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Ectoparasite Investigation on Bats in Universiti Tun Hussein Onn Malaysia, Johor

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Abstract

Bats are widely distributed in both natural and human-modified landscapes in Malaysia. However, information on bat-associated ectoparasites in semi-urban environments remains limited. This study investigated bat host diversity, ectoparasite diversity, host-ectoparasite associations, and infestation rates at Universiti Tun Hussein Onn Malaysia (UTHM), a semi urban environment in Johor. Bat sampling was conducted at UTHM Parit Raja and Tanjung Labuh Aerodrome using mist nets during dusk and night hours. Captured bats were identified morphologically and examined for ectoparasites, which were collected and identified by standard morphological keys. A total number of 28 individuals representing four bat species belonging to two families were recorded at UTHM Parit Raja, specifically *Cynopterus brachyotis, Cynopterus horsfieldii, Eonycteris spelaea,* and *Murina suilla*. Five ectoparasite taxa were identified, consisting of four species of nycteribiid bat flies and mites from the genus *Macronyssus*. The overall ectoparasite infestation rate was 43.3%, with higher infestation observed among *Cynopterus* sp. No bats were captured at Tanjung Labuh due to the open habitat structure, although bat activity was observed. This study provides baseline information on bat-ectoparasite interactions in semi-urban environments and supports future ecological monitoring and zoonotic risk assessment in human-modified environments.

1. Introduction

Bats play important ecological roles such as pollination, seed dispersal, and insect population control, particularly in tropical ecosystems [1]. In Malaysia, bats are commonly found not only in natural forests but also in semi-urban and human-modified landscapes [2,3]. Despite their ecological importance, bats are also known hosts for a wide range of ectoparasites, including mites, ticks, fleas, and bat flies, some of which have been associated with zoonotic pathogens [4]. Bat-associated ectoparasites such as bat flies and mites are obligatory parasites that spend most of their life cycle on the host and have been suggested to play a role in maintaining and facilitating pathogen transmission within bat populations [5,6].

Several studies have documented ectoparasitic infestations on bats in forested regions of Johor, such as Panti Forest Reserve, where acarine infestation rates of 1.5% were reported [1,2]. A nationwide study covering 18 locations across Malaysia also reported ectoparasite infestation in 25.6% of bats examined [1]. Reported ectoparasites include Mesostigmata mites and host-specific bat flies (Nycteribiidae), which are hematophagous parasites capable of causing skin irritation, physiological stress and increased grooming energy costs in infested bats. Some of these ectoparasites have also been reported parasite infestation in 25.6% of bats examined [1]. However, there are currently no published records of bat or ectoparasite surveys conducted in semi-urban areas such as Universiti Tun Hussein Onn Malaysia (UTHM) or in developing coastal environments such as Tanjung Labuh.

Bats are known reservoirs for a range of zoonotic pathogens, and their ectoparasites may contribute to the maintenance and transmission of certain microorganisms within bat populations [4,7]. However, the lack of consolidated local data limits the ability to access ecological patterns and potential risks accurately. [8] highlighted that insufficient local data hampers informed conservation planning and understanding of wildlife-human interactions. Without focused research in semi-urban and coastal areas, bat-ectoparasite dynamics in human-modified landscapes remain poorly understood.

Universiti Tun Hussein Onn Malaysia (UTHM), Johor, comprises a heterogeneous landscape consisting of oil palm plantations, open green spaces, and academic buildings. In addition, the Tanjung Labuh Aerodrome area represents an open coastal habitat with limited vegetation cover. Tanjung Labuh Aerodrome is a university-owned aerodrome managed by UTHM and forms part of the university's designated land area in Johor. These contrasting environments provide an opportunity to examine bat diversity and ectoparasite occurrences in a semi-urban context. Despite previous ectoparasite studies conducted in forest reserves and protected areas, systematic surveys in semi-urban university landscape remain scarce, particularly in Johor. Semi-urban environments present distinct ecological conditions and closer human-wildlife interfaces that may influence host-parasite dynamics. Therefore, targeted investigation in UTHM is necessary to address this data gap and improve understanding of bat-ectoparasite patterns in human-modified habitats.

