

Mammalian Diversity of Gunung Ledang, Johor, Peninsular Malaysia

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ABSTRACT

Mammals play a crucial role for the biotic processes of the rainforest ecosystem. Studying their behaviour and biology are vital to fully understand the jigsaw of rainforest dynamics. This study was made to update the diversity checklist of mammals in Gunung Ledang. This study was done in Taman Negara Johor; Gunung Ledang (2.37°N, 102.60°E) where it is known to be the highest mountain (1,276 m asl.) in the southern Malay Peninsula. This study was conducted from July 2018 to April 2019. In total, 22 cameras were installed along three nature trails which are Sagill trail, Telekom Trail, and Resort Trail. Overall, a total of 31 species of terrestrial mammals from small- to large-sized were recorded in our camera trapping study of 3434 camera-days. Mammals such as the Leopard (*Panthera pardus*), Sumatran Serow (*Capricornis sumatraensis*), and Malayan Tapir (*Tapirus indicus*) were caught in the videos of camera trap. This showed that the diversity of mammals in Gunung Ledang is quite high. This paper already gave valuable insights in a rainforest guild that is highly diverse and of outstanding value to the forest ecosystem. Management plans and strategy to conserve the mammals in Gunung Ledang can be done as accordingly afterwards.

1. Introduction

Malaysia is one of the most mega diverse countries in the world. It ranks 12th globally according to National Biodiversity Index, which is based on country richness and endemism estimation in four terrestrial vertebrate classes and vascular plants. To date, there are around 5,801 mammal species that been described and evaluated the species status (IUCN 2018) and there are about 361 mammals species in Malaysia (Tajuddin 2013). This shows that Malaysia makes up 6.2% of the total mammal species. Gunung Ledang which includes a diverse range of habitats through different vegetation types are such example that potentially consist of rich fauna assemblage that yet to be explored. It is home to more than 1,000 species of plants. The forest consists of timber trees, herbs, shrubs, climbers and other flowering and non-flowering plants. There are four vegetation types in Gunung Ledang; lowland dipterocarp forest, hill dipterocarp forest, lower montane forest and montane ericaceous from lowland to the summit (Kiew 1992). Looking from this diverse

species of plants, Gunung Ledang harbors diversity of animals as well. This can be attributed from the presence of rivers and also a wide altitudinal range of Gunung Ledang.

Even as a protected area, Gunung Ledang is an isolated habitat, thus the ability of species to persevere is of concern (Froese *et al.* 2015). More studies should be made and important in understanding species occurrence and distribution in Gunung Ledang. By having these gathered information, a management and conservation plans can be planned and any potential threats can be addressed (Bernard *et al.* 2013). A continuous survey is necessary in order to get the information needed especially for medium to large sized mammals.

However, some mammals avoid open and disturbed sites and thus are not easily observed through conventional sampling methods, as for example, line transects and visual sampling. Moreover, tropical forest has dense, difficult terrain and also remote areas that will limit the monitoring of the mammals (Azlan 2009). Camera trapping is a good alternative to monitor wildlife in tropical rainforests and can be more effective than conventional surveys. Camera traps can be left in the field to continuously watch an area of habitat for weeks or even months, recording

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the rarest events which occur in nature (Wearn and Glover-Kapfer 2017). Camera traps can be used to monitor a host of different ecosystem variables, such as the abundance, diversity and distribution of animals. Hence, the study using camera trapping of mammals was made to update the diversity checklist of mammals in Gunung Ledang.

2. Materials and Methods

2.1. Study Site

This study was done in Taman Negara Johor; Gunung Ledang (2.37°N, 102.60°E, 86.11 km² in area) which lies in Tangkak District, Johor, Malaysia. The summit is located between the border of Johor and Melaka. Gunung Ledang is the highest mountain (1,276 m asl.) in the southern Malay Peninsula. The park is fully covered with natural forest. Vegetation is classified into four types along the altitude; lowland dipterocarp forest, hill dipterocarp forest, lower montane forest and montane ericaceous forest. Gunung Ledang is isolated from the nearest forest, Endau Rompin National Park (Figure 1) and surrounded by oil palm plantations.

