BAIT PREFERENCES BY DIFFERENT SMALL MAMMAL ASSEMBLAGES FOR EFFECTIVE CAGE-TRAPPING

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ABSTRACT The ecological study of small mammals often uses the cage-trapping method, installed with baits. Capture rates vary according to different baits used. We want to determine the bait preferences by different small mammal groups. The cage-trapping approach used common domestic bait types available, namely, aromatic banana, sweet potato with peanut butter, oil palm fruit, dried salted fish, jackfruit, and roasted coconut flesh. Sampling was conducted in three different habitat categories, namely urban, semi-urban, and recreational forests, located in Selangor, Malaysia, for one year. A total of 537 small mammals from 15 species were sampled, which was then grouped into seven groups (i.e., *Rattus* sp., *Maxomys* sp., *Sundamys* sp., *Leopaldamys sabanus*, *Suncus murinus*, squirrels, and *Tupaia glis*). Bait preferences were significantly different among the different small mammal groups, i.e., F (6,35) = 5.621, p = 0.000, with bananas shown to be most preferred bait, followed by oil palm fruits and sweet potatoes. Non-metric multidimensional scaling (nMDS) analysis revealed that the *Rattus* species encompassed the most diverse bait preference, while *S. murinus* and *L. sabanus* were the most selective. Muridae preferred sweet potatoes with peanut butter over bananas, while Sciuridae and Tupaiidae preferred bananas, and Soricidae preferred dried salted fish. This study elucidates the most effective bait selection for different small mammal assemblages, serving as a guide to increase capture rates when sampling targeted population of small mammals. Apart from that, it is helpful for effective rodent pest control.

ABSTRAK Kajian ekologi mamalia kecil sering menggunakan kaedah perangkap sangkar, yang dipasang dengan umpan. Kadar tangkapan adalah berbeza-beza mengikut jenis umpan yang berlainan. Kami ingin menentukan pemilihan umpan mengikut kumpulan mamalia kecil yang berlainan. Perangkap sangkar menggunakan jenis umpan domestik yang tersedia iaitu pisang aromatik, ubi keledek manis bersama mentega kacang, buah kelapa sawit, ikan kering masin, buah nangka, dan isi kelapa dibakar. Persampelan dilakukan di tiga kategori habitat yang berlainan iaitu bandar, separa bandar dan hutan rekreasi yang terletak di Selangor, Malaysia dalam tempoh satu tahun. Sejumlah 537 mamalia kecil dari 15 spesies, yang kemudiannya dikumpulkan kepada tujuh kumpulan (*Rattus* sp., *Maxomys* sp., *Sundamys* sp., *Leopaldamys sabanus, Suncus murinus,* tupai, dan *Tupaia glis*). Pemilihan umpan adalah sangat berbeza di antara kumpulan mamalia kecil (F (6,35) =5.621, p = 0.000), dengan pisang menunjukkan umpan yang paling digemari, diikuti oleh buah kelapa sawit dan ubi keledek. Analisis Non-metric multidimensional scaling (nMDS) mendedahkan bahawa spesies *Rattus* merangkumi pemilihan umpan yang paling pelbagai, manakala *Suncus* dan *Leopaldamys* adalah paling selektif. Murridae memilih ubi keledek bersama mentega kacang berbanding pisang. Sciuridae dan Tupaiidae menunjukkan pemilihan terhadap pisang, manakala ikan kering digemari oleh Soricidae. Kajian ini menjelaskan pemilihan umpan yang paling berkesan untuk kumpulan mamalia kecil yang berbeza, dan boleh menjadi panduan untuk meningkatkan kadar penangkapan populasi mamalia kecil yang disasarkan. Selain itu, ia berguna dalam pengawalan perosak tikus yang berkesan.

Keywords: Trapping, baits preference, *Rattus*, squirrels, scandent, shrew

1. INTRODUCTION

Apart from their small size (less than 5 kilograms), some small mammals are known as secretive and nocturnal animals. Some of the species are commensal rats and recognised as notorious pests in the urban environment, causing not only damage to properties but also an important reservoir for several zoonotic pathogens, such as *Leptospira*, hantavirus, and plague. Small mammal research and rodent pest-control often use cage-trapping method, installed with various bait types to capture the animals. This method enables the estimation of community structure and population density of small mammals; thus, requiring an effective sampling system (Woodman et al., 1996). Cage-trapping is an essential method for estimating the structure, composition, and population size of small mammals (Stokes, 2012), and essential to understanding the ecological health of specific habitats (Schnurr et al., 2004). A high diversity of small mammals indicates a healthy environment, while a low diversity of small mammals may reveal a depauperate habitat (Avenant, 2000; Jorgensen, 2004).