Thus, this study aimed to (i) identify bat host diversity, (ii) determine ectoparasite diversity and host-ectoparasite associations, and (iii) access ectoparasite infestation rates at Universiti Tun Hussein Onn Malaysia (UTHM), Johor. The findings of this study are expected to provide baseline ecological data to support future research, biodiversity conservation planning, and assessments of potential zoonotic risks associated with bat ectoparasites.

By documenting the occurrence and distribution of bat ectoparasites, this research contributes to baseline data essential for understanding host-parasite dynamics in Malaysia, especially in UTHM Johor. Furthermore, it highlights the need for continuous surveillance and ecological monitoring of bats and their ectoparasites to anticipate potential disease spillover risks. The outcomes of this study are relevant to conservation biologists, epidemiologists, and public health authorities, and they support informed decision-making for both wildlife management and zoonotic disease prevention

2. Methods and Materials

2.1 Study Area

The study was conducted in the semi-urban areas surrounding Universiti Tun Hussein Onn Malaysia (UTHM), specifically at two areas, UTHM Parit Raja (1.8656° N, 103.0832° E) and the Tanjung Labuh Aerodrome area (1.7479° N, 102.9883° E), both located in Johor, Malaysia. These locations are surrounded by a mix of cultivated land, natural vegetation, and small forest fragments, which offer suitable roosting and foraging grounds for various bat species.

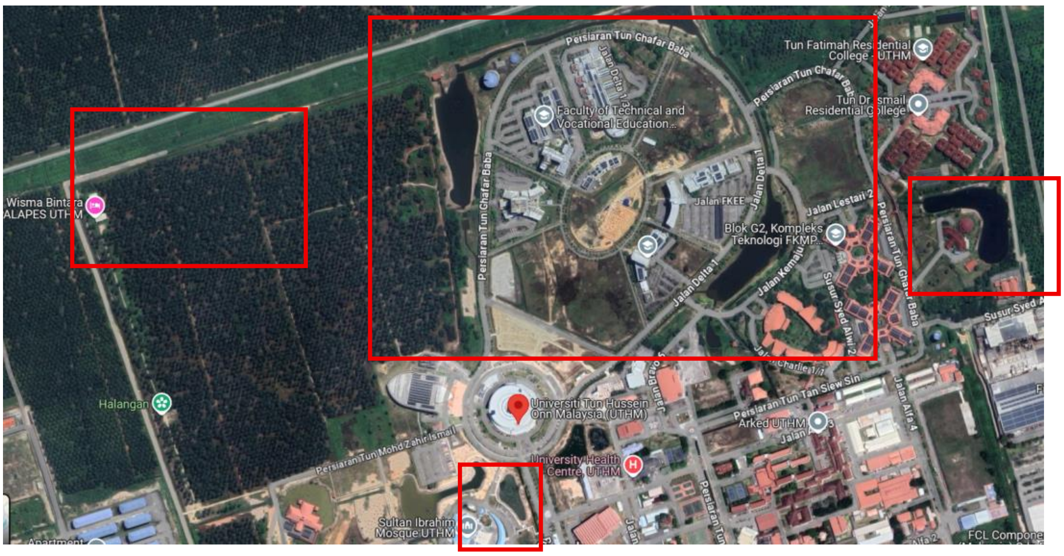

Fig. 1 Sampling site at UTHM Parit Raja, Johor

At UTHM Parit Raja, sampling activities were focused on selected green zones around the university compound, including areas with mixed vegetation near the agricultural training plots and along the forested edges of the campus and watery area. These areas have sufficient canopy coverage and are known for frequent bat activity, making them suitable for sampling efforts.

