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Ectoparasites Investigation on Non-Volant Small Mammals in Universiti Tun Hussein Onn Malaysia, Johor

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Abstract

Rodents and shrews, non-volant small mammals, are significant hosts of ectoparasites and might serve as reservoirs for zoonotic diseases, especially in urban and semi-natural habitats. In this study, we aimed to identify the diversity, prevalence, and host associations of ectoparasites on non-volant small mammals at Universiti Tun Hussein Onn Malaysia (UTHM), Parit Raja, and UTHM Tanjung Labuh, Johor. Live trapping with 30 baited cage traps was carried out across four habitats, comprising oil palm plantations, lake areas, riverine zones, and coastal hill habitats. Mammals were identified by morphological observation and a number of ectoparasites collected using forceps, flea combs, and skin examination were preserved in 70% ethanol before being examined under a microscope and analysed according to standard taxonomic keys. A total of 34 non-volant small mammals of six species were recorded, with Rattus rattus selected as the most common host. Three ectoparasite species, Laelaps echidnidus (mites), Ixodes granulatus (ticks), and Polyplax spinulosa (lice), were identified resulting in 73 ectoparasites for the study. Mites were the most common ectoparasite (over half of the total infestations), followed by ticks and lice. The distribution of ectoparasites differed among habitats and host organisms, with the highest infestation in humid and disturbed environments such as oil palm plantations and riparian areas. Informed by this research, zoonotically important ectoparasites may represent serious public health risks in the university community. These findings also highlight the need for ongoing monitoring of ectoparasites within urban landscapes to gain knowledge about host–parasite relationships, which are vital and beneficial to manage wildlife risk and disease and therefore disease prevention programs.

1. Introduction

Non-volant small mammals, such as rodents and tree shrews, are important components of both urban and semi-natural ecosystems, as part of the food web and seed dispersal [1]. They often coexist closely with humans, especially in urbanized areas like university campuses, where food availability and shelter are relatively high, providing these non-volant small mammals with the opportunity to reproduce and survive [2]. However, despite their ecological importance, these mammals also carry ectoparasites such as ticks, mite and lice which can transfer certain viruses or diseases to humans and other animals, which pose risks to both wildlife and humans [3]. In

Malaysia, the warm and humid climate provides the best environment for both ectoparasite survival and reproduction, which may result to the high populations of non-volant small mammals [2]. In Malaysia, this group consists mainly of rodents (Rodentia), tree shrews (Scandentia), and insectivorous shrews (Eulipotyphla) [4]. Ectoparasites are organisms that live on the surface or on the protrusions of another creature (the host) for varying lengths of time, often to the host's harm [5]. Also, ticks, lice, and mites are most commonly found in non-volant small mammals [6].

Despite all of this, the interactions between non-volant small mammals and their ectoparasites in urban and semi-urban settings remain poorly studied. Most existing research has concentrated on forest reserves, agricultural plantations, or rural settlements, with less emphasis on semi-urban academic institutions where human–wildlife interactions are frequent [7]. The lack of localized data on ectoparasite diversity, host specificity, and spatial distribution within campus environments limits effective risk assessment and wildlife management planning, particularly in areas characterised by intense human activity and habitat modification [8]. This knowledge gap limits the understanding of potential health risks and ecological impacts.

Field sampling for this study was performed at two sites in Universiti Tun Hussein Onn Malaysia (UTHM), Johor, varying in the length of sampling period to reflect site accessibility and disturbance levels. UTHM Parit Raja: Sampling spanned over 40 days in oil palm plantation, lake, and riverine habitats on campus. Conversely, UTHM Tanjung Labuh was sampled for a period of 7 days because of logistical constraints and higher levels of wildlife and anthropogenic disturbance in the area. Variation in sampling duration provides comparative insight into ectoparasite occurrence across habitats with different environmental conditions and degrees of human activity.

The study aims to identify the ectoparasite that infests non-volant small mammals, to project the distribution of ectoparasites on small mammals, and to understand the degree of specificity of each ectoparasite to the small mammal host.

2. Methodology

2.1 Study Area

Universiti Tun Hussein Onn Malaysia (UTHM), Parit Raja (1.8603097,103.0869278), and UTHM Tanjung Labuh, Senggarang (1.73718,102.9933751) are both located in Johor (Fig. 1), Peninsular Malaysia. Where in UTHM Parit Raja, the sampling duration was from 11 August 2025 until 19 September 2025 for 40 days, and in UTHM Tanjung Labuh, it was conducted from 1 to 2 November, 7 to 9 November, and 14 to 16 November 2025.

