SPECIES DIVERSITY AND ABUNDANCE OF NON-VOLANT SMALL MAMMALS USING CAGE TRAPS AT GUA SETIR COMPLEX, KELANTAN

by

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DECLARATION

I declare that this thesis entitled “Species Diversity and Abundance of Non-Volant Small Mammals Using Cage Trap at Gua Setir Complex, Kelantan” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ……..

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Date : ……...

APPROVAL

"I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of the degree of Bachelor of Applied Science (Natural Resources Science) with Honors"

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Date	: ……...

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Species Diversity and Abundance of Non-Volant Small Mammals Using Cage Traps at Gua Setir Complex

ABSTRACT

A study of non-volant small mammal diversity and abundance had been carried out at Gua Setir, Kelantan. The main objective of this study is to determine the diversity and abundance of non-volant small mammals in the area. There were about 50 cage traps that had been used in completing this study which were baited with banana (*Musa acuminata)*. The traps were set up for about twenty six day and in total there were about 13 individuals of non-volants small mammals were recorded. This individual compromising of 4 species that had been captured and 2 species by spotted method, 3 Orders and 3 Families namely: Muridae, Sciuridae, and Tupaiidae. Further study were needed to be carried out at Gua Setir to record more data on the diversity of non-volant small mammals in Kelantan.

Kepelbagaian dan Kelimpahan Spesies Mamalia Kecil Tidak Terbang Menggunakan Perangkap Sangkar di Gua Setir Kompleks

ABSTRAK

Pembelajaran mengenai kepelbagaian dan kelimpahan mamalia kecil tidak terbang yang telah dijalankan di kawasan Gua Setir, Kelantan. Tujuan utama pembelajaran ini ialah untuk menentukan kepelbagaian dan kelimpahan mamalia kecil tidak terbang di kawasan tersebut. Dalam menyelesaikan pembelajaran ini sebanyak 50 perangkap sangkar telah digunakan dengan menggunakan umpan pisang (*Musa acuminata*). Perangkap tersebut telah dipasang selama dua puluh enam hari yang telah memberikan hasil dimana terdapat 13 individu mammalia kecil tidak terbang yang telah berjaya direkodkan. Individu ini terdiri daripada 4 spesies yang berjaya ditangkap dan 2 spesies melalui kaedah pemerhatian, 3 order dan 3 keluarga iaitu: Muridae, Sciuridae dan Tupaiidae. Masih diperlukan kaji selidik yang berterusan di situ untuk merekodkan lebih banyak data terhadap kepelbagaian dan kelimpahan mamalia kecil tidak terbang di Kelantan.

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LIST OF ABBREVIATIONS AND SYMBOLS

IUCN	International Union for Conservation of Nature
LC	Least Concern
%	Percent
sp.	Species
G	Gram

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Kelantan is one of a state in Malaysia that rich with flora and fauna (Maseri, & Mohd-Ros, 2005) that had not been discovered yet. From this factor, many forest reserves were gazetted to protect the natural treasures from lost in the future.

Small mammals are all mammals that weigh less than 500 g. It is the most diverse group of mammals compared to others. Generally, small mammals are poorly studied compared to large mammals, which causes less information spread and brought to least concerned towards it (Jayaraj et al., 2016). Some of the species have never been photographed in wild, which result in some of their ecologies are unknown, undiscovered or described in the region (Francis & Barrett, 2008). Their conservation status is also lows compared to large mammals. The reason why this study was conducted was to document the non-volant small mammals' species, diversity and abundance in Gua Setir, Jeli, Kelantan.

Small mammals diversity and abundance can be influenced by a few factors such as vegetation, the anthropogenic activity of human, climate, elevational gradient, and food availability (Daud et al., 2014). Mammals can be categorized into 14 orders such as Scadentia, Carnivora, and Rodentia due to its characteristics. Tree shrews apparently are classified under order Scadentia. Tree shrews are likely can be seen

same as a squirrel, but differ in many details of anatomy and behaviour. It consists of family Ptilocercidae (feather-tailed tree shrews) and Tupaiidae (tree shrews). Meanwhile, in order Carnivora, it was the most diverse group of mammals that largely evolved. It consists of 7 families that are, Canidae (dogs), Ursidae (bears), Ailuridae (red pandas), Mustelidae (martens, weasels, badgers, and otters), Viverridae (civets), Herpestidae (mongooses), and Felidae (cats). In mammals, Order rodents are the largest compared to the others. Rodentia shows the most success in the class Mammalia in terms of its diversity, abundance, distribution compared to others. Rodent species diversities can be classified into 29 extant families but 89% of rodent species be classified into 5 families that are (1) Muridae (rats and mice), (2) Sciuridae (squirrels), (3) Echimyidae (spiny rats), (4) Heteromyidae (pocket mouse and kangaroo rats) and (5) Dipodidae (jerboas and jumping mice).

