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## Two New Distributional Records of Gliding Squirrels in Merapoh Forest Complex, Pahang.

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**Abstract.** A preliminary survey on the diversity of gliding squirrels was conducted from September 2019 until February 2020 in several locations within Merapoh, Pahang, Peninsular Malaysia using standard line transect method. The survey areas include a pristine forest, logged-over forest and agro-forested plantations. Gliding squirrels were spotted using a headlamp, binoculars (8x30 magnification) and a Digital SLR affixed with a telephoto lens (Nikon D500 + Nikkor 200-500 F5.6 VR) as they are mainly nocturnal. The highlight of this short survey was two new distributional records of flying squirrels for Merapoh Forest Complex. These two species were Spotted giant gliding squirrel (*Petaurista elegans*) and Temminck's gliding squirrel (*Petinomys setosus*). Other gliding squirrels recorded in this survey include the Red Giant gliding squirrel (*Petaurista petaurista*), Horsfield's gliding squirrel (*Iomys horsfieldii*) and Red-cheeked gliding squirrel (*Hylomys spadiceus*). Apart from gliding squirrel, a total of eleven (11) species of other squirrels were also recorded within this survey. Continuous and systematic diversity surveys on gliding squirrels are needed as it is still understudied in Malaysia especially Merapoh.



## 1. Introduction

Gliding squirrels are mammals classified in the Order Rodentia and the Family Sciuridae [1]. Gliding squirrels are nocturnal mammals that are elusive and rarely documented in Malaysia. It can be differentiated from other squirrels with the presence of gliding membranes that stretches from its carpal spur to the legs and this gives the ability to glide from one tree to another. Gliding squirrels can be differentiated from Colugo as they can fold its gliding membrane away when not in use. Gliding squirrels are rarely sighted since they are arboreal species. Most existing records are photos of these animals at the canopy layer of tropical rainforest. They play an important role in the tropical forest ecosystem and as an indicator for forest health [2, 3, 4, 5]. This mammal is understudied and taxonomically placed in the family Sciuridae [6] that belong to 15 different genera in two subtribes— (i) subtribe Glaucomyina: *Eoglaucmys*, *Glaucomys*, *Hylopetes*, *Iomys*, *Petaurillus*, *Petnomys*; (ii) subtribe Peromyina: *Aeretes*, *Aeromys*, *Belomys*, *Biswamoyopterus*, *Eupetaurus*, *Petaurista*, *Pteromys*, *Pteromyscus*, *Trogopterus* [7].

Merapoh is located in the Central Forest Spine Primary Linkage I between the two significant forest body of the Peninsular Malaysia, the Titiwangsa range and Taman Negara range. This area consists of different type of vegetation; pristine forest (Taman Negara), agro-forested plantation; farm (fruit orchard), oil palm and rubber plantation (oil palm and rubber) and logged-over forest. This location may probably be the last refuge for gliding squirrel as it consists of several protected areas (Sungai Yu-Sungai Tanum Forest Reserves (CFS-PL1), Ulu Jelai Forest Reserve and Persit Forest Reserve and Taman Negara, Merapoh). For ease of interpretation, these areas in Merapoh are referred as Merapoh Forest Complex (Figure 1). This mammal is currently threatened by habitat loss due to their high dependency on trees and holes for its nests, [5, 6] habitat and hiding places. It was hypothesized by Thorington and Heaney [8] that in thick vegetation, smaller species of gliding squirrels are adapted while larger species are more likely to be seen in open area. They are also threatened by hunting in Malaysia [8]. Understanding its diversity and occurrences is necessary to design proper conservation and effective management plan for these animals. Hence, this assessment aims to update the current conservation status of the gliding squirrels in Malaysia and provide a checklist of this mammal in Merapoh, Pahang, Malaysia.

