DIET OF *Taphozous melanopogon* AT BANDING LAKESIDE INN

by

NUR SAYDATUL NABILA BINTI MOHAMAD SHUKRI

A report submitted in fulfillment of the requirements for the degree of Bachelor of Applied Science (Natural Resources Science) with Honours

FACULTY OF EARTH SCIENCE UNIVERSITI MALAYSIA KELANTAN

2024

DECLARATION

I declare that this thesis entitled "DIET OF *Taphozous melanopogon* AT BANDING LAKESIDE INN is the result of my research except as cited in the references. This thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature:

Name: NUR SAYDATUL NABILA BINTI MOHAMAD SHUKRI

Date: 28 / 7 / 2024

ACKNOWLEDGEMENT

This research is ongoing at Hotel Banding Lakeside Inn. First and foremost, I want to express my gratitude to God for providing me with the bravery, knowledge, skills, and chance to start this study, carry it out, and finish it. I would like to take this opportunity to express my sincere gratitude to my supervisor, Dr. Jayaraj Vijaya Kumaran, who took the time to listen to me, give me advice, and keep me on the right tracks so that I could complete this project, even though he was quite busy with his other duties. I express my gratitude to Mr. Muhammad Aminuddin Baqi Bin Hasrizal for his kind support, assistance, and significant help provided to us during the study.

Keeping this in mind, I appreciate my academic adviser, Dr. Ashikin Binti Mohd Fauzi, who has always given me advice and pointed me in the right direction. I sincerely appreciate all my final year project colleagues for their cooperation and kind support during this project.

I feel a debt of gratitude and am incredibly appreciative to my parents, family members, and friends for their loving support and consumption. I am also grateful to Universiti Malaysia Kelantan's Faculty of Earth Science for donating lab tools and materials for this research.

DIET OF *Taphozous melanopogon* AT BANDING LAKESIDE INN

ABSTRACT

Diet by the Black-bearded tomb bat using faecal analysis. Fresh bat droppings samples were collected in February 2024. Bat droppings were soaked in hot water, separated into fine pieces, and observed under a microscope. Insects that, are photographed and identified up to Order and Family level. All 6 orders of insects that is Coleoptera, Diptera, Hemiptera, Odonata, Orthoptera, and 2 families have been identified, namely Curculionidae and Hesperiidae. The data obtained from the analysis is also expressed in the form of graphs and the form of tables. It is hoped that more surveys will be conducted to gain more information on the level of taxonomy of family of insects.

DIET TENTANG *Taphozous Melanopogon* DI TASIK BANDING

ABSTRAK

Diet oleh kelawar kubur berjanggut hitam menggunakan analisis najis. Sampel najis kelawar segar telah dikumpul pada Februari 2024. Najis kelawar direndam dalam air panas, dipisahkan kepada kepingan halus dan diperhatikan di bawah microskop. Serangga diambil gambar dan dikenal pasti sehingga peringkat "Pesanan" dan "Keluarga". Kesemua 6 pesanan serangga iaitu Coleoptera, Diptera, Hemiptera, Odonata, Orthoptera, dan 2 famili telah dikenal pasti iaitu Curculionidae dan Hesperiidae. Data yang diperoleh daripada analisis juga dinyatakan dalam bentuk graf dan jadual. Diharapkan lebih banyak tinjauan akan dijalankan untuk mendapatkan lebih banyak maklumat tentang tahap taksonomi pada peringkat keluarga serangga.

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

The black-bearded tom bat *Taphozous melanopogon* (Chiroptera: Emballonuridae) is a widespread species that is found throughout South and Southeast Asia (Srinivasulu and Srinivasulu,2012). This species, which can range in colony size from 10 individuals to several hundred, is extremely expressive and lives in diurnal roots in caves (Hackett et al., 2016*). Taphozous melanopogon* is a poor mosquito predator due to its modest size. In the dark, bats use echolocation to locate prey and travel. Most mosquitoes as possible are preyed upon if their existence is recognized (Pedersen et al.,2012).