Rodents consist of 44% of all mammals and there are more than 2000 species of it. 'Rodent' comes from the Latin word that is *rodere* which means 'to gnaw' (Kay & Hoekstra, 2008). The characteristics which converge to the means and its most conspicuous traits can clearly be seen from the single pair of razor-sharp incisors which used to gnaw food, defend themselves when in danger and nuzzle tunnels.

1.2 Problem Statement

No previous data on the species diversity and abundance of non-volant small mammals at Gua Setir, Kelantan had been collected. This study was done to document the diversity and abundance of non-volant small mammal species in ecology, especially in a limestone area. Besides that, as small mammals were poorly studied, more data were needed to make it received much public or conventional attention

(Ruppert et al., 2015). There was less study on small mammals in karst formation in Kelantan.

1.3 Objectives

The objective of this study is to determine the diversity and abundance of non-volant small mammals in Gua Setir area.

1.4 Scope of study

These scope of the study is to identify the diversity and abundance of non-volant small mammals in a karst area that is Gua Setir. The data get were related to the previous data that were collected at the Kelantan area.

1.5 Significance of study

This study is important to determine the diversity and abundance of non-volant small mammals which were related to the biodiversity information of the area as secondary forest. Small mammals play a vital role in the forest, especially secondary forest because of its help as seed predation and suppress forest regeneration (Struhsaker, 1997).

CHAPTER 2

LITERATURE REVIEW

2.1 Diversity of Non-Volant Small Mammals in Kelantan, Malaysia

There were few places that had been choosed in sampling small mammals around Kelantan. The research was conducted at Gunung Reng (limestone area), Gunung Chamah (secondary forest), Lojing Highlands (forest surrounded by agriculture), Gua Musang (limestone area) and Pasir Mas (orchid plantation). From this research 39 species were recorded from this five sampling places (Jayaraj et al., 2016).

Rattus rattus was most abundance at Gunung Reng because most of this species were captured there. Gunung Stong has the highest captured (317 individuals) compared to all sample site, but Gua Musang showed the highest diversity of species (23 species) collected. Majority mammals collected at Gua Musang were bats and this highlight the importance of karst area for bat conservation. Lojing highlands collect 9 species, Gunung Chamah 7 species and followed by Pasir Mas 5 species (Jayaraj et al., 2016).

2.2 Sample Size

In field research, the maximum number of animals to be caught is not the main aim which the researcher can easily make but the researcher only can make an estimation due to the effort. From the effort tested it is important to ensure that the hypothesis and objective did meet with it. The sample size was estimated from efforts that the researcher made from the literature, pilot data or both (Lande & Barrowclough. 1987). The sample size is important to determine the result that the researcher gain due to the information gathered from the efforts made.

Species richness measuring is a crucial objective for many community ecologies and conservation biologists. Species accumulation can be used if it involves new species found in the community and it can be assumed to provide an estimation of species richness. The simplest cumulative is the collector's curve. The cumulative number of species recorded were plotted as the function of sampling effort (Gotelli & Colwell, 2011).

2.3 Trapping Methods

2.3.1 Cage Trap

There are a few traps that can be used to catch the non-volant small mammals. Cage trap is the most suitable trap due to the size and ability to catch various species of non-volant small mammals. Cage trap is used due to its ability to catch non-volant small mammals without harming or killing it. Cage trap made of metal mesh and has a door held open by a trigger mechanism. The way cage trap function is by inserting bait inside the trap and aim for the animals lured in it by finding the best place to attract them. There are a few types of bait that can be used such as peanut butter, sunflower seed, oil palm seed, and banana. The most preferred bait is banana (Bernard, 2003) based on its effectiveness in the previous study. From the previous study that conducted at Gunung Stong, six species were caught a by using the cage trap which the highest number of individuals caught were *Leopaldamys sabanus* (six individuals) followed by *Maxomys whiteheadi* (two individuals) (Jayaraj et al., 2012). Total of the cage trap used in this research was 50 cage trap.

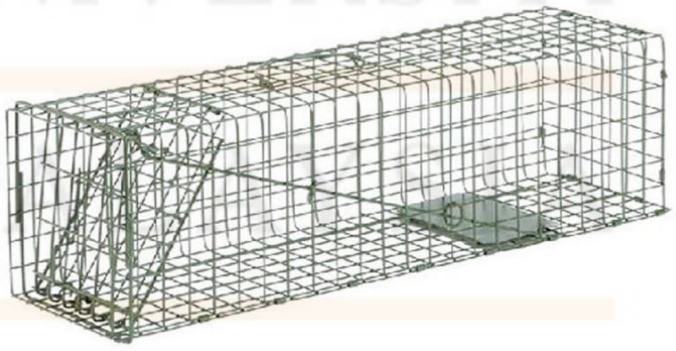

Figure 2.3.1: Cage trap (source: Google, 2018)

