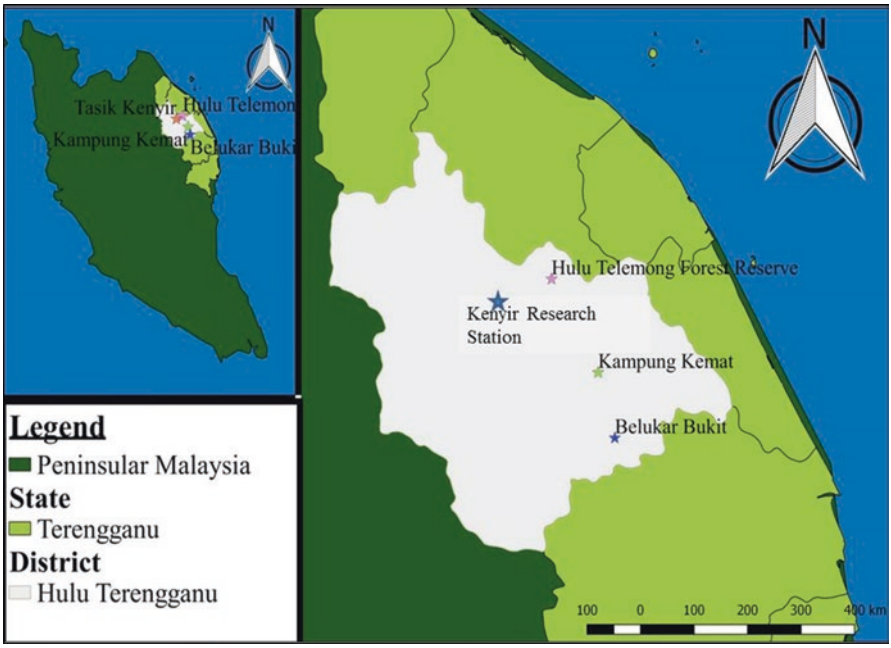

Fig. 1 Map showing the study area in Tasik Kenyir area, Hulu Terengganu

All individuals captured and observed were identified following Francis (2013), Shepherd and Shepherd (2012), Francis (2001, 2008), Payne and Francis (1998), and Medway (1983). All standard measurements of captured individuals were recorded as well. Individuals for museum vouchers were euthanized by using chloroform before being tagged and preserved in 70% ethanol. The species diversity and richness were calculated and compared using t-test and a dendrogram constructed by using PAST software, version 2.17 (Caceres et al. 2011; Hammer et al. 2001).

Species Diversity and Richness of Non-volant Small Mammals in Tasik Kenyir

A total of 56 individuals comprising five orders, six families and 12 species were recorded in Tasik Kenyir area, Hulu Terengganu (Table 1). The most abundant species was the Common Treeshrew (*Tupaia glis*) from family Tupaiidae of order Scandentia. Most species recorded were from order Rodentia consisting of five species of sciurids and three species of murids.

The cluster analysis of non-volant small mammal assemblages separated Kenyir Research Station (KRS) which comprises lowland dipterocarp forest and regenerated forest with the other three sites. The disturbed forest of Kampung Kemat (KK) was closely clustered with Hulu Telemong Forest Reserve (HTFR) with

Table 1 Taxonomic list of non-volant small mammal species recorded with different types of habitat in Tasik Kenyir area, Hulu Terengganu

ORDER family	Species	Method	Sampling site			
			HTFR	BB	KRS	KK
			n (RA)	n (RA)	n (RA)	n (RA)
Insectivora						
Soricidae	*Suncus etruscus*	PF	0 (0)	0 (0)	1 (5)	1 (8)
Scandentia						
Tupaiidae	*Tupaia glis*	CT/VES	6 (67)	4 (29)	9 (45)	3 (23)
Dermoptera						
Cynocephalidae	*Galeopterus variegatus*	VES	0 (0)	0 (0)	1 (5)	0 (0)
Ecarnivora						
Mustelidae	*Martes flavigula*	VES	0 (0)	0 (0)	1 (5)	0 (0)
Rodentia						
Sciuridae	*Callosciurus notatus*	VES	1 (11)	3 (21)	0 (0)	2 (15)
	Sundasciurus lowii	VES	0 (0)	5 (36)	3 (15)	0 (0)
	Sundasciurus tenuis	VES	2 (22)	1 (7)	0 (0)	2 (15)
	Lariscus insignis	VES	0 (0)	1 (7)	0 (0)	0 (0)
	Hylopetes platyurus	MN	0 (0)	0 (0)	0 (0)	1 (8)
Muridae	*Rattus rattus*	CT	0 (0)	0 (0)	0 (0)	4 (31)
	Sundamys muelleri	CT	0 (0)	0 (0)	1 (5)	0 (0)
	Maxomys surifer	CT	0 (0)	0 (0)	4 (20)	0 (0)

Sampling site – *HTFR* Hulu Telemong Forest Reserve, *BB* Belukar Bukit, *KRS* Kenyir Research Station (UMT), *KK* Kampung Kemat
Method – *CT* cage trapping, *VES* visual encounter survey, *PF* pitfall trapping, *MN* mist netting
n number of individuals, *RA* relative abundance

approximately 90% similarity and Belukar Bukit (BB) which consists of lowland dipterocarp forest and riparian forest was secondly clustered with both sites with about 73% similarity (Fig. 2).