Fig. 1 Location of the study sites in UTHM Parit Raja (left) and UTHM Tanjung Labuh (right)

The study was conducted in both urban and semi-natural habitats, including UTHM Parit Raja, around the Oil palm plantation as shown in Fig. 2(a), FPTP's lake as in Fig. 3(a), and MyRivet as shown in Fig. 2(b), and at UTHM Tanjung Labuh as in Fig. 3(b) in the Tanjung Hill areas.

(a) (b)

Fig. 2 (a) Oil palm plantation area; (b) MyRivet area

(a) (b)

Fig. 3 (a) FPTP's lake area; (b) UTHM Tanjung Labuh (hill)

2.2 Sampling Method

The techniques that are applied are adapted from the Journal of Diversity of Small Mammals (non-volant) in the tropical peatland ecosystem [9]. Each habitat was placed with 30 live cage traps, except for the area of UTHM Tanjung Labuh, where around 5 to 10 cages were placed due to both wildlife and anthropogenic disturbances. Each cage traps were baited with either toasted coconut, oil palm fruit, or shrimp pastes, and installed for non-volant small mammals. The traps were examined at early morning for rodents were examined 30 minutes to 1 hour. The baits were changed on the next day or when necessary. The captured non-volant small mammals were photographed and examined for their measurements, physical traits, and marks with nail polish, and then released to prevent recapture. Every habitat was sampled with live cage traps baited with toasted coconut, oil palm fruit, or shrimp paste. UTHM Parit Raja: 40 sampling days (11 Aug–19 Sep 2025) and in UTHM Tanjung Labuh: 7 days (1 & 2, 7 to 9, and 14t to 16 November 2025) due to higher wildlife and anthropogenic disturbances. Traps were placed along likely animal movement routes, such as along vegetation edges, near burrows/logs, and shaded ground cover. and checked each morning, with captured animals processed and released at the capture site to reduce stress and prevent recapture.

2.3 Data Collection

The sampling method and species identification used follow the book A Field Guide to the Mammals of South-East Asia (2nd ed.). [9][10]. Non-volant small mammals were characterized by reference to external morphological features, including body size and shape, texture and colour of the fur, tail length, ear size, and the shape of the snout, using standard field identification guides. Suncus murinus (Asian house shrew) was found to have a slender body, dark grey to black coarse fur, long pointed snout, small eyes, and a thick, sparsely furred tail. It also possesses a strong musky odour, which distinguishes it from rodents. Maxomys rajah (Brown spiny rat) had a medium-sized, robust body, brown fur with stiff spiny hairs, relatively small ears, and a tail shorter than the head–body length. As an example, Maxomys whiteheadi (Whitehead's spiny rat) is smaller, with lighter brown fur, finer spines, and a moderately long, well-furred tail. *Rattus rattus* (Black rat) was distinguished by its slender body, smooth black to dark brown fur, large ears and eyes, and tail being longer than the head–body length. *Rattus exulans* (Polynesian rat) is smaller and lighter in colour, with fur that is light brown to greyish, a slim body, relatively large ears, and a tail slightly longer than the length of the head–body. *Rattus tiomanicus* (Malayan field rat) is described by its medium-sized body, brownish and slightly rough fur texture, medium-sized ears, and a tail approximately equal in length to the head–body length.

After all the sampling sessions were finished, the identification of ectoparasites was done at the laboratory of Universiti Tun Hussein Onn Malaysia (UTHM), Pagoh campus, for further analysis, so the ectoparasites could be identified. Each ectoparasite found on the non-volant small mammals was removed by fine forceps or fine combs. The, each ectoparasites were stored in a vial containing 70% ethanol to preserve its shape, labelled the vials for one each with a matching code that had been written on notebooks containing measurements, such as its sex, total length, tail length, hind foot length, ear length, and weights. Ectoparasites were preserved in 70% ethanol and identified under a stereomicroscope based on external morphology, including body shape, colour, and key diagnostic features. Ticks (*Ixodes granulatus*) were identified by their oval, flattened bodies, dark brown to black colour, presence of a hard dorsal scutum, and an anal groove located anterior to the anus. Mites (*Laelaps echidninus*) were identified by their small, oval body, pale brown to reddish colour, long legs extending beyond the body margin, and a soft body without a scutum. Lice (*Polyplax spinulosa*) were recognised by their elongated, dorsoventrally flattened body, pale yellowish to light brown colour, narrow heads, and segmented abdomens.

