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A Brief Survey of Non-Volant Small Mammals in Pulau Tioman, Pahang, Malaysia

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ABSTRACT. From 26th to 30th August 2019, a brief survey of non-volant small mammals was conducted in Pulau Tioman, Pahang. A transect line has been set up each at Juara trail and Air Batang for this study. At each location, 60 cage traps were deployed with oil palm fruits, salted fish, and ripe bananas with peanut butter as bait. A total of 21 individuals were captured from five species and were classified into three families during five days of sampling. Muridae was recorded as the most abundant (n=12) with *Leopoldamys sabanus* (n=6) as the dominant species, followed by *Rattus tiomanicus* (n=4) and *Maxomys surifer* (n=2). Meanwhile, only one species was recorded for Tupaiidae and Sciuridae which were *Tupaia glis* (n=8) and *Callosciurus notatus* (n=1), respectively. All species were categorized as Least Concern (LC) according to the 2017 IUCN red list. Juara trail comprises a higher species richness and abundance due to the variety of microhabitats which is in the secondary forest area. Extensive sampling is recommended to assess a wider diversity of non-volant small mammals in Pulau Tioman. However, the findings of this survey highlight a decent diversity of non-volant small mammals that should be conserved and protected by sustainable development and management of the island, which has become threatened by the ever-increasing eco-tourism.

Keywords: East coast island, island biogeography, wildlife, ecology, diversity.

INTRODUCTION

Pulau Tioman, which is a part of Pahang state is the largest island in Peninsular Malaysia (110 km^2). It is located at the coordinates 2.7902° N, 104.1698° E (Latiff et al., 1999). Though Pulau Tioman is presently 38 kilometers from Mersing, Johor, it is speculated that it is connected to Borneo and the Malay Peninsula in the Sundaland continent during the previous ice age, probably in the late Pleistocene (Ng et al., 1999; Voris, 2000). The tropical rainforest covers a large part of the island, with hilly topography, inland forest, and some flat land parts along the shore (Abdul, 1999). Tioman was gazetted as a wildlife reserve by the state government of Pahang in 1972 to safeguard its flora and fauna (Abdul, 1999). It is well-known for its beautiful beaches and marine ecosystems, which have attracted many tourists from both local and abroad.

The island's non-volant small animal record was last studied more than half a century ago. A total of 12 species have been recorded by Nadchatram et al. (1966) that are known as *Leopoldamys sabanus, Rattus tiomanicus, Rattus exulans, Callosciurus nigrovittatus, Callosciurus notatus, Crocidura malayana, Hylomys suillus, Lariscus insignis,*

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Maxomys surifer, Niviventer cremoriventer, Sundasciurus tenuis and *Tupaia glis.* Although the last list of mammals on this island was from 1966, the Zoological Reference Collection (ZRC) of the Raffles Museum of Biodiversity Research at the National University of Singapore houses a collection of mammal specimens from that island which was collected between 1899 and 1927 (Lim et al., 1999). Recent works exploring the biodiversity of fauna on this island have also been recorded including herpetofauna species (Grismer et al., 2004; Badli-Sham et al., 2019), snakes (Grismer et al., 2004, 2006; Som et al., 2020), ectoparasites (Kwak, 2020), fishes (Tan et al., 2015; Aqmal-Naser & Amirrudin, 2018) and insects (Zhang et al., 2007; Choong et al., 2017). The aim of this survey is to provide insight into the current diversity of non-volant small mammals in Pulau Tioman, Pahang.

METHODOLOGY

The survey has been conducted from the 26th to the 30th of August 2019 in two locations, Juara trail (2.8150° N, 104.1744° E) and Air Batang (2.8412° N, 104.1612° E) at Pulau Tioman, Pahang, Malaysia (Figure 1). Juara trail is a 7 km jungle trek that connects Tekek and Juara. A total of 60 trap cages with the size of 28 cm x 15 cm x 12 cm were placed in a transect line at each location. Fresh oil palm fruit, salted fish and ripe banana with peanut butter were used as bait in each trap (Saarani et al., 2021; Harris Nasir et al., 2022). Morphological identification was based on five body measurements which include head-body length (mm), tail length (mm), hindfoot length (mm), ear length (mm) and weight (g) (Aplin et al., 2003; Francis, 2008). In addition, all individuals were identified based on morphological features such as the color of the dorsal fur, belly fur, mid-belly line, and tail, the texture of the dorsal fur and guard hairs, the length of the snout, and the number and position of the mammae (Aplin et al., 2003; Paramasvaran et al., 2013; Lim, 2015). The traps were checked twice a day, once in the early morning and once in the late afternoon for five consecutive days.