The ecological studies of small mammals have been documented in various habitat types in Malaysia, especially the lowland rainforests (Kemper & Bell, 1985; Nakagawa et al., 2007; Jayaraj et al., 2012), montane forests (Nor, 2011), islands (Mohd-Taib et al., 2019), semi-urban and urban areas (Yusof et al., 2018; Mohd-Taib et al., 2020). These studies used different baits, including bananas, sweet potatoes, fried coconut, jackfruits, and oil palm fruits. In addition, different habitat types have been shown to encompass different species assemblages of small mammals, as more forested areas exhibit a higher species richness and diversity. Urban areas, on the other hand, exhibit poorer species assemblages, with the domination of commensal species.

It was reported that bait types and trapping protocols such as time, influence the capture rates of small mammals (Hize & Velazco, 2013). Baits or scented lures are commonly used globally to capture small mammals in different habitats (Kok et al., 2013). A previous study reported that the various baits used in different habitat types could affect the number of individuals and species composition of small mammals (Woodman et al., 1996). A vast range of bait types are available for cage-trapping of small mammals, and it differs according to the region. Studies in Indo-China used different types of vegetables, including sticky rice, peanuts, banana, dried fruits, and meat (Starr et al., 2012; Parrot et al., 2014). In New Zealand, researchers have used cheese, chocolate, soap, wax, and oiled wood (Weihong et al., 1999), whereas, in east Asia, minced meat, yeast, fish meal, and egg baits were used (Pervez, 2007). Meanwhile, most studies in Malaysia used banana, papaya, sweet potato, coconut, oil palms, jackfruits, dried fish (Mariana et al., 2005; Bernard et al., 2009; Lee & Goh, 2000; Ishak et al., 2018; Yusof et al., 2019) and even fresh prawns (Hafidzi, 2007) and anchovies (Zakaria et al., 2001). Amni et al. (2019) reported that fried chicken has a high capture rate compared to the other baits, indicating that high protein bait is the most attractive bait for commensal rats in urban areas.

According to Woodman et al. (1996), bait is one of the factors that affect the ability to capture small mammals. It has been shown that different species of small mammals have different bait preferences (Oswald & Flake, 1994), and they require specific baits to be efficiently captured (Stickel, 1948). Knowledge of bait preferences is essential to increase the capture rate of target species (Amni et al., 2019). The trapping success is also affected by the availability of food in the surrounding field, as abundant food resources might reduce the chance of being captured, especially if the bait type used are readily available in the surrounding area (Aplin et al., 2003). Besides, baits provide support and maintenance for trapped animals; thus, reducing the possibilities of trap mortality (Jones et al., 1996), unlike other trapping methods such as snap trap and poison bait, which kill the animals upon contact. Besides, determining the specific bait types to a target population would be the most effective approach for cage-trapping. Therefore, the study aims to assess the bait preferences of different small mammal assemblages. In this study, we include a vast array of small mammal assemblages through a year-long sampling, in different habitat types. This finding would be useful for effective rodent control, as well as optimising the ecological sampling of small mammals.

2. MATERIALS AND METHODS

2.1 Study Areas

The research was carried out from January 2016 to May 2017 in three different habitat types located in Selangor, Malaysia (Figure 1; Table 1). The sites were classified as urban, semi-urban, and recreational forests. Urban areas are rated as the extremely populated provision of adequate living conditions, infrastructure, and facilities (Hassan et al., 2013; Mohd-Taib et al., 2020). Semi-urban areas typically constitute human settlements with less concentrated populations than the urban areas, while recreational forest serves as nature outdoor spots for visitors (Yusof et al., 2018).