2.3.2 Sherman Trap

Sherman trap is another method to capture small mammals alive. But it's only can be entered by the small size of small mammals such as chipmunks, shrews, and rats. The bait that will be used in Sherman trap is peanut butter (Daud et al., 2014). Another bait also can be used depending on the situation. Due to the previous research that carried out at the Kuala Atok, Taman Negara Pahang total of Sherman trap used were 40 with distance from each trap set about 5 meter. The result from this research was combined with the cage trap result. Total species collect from this research were 23 species of small mammals. These were three frugivorous bats, 15 insectivorous bats, four rats and a tree shrew (Tingga et al., 2012).

Figure 2.3.2: Sherman trap (source: Google, 2018)

2.3.3 Pitfall Trap

Pitfall trap is a technique that usually used in studies of the seasonal occurrence, to examine the spatial distribution patterns, comparing relative micro-habitat abundance, community survey and studying daily activity rhythms. It also used bait to attract animal groups or species. Based on the previous research that had been conducted at Pulau Perhentian Besar, Terengganu there was about 30 pitfall trap were employed there. The trap was set up near trail entrance for 6 consecutive days and was checked twice a day. The result gets from using this method is one species were found with the number of individuals four that. The species found is *Crocidura malayana* (Rahim et al., 2016).

Figure 2.3.3: Pitfall trap (source: Google, 2018)

2.4 Biodiversity in Limestone Area

The arises diversity of species in karst area from maltitude of ecological niches is due to complex terrains (e.g extensive caves) and climatic conditions that are variables. Different tectonic and eustatic histories, degrees of isolation and incidences of random events can cause high species endemism (Sodhi et al., 2006). Karst area can be divided into two levels which is surface and cave levels. Both levels provide an ideal condition for speciation. Edaphic (soil-related) isolation flora or flora that produces on the karst surface is unique due to how it can adapt by including many calcicoles to make it able to grow in limestone. At the same time, animal species somewhat that differ from those in the nonkarstic area would give helped that required by others due to their poor dispersal capabilities. Plants and some animals such as invertebrates will have to adapt to highly alkaline conditions, thin soil layers, and desiccation on porous limestone bedrock. Cave animals such as arthropods and fishes must develop specialization to cope with fluctuating levels of light, water quantity, temperature, humidity, gas concentrations and organic materials (Culver et al., 2000).

Karst ecosystem usually supports rare species of animals. Based on the previous study that conducted in Mount Murud, Sarawak, there were about 22 species that had been found in there which consists eight families of small mammals (Soricidae, Tupaiidae, Pteropodidae, Rhinolophidae, Hipposideridae, Vespertilionidae, Muridae, and Erinaceidae). The most successful small mammals that live in the karst area are bats. Bats live in the karst area for hibernating and roosting due to the stable environment in a karst area. It shows the importance of the karst area for conservation of bats in Malaysia (Wiantoro et al., 2009).

2.5 Diversity Indices

2.5.1 Species Richness

The fundamental variables in ecology are species richness. The species richness simply derived quantities of a point pattern where the outcome of the stochastic process (in the term of distribution and abundance) produces "points" (exp., plants or animals location) where both the number and locations are random variables. The present/ absence of an element of a species distribution and abundance can be defined when space was discretized (Kéry & Royle, 2015). Abundance is the number of points per spatial unit and occurrence denotes the event where there is at least one point within the site. Besides that, species richness is a sum of a quantity that naturally derived from the point patterns of all occurring species at the site.

2.5.2 Shannon-Wiener Diversity Index

Shannon-wiener diversity index is used when a system consists too many individuals for each to be identified and examined. A diversity index is used in measuring species diversity in a given community. It differs from the species richness which shows the community composition and takes in the relative abundance of species that present in the community (Michel et al., 2006). Shannon index commonly takes into consideration both abundance and evenness of a species present in the community. It is explained by the formula shown:

$$H = -\sum (P_i * \ln P_i)$$

Where, H represents the Shannon Diversity Index, Pi as the fraction of the entire population made up of species. The high value of H would represent a diverse and equal distribution of community and lower values as a less diverse community.

2.5.3 Evenness

Species evenness is the similarity in species relative abundance in the community that captured another aspect of diversity by determining the diversity as a standardized index of relative species abundance.

$$\text{Evenness; } E = \frac{H}{Hmax}$$

Where H is diversity index, H_{max} the possible maximum diversity. When the range of evenness near to 0 it shows that most individuals belong to few species and if it is near to 1, is shown that the species near abundant (Smith & Wilson, 1996). This also told us how to balance the distribution of the species between two different locations in the term of frequency.