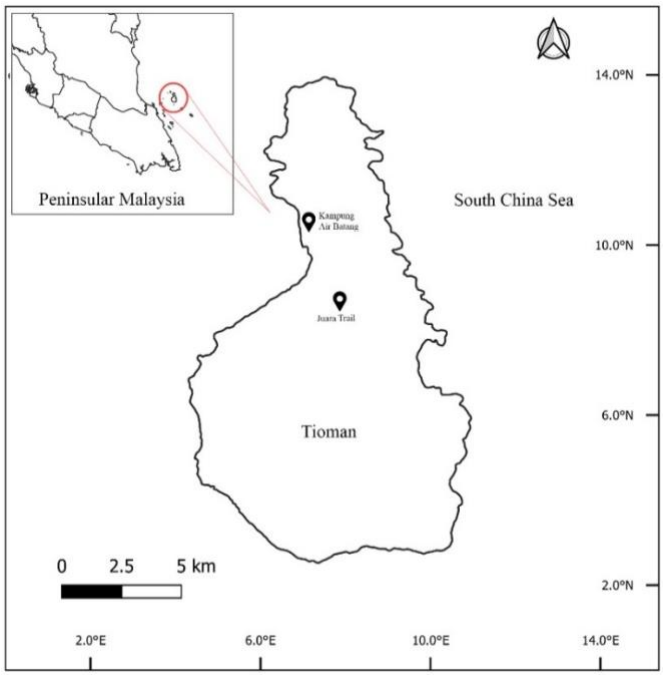

Figure 1. Location of Pulau Tioman, Pahang.

Collective data of the individuals captured were used to compute the diversity indices and tested using PAST 3.26 (PAleontological STatistics) computer software (Hammer et al., 2001). These diversity indices include Dominance (D), Simpson diversity index (1-D), Shannon-Wiener diversity index (H) and Shannon evenness index ($e^{H/S}$).

RESULTS AND DISCUSSION

During the five days of survey, a total of 21 individuals representing three families (Sciuridae, Muridae and Tupaiidae) and five species which are a) *Callosciurus notatus*, b) *Leopoldamys sabanus*, c) *Maxomys surifer*, d) *Rattus tiomanicus* and e) *Tupaia glis*, were collected from Pulau Tioman, Pahang (Figure 2). The external measurements and weight for all the species trapped were recorded as descriptive statistics (Table 1).

Figure 2. Photos of non-volant small mammals collected from Pulau Tioman, Pahang.

Based on Table 2, the most abundant families are Muridae with 12 individuals which is dominated by *L. sabanus* (Long-tailed giant rat, n=6), followed by *R. tiomanicus* (Malayan wood rat, n=4) and the *M. surifer* (Red spiny rat, n=2). Family Tupaiidae is listed as the second abundant with only one species captured, *T. glis* (Common tree shrew, n=8), followed by Sciuridae, with only one species captured which is *C. notatus* (Plantain squirrel, n=1). All species are categorized as Least Concern (LC) by IUCN red list (Aplin, 2016a; Aplin, 2016b; Aplin et al., 2016c; Duckworth,

2016; Sargis & Kennerley, 2017).

Table 1. Measurements of non-volant small mammals captured.

Species	Head-body (mm)	Tail length (mm)	Hind foot (mm)	Ear (mm)	Weight (g)
Callosciurus notatus (n=1)	191.0	185.0	47.0	18.0	522.0
Leopoldamys sabanus (n=6)	202.7 ± 6.4	274.3 ± 22.1	46.8 ± 2.1	26.0 ± 1.21	219.0 ± 25.3
Maxomys surifer (n=2)	210.0 ± 15.0	247.0 ± 72.0	37.5 ± 14.5	25.0 ± 4.0	265.5 ± 42.5
Rattus tiomanicus (n=4)	164.3 ± 7.2	153.3 ± 26.8	36.3 ± 1.0	20.5 ± 0.6	167.0 ± 66.9
Tupaia glis (n=8)	172.0 ± 2.9	149.4 ± 4.2	41.6 ± 0.6	14.3 ± 1.0	148.6 ± 29.0

Table 2. List of non-volant small mammal's species recorded from the survey.