Bats have four long fingers and a thumb that are separated from one another by a thin layer of skin. Their flexible skin membranes and movable joints let them shift direction fast and catch insects in the air (Surlykke et al.,2014). For all animals, feeding is essential for survival and reproduction. The choice of dependable foraging habitats depends on the availability of local food as well as on vegetation structures. Accordingly, bats influence terrestrial ecosystems and the structure of arthropod assemblages (Srinivasulu et al.,2010). The evolution of echolocation call design is also strongly influenced by flight, food, and foraging habits. The difference in wing morphology and echolocation are largely a reflection of the foraging strategy of the bat, where they feed, how they feed, and what they feed on (Mohagan et al.,2018).

Many variables, including sunset and sunrise times (Welbergen, 2006), food availability, weather, temperature (Kunz and Fenton,2003), colony size and reproductive status, possible predators, and social context, can influence the timing and patterns of nightly activity of bats. Another strategy for preventing competition among bat species is the timing of nighttime emergence (Simmons, 2005). Despite a few exceptions in the polar regions, extreme deserts, and lonely islands, bats may be found practically wherever. During the day, they spend it hiding in roosts close to swamps, thick forests, and tropical areas. Bats sleep in roosts, which are typically hidden spots in holes (Boyles et al., 2011).

The capacity to fly for extended periods of time Is what makes bats, the secondlargest order of mammals, unique. Yinpterochiroptera and Yangochiroptera are the two suborders that include approximately 1386 species of bats (Burgin et al., 2018). Bats contribute to a variety of ecological services, which is the reason they are significant. In addition to their significance to ecology, bats must be understood for their species variety, ecological functions, and dangers to develop successful conservation strategies that protect both the bats and their habitats (Kunz et al.,2011). Bats are frequently used as bioindicators to evaluate the potential for biodiversity and the effects on the ecosystem (Pedersen et al.,2012).

1.2 Objective

To determine the main order of insect species consumed by *Taphozous melanopogon* at Banding Lakeside Inn.

1.3 Problem Statement

Bats are limited in their range by the shelter species selected based on factors such as temperature, humidity, and light levels. Every species selects a certain kind of location based on factors including sex, season, and breeding activity. Considering bats roost in such remote locations, little is known about their behavior, particularly regarding eating and diet (Kunz et al.,2011). In order to learn more about the diet and foraging habits of the bats at Banding Lakeside Inn, a variety of field observations will be used. In addition, the behaviors, diet, and ecological preferences of various bat species including those that live in hard-to-find areas have not yet been fully investigated in several Malaysian locations and environments, including the Hulu Perak district of Banding. The study design could include data collection during several seasons and times of the year, as bats may choose their roosting spots based on variables including sex, season, and breeding activities. This could offer a complete understanding of how these factors affect bat behaviour.

1.4 Scope of Study

The scope of the study was to determine how *Taphozous melanopogon* feeds at Banding Lakeside Inn. Data collection methods include recording samples of bat feces to identify the insects that bats eat. Careful steps were taken to collect faecal samples at the Banding Lakeside Inn so as not to disturb the elusive *Taphozous melanopogon* bats. Using this technique, bat faeces samples were carefully collected from specially designated foraging locations where bats were actively feeding. This methodical approach recognizes the fragility of researching these sleeping animals and tries to collect useful faecal samples while avoiding any disturbance to their habitat or activity.

1.5 Significant of Study

This study was conducted because important information about the food selection and foraging habits of *Taphozous melanopogon* bats is not known in detail. In addition, creates the possibility for bats to take precautions if their food sources are threatened. An enhanced understanding of local bat species could play an important role in guiding future conservation efforts. The identification of the unique food sources for *Taphozous melanopogon* bats at the Banding Lakeside Inn presents an opportunity for biodiversity conservationists to improve biodiversity. Conservation projects may lower the usage of pesticides, restore ecosystems, and create protected areas by concentrating on insect and prey species. This strategy emphasizes the mutual connection of species, protects biodiversity, and develops a balanced environment.