2.4 Data Analysis

Statistical test such as the ectoparasite composition, abundance, and diversity, were summarised using descriptive statistics. Prevalence rate of ectoparasites was expressed as the proportion of infested hosts relative to the total number of individuals examined, while mean ectoparasite intensity was determined as the average number of ectoparasites per infested host. Each analysis was performed using both Microsoft Excel and SPSS software to detect significant patterns or trends in ectoparasite distribution in the project area.

3. Result and Discussion

3.1 Host and Ectoparasite Prevalence

Six (6) non-volant small mammals were captured and identified during this study. A total of 34 non-volant small mammals that belonged to six specific species were captured. *Rattus rattus* was the species recorded the most, with 15. Then, *Rattus exulans* was next with 9, and *Maxomys rajah* with 4. The remaining species are *Rattus tiomanicus* (n = 3), *Suncus murinus* (n =2), and *Maxomys whiteheadi* (n = 1). The non-volant small mammals were shown in Fig. 4, Fig. 5, and Fig. 6.

(a) (b)

Fig. 4 a) *Rattus rattus;* (b) *Rattus tiomanicus*

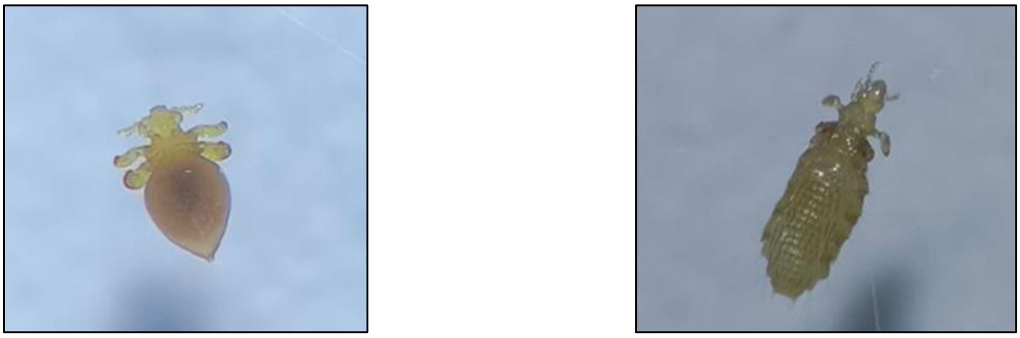
(a) (b)

Fig. 5 (a) *Suncus murinus;* (b) *Maxomys rajah*

(a) (b)

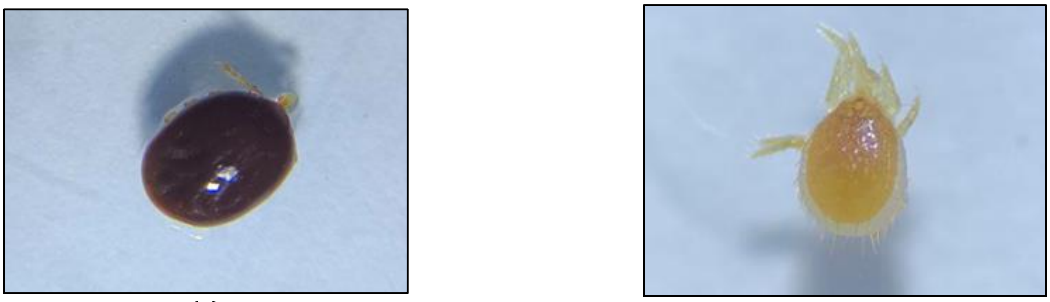
Fig. 6 (a) *Rattus exulans* [11]; (b) *Maxomys whiteheadi*

Meanwhile, a total of three major ectoparasite groups were identified from the hosts, indicating a wide range of ectoparasites within the project area. From those three major ectoparasite species, which are *Polyplax spinulosa* with a total of 5, *Ixodes granulatus* with a total of 30, and *Laelaps ichidnidus* with a total of 38, there are a total of 73 ectoparasites. The ectoparasites were shown in Fig. 7 and Fig. 8.



