

Comparative Diversity of Non-Volant Small Mammals in Hutan Lagenda and Waterfall Gunung Ledang

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Abstract

Gunung Ledang is a biodiversity hotspot of Johor, Malaysia. This forest includes a variety of habitats that support a broad spectrum of species, including small mammals that support the stability of ecosystems. This study investigates and compares the diversity of non-volant small mammals in two distinct sites within Gunung Ledang Johor National Park, Hutan Lagenda and Waterfall as there is not much data on the species diversity in Gunung Ledang National Park. At each location, 24 cage traps were deployed with bananas, dead fish and belacan as bait. A total of 8 individuals were captured from seven species and were classified into three families during twelve days of sampling at both locations. The Muridae family was the most abundant species found with *Leopoldamys sabanus* (n=1), *Maxomys rajah* (n=1), *Rattus tiomanicus* (n=1), and *Rattus norvegicus* (n=1). The second most abundant species was the Sciuridae family with *Callosciurus notatus* (n=1) and *Sundasciurus tenuis* (n=1) and the last was Tupaiidae, with one species recorded, *Tupaia glis* (n=1). The Waterfall site recorded five species whereas Hutan Lagenda reported two species, indicating a higher species richness in the Waterfall site. The p-value of 0.10 showed that the two locations were not significantly different as both of the sites might share similar habitat characteristics and ecological niches.

1. Introduction

Gunung Ledang is the highest mountain in the southern Peninsular of Malaysia, sometimes called Mount Ophir, which rises 1,276 meters above sea level in Johor. It is renowned for its animals, lush vegetation and local folklore, which includes the Puteri Gunung Ledang tale. It is situated in a protected area that is rich in biodiversity [1]. Many hikers are drawn to the mountain by its strenuous paths, breathtaking waterfalls and cultural allure. Lower montane, hill dipterocarp, low dipterocarp and montane ericaceous forests are the four vegetation types found in the park, and the park has two entrances at Sagil, Johor and Asahan, Melaka. Sagil Waterfall is its most well-known and advanced location [2]. A wide range of fauna including amphibians, birds, aquatic creatures, mammals and insects may be found in Gunung Ledang National Park. There are small mammals like squirrels, rodents and bats as well as larger mammals like tapirs, barking deer and wild boars. The Rajah spiny rat (*Maxomys rajah*), which is found in primary forests, the Prevost's squirrel (*Callosciurus prevostii*), and the long-tailed porcupine (*Trichys fasciculata*) which is native to Southeast Asia.

Non-volant small mammals referred to animals in the rodent, marsupial, shrew and threeshew families that weigh less than 1 kg [3]. In Malaysia, Erinaceidae, Muridae, Sciuridae, Soricidae, Tupaiidae and Viverridae are the families that can be found [4,5,6,7,8,9,10]. Non-volant small mammals are essential to ecosystems because they help spread seeds, pollinate plants and regulate insect populations. They also function as indicators of the

health of ecosystems. Investigating these species provides important information for scientific study and conservation [11]. In a previous study, *Rattus rattus* from the family Muridae, *Tupaia glis* and *Sundasciurus* from the family Sciuridae were found in Gunung Ledang [12]. In another research, *Trichys fasciulate*, *Hystrix brachyura*, *Sundasciurus lowii*, *Rattus tiomanicus*, *Ratufa bicolor*, *Callosciurus notatus*, *Callosciurus prevostii*, *Maxomys rajah*, and *Tupaia glis* were recorded [13]. However, there is not much current list of non-volant small mammals in Gunung Ledang National Park. Therefore, this study aims to determine and compare the species diversity of non-volant small mammals between Hutan Lagenda and Waterfall in Gunung Ledang National Park.

2. Methodology

2.1 Sampling Site

This research was conducted in two locations of Gunung Ledang, Hutan Lagenda ($2^{\circ}20'37''$ N, $102^{\circ}37'04.0''$ E) and Waterfall ($2^{\circ}20'00''$ N, $102^{\circ}38'08''$ E). The peak of Gunung Ledang Hutan Lagenda has an elevation of 1276 meters (4186 feet) above sea level and covers an area of 10,022 hectares. Besides that, Gunung Ledang Waterfall or Air Terjun Gunung Ledang can be found in the lush Gunung Ledang National Park and it covers a zone of almost 10,353 hectares. Before the research, the permit was obtained from the Department of Wildlife and National Parks (PERHILITAN) and Johor National Parks Corporation (see Fig. 1).