CHAPTER 2

LITERATURE REVIEW

2.1 Taxonomy and Geographic Range of Black-Bearded Tom Bat

The Black-bearded Tomb Bat, or *Taphozous melanopogon*, is a species that is a member of the Animalia kingdom, Chordata phylum, and Vertebrata subphylum. It is classified as a mammal and belongs to the Chiroptera order, which also contains bats. This species is particularly assigned to the Taphozous genus and family, Emballonuridae. The species name “melanopogon” refers to it. A unique attribute of the Black-bearded Tomb Bat is its position within the taxonomic hierarchy of bat species. Within the larger framework of the animal world, this categorization system assists scientists and researchers in recognizing the physical characteristics and evolutionary relationships of this bat species (Patterson et al.,2003). The Philippines, Borneo, Thailand, Indochina, Central India, and Burma are home to black-bearded tomb bats. They may be found in Indonesia, Bantam, West Java, the Malay Peninsula, Sumatra, Borneo, and Lombok on occasion (Murphy and Chamberlain,2008).

2.1.1 Habitat

The habitats of black-bearded tomb bats include rainforests, woods, abandoned buildings, caves, cliffs, and rock formations. They like regions that are very shaded. They gather in groups of 200–4000 people to roost (Wei et al.,2008). The black-bearded tomb bat's coat varies greatly according to its specific surroundings. It comes in shades of red, multi-brown, and grey. Usually, hairs have a white tip and are progressively redder or browner towards the root. The membrane of the tail (uropatagium) has fur on it. The black beard that men have Is thought to be seasonal (Phelps et al.,2016).

2.1.2 Behavior

Males have been observed forming a protective circle around females and their young within roosts. There appears to be a social structure in the colonies since each male has a certain region that he inhabits. Occasionally, only male, or female colonies are discovered in roosts (which is frequently following the mating season). If these bats are trapped, in danger, or hurt, they often scream in a high-pitched, piercing cry (O'Shea et al.,2003). There is no information about these animals' communication. However, no one can argue with the importance of emotional contact between moms and their children. It's likely that some verbal and chemical communication takes place, aiding moms in recognizing their own children within the nest (Kunz et al.,2009).

2.1.3 Ecosystem Roles

Black-bearded tomb bats are useful in regulating insect populations, and those that eat fruit can fertilize plants and spread seeds. Bats use several feeding methods. If some animals are selective feeders who only eat what is readily available, others are omnivores that eat a wide variety of species. Furthermore, they opportunistically consume appropriately sized creatures depending on what is available in their selected location (Schmitz and Suttle,2001). In addition to reducing insects through predation, some bat species, especially those from the two families Pteropodidae in the Old World and Phyllostomidae in the New World, are important players in plant pollination (Fleming et al., 2009).

2.2 Feeding Habits

A combination of its high oxygen consumption, high concentration of amino acids and saturated fats (which are extremely sensitive to oxidants), and comparatively low quantities of antioxidant enzymes, the brain is an essential organ that is particularly prone to damage caused by oxidation (Maciejczyk et al.,2018). One area of study that illuminates the connection between diet and brain health is the effect of various feeding practices on brain oxidative stress. According to recent research, specific food habits may have an impact on the brain's degree of oxidative stress. For example, eating a diet heavy in fat and sugar has been linked to a higher risk of brain failure and cognitive issues (Leutner et al.,2001). On the other hand, it is well-recognized that diets high in vitamins, minerals, and antioxidants support the brain and shield it from oxidative stress (Tan et al.,2019). Bats are a varied group of animals that have a variety of eating preferences, including hematophagous, insectivorous, and frugivorous groups. Though the precise effects of various eating patterns could range, one of the aspects that might shape a bat's brainpower and adaptive tactics is its food habits (Freitas et al.,2020). Although earlier research has demonstrated that feeding practices can influence the antioxidant state of several bat tissues, nothing is known about how feeding practices affect the antioxidant status of the brain (Żebrowska et al.,2019).