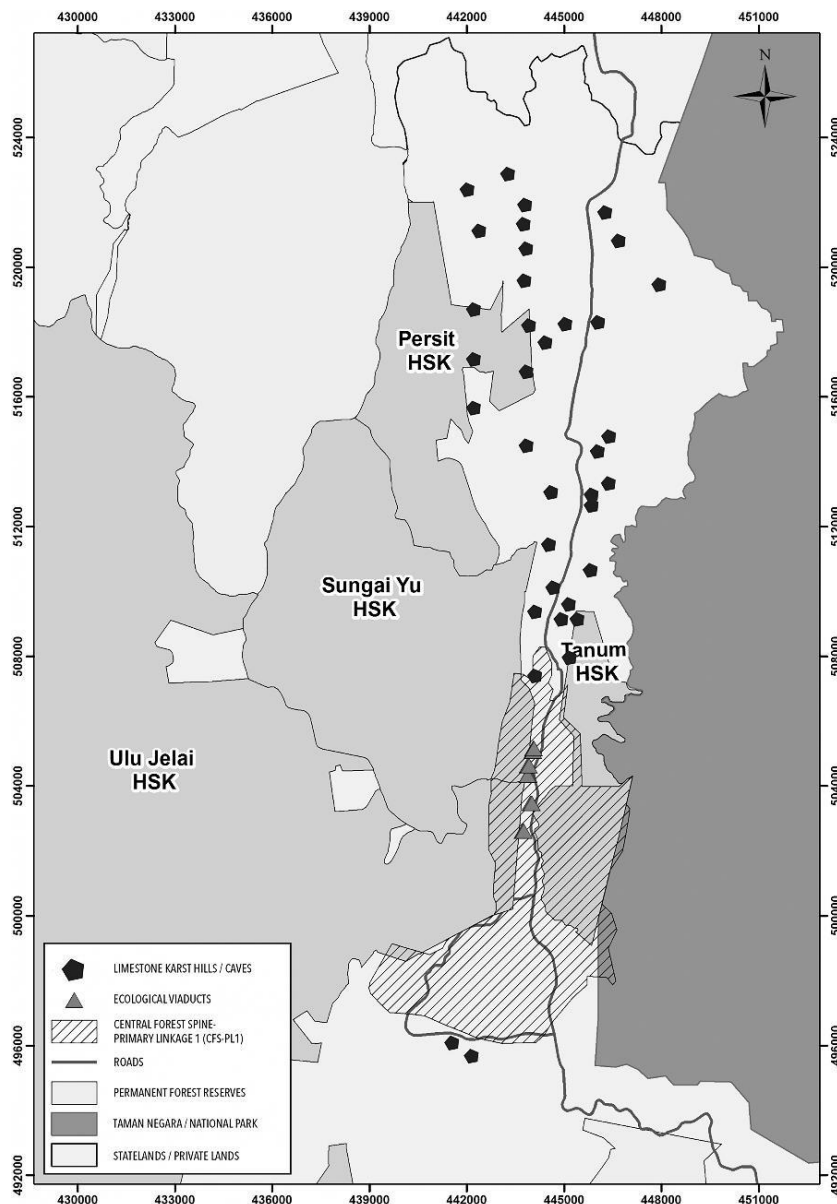
## 2. Materials and Method

### 2.1 Line Transect

Line transect is one of observation method used in estimating any biological abundance and density [9]. We did 20 kilometres of transect survey from the forest edge to maximize the detection of gliding squirrels in different types of vegetation: i) pristine forests; ii) logged-over forests, and iii) agroforested plantations. There was two sessions of sampling, day session for surveying the diurnal squirrel and night session for the gliding squirrel. Petzl-REACTIK + Headlamp 300 lumens was used to spot the gliding squirrels at night. Binoculars Bushnell (8x30 magnification) and a Digital SLR affixed with a telephoto lens (Nikon D500 + Nikkor 200-500 F5.6 VR + Nikon SB-700 AF Speedlight Flash) were used to identify gliding squirrels. The identification keys for species identification follows [10] and [11] with updates on available literature. The Malaysia Wildlife Conservation Act (WCA) 2010 [12] was referred to determine the current conservation status and legislative protection of the wildlife. The recorded species were checked with the IUCN Red List of Threatened Species 2020.

## 3. Taxonomic Checklist

A total of **5** out of **15 species** of gliding squirrels that can be found in Malaysia [13] were recorded in this preliminary survey. Merapoh gliding squirrel diversity is currently 50% of total diversity known in Peninsular Malaysia as there are 10 species of gliding squirrels in Peninsular Malaysia. Four species of these gliding squirrels are listed as Least Concern (LC), while the remaining one species is **listed as Vulnerable (VU)** by the International Union for Conservation of Nature (IUCN) Red List of Threatened Species 2020. **All species of gliding squirrels are listed as Totally Protected (TP)** under the Malaysian Wildlife Conservation Act (2010).