Fig. 1 Map of Hutan Lagenda and Waterfall Gunung Ledang, Johor (Google Map)

2.2 Cage Trap

In this study, non-volant small mammals were collected using a cage trap. This method was frequently employed to capture small mammals. To catch the non-volant small mammals, cage traps were set up at Hutan Lagenda and Waterfall Gunung Ledang. There will be a total of 24 cage traps spread throughout the two sites in Hutan Lagenda, with 12 cage traps on the ground and branches respectively. The same technique was applied at the Waterfall site. The cage traps were positioned on either side of the about 100-meter-long paths, with a minimum of 10 meters between each successive cage. Each site was conducted for 6 days, a total of 12 days for both sites. A variety of baits including dead fish, belacan and bananas were used to bait the cage traps [14]. On the morning of the first sampling day, the traps were opened and on the last sampling day, they were closed. Every two to three hours, the cage traps were checked. In order to gather information for identification, the non-volant small mammals that were captured in the cage trap were moved to a cloth bag. The number of small mammals captured was noted in a notebook to determine their diversity. The captured animals were returned to the forest once all the data such as head and body length, tail length, ear length and limb length, hindfoot length had been recorded. All the small mammals caught were identified based on the taxonomic keys.

2.3 Data Analysis

The data collected were organized and analysed using Shannon Weiner Index (H') and Simpson Index (D) with Microsoft Excel and SPSS (Statistical Package for Social Science) software respectively. The Shannon-Wiener diversity index is commonly used for comparing diversity across different habitats [15] whereas the Simpson Index is a weighted average of relative abundances, assessing the likelihood that two randomly chosen individuals from a sample will be from the same species [16].

$$\text{Shannon-Weiner Index } (H') = -\sum_{i=1}^S \pi_i \ln \pi_i \quad (1)$$

where:

H' = the species diversity index

Σ = the sum of the calculations

S = the number of species

i = the presence of species

p = the proportion (n/N) of individuals of one species found (n) divided by the total number of individuals found

$$(N) = \frac{\text{Number of individuals of one species } (n)}{\text{Total number of individual species } (N)}$$

\ln = the natural log

$$\text{Simpson Diversity Index } (D) = 1 - \frac{\sum n(n-1)}{N(N-1)} \quad (2)$$

where:

Σ = the sum of the calculations

n = the number of individuals per species

N = the total number of all individuals

3. Result and Discussion

3.1 Recorded Species of Non-volant Small Mammals in Gunung Ledang

A total of 8 individuals of non-volant small mammals belonging to 7 species in 3 families were caught during this study (Table 1). The captured small mammals are shown in Fig. 2. The body measurements of non-volant small mammals were recorded in Table 2. According to Table 1, *Rattus tiomanicus* was discovered in the Hutan Lagenda site with one individual while *Leopoldamys sabanus*, *Maxomys rajah* and *Rattus norvegicus* were reported at the Waterfall with one individual from the Muridae family. Both *Sundasciurus tenuis* and *Callosciurus natatus*, members of the Sciuridae family were captured at the Waterfall and Hutan Lagenda respectively with single individual. There were two individuals of the Tupaiidae family represented by *Tupaia glis* at the Waterfall and non at Hutan Lagenda. In this study, *Tupaia glis* ($n=2$) from the family Tupaiidae were the most recorded species whereas just one individual of each species was recorded. The majority of the species among the three families were found in the Muridae family (4 species), which included *Leopoldamys sabanus*, *Maxomys rajah*, *Rattus tiomanicus* and *Rattus norvegicus*. Followed by the Suciuridae family (2 species) which included *Callosciurus notatus* and *Sundasciurus tenuis*, and last the Tupaiidae family (1 species).