2.2.1 Diet

In forest ecosystems, *Taphozous melanopogon's* diet is primarily composed of Coleoptera, Homoptera, Lepidoptera, Hemiptera, Orthoptera, Odonata, and Araneidae. Conversely, in semi-urban ecosystems, the diet is primarily composed of Diptera, Lepidoptera, Orthoptera, Odonata, Hemiptera, Araneidae, and Homoptera (Zubaid,1990). The species composition of bats from various habitat types varies in their diet, Indicating that bats adjust their eating repertoire to match the variety and accessibility of insect prey (Camiletti-Moirón et al.,2014).According to observations, they are more of an opportunistic feeder in the woodland habitat, feeding on the insects they come across in their semi-urban habitat, however, insects select the size that best suits their nutritional demands (Zhang et al., 2005).

2.3 Nutrient Requirements

Despite animal diets and feeding strategies being distinct most investigated species seem to have similar qualitative nutritional requirements for optimal tissue metabolism. These comparisons probably also apply to bats. For mammals, about fifty nutrients have been shown to be necessary in their diets. This is, because they cannot be naturally developed in sufficient amounts to suit animal demands, they must be acquired from the diet or through the activities of digestive microorganisms (Wendeln et al.,2000).

2.3.1 Water

The simplest and most affordable nutrition to give in captivity is water. Water supply is significant because it plays several vital roles in bodily processes. Variables like ambient air temperature and humidity, heat from the sun, metabolic rate, and the type and quantity of food consumed all affect the requirement for liquid water. However, it has been noted that many species, including bats in both the wild and captivity, actively feed (Silver et al.,2000).

2.3.2 Protein and Amino Acids

All tissues depend on proteins, which are essential components of the animal body and include nitrogen. Since amino acids are the structural components of proteins, animals with very simple stomachs and little to no fermentation ability need dietary sources of the 10–12 amino acids that are not readily synthesized metabolically (dietary necessities) (Dierenfeld et al.,2000).Although it has been reported that the fruit pulp protein of four plant species (Cecropia 11eltate, Chlorophora tinctoria, Ficus ovalis, and Piper amalago) contains relative concentrations of arginine, isoleucine, leucine, lysine, methionine, threonine, and valine, the essential amino acid requirements for bat species are unknown (McNab et al.,2001). Considering fruit has a lower protein level than other plant and animal food sources, many studies believe that fruit alone constitutes an insufficient diet, albeit the quality of the protein is a key factor in this assessment (Shanahan et al.,2001).

2.4 Foraging Behavior

Among the most fundamental links in biology are those between shape and function in behavior. The clearest instances of these relationships are frequently seen in cases involving foraging, as an animal's morphology can influence the variety of eating options that are accessible to it. Morphological traits may have played a key role in the genesis of new species through functional relationships (Grant,2001). Variations in the architecture of the jaw, teeth, and muscles of animal-eating bats indicate their capacity to handle either soft or hard food, such as beetles or moths (Feldman et al., 2000).

CHAPTER 3

MATERIALS & METHOD

3.1 STUDY AREA

Discovering Lake Temenggor and the Royal Belum Rainforest is ideal from Banding Island. Undoubtedly, this is one of Malaysia's most picturesque regions. To take advantage of the unique characteristics of Lake Temenggor and the surrounding Royal Belum Rainforest in studying the feeding habits of *Taphozous melanopogon*, a systematic sampling strategy was developed to collect bat faecal samples. The strategy involves considering the diversity of ecosystems in the rainforest and around the lake, with a focus on selecting sampling sites that represent different ecological niches. At more than 70 kilometers long, up to 5 km broad in certain spots, and 120 meters deep, Lake Temenggor is huge. Formerly called the coordinated Jemputree Hotel & Eco Resort, Banding Lakeside Inn 5°32'34.2"N 101°19'51.4"E. If approaching from the direction of Gerik, this location is on the "mainland," right before the bridge leading to Pulau Banding.