**Figure 1.** Map of Merapoh Forest Complex

We also managed to record a total of **10 species** of non-gliding squirrels. Eight species are listed as Least Concern (LC) followed by **two (2) Near Threatened (NT)** by the International Union for Conservation of Nature (IUCN) Red List of Threatened Species 2020. Under the Wildlife Conservation Act (2010), **two (2) are listed as Totally Protected (TP)**. The findings of our survey on gliding and non-gliding squirrels are outlined in **Table 1**.

Besides gliding and non-squirrels, there were also 9 species of nocturnal small mammals that were observed during these surveys. Seven species of these mammals are listed as Least Concern (LC): *Hystrix brachyura*, *Paradoxurus musangus*, *Arctogalidia trivirgata*, *Prionailurus bengalensis*, *Galeopterus variegatus*, *Pteropus hypomelanus* and *Tupaia glis*. One species listed as Near Threatened (NT) (*Hemigalus derbyanus*) and another classified as Vulnerable (*Nycticebus coucang*) by the International Union for Conservation of Nature (IUCN) Red List of Threatened Species 2020. The information on the diversity and occurrence of the gliding squirrels is important to prepare a strategic management and conservation action plan for this poorly understood and elusive taxa. The adaptability

of gliding squirrels in modified habitats found in Merapoh, Pahang need to be elucidated to reduce human-wildlife conflict that may arise in the future.

**Table 1.** Taxonomic checklist of gliding and non-gliding squirrel.

	Taxonomy	Common name	Malay name	WCA 2010	IUCN 2020
	<b>Order: Rodentia</b>				
	<b>Family: Sciuridae</b>				
	<b>Tribe: Pteromyini</b>				
1	<i>Petaurista petaurista</i>	Red giant gliding squirrel	Tupai terbang merah	TP	LC [14]
2	<i>Petaurista elegans</i>	Spotted gliding squirrel	Tupai terbang bintang	TP	LC [15]
3	<i>Iomys horsfieldii</i>	Horsfield's gliding squirrel	Tupai terbang ekor merah	TP	LC [16]
4	<i>Hylopetes spadiceus</i>	Red-cheeked gliding squirrel	Tupai terbang pipi merah	TP	LC [17]
5	<i>Petinomys setosus</i>	Temminck's gliding squirrel	Tupai terbang dada putih	TP	VU [18]
	<b>Family: Sciuridae</b>				
7	<i>Ratufa bicolor</i>	Black giant squirrel	Tupai kerawak	TP	NT [19]
8	<i>Ratufa affinis</i>	Cream-coloured giant squirrel	Tupai kerawak putih	TP	NT [20]
9	<i>Callosciurus prevostii</i>	Prevost's squirrel	Tupai gading	TP	LC [21]
10	<i>Callosciurus notatus</i>	Plantain squirrel	Tupai merah	-	LC [22]
11	<i>Callosciurus caniceps</i>	Grey-bellied squirrel	Tupai dada kelabu	-	LC [23]
12	<i>Callosciurus erythraeus</i>	Pallas's squirrel		-	LC [24]
13	<i>Sundasciurus lowii</i>	Low's squirrel	Tupai ekor pendek	-	LC [25]
14	<i>Sundasciurus tenuis</i>	Slender squirrel	Tupai cerleh	-	LC [26]
15	<i>Lariscus insignis</i>	Three-striped ground squirrel	Tupai belang tiga	-	LC [27]
16	<i>Tamiops maclellandii</i>	Himalayan stripe squirrel	Tupai bunga	-	LC [28]

#### 4. Species Account

##### A. Red Giant gliding squirrel, *Petaurista petaurista* (Pallas, 1766)

According to Wilson and Reeder [29], the Red Giant Flying Squirrel occurs throughout Asia ranging from Afghanistan, Pakistan, India, Nepal, South China, Myanmar, Thailand, Malaysia, Sumatra, Java and Borneo. It can be found in various habitat including lowlands and montane area, moist evergreen broadleaf forests, and temperate forest [30]. The squirrel was spotted within the agro-forested plantation, disturbed forest and pristine forest. It is the easiest species of gliding squirrel to be identified because of the size, colour and lack of white spots on its upperparts body.