(a) (b)

Fig. 7 (a) Female *Polyplax spinulosa;* (b) Male *Polyplax spinulosa*



(a) (b)

Fig. 8 (a) *Ixodes granulatus;* (b) *Laelaps ichidninus*

The ectoparasite species associated with non-volant small mammals in this project is dominated by mites and ticks, with lice representing a smaller but still-harbouring host species. The high prevalence of *Laelaps echidninus*, or mites, suggests that environmental conditions favoured their persistence, while *Ixodes granulatus*, or ticks, highlights the importance of host-tick relationships. The presence of *Laelaps ichidninus or* lice populations indicates complex host-ectoparasite dynamics. The duration of sampling aligned with the rainy season, which likely affected both the behaviour of hosts and the dynamics of ectoparasites. Increased rainfall can diminish the surface activity of rodents, leading them to seek refuge in sheltered microhabitats such as burrows, dense vegetation, and riverbanks. This clustering elevates the rates of host interactions and promotes the transmission of ectoparasites [12]. When it is raining, humidity will increase and coat the animal with moisture, which causes rodents to experience reduced insulation, skin irritation, and creates an environment that favors ectoparasite survival and attachment [13]. This heightened or increased grooming during the rainy period, where it may actively remove emerging ectoparasites on their fur [14].

3.2 Host – Ectoparasite Association

Table 1 highlights the association between host species and their ectoparasite species, reveals the distribution and prevalence of ectoparasites among non-volant small mammals. Among six (6) sampled non-volant small mammals, Rattus rattus was the most abundant species with a total of 15. This species harboured various ectoparasites, including Ixodes granulatus, Laelaps echidninus, and Polyplax spinulosa. Although Rattus rattus, commonly called the Black rat, two-thirds of individuals are not infected with ectoparasites, suggesting variability in susceptibility or the grooming frequencies this species does, which may reduce the ectoparasite loads, as they accompany the rainy season during the sample session.

In contrast, *Rattus exulans* or Polynesian rat, although it had a lower number of individuals, harboured all three (3) ectoparasite species found across all species, and had a lower proportion of individuals without ectoparasites compared to *Rattus rattus.* This could indicate that *Rattus exulans* are consistently affected or infested by ectoparasites, due to ecological or behavioral differences with *Rattus rattus.*

Also, *Maxomys rajah* and *Maxomys whiteheadi* demonstrate a host-ectoparasite relationship. For example, *Laelap echidninus,* also known as the dominant mite on *Maxomys rajah*, suggests a possible preference for mites for this host species. Meanwhile, *Suncus murinus* individuals sampled were only infested by *Ixodes granulatus* (tick), illustrating potential host specificity or environmental conditions.

The distribution of ectoparasite species across various host species would highlight ecological relationships. For example, *Ixodes granulatus* is found in most host species, which may suggest it is a generalist tick, adaptable and capable to infest various host species. Compared to *Laelaps ichidninus,* this ectoparasite species displayed a more limited range of host species, which were mainly associated with *Maxomys* and some *Rattus species.* Also, the limited presence of *Polyplax spinulosa*, which infests only *Rattus exulans* and *Rattus rattus,*were matched to sucking louse ecology behaviour, which it only infests specific hosts. The differences in ectoparasite associations among host species likely reflect variations in habitat use, grooming behaviors, and social behaviors that can influence the likelihood of acquiring and harboring ectoparasites [15].

Table 1 Association between host species and their ectoparasite species

	Ectoparasite			
Host	*Ixodes granulatus*	***Laelaps ichidninus***	***Polyplax spinulosa***	**Not infected**
Maxomys rajah	1	3	-	-
Maxomys whiteheadi	-	1	-	-
Rattus exulans	3	2	3	1
Rattus rattus	2	1	9	3
Rattus tiomanicus	1	1	1	-
Suncus murinus	2	-	-	-

The ectoparasite species associated with non-volant small mammals in this project is dominated by mites and ticks, with lice representing a smaller but still-harbouring host species. The high prevalence of *Laelaps echidninus,* or mites, suggests that environmental conditions favoured their persistence, while *Ixodes granulatus,* or ticks, highlights the importance of host-tick relationships. The presence of lice populations indicates complex host-ectoparasite dynamics.