CHAPTER 3

MATERIALS AND METHODS

3.1 Study Area

In sampling non-volant small mammals, this had been carried out at Gua Setir, Kelantan which this place had no previous data recorded. The lithology of Gua Setir consists of shale, mudstone, sandstone, and limestone. The area has a few rivers which most of the source come from the Setir river. Alluvium soil covered the area of Gua Setir nearby to Kampung Pasir Dusun (Hamdan, 2013).

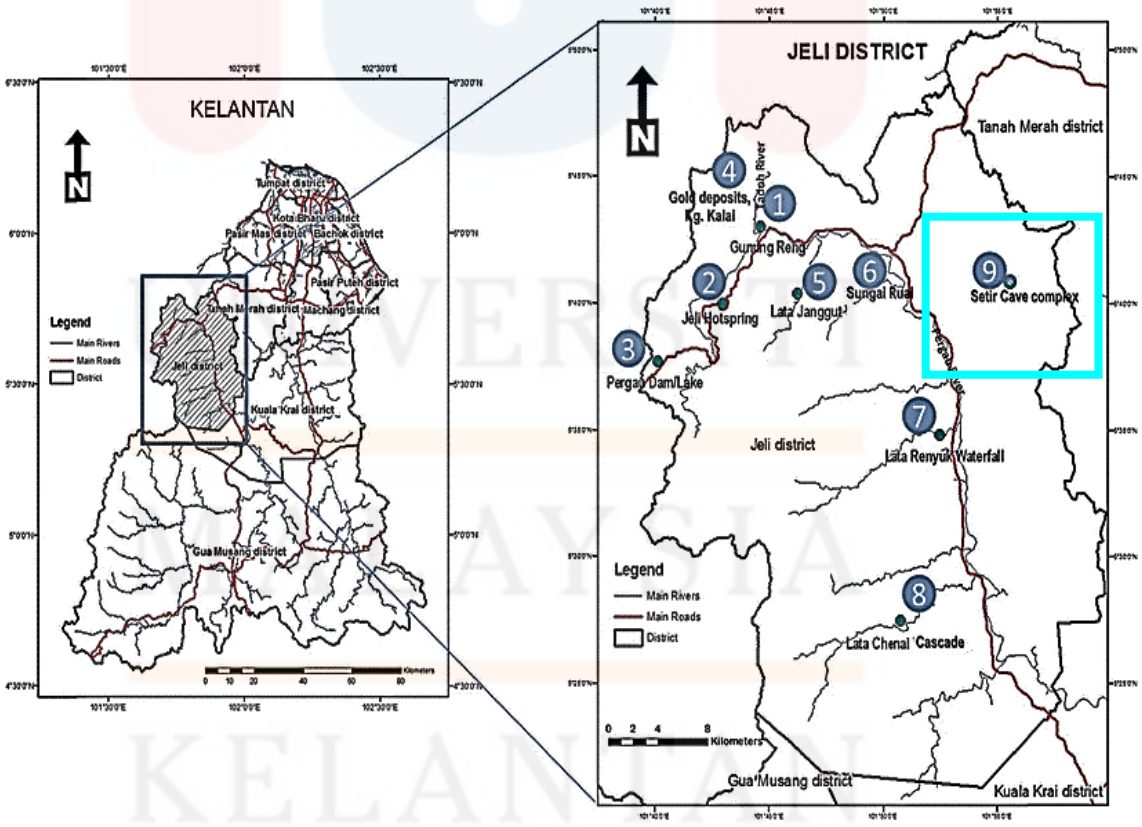

Figure 3.1: Map of Gua Setir, Kelantan (Source: Google Earth, 2018)

3.2 Material

The material and apparatus were divided into two categorize, which used in capturing small mammals and identifying the species.

In capturing small mammals the materials used were cage traps that baited with banana. Cloth bags were used to put the sample after taken out from the cage trap. Nail varnish was used to mark all the individuals captured before released to avoid from capturing the same individuals that would affect the data collection (Batin et al., 2002). In preserving the sample, it was euthanized using chloroform and the skin, the skull, been prepared as dry specimens and the remaining skeleton/body as a fluid specimen. For muscle and liver, tissues deposited for DNA studies, it 95% ethanol were used to preserve it and had been deposited in SEN Museum UMK Jeli Campus.

In order to identify the species, all the information and measurement from each sample were recorded by using the key from Francis & Barrett (2008).

3.3 Methods

3.3.1 Sampling

When conducting these study the method used was trapping by using cage trap. There were 50 cage trap that used for this study and this trap was set up in and around Gua Setir area. Distance from one cage trap to another was 20 meters. Transect and random method used to approach small mammals and rodents. The transect was set up to following the forest train. There were five random location choosed in setting up the trap. There were 10 traps at each transect. Each transect line distance were about 400 meters and the total distance transect line was about 2 km. The trap location was remained fixed and using transect line were more effective in estimating species richness and also generate abundance indices for small mammals (Pearson & Ruggiero, 2003). Besides that, to reflect a better community composition and better samples in examining demographic attributes such as sex ratios, age, and habitat relationship transect provide better.

