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Diversity of Non Volant Small Mammals in Different Landscapes in Universiti Tun Hussein Onn Malaysia, Johor

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Abstract

Non-volant small mammals are important ecological indicators due to their sensitivity to habitat disturbance and environmental change. However, empirical evidence on how campus-scale landscape variation influences their distribution remains limited in Malaysia. The diversity of non-volant small mammals was investigated across different landscapes areas within Universiti Tun Hussein Onn Malaysia (UTHM), Johor. This study aimed to (1) catalogue the variety of non-volant small mammal species present in the study area and (2) assess how different habitat types influence their distribution and abundance. Field sampling was conducted between August and November 2025 using ground level live trapping and direct observation across three habitat types: agricultural monoculture area (oil palm), disturbed area (lake edge), and coastal area. A total of eight non-volant small mammal species were recorded through direct live trapping, comprising 41 individuals, while three additional arboreal species (*Tupaia gliss*, *Callosciurus notatus*, and *Ratufa bicolor*) were documented through direct observation. The captured assemblages were dominated by generalist rodent species, particularly *Rattus rattus*, *Rattus exulans*, and *Rattus tiomanicus*. Forest associated species such as *Maxomys rajah* and *Maxomys whiteheadi* were recorded in low number, indicating limited suitability of highly modified habitats for disturbance sensitive taxa. Observational records revealed the presence of arboreal species including *Tupaia glis*, *Callosciurus notatus*, and *Ratufa bicolor*, which were not effectively sampled by ground level live traps. Species richness and distribution varied among habitat types. The disturbed lake edge habitat supported the highest species richness and diversity. In contrast, the agricultural monoculture area exhibited lower diversity with strong dominance by generalist to overall species presence. The Shannon-Wiener diversity index (H'=1.597) indicated moderate species diversity with uneven species distribution across habitats. Overall, the findings demonstrate that habitat type and structural complexity play important roles in shaping non volant small mammal communities. This study provides essential baseline data for future ecological research and highlights the importance of integrating multiple sampling approaches when assessing small mammal assemblages in human modified landscapes.

1. Introduction

Non-volant small mammals constitute an important component of terrestrial ecosystems, functioning as seed dispersers, prey species for higher trophic levels, and sensitive indicators of environmental change [1,2]. Due to their relatively small home ranges, short life cycles, and close association with habitat structure, changes in land use and environmental conditions are often rapidly reflected in their distribution and population dynamics. In development, particularly in Southeast Asia, rapid landscape modification driven by agricultural expansion, urban development, and infrastructure growth has altered habitat composition and connectivity. Such changes frequently result in simplified habitat structures that favour adaptable generalist species while reducing the persistence of disturbance sensitive taxa [3,4]. Consequently, the study of non-small mammal communities has been widely used to assess the ecological impacts of habitat disturbance and land use change. Universiti Tun Hussein Onn Malaysia (UTHM), Johor, encompasses a heterogeneous landscape consisting of agricultural monoculture areas, disturbed habitats, and coastal environments. These different habitat types provide an opportunity to examine how variation in habitat structure and disturbance levels influence the distribution and diversity of non-volant small mammals within a relatively confined spatial scale. Rapid land use change and habitat modification within university campuses and surrounding areas have the potential to significantly influence local biodiversity, including non-volant small mammal communities [4].

However, empirical data on how different habitat types within such landscapes affect species composition, abundance, and diversity remain limited in Malaysia. Within UTHM, a variety of habitat types exist in proximity, including agricultural monoculture areas, disturbed habitats, and coastal environments. Despite this heterogeneity, systematic studies assessing non-volant small mammal distribution across these habitats are lacking. The absence of such information creates a knowledge gap that limits effective biodiversity assessment and evidence-based habitat management within the campus landscape [3]. The objectives of this study were: to (1) catalogue the variety of non-volant small mammal species present in the study area and (2) assess how different habitat types influence their distribution and abundance. The scope of the study was limited to non-volant small mammals. Volant mammals such as bats were excluded due to differences in sampling techniques and ecological characteristics [1,5]. The findings therefore reflect the distribution patterns of non-volant small mammals within the selected habitats during the sampling period and should be interpreted within these methodological constraints.