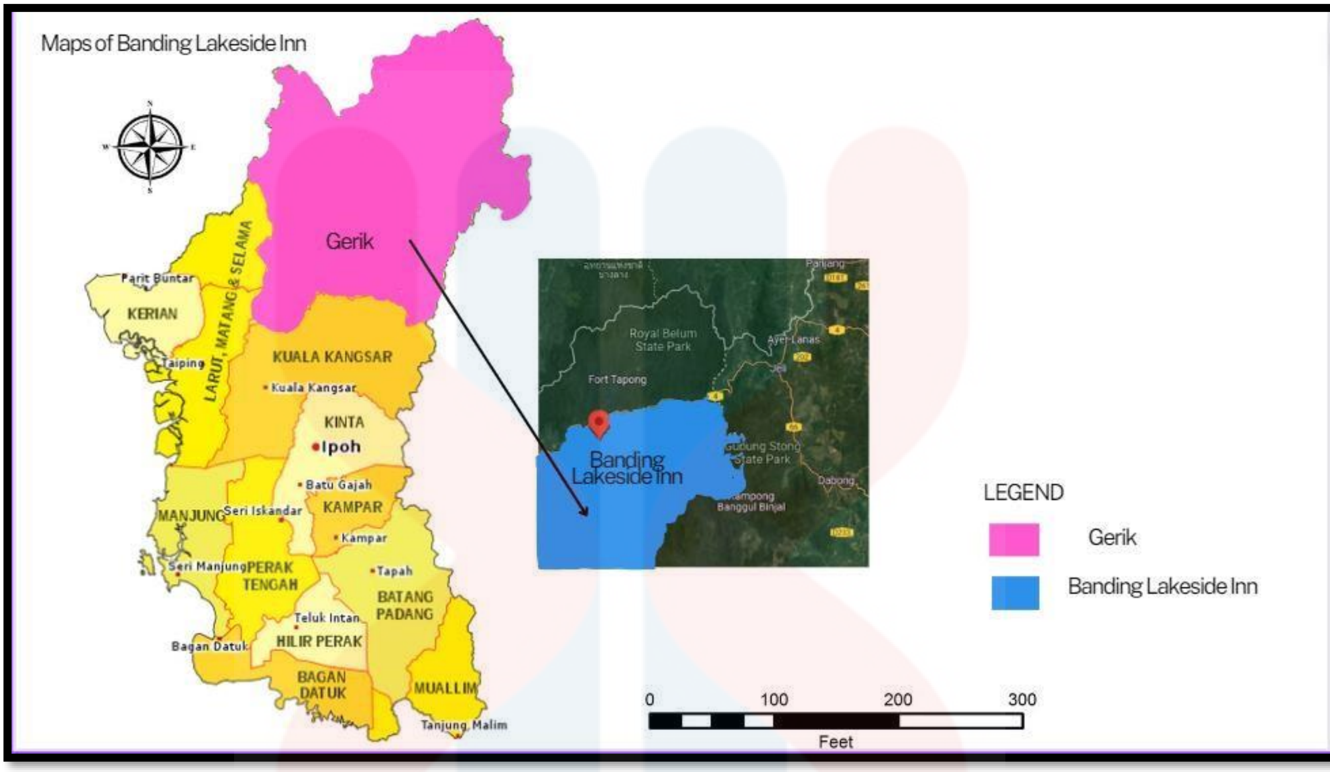


Figure 3.1: shows the map of Banding Lakeside Inn, Gerik, Perak.

3.2 MATERIAL

In capturing bats for diet analysis, materials, and methods were designed to ensure the safety and well-being of bats while obtaining important samples. Harp traps, made of fine metal wire, guided bats into collection bags with minimal danger. Additionally, hand capture served as a replacement method if a sample was not obtained, involving the use of gloves or soft cloth for gentle handling, especially when bats roosted in convenient locations.

Bat roosting nets were constructed of lightweight fabric or netting and were positioned at entrances and exits to capture bats as they came in or went out. Concerns about ethics put bat health first during the capture process, ensuring humane treatment, obtaining appropriate permissions, and adhering to ethical principles. To minimize the amount of time bats spent in captivity, routine trap inspections were also crucial. This proactive strategy minimized any possible harm to the well-being of the bats by ensuring that they were quickly examined, sampled, and released after being collected. Regular trap monitoring not only promoted capture efficiency but also complied with legal requirements by prioritizing the well-being of the bats during the study project.