2.2. Camera Trapping

This study was conducted from July 2018 to April 2019 as a total of 10 months field survey. In total 22 cameras were installed along three nature trails in July 2018 (Figure 1). Cameras were individually placed along each trail and some were deployed around visitor's complex. They were patrolled every two months to retrieve and change the memory cards and every four months to change batteries. There were, however, several instances where the

cameras were not working so replacements were deployed. Cameras were only removed or relocated to accommodate changing local conditions such as tree fall, dense undergrowth, and if the cameras went missing. The trapping effort at each camera-trap site was not, therefore, identical due to some of the relocation of the cameras. For this project, cameras of Acorn Ltl 6310 WMC with non-glow infrared LED light (940 nm) were used. All camera units were mounted on trees, 2–5 m from a path or trail, set around 30–50 cm from the ground. The cameras were set to 15 seconds recording time setting and 30 seconds interval between each videos. The video setting were assigned to all the cameras to video mode only. All animals were identified based on the taxonomic keys according to their respective kingdom. In essence, mammals were identified using (Payne 1985).

For the first stage, three different nature trails were used to install the cameras. We started the camera trapping from the foot of the mountain to the summit of Gunung Ledang. The trails used were Telekom trail (Trail A) and Sagil trail (Trail B) which is usually used by hikers (Figure 1). For the next stage (Figure 1), the manmade salt licks were put in two different places around visitor complex and at the bird tower, respectively. The cameras were set up in these two locations as well as the trails mentioned along their elevation.

2.3. Data Analysis

Paleontological Statistic (PAST) v2.17 software (Hammer *et al.* 2012) was used to calculate Shannon's diversity index. To perform diversity comparison with unequal sampling effort among sampling sites, we

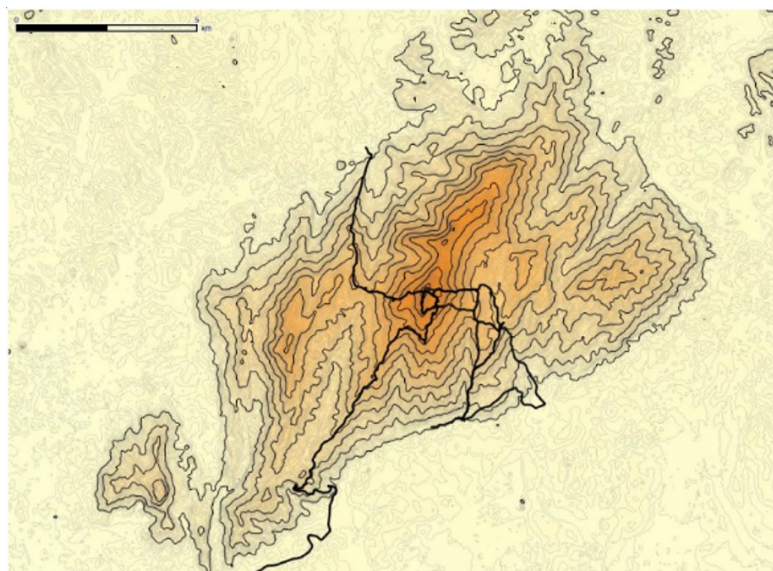


Figure 1. Map of Gunung Ledang, with the trails used for the study Johor, southern of Peninsular Malaysia

used rarefaction curve constructed by using EcoSim v1.2d software (Enstminger 2014) and Microsoft Excel. We also constructed species accumulation curve using EcoSim software. In addition, a taxonomic list of mammals was compared with previous studies done in Ledang in an expedition made by Universiti Teknologi Mara before.