2. Materials and Methods

2.1 Study Area

The study was conducted at Universiti Tun Hussein Onn Malaysia (UTHM), Johor, and the adjacent coastal area at Pantai Tanjung Labuh. These locations represent a semi urban landscape comprising multiple habitat types within proximity. Three habitat types were selected for this study which are agricultural monoculture area (oil palm), disturbed area (lake edge), and coastal area.

The agricultural monoculture area consisted of actively managed oil palm plantations characterized by uniform vegetation structure, limited understorey growth, and frequent human activity. The disturbed area was located along the edge of freshwater lake within UTHM campus and exhibited higher structural heterogeneity, including grass, shrubs, scattered trees, and continuous access to water. The coastal habitat at Pantai Tanjung Labuh was characterized by sandy substrates, coastal vegetation, and exposure to marine influences, representing a contrasting environment to the inland study sites. The geographical locations of the study areas are shown in Figure 2.1 and Figure 2.2.

Fig. 1 Map Pantai Tanjung Labuh, Johor area (Google Maps, 2025)

The coastal area represents a contrasting habitat influenced by marine conditions and sparse terrestrial vegetation. The inclusion of these contrasting habitat types enabled an assessment of how habitat characteristics influence the distribution and diversity of non-volant small mammals.

Fig. 2 Map UTHM Parit Raja, Johor area (Google Maps, 2025)

The agricultural monoculture area represents a simplified habitat dominated by oil palm plantations, whereas the disturbed area along the lake edge provides increased habitat heterogeneity and access to water resources.

2.2 Sampling Methods

Field sampling was conducted between August and November 2025, corresponding to the transitional period between the Southwest Monsoon and the onset of the Northeast Monsoon in Peninsular Malaysia. This period was selected to capture small mammal activity under varying environmental conditions while maintaining logistics feasibility. Sampling duration differed among habitat types due to site accessibility and logistical constraints. These differences in sampling effort were documented and considered during data interpretation to minimise potential bias when comparing results across habitats.

A combination of bait, including ripe banana, roasted coconut, roasted oil palm fruit, and fermented shrimp paste, was used to maximised attraction across different dietary preferences. Strong smelling baits have been shown to increase capture success in tropical environments by attracting frugivorous, omnivorous, and opportunistic species [6,7]. Traps were set in the late afternoon (1600-1800 h) and checked daily in the early morning within a two-hour inspection window. This checking regime reduced confinement time, minimised heat exposure, and decreased the risk of predation on trapped individuals [8]. Captured individuals were carefully removed from the traps using protective gloves and temporarily restrained in cloth bags during processing. Handling time was minimised to reduce stress. Each individual was photographed to provide a visual record for species verification.

Species identification was conducted to the lowest possible taxonomic level based on external morphological characteristics. Identification followed diagnostic keys and species descriptions provided in *A Field to the Mammals of Southeast Asia* [1] and *The Wild Mammals of Malaya* [9], with verification using outline image references from the [21]. Morphological traits examined included fur color, tail to body length, body measurements, and distinguishing features such as spines and dorsal striping. For each individual, data recorded included species name, body length, tail length, body weight, sex, and trap location. All individuals were released immediately at the point of capture following data collection.

All field sampling and animal handling procedures were conducted in strict accordance with ethical guidelines for wildlife research. Live trapping methods were exclusively employed, and no chemical immobilization, anesthesia, or lethal sampling techniques were used throughout the study. Prior to the commencement of fieldwork, an official research permit under the educational category was obtained from the Department of Wildlife and national Parks (PERHILITAN), the national authority responsible for wildlife conservation, management, and regulation in Peninsular Malaysia. Approval from the Department confirmed that the trapping design, handling procedures, and release protocols met acceptable ethical standards for research involving live wild animals [8].