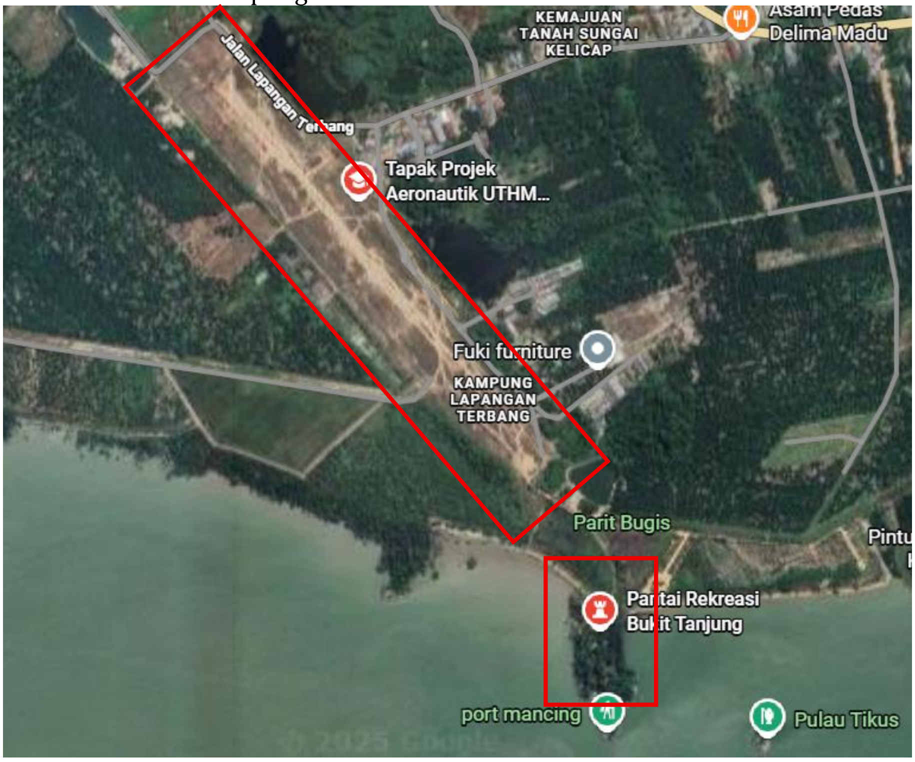

Fig. 2 Sampling site at Tanjung Labuh Aerodrome

Tanjung Labuh Aerodrome is a university-owned aerodrome under UTHM management and is located within the university's designated land area. The site is situated in a coastal environment and is characterized by open landscapes, sparse vegetation, and minimal canopy cover. Due to the open habitat structure, the site presents different ecological conditions compared to the semi-urban campus environment at UTHM Parit Raja.

2.2 Bat Sampling

Bat sampling was conducted during evening and night hours between approximately 1830H and 2330H, following standard bat sampling practices described in previous Malaysian bat studies [1]. Preliminary dusk observations were carried out to identify potential bat flyways prior to trap installation [9,10]. Mist nets were deployed along identified commuting and foraging routes as shown in Fig. 3. Bats were frequently observed flying at high altitudes, particularly in open and exposed habitats which influenced the effectiveness of mist net sampling [11,12].

Fig. 3 Installation of mist net at study site

Sampling at UTHM Parit Raja was conducted over a six-week period from 11 August 2025 until 11 September 2025, comprising approximately 40 sampling nights. A total of 8 mists nets were deployed per session. Each mist net measured 9m x 3m with a mesh size of 38mm. nets were installed along identified commuting and foraging routes and checked at regular intervals of approximately 2 hours to minimize bat stress and escape. The sampling effort was divided into two phases, with the first three weeks focused on oil palm plantation areas, followed by three weeks in surrounding habitats including green spaces and forest edges.

At Tanjung Labuh Aerodrome, the same trapping effort approach was applied; however, capture success was low due to open habitat structure and limited canopy cover. Therefore, direct observations of bat flight activity were also recorded to supplement capture data.

2.3 Ectoparasite Collection and Identification

Captured bats were carefully removed from the nets and temporarily placed in individual cloth bags prior to processing. Bats were identified to species level based on external morphological characteristics, and basic morphometric measurements were recorded [16]. Each captured bat was visually examined for ectoparasites, particularly around the ears, wing membranes, axillary regions, and fur. Ectoparasites were removed using fine-tipped forceps and preserved in 70% ethanol. Identification was conducted using morphological characteristics as described in previous ectoparasite studies [13]. In cases where mite infestation was extremely dense, infestation intensity was recorded as too numerous to count (TNTC), as individual counting was not feasible [14].