Banana was used as bait due to its effectiveness based on the previous study that had been done (Bernard, 2003). The trap that had been set up were checked twice a day and be rebaited when needed (Weihong et al., 1999). This study was conducted for about twenty six days due to number of maximum species captured and accumulation of the species number. This study which was conducted between July and August 2018 based on the result number of samples collected.

3.3.2 Measurement and Species Identification

The method used to identify the sample would follow to Francis & Barrett (2008). The following parameters of each individual were recorded: species, gender, age (estimated by size and sexual maturity), weight (Wt), head-body from nose tip to the anus in a stretched position (HB), tail-length from anus to tail-tip (T), ear length (E), and hind foot length (HF).

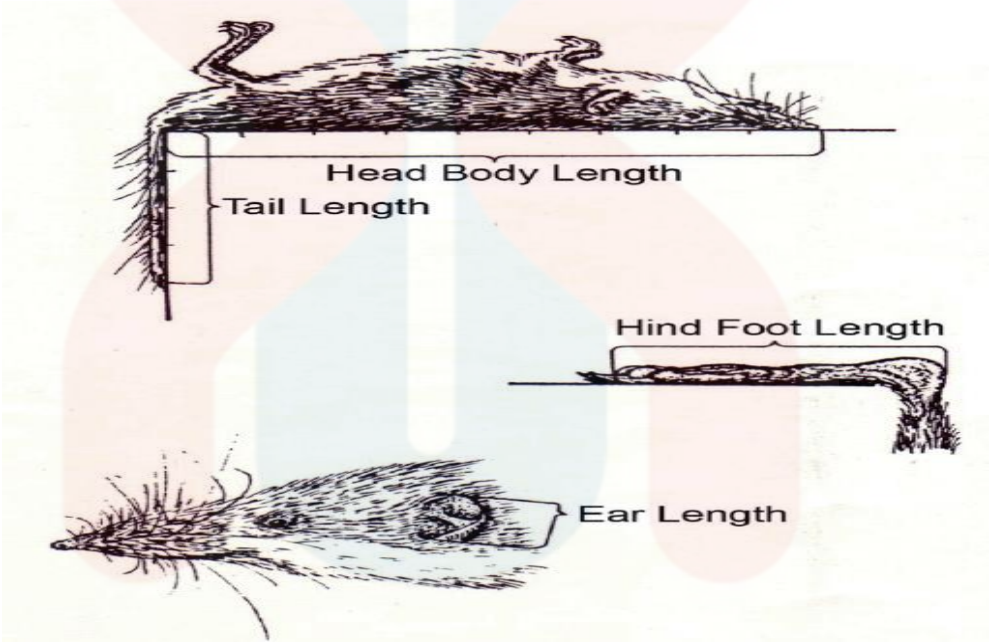

Figure 3.3.2: Measurement of the small mammal (example: shrew) (Source: Francis & Barrett, 2008).

3.4 Data Analysis

3.4.1 Capture Rate

Capture rate used to demonstrate success of the method used in sampling species that had been studied. The method used to calculate the capture rate as follows: (Ardente et al., 2017).

(Number of individuals captured/number of traps*number of days sampling)…… (equation v).

3.4.2 Accumulative Species

The cumulative species graph was used to see whether the result was adequate to the sample or not. From this, it was shown how frequently (in number) does each species found in an area. The frequency of individuals found for each species represented the level of evenness where species accumulation curves showed the rate of new species found within the community and can be extrapolated to provide an estimated species richness.

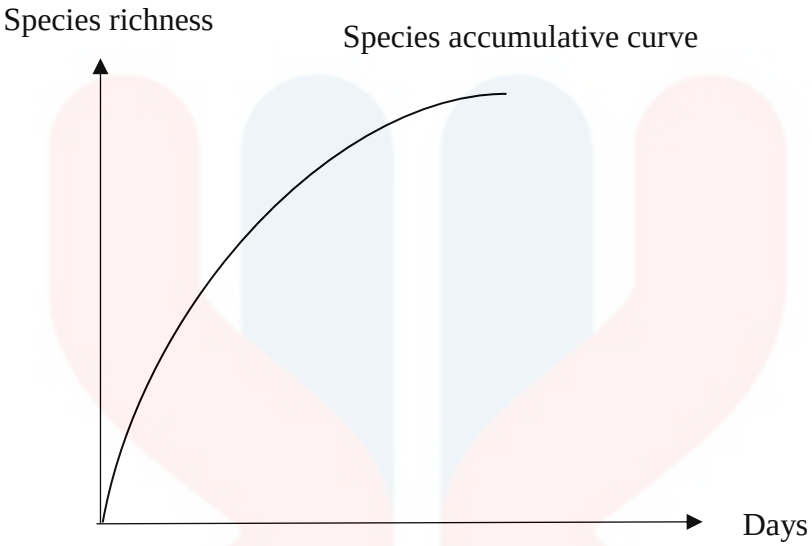

Figure 3.4.2: species accumulative curve.