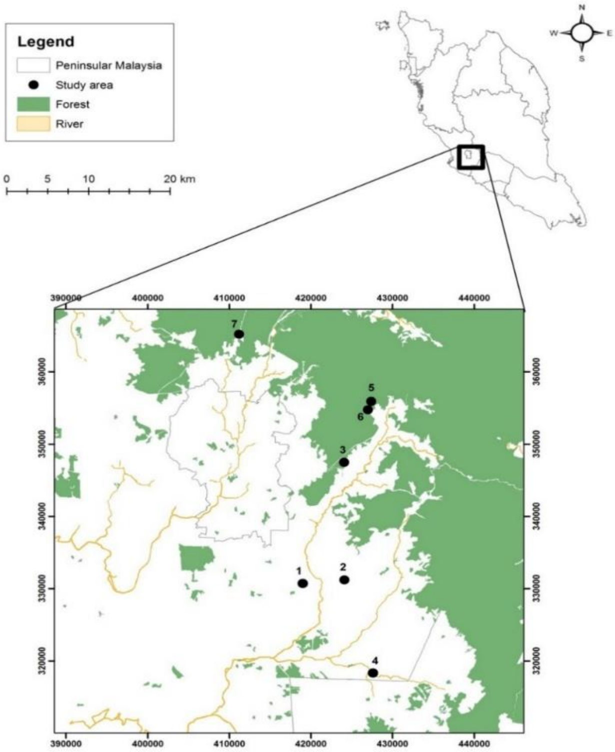

Figure 1. Location of the study sites in Selangor state, Malaysia

Table 1. Study sites according to the habitat categories

Study sites		Habitat category	GPS coordinate	
			N reading	E reading
1	Sungai Ramal Baru, Kajang	Urban	02°59'17.9"	101°45'56.0"
2	Taman Sri Jelok, Kajang	Urban	02°59'33.0"	101°48'46.0"
3	Kg. Sg. Semungkis, Hulu Langat	Semi-urban	03°08'18.7"	101°48'41.2"
4	Kem PLKN Millennium	Semi-urban	02°52'35.1"	101°50'36.8"
5	Sg. Congkak, Hulu Langat	Recreational forests	03°12'35.7"	101°50'35.3"
6	Sg. Hulu Perdik, Hulu Langat	Recreational forests	03°12'18.1"	101°50'10.0"
7	Sg. Tua, Ulu Yam, Hulu Selangor	Recreational forests	03°18'02.9"	101°41'42.4"

2.2 Fieldwork Sampling

Small mammal sampling involved deploying 100 cage traps (16 × 16 × 50 cm) randomly with at least a 10-meter distance to one another, at each study site. The cage traps were located on the ground along the forest trails, river, and around residential houses. The animals were baited with different bait types, which include aromatic banana, sweet potato with peanut butter, oil palm fruits, dried salted fish, jackfruits, and roasted coconut flesh. The cages with different baits were placed interspersed between each other fairly equally (Fig. 2). All cage traps were left open overnight and during the day to increase the chances of capturing nocturnal and diurnal species (Kok et al., 2013). Traps were checked once daily in the morning (10:00 hour) and stolen, or damaged baits were replaced with a new one. Sampling was conducted in two phases, in alternate months at each site throughout the sampling period. Trapping was carried out for six days and five nights for each phase.

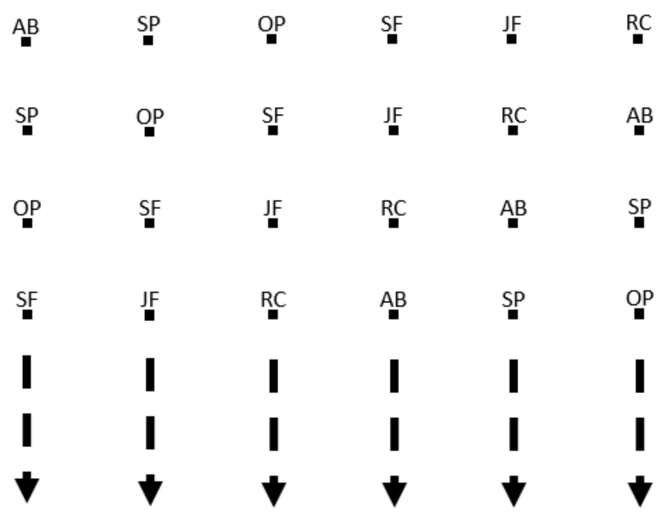

Figure 2. Cage with different baits placements interspersed with each other (Note: black squares referred to cages, baited with varying types of bait; AB=aromatic bananas; SP = sweet potato; OP = oil palm fruits; SF = salted fishes; JF = Jackfruits; RC=roasted coconut)

Trapped animals were taken to the research station for examination. Morphological data such as species, sex (male or female), age classes (adult, sub-adult, or juvenile), health conditions (good, fair, or poor), reproductive conditions (pregnant or non-pregnant), bait preferences, and morphometric measurement data, including body weight, head and body length, tail length, hindfoot, and ear length were recorded. Each small mammal was identified morphologically according to recorded measurements and graphic illustrations, as described by Francis (2008). All captured animals were anaesthetised with an intramuscular injection of Zoletil®100 (Massolo et al., 2003) from 0.02 mL up to 0.05 mL depending on the weight of the animals (King et al., 2011) and returned to their captured sites. This study has been approved by the animal research Ethics

Committee at Universiti Kebangsaan Malaysia (FST/2016/SHUKOR/18-MAY/750-MAY-2016-SEPT.-2018-AR-CAT2).