3.3 METHOD

Fecal Sample Collection

The study began by setting up a harp trap in a different building room and using hand capture techniques in locations with known or suspected bat activity and high insect densities. The harp trap height adjustment was the normal flying height of the target bat species. After two hours, bat feces were carefully collected directly from the bag, regardless of sex, from seventy randomly selected bats. There are also fecal samples taken directly on the floor of the building. Each sample consisted of forty-five to fifty stool pellets obtained. Before installing the harp trap, observations were made, and it was found that a large group of *Taphozous melanopogon* and its feces were trapped in the room. The harp trap at point 2 was situated at coordinate 5°33’6” N 101°20’44” E. The second point was chosen close to the first point above the same factor that has an excessive number of *Taphozous melanopogon*.

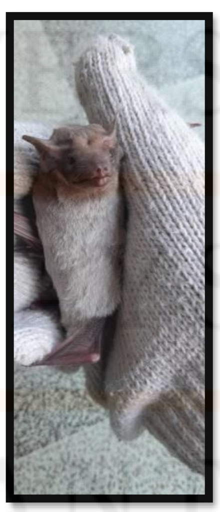


Figure 3.3: Removing bats from the cloth bag.

Feces Analysis

To ensure the longevity of the samples, dimethyl sulfoxide (DMSO) was employed as a mixing or protective solvent, with concentrations ranging from 1% to 10% in various solutions. The DMSO stock solution was prepared by reducing DMSO in an appropriate solvent, using water or a culture medium to achieve the desired concentration. Subsequently, the collected fecal samples were stored, and a preservation method involved placing them in a petri dish with hot water and a few drops of glycerol to soften the samples and prevent rapid water condensation.

The next step involved the careful processing of the fecal samples. Each sample was softened, and any condensation was prevented within a day. Using a dissecting needle, the fecal samples were carefully split into tiny pieces and then examined under a 10x magnification lens. For a more efficient sample scanning process, a low-power dissecting microscope with a 10x magnification objective was utilized. This stage of the investigation was important, as it involved the examination of numerous samples.

Figure 3.4: Fecal collected and put into a tube.

Counting Insects' Preparation and Identification

Many insect families are very unlikely to be found by the general. It contains small that may be overlooked because it has a very limited geographic range. In the final phase, insect remains are identified up to order level, with classification sometimes reaching family and order levels. The percentage is calculated for each order found in the pellet, and the frequency of each is focused on the order of insects, followed by the order of families is also determined according to the rate that can be identified at the level of families.

3.3.1 Data Analysis

In the data analysis process that aims to find out the type of insects eaten by bats of this species, information is collected from various sources, including the analysis of feces as the focus of this study. To determine the adequacy of sampling in the study of bat diet, statistical methods, and practical considerations were used, namely a pilot study which is a small-scale preliminary study carried out before the main research to check the feasibility. Samples of bat feces were carefully dissected to analyse the contents of what they ate. Under the microscope, the contents of the feces sample are examined and identified by characteristics of morphological features referring to insects such as legs, wings, and antennae. Each component is classified into a taxonomic group as mentioned in the objective. By a point, the combination of quantitative analysis and comprehensive microscopic examination benefits finding an appropriate sample analysis answer.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Result

4.1.1 Sample Identification of *Taphozous melanopogon*

At the study site, which is at the Banding Lakeside Inn Hotel, there is only one type of bat species, the species *Taphozous melanopogon*. This species is very abundant in that place, and it is very easy to catch it only by using a harp trap or by hand for random sampling of bats. This is captured using only one harp trap installation at two points. This method made it possible to gather enough *Taphozous melanopogon* specimens for further examination.

Taphozous melanopogon that have been captured by using a harp tarp. Point 1, a total of 17 numbers were obtained by using a harp trap. At the beginning of the harp trap installation, there were more bats, but they managed to escape through the open window in the room. Next, at point 2 only 13 bats were obtained because they missed when trying to put the bats into a cloth bag. Therefore, only 30 *Taphozous melanopogon* bats were successfully caught using harp traps for both targeted points.