2.3 Data Analysis

Data collected from live trapping and direct observation conducted between August and November 2025 at UTHM Parit Raja and Pantai Tanjung Labuh were analysed to determine species composition, relative abundance, habitat based distribution, and overall diversity of non volant small mammals. All data were first organised and verified using Microsoft Excel prior to analysis to ensure accuracy and consistency. Species composition was summarised by calculating the total number of individuals recorded for each species across all study sites. Relative abundance was expressed as the proportion of individuals of each species relative to the total number of individuals captured. These data were used to identify dominant, common, and rare species. Habitat based species distribution was analysed by comparing the presence and abundance of each species across the three habitat types, namely agricultural monoculture area (oil palm), disturbed area (lake edge), and coastal area. Species occurrence patterns were interpreted descriptively to assess habitat associations and to identify species restricted to specific habitat types.

Species diversity was assessed using the Shannon-Wiener diversity index (H'), which incorporates both species richness and evenness, and is widely applied in ecological studies of community structure. The index is expressed as:

$$H' = -\sum_{i=1}^{S} p_i \ln p_i \tag{1}$$

This index was selected because it is widely applied in ecological studies and is suitable for evaluating diversity patterns in heterogeneous and human modified landscapes such as university campuses, plantation habitat, and coastal environments [2]. Where H' is the Shannon-Wiener diversity index, S is the total number of species, p_i is the proportion of individuals belonging to the species i, and ln denotes the natural logarithm. The calculated Shannon-Wiener diversity index indicated moderate overall species diversity with uneven distribution of individuals, reflecting strong dominance by a few generalist taxa and low representation of forest associated species. Such diversity patterns are commonly observed in human modified and semi urban landscapes where habitat simplification favours adaptable species [2,18]. The Shannon-Wiener diversity index was calculated using pooled data from all habitats to provide an overall assessment of non-volant small mammal diversity within the study area. A higher H' value indicates greater diversity, whereas a lower value suggests dominance by one or few species. This index is widely used in ecological research because it incorporates both richness and evenness, which are essential in detecting subtle differences in community structure between sites [10].

An evenness value, $E = H' / \ln(S)$. where E represents Pielou's evenness, H' is the Shannon–Wiener diversity index, and S is the total number of species recorded. E close to 1 indicates a community with a relatively even distribution of individuals among species, whereas lower values suggest uneven distribution and dominance by certain species. Observational records of non-captured species were analysed descriptively and integrated with live trapping results to provide a more comprehensive assessment of non-volant small mammal presence within the study area. These records were particularly important for arboreal and semi arboreal species that are less susceptible to ground level live trapping.

3. Results and Discussion

A total of 41 individuals representing eight species of non-volant small mammals were recorded through live trapping across all study sites. The species composition and total number of individuals recorded are summarised in Table 1.

Table 1 Species composition and total number of individuals recorded for non volant small mammals at UTHM, Johor

Species	Common Name	Number of individuals
Rattus rattus	Black rat	19
Rattus exulans	Pacific rat	8
Rattus tiomanicus	Malaysian wood rat	5
Rattus argentiventer	Rice-field rat	3
Maxomys rajah	Rajah spiny rat	2
Suncus murinus	Asian house shrew	2
Maxomys whiteheadi	Whitehead's spiny rat	1
Sundamys muelleri	Müller's giant rat	1
Total		41

The assemblage was strongly dominated by rodents of the genus *Rattus*, with *Rattus rattus* recording the highest number of individuals (Table 1). Forest associated and disturbance sensitive species such as *Maxomys rajah*, *Maxomys whiteheadi*, and *Sundamys meulleri* were recorded in low abundance, indicating limited suitability of highly modified habitats for specialist taxa. The dominance of Rattus species observed in this study is consistent with patterns reported from disturbed and agricultural landscapes in Malaysia, where generalist rodents exhibit high ecological flexibility, broad dietary preferences, and strong tolerance to human disturbance [11-13].

Species distribution varied markedly among habitat types. The disturbed lake edge habitat supported the highest species' richness and abundance, followed by the agricultural monoculture area (oil palm), while the coastal area recorded the lowest number of captured individuals. The distribution of non-volant small mammals across the three habitat types is illustrated in Fig.1

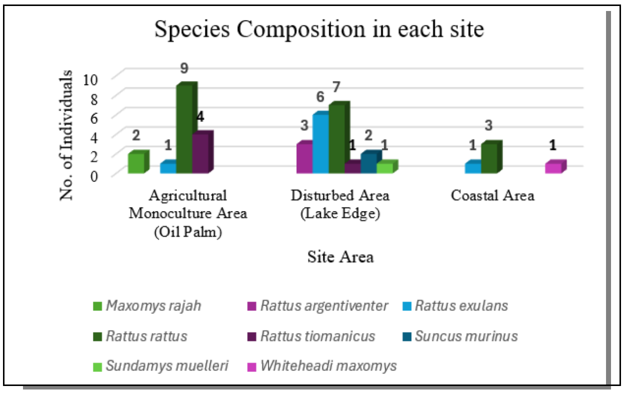

Fig. 3 Distribution of non volant small mammals across three habitat types at UTHM, Johor.