2.4 Data Analysis

Ectoparasite infestation rate was calculated as the proportion of infested bats relative to the total number of bats examined by using equation 1. Descriptive analysis was used to summarize bat species diversity, ectoparasite groups, and host-ectoparasite associations at each study site.

$$\text{Infestation Rate (\%)} = \frac{\boldsymbol{number\ of\ bats\ infested}}{\boldsymbol{Total\ number\ of\ bats\ examined}} \times \mathbf{100} \tag{1}$$

3. Results and Discussion

3.1 Bat Host Diversity

Bat captures were successfully obtained only at UTHM Parit Raja with a total number of 28 individuals representing four bat species belonging to two families were recorded specifically *Cynopterus brachyotis, Cynopterus horsfieldii, Eonycteris spelaea,* and *Murina suilla*, while no bats were captured at Tanjung Labuh Aerodrome, despite consistent observations of bat activity at the site. These contrasting outcomes highlight the strong influence of habitat structures and sampling constraints on bat detectability.

Fig. 4 (a) Fruit bat (*Cynopterus horsfieldii*); (b) Fruit bat (*Cynopterus brachyotis*); (c) Nectar bat (*Eonycteris spelaea*); (d) Insectivore bat (*Murina suilla*)

Cynopterus horsfieldii, as shown in Fig. 4(a), is a medium-sized fruit bat commonly associated with agricultural landscapes, forest edges, and semi-urban environments [3]. This species is known to roost in small groups among vegetation and exhibits high tolerance to habitat disturbance [15]. Its abundance in oil palm plantations may be attributed to the open canopy structure, which facilitates flight, as well as the availability of fruiting plants along plantation edges and nearby human-modified areas. These characteristics make oil palm landscapes suitable for foraging and commuting activities of *C. horsfieldii*.

Similarly, *Cynopterus brachyotis*, as shown in Fig. 4(b), is a highly adaptable generalist frugivore widely distributed throughout Peninsular Malaysia [16]. This species frequently occupies disturbed habitats, including plantations, orchards, and urban green spaces [17]. Its high occurrence in oil palm plantations reflects its ability to exploit a wide range of food resources and roosting sites. The relatively open understory and predictable landscape structure of oil palm plantations may enhance foraging efficiency for *C. brachyotis*, contributing to its frequent capture in this habitat.

In contrast, the surrounding areas recorded lower overall capture numbers but supported a different species composition. *Eonysteris spelaea*, a nectar-feeding fruit bat as illustrated in Fig. 4(c), was recorded exclusively in surrounding habitats. This species is closely associated with flowering plants and may therefore depend on habitats with higher floral diversity, which are more commonly found in semi-natural vegetation compared to monoculture plantations [18]. Unlike *Cynopterus* species, *E. spelaea* relies heavily on floral resources rather than fruits, which explain their absence of them from the oil palm plantations. Green space areas, which consist of semi-natural vegetation and higher plant diversity, are more likely to provide continuous nectar sources required by this species. The presence of *E. spelaea* in green areas highlights the ecological importance of these habitats in supporting species with more specialized feeding requirements [19].

Murina suilla, visualized in Fig. 4(d), was an insectivorous bat from the Family Vespertilionidae, which was recorded only in oil palm plantations. This species is characterized by a small body size, agile flight, and reliance on echolocation to capture insect prey. The low number of captures may reflect limitations of mist net sampling, as insectivorous bats are often able to detect and avoid nets more effectively than fruit bats [10]. Alternatively, its occurrence in oil palm habitats may reflect opportunistic foraging behaviour in open areas where insect prey is abundant.