3. Results

3.1. Diversity Checklist of Mammals in Gunung Ledang

A total of 31 mammal species, belonging to nine orders from 17 families were recorded in the videos from the camera trap (Table 1). Seven of these species are categorized as Vulnerable in IUCN Red

List, another one species as Endangered and there is one Critically Endangered which is *Manis javanica* (Sunda pangolin) (Challender *et al.* 2011). The seven species listed under Vulnerable are *Neofelis nebulosi* (Clouded leopard), *Panthera pardus* (Leopard), *Aonyx cinereus* (Asian small clawed otter), *Arctictis binturong* (Binturong), *Capricornis sumatraensis* (Sumatran serow), *Macaca nemestrina* (Southern pig tailed macaque), and also *Maxomys rajah* (Rajah spiny rat). While for species listed under Endangered species category is *Tapirus indicus* (Malayan tapir). The mammalian order with most species recorded was Carnivora which is 12 species followed by Rodentia, seven species. From the project, a total of 12,560 videos were caught. The total sampling effort was 3434 camera trap days over the course of 10 months.

Table 1. List of mammals of Gunung Ledang recorded in the studies

Scientific name	Name	Order	Family	IUCN status
<i>Canis lupus familiaris</i>	Domestic dogs	Carnivora	Canidae	N/A
<i>Catopuma temminckii</i>	Asiatic golden cat	Carnivora	Felidae	NT
<i>Neofelis nebulosi</i>	Clouded leopard	Carnivora	Felidae	VU
<i>Panthera pardus</i>	Leopard	Carnivora	Felidae	VU
<i>Prionailurus bengalensis</i>	Leopard cat	Carnivora	Felidae	LC
<i>Pardofelis marmorata</i>	Marbled cat	Carnivora	Felidae	NT
<i>Aonyx cinereus</i>	Asian small clawed otter	Carnivora	Mustelidae	VU
<i>Martes flavigula</i>	Yellow throated marten	Carnivora	Mustelidae	LC
<i>Prionodon linsang</i>	Banded linsang	Carnivora	Prionodontidae	LC
<i>Arctictis binturong</i>	Binturong	Carnivora	Viverridae	VU
<i>Viverra zibetha</i>	Large Indian civet	Carnivora	Viverridae	LC
<i>Paguma larvata</i>	Masked palm civet	Carnivora	Viverridae	LC
<i>Sus scrofa</i>	Wild boar	Cetartiodactyla	Suidae	LC
<i>Tragulus napu</i>	Greater oriental chevrotain	Cetartiodactyla	Tragulidae	LC
<i>Capricornis sumatraensis</i>	Sumatran serow	Cetartiodactyla	Bovidae	VU
<i>Muntiacus muntjak</i>	Southern red muntjak	Cetartiodactyla	Cervidae	LC
<i>Echinosorex gymnura</i>	Moon rat	Eulipotyphla	Erinaceidae	LC
<i>Tapirus indicus</i>	Malayan tapir	Perissodactyla	Tapiridae	EN
<i>Manis javanica</i>	Sunda pangolin	Pholidota	Manidae	CR
<i>Trachypithecus obscurus</i>	Dusky leaf monkey	Primates	Cercopithecidae	NT
<i>Macaca fascicularis</i>	Nicobar crab eating macaque	Primates	Cercopithecidae	LC
<i>Macaca nemestrina</i>	Southern pig tailed macaque	Primates	Cercopithecidae	VU
<i>Trichys fasciulate</i>	Long tailed porcupine	Rodentia	Hystricidae	LC
<i>Hystrix brachyura</i>	Malayan porcupine	Rodentia	Hystricidae	LC
<i>Sundasciurus lowii</i>	Low's squirrel	Rodentia	Sciuridae	LC
<i>Rattus tiomanicus</i>	Malayan field rat	Rodentia	Muridae	LC
<i>Ratufa bicolor</i>	Malayan giant squirrel	Rodentia	Sciuridae	NT
<i>Callosciurus notatus</i>	Plaintain squirrel	Rodentia	Sciuridae	LC
<i>Callosciurus prevostii</i>	Prevost's squirrel	Rodentia	Sciuridae	LC
<i>Maxomys rajah</i>	Rajah spiny rat	Rodentia	Muridae	VU
<i>Tupaia glis</i>	Common tree shrew	Scandentia	Tupaiaidae	LC