2.3 Data Analyses

Normality test was first performed to determine the distribution of the mean (normal distribution via Shapiro-Wilk test; $p > 0.05$). A two-way ANOVA (without replication) was performed to determine the main effects contributing to the food preference among the small mammals captured. A one-way ANOVA was then performed to determine if there is a significant difference between the bait types and small mammal groups on bait preferences, followed by a Tukey post-hoc test to distinguish the significant difference of each factor. This analysis was performed using SPSS software version 23 (IBM Corporation). A gradient analysis approach, non-metric multidimensional scaling (nMDS), which produces an ordination based on a distance or dissimilarity matrix, was also presented based on the Bray-Curtis index to demonstrate the pattern of food preference by different small mammal species assemblages. Prior to this analysis, one-way permutational analysis of variance (PERMANOVA) was adopted to calculate the effect of different environmental factors and interactions in shaping the food preference among the small mammals. This analysis was performed using PAST version 2.17c downloaded from (http://folk.uio.no/ohammer/past).

2.4 Results

2.4.1 Species assemblages and abundance of small mammals at different habitat categories

During this study, 537 individuals of small mammals comprising of three orders (Insectivora, Scandentia, and Rodentia), four families (Muridae, Sciuridae, Tupaiidae, and Soricidae) and 15 species were captured in three habitat categories, as shown in Table 2. The urban areas recorded a higher number of individuals (n = 226) compared to the semi-urban (n = 189) and recreational forests (n = 122). The largest and most dominant family recorded in all three habitats was Muridae (437 individuals, 8 species), composed of 84% of the total number of small mammals captured, followed by Sciuridae (23 individuals, 5 species), Tupaiidae (53 individuals, 1 species), and Soricidae (7 individuals, 1 species). However, the semi-urban areas recorded the highest number of species (13 species), followed by the recreational forests (11 species), and the lowest was in the urban areas (4 species).

Based on Table 2, the most abundant and common species captured was *Rattus norvegicus* (n = 155), followed by *Rattus rattus* (n = 100), *Maxomys whiteheadi*, (n = 68), and *Rattus tiomanicus* (n = 66). Meanwhile, the least captured was *Maxomys surifer* (n = 2), *Callosciurus caniceps* (n = 2), and *Lariscus insignis*, (n = 1). The urban areas were dominated by *R. norvegicus* (n = 149) and *R. rattus* (n = 52). In contrast, the semi-urban areas were dominated by *R. tiomanicus* (n = 55), *R. rattus* (n = 34), and *Tupaia glis* (n = 28), whereby recreational forests were dominated by *M. whiteheadi* (n = 41) and *Sundamys muelleri* (n = 26). Three species were found in all three habitats, namely *R. norvegicus*, *R. rattus*, and *T. glis*. Both semi-urban and recreational forests shared nine species of small mammals (*M. whiteheadi*, *R. tiomanicus*, *R. rattus*, *S. muelleri*, *Leopaldamys sabanus*, *R. norvegicus*, *Maxomys rajah*, *T. glis*, and *Sundasciurus lowii*).

Table 2. Number of small mammal individuals captured at the three habitat categories

Family	Species	Common Name	Habitat category			Total
			Urban	Semi-urban	Recreational forests	
Muridae	*Rattus norvegicus*	Norway rat	149	4	2	155
	Rattus rattus	Black rat	52	34	14	100
	Rattus tiomanicus	Wood rat	0	55	11	66
	Maxomys whiteheadi	Whitehead's spiny rat	0	27	41	68
	Maxomys rajah	Rajah's spiny rat	0	2	6	8
	Maxomys surifer	Red's spiny rat	0	0	2	2
	Sundamys muelleri	Muller's Giant Sunda rat	0	18	26	44
	Leopoldamys sabanus	Long-tailed Giant rat	0	2	9	11
Sciuridae	*Callosciurus notatus*	Plaintain squirrel	0	12	0	12
	Callosciurus caniceps	Grey-bellied squirrel	0	2	0	2
	Sundasciurus lowii	Low's squirrel	0	1	3	4
	Sundasciurus tenuis	Slender squirrel	0	0	4	4
	Lariscus insignis	Three-striped squirrel	0	1	0	1
Tupaiidae	*Tupaia glis*	Common treeshrew	21	28	4	53
Soricidae	*Suncus murinus*	House shrew	4	3	0	7
TOTAL			226	189	122	537