Kampung Kemat (KK) has recorded the highest diversity and richness ($H' = 1.67$, $R_1 = 1.95$, $J' = 0.93$) with 13 individuals belong to three orders, four families six species while the lowest species diversity and richness was recorded for Hulu Telemong Forest Reserve (HTFR) ($H' = 0.85$, $R_1 = 0.91$, $J' = 0.77$) (Table 2) a result of the lowest recorded number of total individuals of only nine individuals from two orders, two families and three species among the four sampling sites.

The species cumulative curves showed that the total of non-volant small mammals species recorded in all sites have yet to reach asymptote indicated that there were still additional species to be found in the future (Fig. 3).

The Common Treeshrew (*T. glis*) was the dominant species in Tasik Kenyir area because it was found in all the study sites and proved that this species is a generalist that could occupy all types of habitat present in this study area. Moreover, the high abundance of this ground-dwelling species may result from its ability to breed anytime throughout the year, short gestation period and the species is not restricted to breeding season (Francis 2013; Medway 1983). Bananas were used in this study as

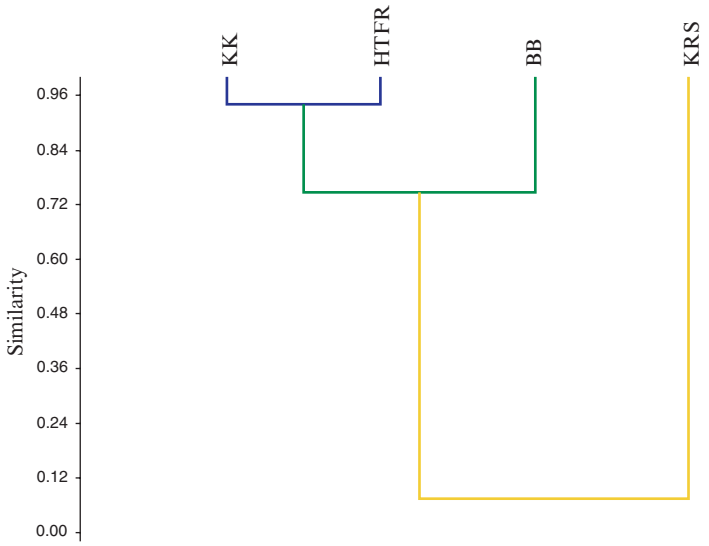

Fig. 2 Dendrogram shows the similarity between non-volant small mammal assemblages for each site

Table 2 Diversity measures of non-volant small mammal assemblages in Tasik Kenyir area

	HTFR	BB	KRS	KK
Shannon diversity index (H')	0.85	1.43	1.57	1.67
Margalef richness index (R_l)	0.91	1.52	2.00	1.95
Evenness (J')	0.77	0.89	0.80	0.93

HTFR Hulu Telemong Forest Reserve, *BB* Belukar Bukit, *KRS* Kenyir Research Station (UMT), *KK* Kampung Kemat

the species is easily attracted to any conventional baits (Bernard 2003; Medway 1983). Previous studies in Selangor, Kelantan, Pahang, Kelantan and Perak had recorded this species (Ruppert et al. 2015; Jayaraj et al. 2012, 2013; Tingga et al. 2012; Zakaria et al. 2001).

The non-volant small mammal assemblages in Kampung Kemat (KK) and Hulu Telemong Forest Reserve (HTFR) were clustered together with more than 90% similarity of species richness or assemblages in both sampling sites (Fig. 2). Subsequently, the two sites were followed by Belukar Bukit (BB) with approximately 73% of similarity. These three sites were found to be distantly clustered to Kenyir Research Station (KRS) with less than 12% similarity signified that most species found in the regenerated forest were different from disturbed and riparian forests.

The presence of variety of disturbed habitats such as human settlements, oil palm plantations and orchards in Kampung Kemat showed that the high abundance of non-volant small mammals which included the pests and commensal species, House Rat (*Rattus rattus*) that mainly found in correlation with human and the rarely