Table 1 List of non-volant small mammals recorded in Hutan Lagenda and Waterfall

Family	Species	Sampling Site	
		Hutan Lagenda	Waterfall
Muridae	<i>Leopoldamys sabanus</i>	0	1
	<i>Maxomys rajah</i>	0	1
	<i>Rattus tiomanicus</i>	1	0
	<i>Rattus norvegicus</i>	0	1
Sciuridae	<i>Callosciurus notatus</i>	1	0
	<i>Sundasciurus tenuis</i>	0	1
Tupaiidae	<i>Tupaia glis</i>	0	2

Total Individuals	2	6
Total Species	2	5

Table 2 Measurements of non-volant small mammals captured

Species	Gender	Head & Body (cm)	Tail (cm)	Limb (cm)	Hind feet (cm)	Ear (cm)	Total Length (cm)
Hutan Lagenda							
<i>Rattus tiomanicus</i> (n=1)	Female	14.4	12.5	2.0	3.0	1.5	26.9
<i>Callosciurus notatus</i> (n=1)	-	-	-	-	-	-	-
Waterfall							
<i>Leopoldamys sabanus</i> (n=1)	Male	22.3	33.8	4.4	4.7	2.7	56.1
<i>Maxomys rajah</i> (n=1)	Female	20.4	29.9	3.6	4.5	2.7	50.3
<i>Tupaia glis</i> (n=2)	Female	17.3±0.1	16.5±0.1	5.1	10.3±0.2	-	33.8±0.2
<i>Sundasciurus tenuis</i> (n=1)	Female	15.5	14.0	3.6	8.0	-	29.5
<i>Rattus norvegicus</i> (n=1)	-	-	-	-	-	-	-



(a)



(b)



(c)



(d)



(e)



(f)



(g)

Fig. 2 Picture of non-volant small mammals (a) *Leopoldamys sabanus* (b) *Maxomys rajah* (c) *Rattus tiomanicus* (d) *Rattus norvegicus* (e) *Callosciurus notatus* (f) *Sundasciurus tenuis* (g) *Tupaia glis*

3.2 Comparison of Species Diversity of Non-volant Small Mammals

Based on Table 3, the species richness of the Waterfall site (5 species) was higher than the Hutan Lagenda site (2 species). The Waterfall site has a higher Shannon Weiner Index ($H' = 1.56$) than the Hutan Lagenda site ($H' = 0.69$). Additionally, the Waterfall site also has a higher Simpson Diversity Index ($D = 0.78$) compared to the Hutan Lagenda site ($D = 0.50$). The p-value (0.10) indicates that there was no significant difference between these two sample sites at the conventional significance level ($p < 0.05$). The Waterfall site showed higher diversity in terms of species richness, Shannon Weiner Index and Simpson Diversity Index compared to the Hutan Lagenda site because the Waterfall was closed to visitors since October 14, 2024, which likely had higher captures due to reduced human disturbance. Pest management for leptospirosis and heavy rainfall during the study may have affected small mammals' activity and abundance, especially at Hutan Lagenda [17]. Rain would impact vegetation, food availability and movement of small mammals [18]. Some of the small mammals are forced to move to new areas in order to find food and suitable habitats during the rainy season [19]. Besides that, factors like trap placement, short sampling duration and bait choice [20] may have influenced trapping success. The p-value of 0.10 indicates no statistically significant difference in non-volant small mammal diversity between Hutan Lagenda and the Waterfall as the two locations might share similar ecological conditions such as food availability and habitat structure. Additionally, a small sample size and limited sampling effort could have underestimated the true species richness and diversity.

Table 3 Diversity measures of non-volant small mammal assemblages in Hutan Lagenda and Waterfall

Indices	Sampling Site	
	Hutan Lagenda	Waterfall
Species Richness	2	5
Shannon Weiner Index (H')	0.69	1.56
Simpson Diversity Index (D)	0.50	0.78
	p-value = 0.10	

4. Conclusion

In conclusion, the study successfully achieved its objectives, investigating non-volant small mammal diversity at two sites in Gunung Ledang National Park, and identifying seven species from three families with higher diversity at the Waterfall site. However, the study faced limitations such as a short sampling duration, small sample size, and challenges with cage traps and bait attractiveness which may have underestimated diversity. Further research should extend the sampling period across multiple seasons, increase sampling sites and traps and use advanced methods like camera traps.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: **study conception and design:** Ng Yi Thong; **data collection:** Ng Yi Thong; **analysis and interpretation of results:** Ng Yi Thong, Arney Sapaat; **draft manuscript preparation:** Ng Yi Thong, Arney Sapaat. All authors reviewed the results and approved the final version of the manuscript.

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