The focus quickly moved to gathering faecal samples to determine the bats' main feeding methods after they were captured. Each bat that was captured had to have its feces carefully collected to guarantee that the sample accurately represented the bat's recent feeding activities. The rest of the feces is collected on the floor at the target point. Research for the collection of bat feces is done by observing and selecting black feces because black feces are new feces, and it is easy to see the insects eaten by them compared to brown feces that have been feces for a long time.

4.1.2 Diet analysis of *Taphozous melanopogon* bats based on order categories

A total of 46 insects from 60 feces samples across various orders, highlighting the diversity and abundance of insect life in the collected data. These 60 sample tests of feces were collected from the dropping of *Taphozous melanopogon* bats at different points at Hotel Banding Lakeside Inn. There were 6 insect orders identified namely Odonata, Hemiptera, Diptera, Orthoptera, Coleoptera, and Blatttodea. The high frequency in the collection is indicated by the considerable representation of Diptera, and the presence of unidentified species indicates areas. This information offers important new perspectives on the distribution and species makeup of insects in the studied area as shown in table 4.2.1.

Six different orders and one unidentified category were collected and examined in this study (figure 4.2). On 19, the Diptera order accounted for 42% of the total sample and was seen most frequently. Blattodea accounted for nine individuals, or 20% of the total, making it the second most common order. Seven insects, or 16% of the sample, fell into the unknown group, including insects that could not be positively identified in any sequence. Three specimens from each taxon of Odonata and Orthoptera represent 7% of the entire collection. With only two individuals per order, Hemiptera and Coleoptera were the least frequent, accounting for only 4% of the entire sample.

These results explain the diverse insect ecology of the investigated area, with a significant predominance of Diptera. This may indicate that the environment is particularly suitable for Diptera species. The large number of specimens that can still be identified emphasizes the possibility of finding rare species eaten by black-bearded tomb bats. The abundance of Blattodea and unidentified insects indicates the diverse ecosystem of the area and the abandoned area. The relatively low numbers of Hemiptera and Coleoptera indicate that *Taphozous melanopogon* may be more difficult or rare to capture in this group in this type of environment.

Belong to order Odonata are the insects collectively referred to as dragonflies and damselflies. Large compound eyes, lengthy bodies, and two pairs of transparent wings are characteristics of these insects. Being predators, they usually eat insects like flies and mosquitoes. Since they help in managing insect populations, Odonata plays an important part in aquatic ecosystems (Trottier,2002).

Hemiptera, also known as true bugs, can be distinguished from other insect groups by several unique traits. Hemipterans are identified by their unique mouthparts, which combine to form a rostrum, a structure like a beak. These mouthparts are designed to feed on a range of materials, like blood, other insects, and plant sap. Typically having two pairs of wings, hemipterans have fully flexible back wings and thicker, leathery front wings called hemelytra that are membranous at the ends. They have a very diverse range of body shapes; they might be long and thin or more rounded or shield shaped (Todd,2000).

Cockroaches and termites are members of the Blattodea order of insects, which stands out by some unique features. These insects usually have long antennae and a pronotum (nose) that frequently hides their head, as well as an oval, flattened body that enables them to hide themselves in small spaces. Though many species are flightless, most cockroaches have two sets of wings, with the raised wings being flexible and the forewings being leathery (MCkittrick,1999).

Grasshoppers, crickets, katydids, and locusts are among the insects in the order Orthoptera. They are characterized by their long, elongated bodies and strong, significant hind legs that are designed for jumping. Usually, these insects have two pairs of wings, the weaker, membranous hind wings, which are utilized for flight, are shielded by the narrow, leathery forewings, or tegmina. Orthopterans may feed on a variety of plant materials due to their chewing mouthparts, crickets and katydids are especially known for their long, thread-like antennae (Roof et al.,2004).