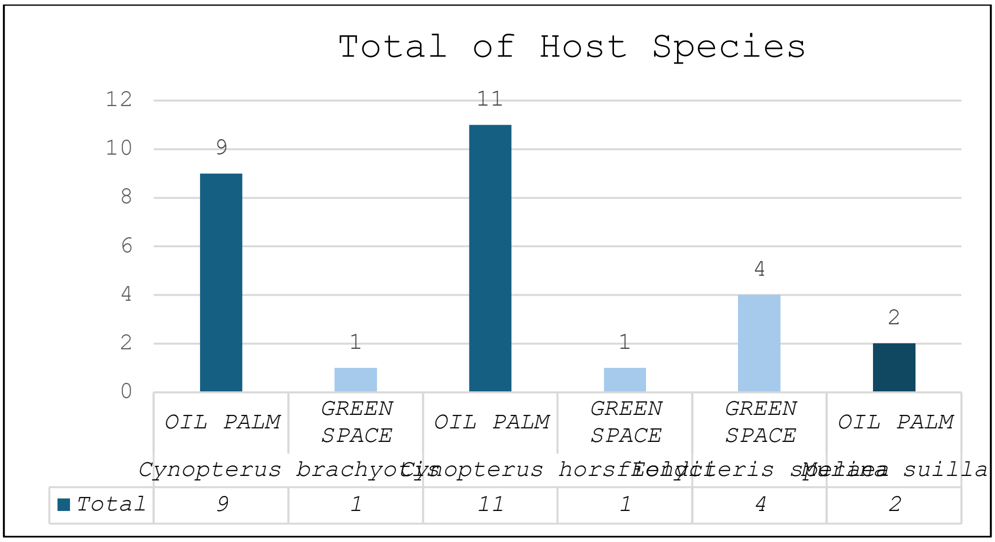

Fig. 5 Distribution of the bat species

Fig. 5 illustrates the distribution of bat species recorded across the oil palm plantations and green space areas at UTHM Parit Raja. Fruit bats from the Family Pteropodidae dominated captures in oil palm plantations, with *C. horsfieldii* being the most frequently recorded species (n=11), followed by *C. brachyotis* (n=9). The high occurrence of these species in oil palm habitats reflects their classification as generalist frugivores capable of exploiting disturbed and modified landscapes. The structural openness of oil palm plantations, combined with the availability of fruiting vegetation along plantation edges, may facilitate foraging and commuting activities for these bats.

On the other hand, no bats were captured at Tanjung Labuh Aerodrome, although bat flight activity was consistently observed during the dusk hours. The aerodrome is characterized by an open coastal landscape with sparse vegetation and exposure to coastal winds. Such habitat conditions are known to influence bat flight behavior, often resulting in higher flight altitudes and reduced interception by ground-level mist nets. Although quantitative assessment of bat host diversity was not possible at this site, habitat characteristics and observational evidence suggest that the area has the potential to support bat species adapted to coastal and open environments. Fruit bats from the Family Pteropodidae, such as *Pteropus vampyrus* and *Eonysteris spelaea*, have been widely reported in coastal and lowland areas due to their broad foraging ranges and ability to exploit diverse food resources [3,16]. These species are known to utilise coastal vegetation and open landscapes for foraging and commuting.

3.2 Ectoparasite Diversity

Ectoparasite analysis was conducted exclusively on bats captured at UTHM Parit Raja. A total of five ectoparasite species belonging to two major arthropod groups, namely mites and bat flies, were identified during the study period, as shown in Fig. 6.

(a) (b) (c) (d) (e)

Fig. 6 (a) E. penthetoris; (b) L. ferrarii; (c) L. obliqua; (d) L. brachytrinax; (e) Macronyssus sp

Mites recorded in this study include *Macronyssus* sp., as shown in Fig. 6(e), which belongs to the Order Mesostigmata under the Family Macronyssidae [20]. These mites were detected on seven bat hosts and were classified as too numerous to count (TNTC). Due to the high density of mites present on individual hosts, accurate enumeration was not feasible; therefore, mite infestation was recorded qualitatively based on host presence rather than quantitative counts. Other than that, several species of bat flies were recorded as shown in Fig. 6, all belonging to the Family Nycteribiidae, namely *Leptocyclopodia ferrarii* (b), *Leptocyclopodia brachytrinax* (d), *Leptocyclopodia obliqua* (c), and *Eucampsipoda penthetoris* (a). Nycteribiid bat flies are obligate, host-specific ectoparasites that spend their entire life cycle on bats and exhibit specialized morphological adaptations for clinging to host fur and wing membranes [6]. In this study, each bat fly species was recorded at low abundance, with only a single individual detected per species.

3.3 Host-Ectoparasite Associations and Infestation Rate

Host-ectoparasite associations varied among bat host species, as summarized in Table 1, a total of four species of bat flies belonging to the Family Nycteribiidae (*L. obliqua*, *E. penthoris, L. brachytrinax* and *L. ferrari*) and mites from the Family Macronyssidae (*Macronyssus* sp.) were identified from the examined bat hosts.