##### B. Spotted Giant gliding squirrel, *Petaurista elegans* (Müller, 1840)

It is reported that this species occur in Nepal, Bhutan, Sikkim and northeastern India, south China and Myanmar, Laos, Vietnam, Thailand, Peninsular Malaysia, Sumatra, Java and Borneo on the northwest side [31]. **This sighting is a new local record for Merapoh, Pahang** based on the previous report by the Department of Wildlife and National Parks in the Red List of Mammal for Peninsular Malaysia (version 2) [12]. It is easily distinguished from other gliding squirrels by looking at its size, colour and white spot on their upperparts body.

C. Horsfield's gliding squirrel, *Iomys horsfieldii* (Waterhouse, 1838)

Corbet and Hill [32] reported that this species is distributed in Java and Sumatra, Indonesia, but Francis [10] updated that it can be found in Peninsular Malaysia, Borneo and Singapore as well. This species is distinguished from others by its flattened orange to reddish feather-like tail and orange gliding membrane's margin [33].

D. Red-cheeked gliding squirrel, *Hylopetes spadiceus* (Blyth, 1847)

The distribution of *H. spadiceus* ranges from Myanmar to Vietnam and western Cambodia, down to Thailand, Peninsular Malaysia and Singapore and Kundur Island (Riau Islands), Bangka Island, and Bunguran Island (Natuna Islands) in Indonesia [10, 33, 34]. It can also be found in Borneo [32] and has been reported as the most common gliding squirrel that can be found in lowland forest [35].

E. Temminck's gliding squirrel, *Petinomys setosus* (Temminck, 1844)

This species occurs from northern Myanmar, Thailand and Peninsular Malaysia. It also occurs in Sumatra and Sabah, Brunei, and Sarawak of the Borneo Island [11, 33]. **This finding is also a new local record for Merapoh, Pahang** based on the previous report by the Department of Wildlife and National Parks in the Red List of Mammal for Peninsular Malaysia [12]. This species can be identified by greyish to blackish brown upperparts and white underparts. The tail is dark brownish-grey and white at the base [10, 31].

### Conclusion

This study established the first diversity checklist of gliding squirrels and other squirrels found in Merapoh, Pahang, Malaysia as only one study on gliding squirrels has been done in Merapoh [36]. Continuous studies on gliding squirrel diversity, occurrence and behaviour need to be done with an increase in sampling effort to shed more light on the ecology of these elusive animals. This preliminary sampling shows that the diversity of gliding squirrels in Merapoh is high and there is a possibility of more records in the future based on the current data presented in the Red List of Mammals for Peninsular Malaysia by the Department of Wildlife and National Parks (2017). Such biodiversity studies in understudied areas are crucial for the conservation planning and management of understudied taxa [37, 38, 39].

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**Appendix A**



Red Giant gliding squirrel



Spotted Giant gliding squirrel



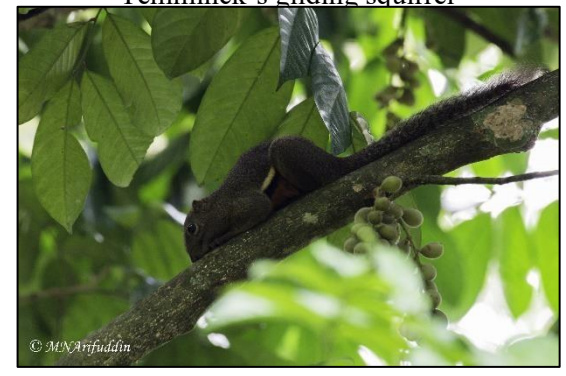
Horsfield's gliding squirrel



Temminck's gliding squirrel



Red-cheeked gliding squirrel



Plaintain squirrel



Prevost's squirrel



Himalayan striped squirrel



Three-striped ground squirrel



Cream-coloured giant squirrel



Black giant squirrel

**Figure A1.** Some photos of gliding squirrels and non-gliding squirrel at Merapoh, Pahang, Malaysia

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