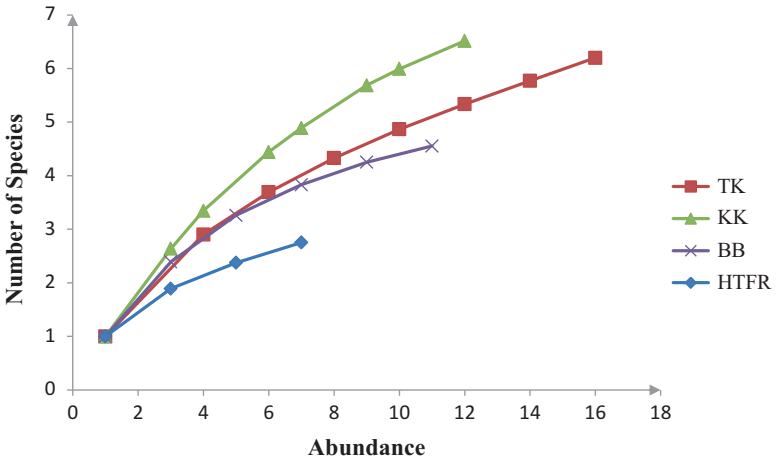

Fig. 3 Species accumulation curves for non-volant small mammals in Tasik Kenyir area, Hulu Terengganu

captured flying squirrel, Grey-cheeked Flying Squirrel (*Hylopetes platyurus*). The non-volant small mammals may rely on the abundance of resources available in these kinds of habitat (Wells et al. 2004). The high diversity of non-volant small mammal assemblage in Kampung Kemat may also be influenced by the presence of microhabitats such as tree logs, burrows and tree holes where these microhabitats could provide shelters and nesting places. Zakaria and Nordin (1998) suggested that variability of habitats is affecting the species assemblages in an area aside from other factors such as distribution and abundance of food supplies. In contrast, Hulu Telemong Forest Reserve recorded the lowest species diversity and richness because of human encroachment and disturbance are affecting the non-volant small mammal community. Zakaria et al. (2001) and Corlett (1992) stated that the Common Treeshrew (*T. glis*) and the Plantain Squirrel (*Callosciurus notatus*) have high tolerance towards habitat disturbance.

The species accumulation curves have shown that 23 sampling nights were inadequate to record all non-volant small mammal assemblages in Tasik Kenyir area as the curves were increasing exponentially. Other species may be added to the species checklist of Tasik Kenyir if the sampling duration is extended.

Conclusion

The variety of microhabitats could sustain a high diversity of non-volant small mammals. Although the disturbed forest of Kampung Kemat recorded the highest diversity of non-volant small mammals with 13 individuals belong to three orders, four families and six species, most of the species such as the Common Treeshrew (*T. glis*) and Plantain Squirrel (*C. notatus*) are very adaptable in any kind of habitat.

Therefore, types of habitat may influence the species richness and diversity of non-volant small mammals by their tendency to adapt to those types of habitat. Therefore, it is suggested that a proper forest inventory and stricter laws be established for the protection and conservation of endangered species in Tasik Kenyir area, Hulu Terengganu to conserve the non-volant small mammal community in the area.

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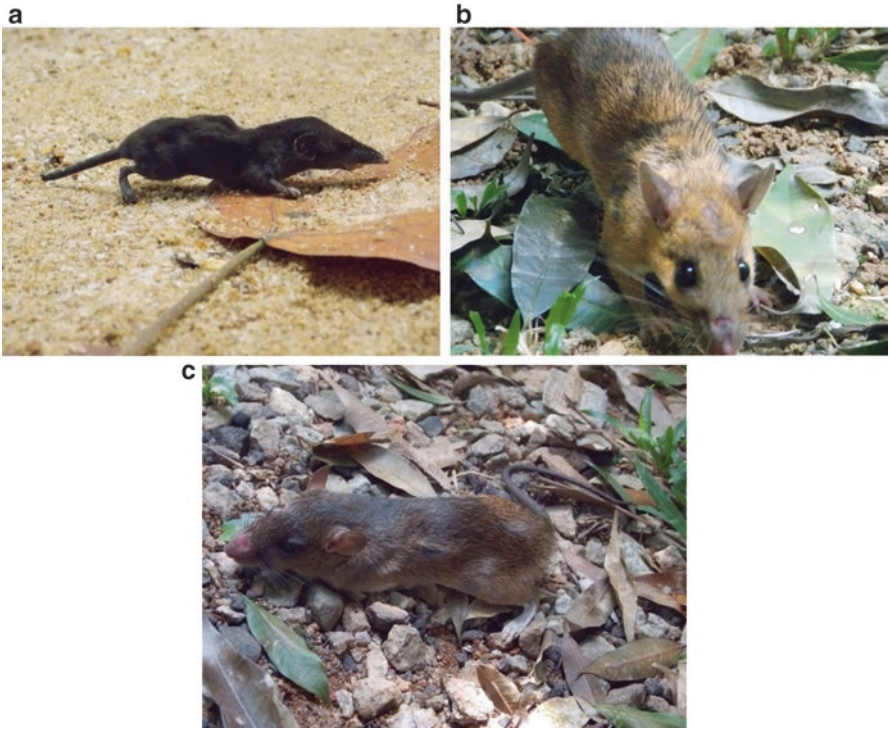
Appendix

Some photos of the non-volant small mammals recorded at Tasik Kenyir, Hulu Terengganu, Terengganu (a) Savi's Pigmy Shrew (*Suncus etruscus*), (b) Red Spiny Maxomys (*Maxomys surifer*) and (c) Müller's Rat (*Sundamys muelleri*).



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