3.4.2 Species Richness

The species richness was calculated by calculating the total number of species that have been caught. To get the abundance of the sample the total number of an individual per species divided by the total number of individuals.

Species richness = total number of species caught …… (equation i)

$$\text{relative abundance} = \frac{\text{total number of individuals per species}}{\text{total number of individuals}} \ldots\ldots\ldots\ldots \text{(equation ii)}$$

3.4.4 Shannon Wiener Index

The Shannon-Wiener Diversity Index and Evenness Index calculated by taking the account an equal number of sampling effort (Gotelli & Colwell,2011). In sampling the community, $P_i=n_i/N$ was used where n_i was the number of individuals in species and N refer to the total number of individuals in the community. Shannon- Wiener Diversity Index (H) = -sum (pi lnpi)……. (equation iii)

$$pi= \frac{\text{the number of individuals in species}}{\text{total number of individuals in the community}}$$

3.4.5 Species Evenness

Species evenness used to show how frequently does each species found in the area (in number). The frequency of the individuals in each species would represent the level of evenness.

Evenness; $E = \frac{H}{Hmax}$……(equation iv).

Maximum diversity possible; $H_{max} = \ln (\frac{1}{s})$.

(s= total number of species)

CHAPTER 4

RESULT AND DISCUSSION

4.1 Result

From the sampling that had been carried out there were 6 species that had been recorded and classified into two orders (Rodentia and Scandentia) and classified into families Tupaiidae and Muridae with 13 number of individuals followed by family Sciuridae which done by observation.

Table 4.1.1 shows that Gua Setir most diverse family of small mammals that recorded were Muridae with 3 species. *Sundamys muelleri* (7 individuals) is the most abundance small mammals followed by *Maxomys surifer* (3 individuals) and *Rattus tanezumi* species (2 individuals) and lastly *Tupaiia glis* (1 individu).

Table 4.1.1: List species of non-volant small mammals in Gua Setir, Kelantan.

Species	**Total**	**IUCN status (IUCN 2018)**
Scandentia		
Tupaiidae		
Tupaiia glis	1	LC
Rodentia		
Muridae		
Maxomys surifer	3	LC
Sundamys muelleri	7	LC
Rattus tanezumi	2	LC
OBSERVATION		
Sciuridae		
Callosciurus notatus	-	LC
Sundasciurus tenius	-	LC
Total number of individuals	13	
Number of species	6	
Number of families	3	
Trap-days	26	
Capture rates	0.01	

Table 4.1.2 shows the Shannon Wiener diversity index for Gua Setir area. The table showed the diversity of non-volant small mammals (1.157) which means the non-volant small mammals at Gua Setir, Kelantan had shown that it has less diverse community (Michel et al.,2006) due to the low value of H.

Table 4.1.2: Shannon Wiener Diversity and Evenness index of Gua Setir

Species	No. Of Individuals	(pi)	[ln(pi)]	(pi)[ln(pi)]	Evenness
Tupaiia glis	1	0.077	2.565	0.197	
Maxomys surifer	3	0.231	1.466	0.338	
Sundamys muelleri	7	0.538	0.619	0.333	
Rattus tanezumi	2	0.154	1.872	0.288	
Callosciurus notatus	-	-	-	-	
Sundasciurus tenuis	-	-	-	-	
Total	13	1.000		1.157	0.646

Figure 4.1.1 showed that the curved of samples captured still not covered the total species that should have at Gua Setir. There are still more species at Gua Setir that still not been captured. Example species that should been captured during this study such as *Maxomys rajah* based on the research that had been conducted at Gua Muasang, Kelantan (Jayaraj et al., 2016). From the graph it is clearly show that the total trapping effort was still not enough to document all species rodent and small mammals available at Gua Setir area. Eventhough the graph had reach the asymtotic levels but the number of species caught not enough to document the data.