2.4.2 Baits preferences among small mammal groups

Overall, traps baited with aromatic banana caught the highest number of individuals (n = 183, 11 species), followed by sweet potato and peanut butter (n = 143, 10 species), and oil palm fruits (n = 141, 11 species), as shown in Table 3. Small mammal showed a poor response towards jackfruits (n = 7, 4 species) and roasted coconut flesh (n = 4, 1 species). The trends in baits selection among small mammals can be seen between four groups of family, Muridae, Sciuridae, Tupaiidae, and Soricidae. Muridae, which comprised of four groups (*Rattus* sp., *Maxomys* sp., *Sundamys* sp., and *L. sabanus*), preferred sweet potato with peanut butter over the banana. Meanwhile, Sciuridae (squirrels) group (*Sundasciurus*, *Callosciurus*, and *Lariscus*) and Tupaiidae (*T. glis*) showed a high preference on aromatic banana, while dried salted fish became the first choice of Soricidae group (*Suncus murinus*). From this result, it can be proven that *Rattus* sp. and *Sundamys* sp. groups were composed of more diverse bait preferences, followed by *Maxomys* sp. and *L. sabanus*. Specialised bait preferences were more apparent, especially in *S. murinus*, followed by *T. glis* and squirrels.

Table 3. The total number (and percentage) of captures for each small mammal species with different bait types

Species	Banana	Peanut butter	Oil palm fruits	Dried salted fish	Jackfruits	Coconut
Family Muridae						
Rattus norvegicus	51 (33)	60 (38.9)	9 (5.84)	31 (20)	-	4 (2.59)
Rattus rattus	29 (28.7)	28 (27.7)	24 (23.7)	19 (18.8)	-	-
Rattus tiomanicus	17 (25.7)	16 (24.2)	31 (46.9)	2 (3.03)	-	-
Maxomys whiteheadi	10 (14.7)	15 (22)	40 (60.6)	-	3 (4.4)	-
Maxomys rajah	4 (50)	1 (1.47)	3 (37.5)	-	-	-
Maxomys surifer	-	-	-	1 (50)	1 (50)	-
Sundamys muelleri	17 (38.6)	14 (31.8)	10 (22.7)	2 (4.54)	1 (2.27)	-
Leopoldamys sabanus	4 (36.3)	1 (9.1)	6 (54.5)	-	-	-
Family Sciuridae						
Callosciurus notatus	9 (75)	-	3 (25)	-	-	-
Callosciurus caniceps	-	-	2 (100)	-	-	-
Sundasciurus lowii	2 (50)	2 (50)	-	-	-	-
Sundasciurus tenuis	-	-	2 (50)	-	2 (50)	-
Lariscus insignis	1 (25)	-	-	-	-	-
Family Tupaiidae						
Tupaia glis	39 (73.5)	3 (5.66)	11 (20.7)	-	-	-
Family Soricidae						
Suncus murinus	-	3	-	4 (57)	-	-
TOTAL	183 (34.1)	143 (26.6)	141 (26.3)	59 (10.8)	7 (1.3)	4 (0.9)

A two-way ANOVA without replication was carried out to determine if the bait preferences were different among small mammal groups (n = 7) and bait types (n = 6). Small mammals were grouped into *Rattus* sp. (n = 321), *Maxomys* sp. (n = 78), *Sundamys* sp. (n = 44), *L. sabanus* (n = 11), *S. murinus* (n = 7), squirrels (Sciuridae; n = 23), and *T. glis* (n = 53). The data were normally distributed for each group, as assessed by the Shapiro-Wilk test ($p > 0.05$). There was a significant difference in food preference for small mammal groups (F = 7.178, dF = 6, $p = 0.000$) and bait types (F = 2.937, dF = 5, $p = 0.0283$). However, one-way ANOVA of food preference was only significantly different for small mammal groups ($F [6,35] = 5.621$, $p = 0.000$), but not for bait types ($F [5,36] = 1.447$, $p = 0.231$). For small mammal group, Tukey post-hoc analysis revealed that food preferences of *Rattus* sp. groups were significantly different with other small mammal groups ($p < 0.05$), but no significant difference among other groups (Figure 3).