Table 1 Host-ectoparasite association

	Ectoparasite Species				
Host species	*L. obliqua*	*E. penthetoris*	*L. brachytrinax*	*L. ferrari*	*Macronyssus sp*
C. brachyotis	presence	presence	presence	absence	TNTC
C. horsfieldii	presence	absence	presence	presence	TNTC
E. spelaea	absence	absence	absence	absence	absence
Murina suilla	absence	absence	absence	absence	TNTC

Cynopterus species exhibited the strongest association, harboring multiple species of nycteribiid bat flies in addition to heavy mite infestations [21]. These patterns suggest favourable conditions for ectoparasite persistence on *Cynopterus* hosts, potentially related to their gregarious behaviour, repeated use of roosting sites, and higher local abundance. In contrast, *E. spelaea* was not infested with any ectoparasites during the study period, which may be attributed to differences in roosting ecology and movement behaviour that reduce sustained parasite attachment. *Murina suilla* displayed a distinct infestation pattern, being infested exclusively by mites at TNTC levels while no bat flies were recorded, indicating differences in host specificity among ectoparasite groups.

Overall ectoparasite infestation was recorded in 12 out of 28 bat host, corresponding to an infestation rate of 43.3%. Infestation patterns were unevenly distributed across host species, with *Cynopterus* species contributing most substantially to the observed infestation. These findings suggest that ectoparasite occurrence was strongly influenced by host species identity and associated ecological traits rather than random exposure alone.

3.4 Implications of Ectoparasite Infestation

Ectoparasite infestation may have several biological implications for bat hosts. High infestation intensity, particularly by mites recorded at TNTC levels, may impose physiological stress on infested individuals through blood feeding, skin irritation and increased energy expenditure associated with grooming behaviour. Prolonged ectoparasite infestation may negatively affect host body condition, immune function and overall fitness [22].

At the population level, ectoparasites may influence interactions among bat hosts. Close physical contact during roosting and social behaviour can facilitate ectoparasite transmission between individuals, particularly in species that repeatedly use the same roosting sites, such as *Cynopterus* spp. This may result in uneven distribution of ectoparasite loads within bat populations, with certain host species acting as important reservoirs for ectoparasite persistence [21].

From a broader ecological and public health perspective, the presence of ectoparasites on bats inhabiting semi-urban landscapes may have implications for surrounding environments, including areas frequented by humans [23]. Although ectoparasite infestation does not directly indicate pathogen transmission, some bat-associated ectoparasites have been recognized as potential carriers of zoonotic agents. In agricultural and campus environments, increased proximity between bats, human and domestic animals may elevate opportunities for indirect exposure to ectoparasites, underscoring the relevance of host-ectoparasite studies within a One Health framework [24].

Overall, the implication of ectoparasite infestation extend to bat health, population dynamics, and ecosystem functioning. Understanding these implications provides valuable context for interpreting infestation patterns and emphasizes the importance of incorporating host ecology and habitat characteristics when assessing bat-ectoparasite interactions. In human-modified landscapes, such information is essential for balancing bat conservation efforts with ecological and public health considerations.

4. Conclusion

This research successfully met its objectives by documenting bat host diversity, ectoparasite diversity, host-ectoparasite associations and infestation rates in UTHM environment. A total of four bat species representing two families under the Order Chiroptera were recorded, comprising both fruit and insectivorous bats. Fruit bats from the genus *Cynopterus* were the most dominant, reflecting their adaptability to disturbed habitats such as oil palm plantations, while green spaces supported species with more specialized ecological requirements. Ectoparasite assessment identified four species of nycteribiid bat flies and mites from the genus *Macronyssus*. Overall, ectoparasite infestation was recorded in 12 out of 28 bat hosts, resulting in an infestation rate of 43.3%, with *C. brachyotis* and *C. horsfieldii* contributing most to the infestation. These findings provide baseline information on bats-ectoparasite interactions in human-modified landscapes and highlight the host-dependent nature of ectoparasite occurrences.

This study faced several limitations, including low capture success in open habitats, particularly at the Tanjung Labuh Aerodrome area where bats were observed but not captured, likely due to flight height and habitat structure. Unpredictable weather conditions, especially frequent rainfall, further affected sampling efficiency by limiting fieldwork duration and reliance primarily on mist nets constrained species detection. Future studies should extend the sampling period, increase spatial and temporal coverage, and incorporate additional trapping methods such as acoustic monitoring to improve capture efficiency. Long-term monitoring of bat-ectoparasite dynamics is recommended to enhance ecological understanding and support conservation and public health considerations in semi-urban environments.

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Conflict of Interest

The author confirms that there are no conflicts of interest regarding the publication of the paper.

Author Contribution

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

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