CR:critically endangered, EN:endangered, VU:vulnerable, NT:near threatened, LC:least concern, N/A:not available

3.2. Species Richness and Species Accumulation Curve

The results also indicates that the family Felidae has the highest number of species obtained. The family which includes five species caught in the videos were Asiatic golden cat, Leopard, Clouded leopard, Leopard cat, and also Marbled cat (Figure 2). This is followed by three family, Viverridae, Cercopithecidae and Sciuridae which caught three species each in the study.

The species accumulation curve appeared to increase by the effort time of camera days, suggesting that the number of few additional species will be discovered with further camera trapping effort (Figure 3). From the graph in Figure 3, the number of species caught in video starting from July 2018 increased proportionally until April 2019.

3.3. Mammal Diversity Comparison Between Gunung Ledang and Endau Rompin

This forest ecosystem is very unique in southern part of Peninsular Malaysia but has not been studied much looking from the viewpoint of medium to large mammals. Based on a preliminary survey by (Madinah *et al.* 2011), a total of 17 species of mammals from 10 families were recorded in Gunung Ledang by trapping (13 spp.) and observations (4 spp.). The study made

by (Madinah *et al.* 2011) was a short survey focusing only two sites but yielded important information on animals in Gunung Ledang. Another study in Gunung Ledang by (Wazir *et al.* 2017) yielded only four mammal species, while another study by (Ilyas and Ebil 2017) gained 19 mammals species. These two studies were more focused on non-volant small mammals. However, there is one study by (Farid *et al.* 2017) that focused more to large mammals and they managed to get a total of 11 species of large mammals. The comparison of the studies previously made in Gunung Ledang is shown in Table 2.

4. Discussion

4.1. Diversity of Mammals in Gunung Ledang

Azlan (2006) conducted a study of camera trapping in disturbed forest in Peninsular Malaysia. In comparison with his findings, this study did not detect Asian Elephant (*Elephas maximus*) and Tiger (*Panthera tigris*). Although previously in an old record of Gunung Ledang by (JNPC 2012), it showed that both big mammals lived in Gunung Ledang. However, the similarities in other captured animals such as Tapir (*Tapirus indicus*), Black panther (*Panthera pardus*), Sumatran serow (*Capricornis sumatraensis*) and also some other mammals, showed that Gunung Ledang