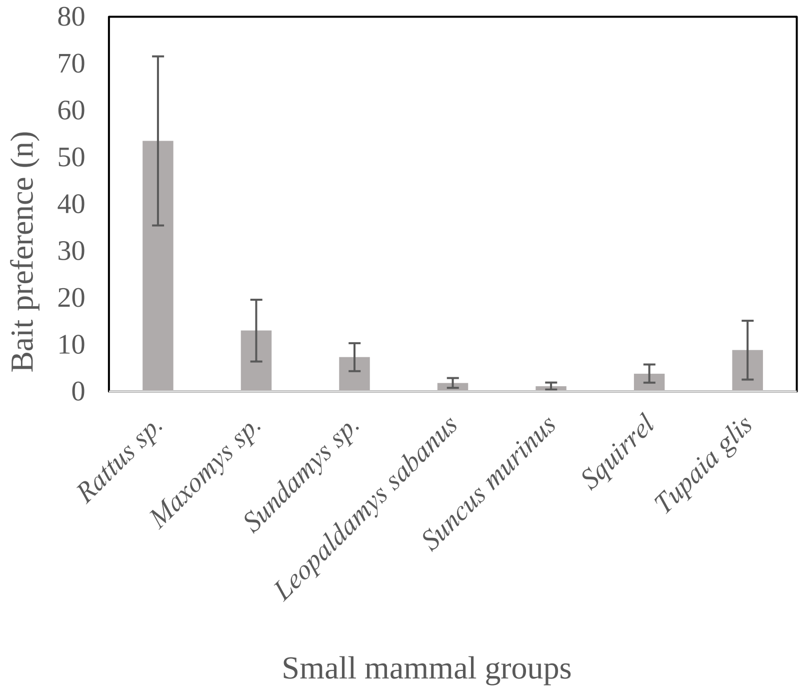

Figure 3. Mean ± SE of bait preferences for each small mammal group.

The nMDS ordination based on the food preference reveals different pattern among small mammals (Figure 4). A stress value of 0.06 (0.05 to 0.1) is considered a fair representation of the model. *Rattus* group showed the biggest convex hulls polygon, indicating the most diverse bait selection, with the highest overlapping points with *Maxomys* sp. and *Sundamys* sp. Meanwhile, *S. murinus* showed the most non-overlapping points, indicating a highly distinct bait preference compared to the other groups. One-way PERMANOVA analyses showed that there were no significant differences in food preference among the different small mammal groups (PERMANOVA, F = 1.347, $p = 0.179$). However, for pair-wise comparison, *L. sabanus* and *S. murinus* showed a significant difference with *Rattus* sp. preferences with $p = 0.0245$ and $p = 0.016$ respectively. Other small mammal groups did not show a significant difference in the bait preference to *Rattus* ($p > 0.05$). This can be further explained by the cumulative percentage of bait preference among different small mammal groups (Figure 5). As explained earlier, the *Rattus* sp. encompassed the most diverse food preference, followed by *Maxomys* sp. and *Sundamys* sp. In contrast, *S. murinus* preferred minimal bait types, i.e., dried fish and sweet potato with peanut butter.

In terms of bait selections, banana was found to be the most preferred bait, followed by sweet potato with peanut butter, and oil palm fruits. *Tupaia* and squirrel groups preferred highly on banana compared to other bait types.

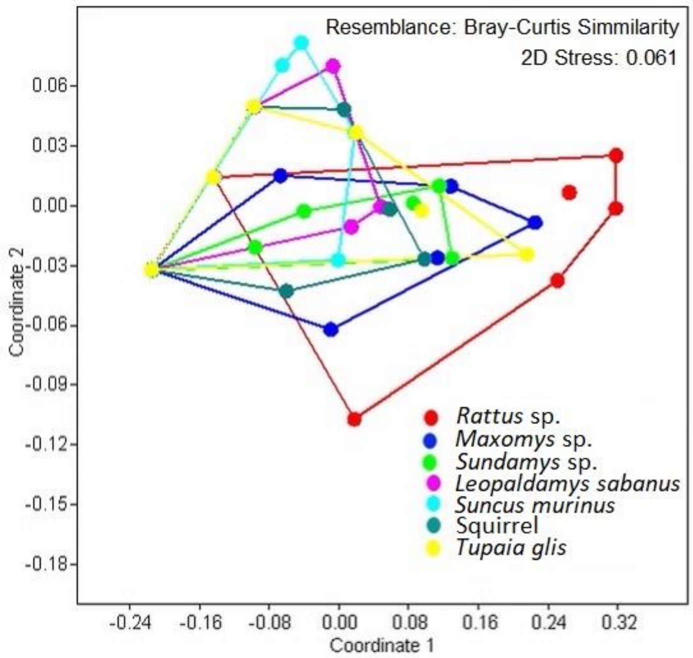

Figure 4. Non-metric multidimensional scaling (nMDS) ordinations of bait preference among the different group of small mammals with convex hulls polygon representing different groups.