Family	Species	Common name	Juara trail	Air Batang	Total individual (n)	IUCN (2017) status
Sciuridae	*Callosciurus notatus*	Plantain squirrel	1	0	1	LC
Muridae	*Leopoldamys sabanus*	Long-tailed giant rat	5	1	6	LC
	Maxomys surifer	Red spiny rat	2	0	2	LC
	Rattus tiomanicus	Malayan wood rat	3	1	4	LC
Tupaiidae	*Tupaia glis*	Common tree shrew	6	2	8	LC

Table 3 shows the comparison of the list of non-volant small mammal species recorded from this study and previous study by Nadchatram et al. (1966). The diversity analysis of non-volant small mammals between both sampling sites, Juara trail and Air Batang is shown in Table 4. Juara trail encompasses higher species abundance and richness which records about 17 individuals comprised of five species, while Air Batang records only four individuals comprised of three species. Our results also show that the species diversity is higher at Juara trail with 1.452 than Air Batang with 1.04. These diversity results are probably due to Air Batang experiencing a higher degree of human disturbance since this site is near to the housing area. Meanwhile, Juara trail is located at hilly dipterocarp forest which is less human disturbance and a decent habitat for small mammals (William-Dee et al. 2019).

Table 3. Comparison of non-volant small mammal species recorded from two studies.

Family	Species	Common name	Nadchatram et al. (1966)	This study
Erinaceidae	*Hylomys suillus*	Short-tailed gymnure	1	0
Sciuridae	*Callosciurus notatus*	Plantain squirrel	9	1
	Callosciurus nigrovittatus	Black-striped squirrel	5	0
	Sundasciurus tenuis	Slender squirrel	4	0
	Lariscus insignis	Three-striped ground squirrel	5	0
	Iomys horsfieldii	Javanese flying squirrel	4	0
Soricidae	*Crocidura malayana*	Malayan shrew	3	0
Muridae	*Leopoldamys sabanus*	Long-tailed giant rat	8	6
	Maxomys surifer	Red spiny rat	17	2
	Rattus tiomanicus	Malayan wood rat	55	4
	Rattus exulans	Polynesian rat	6	0
	Niviventer cremoriventer	Dark-tailed Tree Rat	4	0
Tupaiidae	*Tupaia glis*	Common tree shrew	35	8

Table 4. Diversity indices of non-volant small mammals in Juara trail and Air Batang.

	Juara trail	Air Batang
Type of ecology	Hill dipterocarp, lowland mixed dipterocarp	Coastal vegetation, lowland mixed dipterocarp, near housing area
Number of species	5	3
Individuals	17	4
Dominance (D)	0.23	0.38
Simpson (1-D)	0.74	0.63
Shannon (H)	1.45	1.04
Evenness ($e^{H/S}$)	0.85	0.94

CONCLUSION

The species number of non-volant small mammals from this survey is less than what have been recorded by Nadchatram et al. (1966). This is most likely due to our limited sampling time, effort, and sampling location, which does not cover a major portion of the island. However, this survey provides an updated list of the current status of the diversity of forest small mammals in Pulau Tioman. To identify more of Pulau Tioman's non-volant species diversity, future survey should be done over a longer period of time with a larger sampling effort.

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AUTHOR CONTRIBUTIONS

Mohamad Harris Nasir: Conceptualisation, methodology, formal analysis and investigation, writing-original draft preparation, writing-review and editing, resources; **Muhammad Farhan Abd Wahab:** Conceptualisation, methodology, formal analysis and investigation, writing-review and editing resources; **Mohamad Azam Firdaus Saarani:** Conceptualisation, methodology, formal analysis and investigation, writing-review and editing resources; **Nurhalimah Mohd Saad:** Conceptualisation, methodology, formal analysis and investigation, writing-review and editing resources; **Nur Izyan Izzati Binti Mansor:** Formal analysis and investigation; **Nurin Nabihah Binti Mohd Ab-Aziz:** Formal analysis and investigation; **Areesa Myra Binti Ramli:** Formal analysis and investigation; **Cheong Zhi Qing:** Formal analysis and investigation; **Hasmahzaiti Omar:** Conceptualisation, writing-review and editing, resources, funding.

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COMPETING INTEREST

The authors declare that there are no competing interests.

COMPLIANCE WITH ETHICAL STANDARDS

This study received approval from the Institutional Animal Care and Use Committee, Universiti Malaya, Malaysia (UM IACUC) (S/18042019/26112018-04/R).

SUPPLEMENTARY MATERIAL

Not applicable.

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