The higher species richness and abundance recorded at the disturbed lake edge habitat highlight the influence of habitat heterogeneity on non-volant small mammal communities. The presence of mixed vegetation layers, scattered trees, dense ground cover, and continuous access to water likely enhanced food availability and shelter, thereby supporting greater small mammal activity. Disturbed and edge habitats with moderate levels of structural complexity have been shown to support higher abundance of small mammals compared to homogenous landscapes [3,2].

The agricultural monoculture area (oil palm) exhibited the lowest species richness and was strongly dominated by Rattus rattus and Rattus tiomanicus. This pattern is characteristic of monoculture systems, which are typically defined by uniform canopy structure, reduced plant diversity, and limited understorey development. Such environments offer fewer ecological niches and reduced shelter diversity, conditions that favour disturbance tolerant generalist species while excel the occasional occurrence of Maxomys rajah within oil palm sites suggests opportunistic use of microhabitats such as oil palm frond piles, root collars, and shaded ground patches. These features may temporarily replicate forest floor conditions by providing cover, moderated temperatures, and access to seeds and invertebrates [4,14]. However, extensive studies indicate that Maxomys species are strongly associated with forest and semi forest habitats and exhibit reduced fitness and persistence in monoculture landscapes [1,15]. Their low abundance in oil palm areas therefore likely reflects marginal habitat use rather than successful adaptation. using forest dependent taxa [11,4,13]. These features may temporarily replicate forest floor conditions by providing cover, moderated temperatures, and access to seeds and invertebrates [4,14]. However, extensive studies indicate that Maxomys species are strongly associated with forest and semi forest habitats and exhibit reduced fitness and persistence in monoculture landscapes [1,15]. Their low abundance in oil palm areas therefore likely reflects marginal habitat use rather than successful adaptation.

The coastal habitat records the lowest number of captured individuals overall. Coastal environments impose multiple abiotic streesors, including saline soils, strong wind exposure, unstable sandy substrates, and limited understorey vegetation. These factors reduce shelter availability, constrain food resources, and increase energetic costs for small mammals [16,17]. Consequently, only species with high physiological tolerance or specific behavioural adaptations can persist in such environments. Despite low capture rates, the presence of some species indicates that coastal habitats still contribute to overall landscape level diversity, particularly as transient or supplementary habitats for edge associated or arboreal taxa. Similar patterns have been reported in coastal and mangrove adjacent systems in Southeast Asia, where small mammal diversity is generally low but ecologically distinct [17,18]. In addition to ecological factors, methodological considerations further shape habitat specifically capture outcomes. Bait type influenced detection probability, with roasted coconut and roasted oil palm fruit proving more effective due to their strong odour and resistance to rapid decomposition under humid conditions. In contrast, ripe bananas deteriorated quickly and frequently attracted nontarget animals such as monkeys, reducing trapping efficiency. Previous studies have demonstrated that high odour, lipid rich baits preferentially attract omnivorous rodents, thereby biasing captures towards generalist species [4,19,20]. Such biases may have reinforced the dominance of Rattus species in oil palm and disturbed habitats.

The integration of ground level live trapping and direct observation enhanced species detection by complementing terrestrial sampling with records of arboreal taxa that were not effectively sampled by traps. Previous studies have shown that reliance on a single sampling method may underestimate true species' richness, particularly for arboreal or behaviorally elusive species [1,5]. The combined approach adopted in this study therefore provides a more comprehensive assessment of non-volant small mammal presence across heterogeneous habitats.