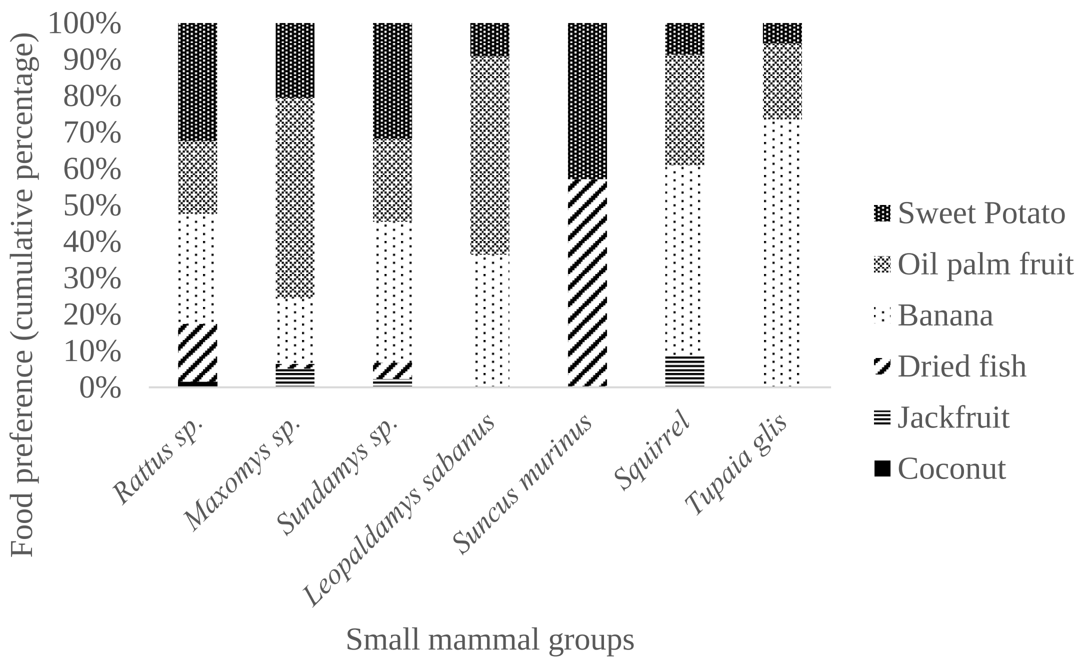

Figure 5. Cumulative percentage of bait preferences among different small mammal groups

3. DISCUSSION

This present study of small mammals in three habitat types allowed us to evaluate how different bait types used during cage-trapping affects the total number of captured small mammals and the effectiveness of each bait type used. Our results indicate that bait preferences differ significantly among different small mammal assemblages. *Rattus* sp. group showed the most diverse bait preferences, followed by *Maxomys* sp. and *Sundamys* sp. In contrast, *S. murinus* showed a very limited range of bait preference. Apart from that, there were distinct bait preferences among rodents (except squirrel) and scandent (*Tupaia*), whereby rodents preferred oil palm fruits, followed by banana and sweet potato with peanut butter. In contrast, squirrels and scandent preferred banana over oil palm fruits.

Aromatic banana caught more small mammals (34%) than other bait types. This finding is in agreement with the research work done by Zakaria et al. (2001) and Md. Nor (2001), who reported that banana was the most effective bait in capturing small mammal. However, even though banana caught more individual and species overall, the trends in bait preferences vary among different small mammal groups (Bernard, 2003). For instance, Muridae, the largest small mammal group captured with 8 species, showed 51% of the total individual preferred sweet potato with peanut butter over banana. Previous research indicated that a trap baited with peanut butter has a positive effect on the success of capturing small mammal (Kumar et al., 2013). Previously, Beer (1964) and Patric (1970) indicated the preference of peanut butter as bait in trapping small mammals. Beer (1964) discovered that peanut butter mixed with rolled oats was preferred over other baits, whereas Patric (1970) proved that peanut butter was preferred over all other baits, including meat baits. In addition, Manville et al. (1992) revealed that white-footed mouse (*Peromyscus leucopus*) climbed the trees that were marked with peanut butter and proved significantly that *P. leucopus* were lured into trees by baits. Furthermore, baits such as sweet potato, banana, oats, and coconut coated or mixed with peanut butter may provide additional and strong smell to attract a variety of small mammal groups (Harkins et al., 2019). Besides, Bernard (2003) found that mixed bait caught almost two times the number of small mammals compared with single baits type. However, Kumar et al. (2013) discovered that the disadvantage of using peanut butter as bait is that it attracted other animals that either crushed or destroyed the traps or carried it away.