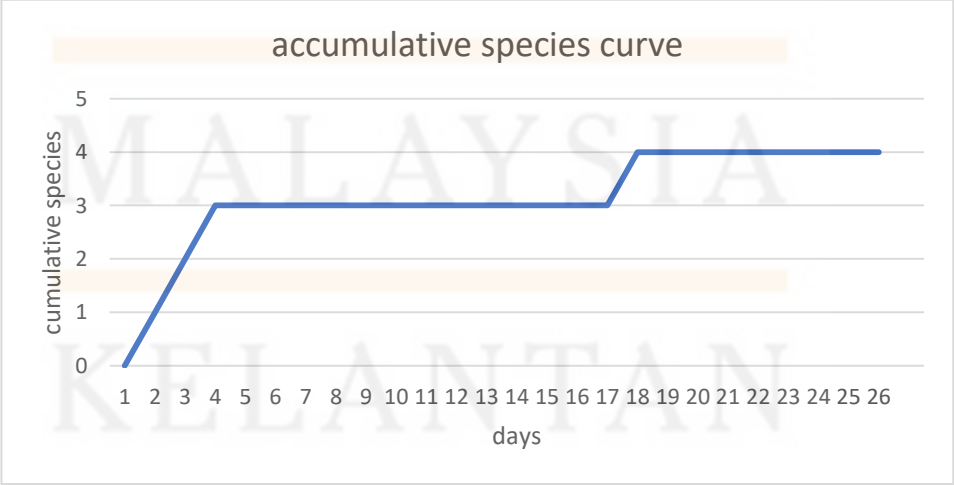

Figure 4.1.1: Species accumulative curve of non-volant small mammals at Gua Setir area

4.2 Species account

4.2.1 Common Treeshrew (*Tupaiia glis*)

Tupaiia glis habitat can be found at plantations or garden near forest (Francis & Barrett, 2008). For this study the species found near the cave area. Based on the research that had been conducted at Wang Kelian State Park this species were dominating by number captured 18 out of 38 individuals caught (Jayaraj et al., 2013). The number of species recorded at Gua Setir was only one. In IUCN Red List of Threatened Species this species is listed as Least Concern (Sargis & Kennerley, 2017) and the current population trend are decreasing.

Figure 4.2.1: *Tupaiia glis* (source Google, 2018)

4.2.2 Red Spiny Maxomys (*Maxomys surifer*)

This species can commonly found at lowland and this were exclusively terrestrial species. It can ususally be found in primary forest and forest edge habitats (including adjacent garden). This species location found was outside the cave. At Gua Setir the number of individuals that had been captured were 3. This species assigned

under Least Concern in the IUCN Red List of Threatened Species (Aplin et al., 2016b). Due to IUCN Red List of Threatened Species this population trend are decreasing.

Figure 4.2.2: *Maxomys surifer* (source Google, 2018)

4.2.3 Müller's Rat (*Sundamys muelleri*)

Sundamys muelleri occurs in primary and secondary forest (Sanborn 1952) and it is ususally can be found near streams and its prefer moist habitat. In this study this spcies were found mostly in the cave and near the cave area. During this study about 7 individuals were captured. This species list as Least Concern in the IUCN Red List of Threatened Species and its population trend now were decreasing (Aplin et al., 2016a).

Figure 4.2.3: *Sundamys muelleri* (source Google, 2018)

4.2.4 Tanezumi Rat / Asian House Rat (*Rattus tanezumi*)

Rattus tanezumi mostly can be found at any area in and around villages and agricultural area. Its habitat type are at artifical/ terrestrial forest. It can be classified under small medium rat with tail that same length or longer than the body and head. It is morphometrically indistinguishable from *Rattus rattus* (Aplin et al., 2003). The location of the species found were near the river area close to the cave area. In this study there were 2 individuals captured. The status of *Rattus tanezumi* based on IUCN Redlist of Threatened Species are Least Concern (Heaney & Molur, 2016) and due to its short life cycle and reproductive stage this species are important food source for certain species such as snake, however their presence in unsanitary areas can lead to lead to diesease outbrake because they are disease carriers. Its population trend recorded were increasing.

Figure 4.2.4: *Rattus tanezumi* (source Google, 2018)

4.2.5 Plantain Squirrel (*Callosciurus notatus*)

This species mostly can be found in secondary forest, coastal forest, mangrove, plantation, semi-urban area and parklands. Based on the observation made this species commonly can be found at the forest area. This species been classified under Least

Concern based on IUCN Redlist of Threatened Species (Duckworth, 2016). The population trend for this species based on IUCN Red List are increasing.

Figure 4.2.5: *Callosciurus notatus* (source Google,2018)

4.2.6 Slender Squirrel (*Sundasciurus tenius*)

Slender squirrel is small species that can be found in primary and tall secondary forests. It also can be found at lowlands and mountains (Lekagul and McNeely, 1988) and seems to be more cope with land that had been affected by logging. The way to identify slender squirrel based on its coloration are on its upperparts of body and tail olive brown and its underside are greyish with whitish or buff tips to the fur. Around it eyes are pale. *Sundasciurus tenius* body is smaller and slender as for its tail it is more furry but slender and bristle-like compared to *Callosciurus notatus* that is larger, and for its tail more furry but thick and bushy (Baker, 2008). Based on IUCN Redlist of Threatened Species this species is listed as Least Concern (Meijaard, 2016). Current population trend for this species are decreasing based on IUCN Red List.