The calculated Shannon-Wiener diversity index for the study area was $H' = 1.597$, indicating moderate species diversity. This value reflects the presence of several species combined with strong dominance by a small number of generalist rodents, particularly Rattus rattus. Moderate H' values are commonly reported in disturbed tropical landscapes and agricultural mosaics, where habitat modification reduces structural complexity and favours adaptable generalist species over forest dependent taxa [17]. In the present study, diversity was influenced by the combined effects of habitat disturbance, seasonal sampling period, and uneven species abundance across habitats. Although eight species were recorded, the disproportionately high number of individuals belonging to Rattus rattus reduced overall diversity by lowering the contribution of rarer species to the index. The presence of rare species such as Maxomys rajah, Maxomys whiteheadi, and Sundamys muelleri contributed positively to species richness but had limited influence on overall diversity due to their low abundances.

Overall, the results demonstrate that habitat type and structural complexity play key roles in determining species composition, abundance, and diversity of non volant small mammals within the study area. Disturbed habitats with higher heterogeneity supported greater diversity, whereas simplified agricultural landscapes favoured dominance by adaptable generalist species. These findings provide baseline ecological information relevant to biodiversity assessment and habitat management within university and semi urban landscapes in Malaysia.

4. Conclusion

This study investigated the distribution of non-volant small mammals across different landscapes areas within UTHM, Johor, with two main objectives: (1) to catalogue the variety of non-volant small mammals species present in the study area, and (2) to assess how different habitat types affect the distribution and abundance of these species. The first objective of this study was successfully achieved. A total of eight species of non-volant small mammals were recorded through live trapping, while additional species were documented through direct observation. The inclusion of observational records complemented trapping data and reduced sampling bias associated with records complemented trapping data and reduced sampling bias associated with ground level live trapping, particularly for arboreal and highly mobile species [1,15]. The recorded assemblages were dominated by generalist rodents, especially *Rattus rattus*, a pattern commonly observed in disturbed and human modified environments [4,2]. The presence of rarer forest associated species, although in low abundance, suggests that certain microhabitats within the study area still supports species with more specialised ecological requirements. The second objectives of this study were also achieved. Clear differences in species distribution, abundance, and diversity were observed among the agricultural monoculture area, disturbed lake edge, and coastal habitats. Habitat heterogeneity and structural complexity were identified as key factors influencing species occurrence, with disturbed edge habitats supporting higher diversity compared to monoculture landscapes [4,3]. Diversity indices further indicate moderate species diversity with uneven species distribution, driven by dominance of adaptable generalist species. Such patterns are typical of disturbed tropical landscapes where habitat modification favours a limited number of tolerant species [2]. Overall, the results confirm that habitat type plays a significant role in shaping non volant small mammals' distribution within the study area, thereby fulfilling the second objectives.

Further studies should incorporate additional sampling methods such as arboreal trapping, camera trapping, and extended seasonal surveys to improve detection of trap-shy and arboreal species. Maintaining habitat heterogeneity within campus landscapes, including tree cover and vegetated buffer zones, may further enhance biodiversity conservation [1,5]. Long-term monitoring is recommended to assess temporal changes in non-volant small mammal communities and to evaluate the impacts of ongoing habitat modification on population dynamics [2]. Maintaining habitat heterogeneity within the campus landscapes, including tree cover and vegetated buffer zones, may enhance small mammal diversity and contribute to biodiversity conservation within university environments [3].

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Conflict of Interest

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:*** *Hani Fasihah Mohd Shaifuddin, Arney Sapaat;* ***data collection:*** *Hani Fasihah Mohd Shaifuddin;* ***analysis and interpretation of results:*** *Hani Fasihah Mohd Shaifuddin, Arney Sapaat;* ***draft manuscript preparation:*** *Hani Fasihah Mohd Shaifuddin. All authors reviewed the results and approved the final version of the manuscript.*

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Appendix A

Fig. 4 Photographs of Captured Species. Photographs were taken during fields sampling conducted between August and November 2025: (a) *Rattus tiomanicus*, (b) *Rattus exulans*, (c) *Suncus murinus*, (d) *Rattus rattus*, (e) *Rattus argentiventer*, (f) *Maxomys rajah*, (g) *Sundamys muelleri*, and (h) *Maxomys whiteheadi*.