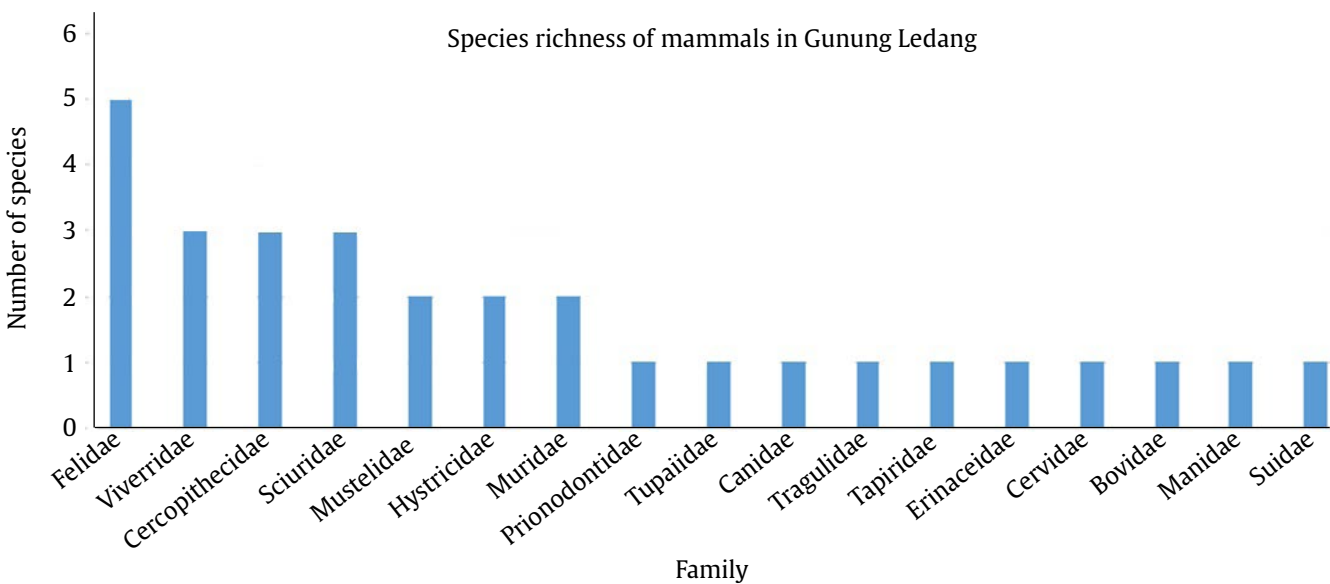


Figure 2. Graph of mammals species richness according to family

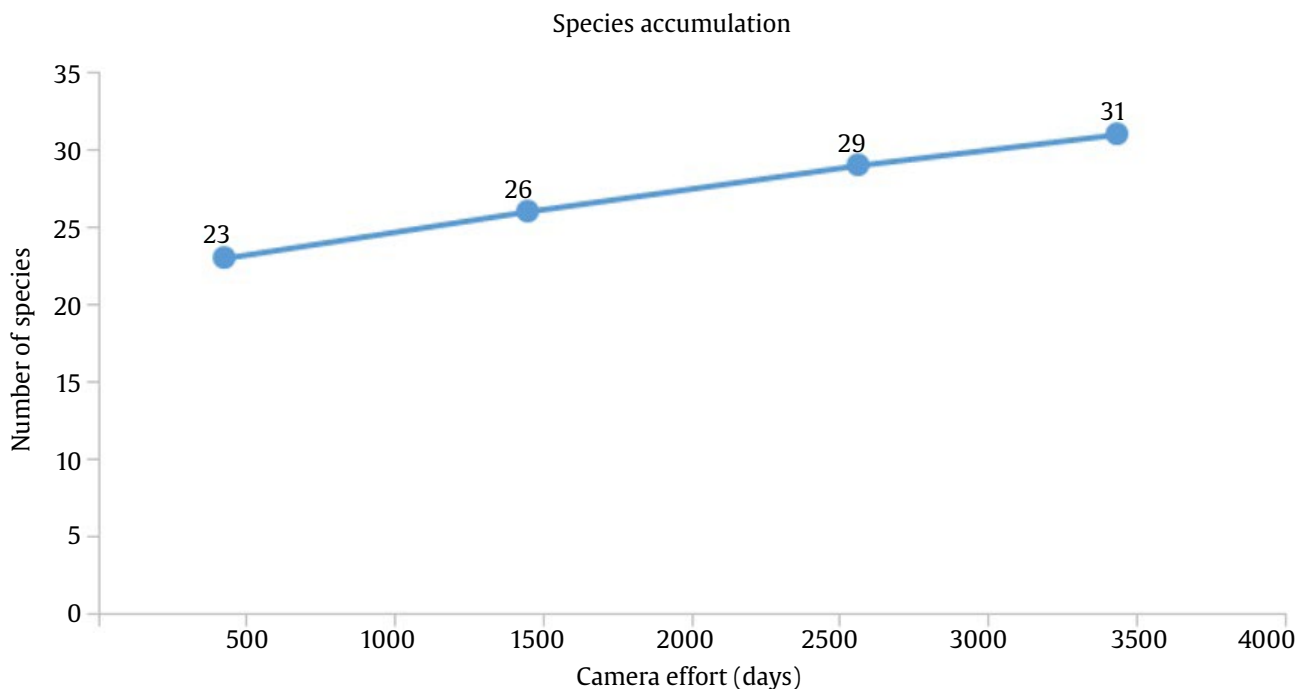


Figure 3. Cumulative number of species caught in GLNP from July 2018 to April 2019