Figure 4.2.6: *Sundasciurus tenius* (source: Google, 2018)

4.3 Factor That Influence The Capture Rate

There are a few factors that give effects on capturing rate of non-volant small mammals at Gua Setir which are; bait selection; fruit seasons; sampling effort and weather.

4.3.1 Bait Selection

Selecting bait to be used are one of the important factors that can influence the capture rate of non-volant small mammals Based on previous study that carried out by Bernard (2003) he indicate that the used of local banana 'pisang emas' (*Musa acuminata*) is the preffered bait in order to get best capture of non-volant small mammal. Based on the research that had been conducted at Gunung Stong State Park pineapple were chosed as bait and it resulting in low capture rate of non-volant small mammals (Jayaraj et al., 2012). As for this study, *M. acuminata* were chosed with palm seed as bait. This bait selection give almost good result for this study.

4.3.2 Fruit Season

Capture rate of non-volant small mammals can be effected by fruit season. When this study were carried out at Gua Setir it is fruit season time. This causes non-volant small mammals to loss their attraction to the bait that had been prepared due to the acttractiveness of fruit either on the tree or that had fall to the ground. As for research that had been conducted at Samusam Wildlife Sanctuary, Sarawak, Malaysia Borneo had shown that although banana was recorded as the most preferred bait by rodent, squirrel and treeshrew (Lim,1973) it is possible that some of the species does not attracted to the smell of banana due to fruit season that occur (Khan et al., 2014).

4.3.3 Sampling Effort

For this survey the sampling effort was not adequate in order to record the number of non-volant small mammals population at Gua Setir area due to the capture rates shown was still not enough. There were 6,000-7,200 traps days were required to document diversity of non-volant small mammals at Mount Jerai Kedah (Shahrul Anuar et al., 2006). The sampling effort done is 50 cage traps per day with the total of capture rate at 1% still not enough to document the total number of non-volant small mammals at Gua Setir area. There still need further study to be done there in order to complete the inadequency of this survey.

4.3.4 Weather

Rainy season can give a huge impact to on the capturing rate of non-volant small mammals. Research that had been conducted at Sungai Dusun Wildlife Reseve, Selangor, Malaysia was also affected by the rainy season due to the number of non-volant small mammals that expected to be more due to its wide distribution (Daud et al., 2014). The sampling period of this study was held during the rainy season in Gua Setir which caused the non-volant small mammals not very active and its prefferedness to be in their nest or hole than being outside. Rain also cause the bait to lose it attractiveness and make it easily turn bad. The rain cause flood to occur which possibly forced them to move further in side the forest (Tingga et al., 2012) and flush all the bait that had been set up to other place or made it turn bad easily which causing them to loss attractive towards the bait.

4.4 Factor that influence the diversity of non-volant small mammals at Gua Setir

From this study that had been conducted for about one month there were also other factor that influence the diversity of the rodent in this area. The factors included the human involvement in forest exploitation (Jayaraj et al., 2016) and habitat fragmentation.

4.4.1 Human Involvement in Forest Exploitation

The type of forest at Gua Setir is secondary forest. Some of the area had been used for gold mining a few years back. For current time the mining activities had already stop but the effect of the mining, it cause some losses to the habitat of wildlife

there. There also a few residents house at the area that cause some impact to the diversity of the non-volant small mammals (Shankar-Rahman et al., 1998).

4.4.2 Habitat Fragmentation

Forest fragmentation always occur especially for tropics forest which lead to the loss of forest biodiversity (Bierregaard, 2001) followed by the loss of habitat, patch size reduction and increasing distance between the patch (Andrén, 1994). Gua Setir condition from what can be observe was the secondary forest was cut down for mining and some turn into rubber and oil palm plantation. The species diversity at there has been isolated due to habitat fragmentation created by human.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

As a result that gain from Gua Setir, Kelantan, there are new information gain on diversity and abundance of non-volant small mammals at there. The information also include their habitat and ecology, species account and the factor that influence the capture rate. All of the non-volant small mammals that had been capture during this study were all listed as Least Concern in the IUCN Red List of Threatened Species and this showed that Gua Setir need to be preserved to maintain its flora and fauna diversity.

5.2 Recommendation

Based from this study that had been run out its focuses on diversity and abundance of non-volant small mammals in Gua Setir, Kelantan because there still no data recorded on it. This preliminary study has create new guideline data for further study in future. Then, this data also needed for conserving that place from any disturbance in protecting the biodiversity there. There should be more further study run at Gua Setir because from what that had been observe there still more species that can be found there.

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