Ectoparasites (e.g., ticks, mites, and lice) on non-volant small mammals, which occur in the plantation, riverine, and coastal areas, are major public health problems. Natural settings close to rivers and university campuses are frequently visited by both students and staff, increasing the likelihood of human exposure to an environment infested with these ectoparasites [16]. For example, *Ixodes granulatus*, a tick were well-documented vector for zoonotic diseases such as Lyme disease [17]. The detection of ticks during this study on rodent hosts highlights the potential for disease transmission between both humans and wildlife, especially in areas where these rodents coexist with human settlements or activities, such as around the FPTP's lakes, where students, lecturers, and staff are doing their activities in daily basis.

Natural environments such as oil palm plantations, riverbanks (FPTP and MyRivet lakes), and coastal areas (UTHM Tanjung Labuh) are located near university campuses, which are bustling with students, staff, and local communities, increasing the risk of human to expose to ectoparasites and the pathogens these ectoparasites carry [16]. Human activities such as recreational use, agricultural activities, or even fieldwork can increase contact rates between humans and hosts that may be infested with ectoparasites or environments, enhancing even higher potential for zoonotic disease transmission [18].

3.3 Spatial Distribution of Ectoparasites

Following Table 2, the MyRivet area would be the highest total containing ectoparasites with a total of 31, following oil palm plantation with a total of 22. Meanwhile, for the FPTP lake and the UTHM Tanjung Labuh area, both with a total of 17 and 3, the UTHM Tanjung Labuh area would have the lowest frequency of ectoparasite, and it was due to a few factors. One of them would be the limited time to do the sampling session; the anthropogenic and macaque disturbances also made it hard to capture its host species; thus, this rodent species might scurry away from the baited cages. Hosts exhibiting elevated ectoparasite loads were predominantly found in sites with high moisture levels, dense vegetation, and minimal direct disturbances.

The riverine habitats (in conjunction with the FPTP's lake and MyRIVET rivers) had a higher prevalence of ectoparasites due to their consistently moist conditions and favorable off-host microhabitats. Similarly, captures from Tanjung Labuh Hills correlated with higher ectoparasite counts, highlighting coastal humidity and protected hilltop habitats as the influencers. In contrast, areas within oil palm plantations exposed to frequent human activity and machinery operation displayed more fluctuating ectoparasite abundance. The distribution of ectoparasites across the campus environment is shaped through the combined influences of habitat type, microclimate factors, and disturbance levels.

Table 2 Association between ectoparasite species and their habitat

	Habitat			
Ectoparasite species	**FPTP lake**	**MyRivet**	**Oil palm plantation**	**UTHM Tanjung Labuh**
Ixodes granulatus	8	6	16	-
Laelaps ichidninus	6	25	4	3
Polyplax spinulosa	3	-	2	-

Macaque activity in oil palm plantations and riverine areas may indirectly influence rodent populations through habitat disturbance and competition for food resources. These disturbances can also change the nesting behaviour and movement of rodents, which affects ectoparasite burden and spatial distribution. Plantation maintenance, recreational use of river areas, and routine campus movement by humans add another level of disturbance. Plantation operation-related machinery noise is a chronic anthropogenic stressor that may lead rodents to avoid highly disturbed areas. As a result, rodents can be clustered at quieter sites, including river margins and near-coastal hill habitats, which may promote regional spikes in ectoparasite abundance.

4. Conclusion

By identifying the ectoparasites that infest non-volant small mammals, knowing their distribution, and understanding the specificity of ectoparasites infecting non-volant small mammals in UTHM Parit Raja and Uthm Tanjung Labuh, this study met its objectives. A total of six (6) species of rodents (non-volant small mammals): *Maxomys rajah* (Brown spiny rat), *Maxomys whiteheadi* (Whitehead's spiny rat), *Rattus exulans* (Polynesian rat), *Rattus rattus* (Black rat), *Rattus tiomanicus* (Malayan field rat), and *Suncus murinus* (Asian house shrew), and three (3) main ectoparasite species: *Ixodes granulatus* (tick), *Laelaps ichidninus* (mite), and *Polyplax spinulosa* (lice). Among these rodent species, *Rattus rattus was the most abundant species, and Laelaps ichidninus* (mite) had the highest frequency in infecting rodent species.

Through the association between ectoparasite species and habitat, it could be concluded that the MyRivet area, which was a riverine area, contains a higher abundance of ectoparasite species compared to other habitats containing ectoparasites, with a total of 31, following the oil palm plantation with a total of 22. Meanwhile, for the FPTP lake and the UTHM Tanjung Labuh area, both with a total of 17 and 3, the UTHM Tanjung Labuh area would have the lowest frequency of ectoparasites.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

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

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