Table 2. Comparison studies between Gunung Ledang and Endau Rompin

	Gunung Ledang					Endau Rompin
	Present study	Madinah <i>et al.</i>	Ilyas and Ebil	Wazir <i>et al.</i>	Mohd Farid <i>et al.</i>	Aihara <i>et al.</i>
Sampling effort	3,434	175	Unknown	280	Unknown	220
Total mammal species	31	17	19	4	11	84
Total camera photos	12,560	N/A	N/A	N/A	Unknown	34
Type of observation	CT, O	HT, LT, O	LT, O	LT	CT, O	CT, O

CT:camera trapping, HT:harp trap, LT:live trap, O:observation

still harbor many endangered and elusive species. This indicates that the forest of Gunung Ledang value is irreplaceable.

Following the result in this study, the number of Felide family caught in the camera are high. In the absence of hunting, prey availability appears to be the main factor controlling carnivore densities, although there will be some exceptions to this (Creel 2001). This is supported by the abundance of small mammals in the Gunung Ledang being caught in the video. For the Rodentia family for example, they are the main food for predatory animals such as cat species and snakes (DWNP 1998).

4.2. Species Richness and Species Accumulation Curve

The accumulative curve in this study is not yet to level off after ten months of sampling. This is in line with the study by (Azlan 2006) which did a research

in a secondary forest in Malaysia. Their species accumulative curve leveled off after 16 month with 24 camera stations (c. 11,520 camera days) with a total of 25 species of wild mammals detected. However, the hilly terrain may affects the diversity of small species of mammals within the Gunung Ledang. Usually, large numbers of small mammals are found in lowland forests and while in the highlands, less are found (DWNP 1998).

In contrast of the study, daily weather variables such as rainfall, temperature or humidity will affect the number and species caught in the trap or video (Read and Moseby 2001). All the variables will later abrupt the behavior of the animals and thus, the accumulative curve. However, more research time is needed to see the changes in the curve and the study suggested that more number of species will be caught by camera in Gunung Ledang as the study continues.

4.3. Mammal Diversity Comparison Between Gunung Ledang and Endau Rompin

For a comparison, a total of 84 spp. of mammals inhabiting Taman Negara Endau Rompin (Aihara *et al.* 2016), an adjacent national park in Johor. This shows a very huge difference in number of mammals caught in both sites, Gunung Ledang and Endau Rompin. The difference in mammal diversity between these two places varies due to various factors including sampling methods, total effort, the duration of study and also the size of the sites (Azlan 2009). The size of Gunung Ledang is 86.11 km² while 489.05 km² for Endau Rompin. Moreover, Gunung Ledang is an isolated mountain surrounded by oil palm plantation making it not connected to the other forest; thus limiting the mammals' movement.

However, the results from this present study revealed that there are Sumatran serow, golden cat, leopard and some other large mammals which were not discovered in previous study. By having this extensive survey of camera trapping and the sites of camera placing are more distributed, more information on distribution and abundance of the mammals in Gunung Ledang.

5. Conclusion

In conclusion, our study indicates that Gunung Ledang can accommodate very diverse and dynamic part of the ecosystem that is constantly changing. More studies are needed to confirm our preliminary findings and to further investigate the factors that affect mammalian species presence within the highland forest. Nevertheless, this paper already gave valuable insights in a rainforest guild that is highly diverse and of outstanding value to the forest ecosystem. Mammals play a crucial role for the biotic processes (like seed dispersal) of the rain forest ecosystem. Studying their behaviour and biology is vital if one wants to fully understand the jigsaw of rain forest dynamics. Only by understanding how the different components of this jigsaw work together we will be able to act towards conservation and preservation of this highly vulnerable ecosystem. Thus, the videos and pictures obtained from our study can be used to attract more people who want to learn about the nature of Gunung Ledang (ecotourism).

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