Nonetheless, *Rattus* species was shown to exhibit the most diverse bait preference compared to the other small mammal groups. These species, particularly *R. norvegicus* and *R. rattus* are geographically widespread and reach maximum population densities in urban areas where there are plenty of food sources (Glass et al., 1989). Due to their commensal behaviour, these species possibly tend to diversify their diet intake, especially common in households such as peanut butter, banana, dried salted fish etc. Many studies have indicated their attractiveness to flavoured baits, especially loaded with poison for pest control effort (Pervez, 2007; Shafi et al., 2008; Schlötelburg et al., 2018). Apart from that, these species were also known to be cautious, favour the familiarity with a known environment, and eat only small quantities of new foods (Patergnani et al., 2010). Unlike these two species, the conspecific *R. tiomanicus* was not recorded from the urban areas, instead primarily found in the secondary forest and the agricultural areas (Payne et al., 1985). Therefore, diversification of bait types potentially increases the trapping success of the *Rattus* species. *Sundamys* sp. and *Maxomys* sp. exhibited the next most diverse bait preferences. These two species are commonly found in semi-urban and near forest fringe. These habitats were usually located at some residential houses, as well as recreational areas, which introduced various food sources from human consumption and others, unlike their typical diets, which composed of insects, fruits, leaves, shoots and other vegetable matter (Yusof et al., 2019). Therefore, explaining the preferences of these species towards the introduced baits such as sweet potato with peanut butter, dried fish, and banana.

Our study also showed the Family Sciuridae (tree squirrels), and Tupaiidae (ground squirrel) preferred banana (52%) and oil palm fruits (30%) over other baits. In general, this group is categorised as omnivores, which are insects, fruits, and vegetable feeders (Francis, 2008; Charles & Ang, 2010). Plantain squirrel (*Callosciurus notatus*) was found higher in semi-urban areas compared with the other four squirrel species. Studies on the stomach contents of this species revealed that insect was the primary food item, followed by oil palm fruits (Hafidzi, 1998). Similarly, over 70% of treeshrew (*T. glis*) captured in this study also preferred banana and oil palm fruits. Aromatic banana is the most effective bait to attract squirrels and treeshrews (Charles & Ang, 2010). However, Fitch (1954) claimed that it is notoriously difficult to capture certain groups of small mammals, such as house shrews. The only species of Soricidae group captured in this study was *S. murinus*, which only took dried salted fish and sweet potato with peanut butter as baits. Rahelinirina et al. (2017) used dried fish and onion, while Lee (1997) used sweet potato with peanut butter to sample small mammals in human habitation and recorded a high abundance of house shrews compared to other rat species.

Lim (2015) mentioned that a careful selection of baits might increase the number of animals captured concerning the type of habitats sampled. Earlier, Patric (1970) suggested that the perfect bait for small mammals should be appealing enough to catch relatively large numbers of small mammal species. Amni et al. (2019) indicated that protein-based items were most favoured by rats, especially among commensal rodents. Another thing to note is for an appropriate rodent control plan to take place, the first thing to do is to reduce the alternative food sources that may influence the bait preference. Recently, Takacs et al. (2018) developed a new food bait containing synthetic, long-range volatile food attractants that represent rodent's favourite foods that successfully attracted rodents. They proved that the modified baits enabled rodent trapping to be more effective compared to commercial baits such as peanut butter. The use of attractants from household materials as used in this study could overcome the problem of bait-shyness and neophobic among targeted rodent population.

4. CONCLUSION

This paper suggests that different bait types had an effect on the capture rate of various small mammal groups, in which different groups of small mammals showed varied preferences towards different bait types. The information on bait preferences by various small mammal groups could serve as a guide on which bait types to use for distinct habitat types, concerning the small mammal assemblages present. Therefore, it proved that bait types are an important factor to be considered for small mammal population sampling, as well as rodent pest control. Other factors to consider for future study are the environmental factors that might directly influence bait consumption; thus, may affect the rodent control plan that has been carried out, such as the placement of the baited traps, the existence of predators and food competitors, and weather conditions. Therefore, determination of the most effective bait types is essential for constructing a specific condition where rodent control effort is targeted.

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