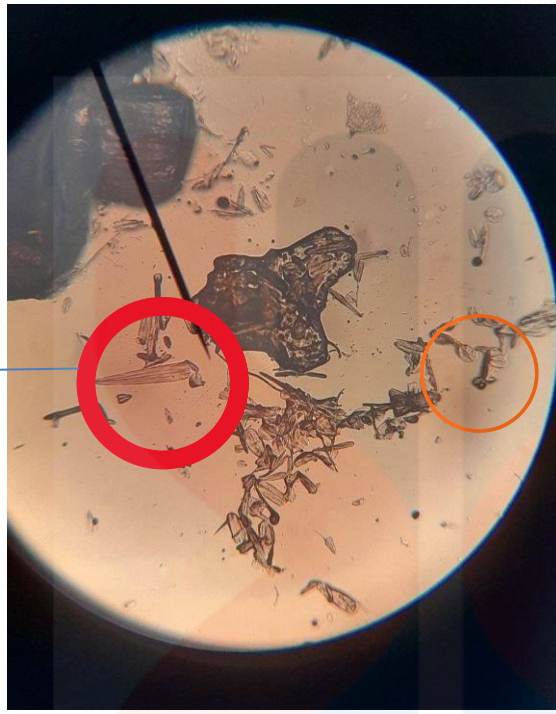
The single pair of wings that identify Diptera, the order of insects commonly known as flies, are unique, the second pair developed into tiny structures called tails, which serve as gyroscopic stabilizers to assist with balance and flexibility during flight. The bodies of dipterans are typically streamlined and small, while species-to-species variations occur in both size and morphology. They have highly specialized mouth parts suited to different eating techniques. Depending on the species, its usually short antennae might have simple or complicated features (James,2004).

Like beetles or Coleoptera, they have characteristics that make them one of the most abundant and diverse insect groups on the planet. The tough coverings on beetles' forewings, known as elytra, are a distinguishing characteristic. They serve to shield the fragile hindwings needed for flight. These elytra have a wide range of shapes, textures, and colors, and they frequently have additional uses like thermoregulation or camouflage. Because of their adaptable chewing mouthparts, beetles can be herbivores, carnivores, scavengers, or omnivores. Their divided antennae offer sensory information for identifying possible predators, partners, and food sources (Jankielsohn et al.,2001).

All the analysts considered, show findings that provide a complete picture of the various types of insects found in the fecal samples examined in the study area. Habitat biodiversity is affected by wide diversity across orders, and inconclusive results impact further taxonomic and ecological research to fully understand insect feeding by *Taphozous melanopogon* in this research area.

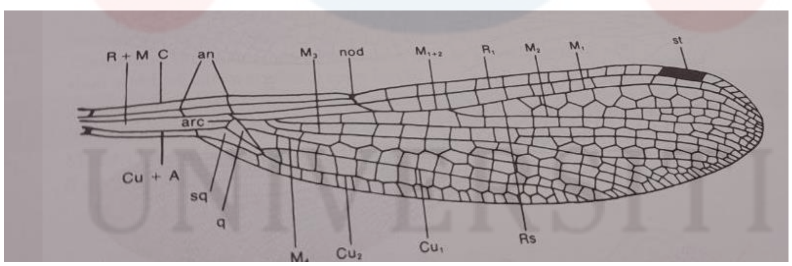
Order Coleoptera (Curculionidae)

wing

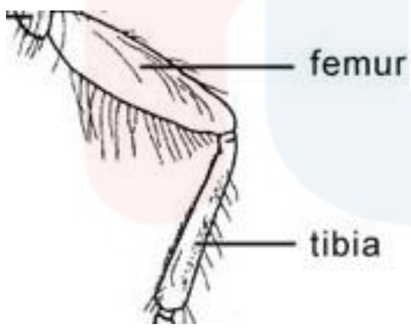


Antenna

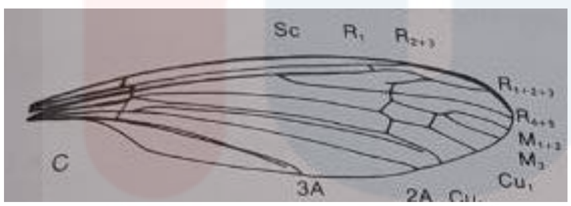
Order Odonata (Hesperiidae)

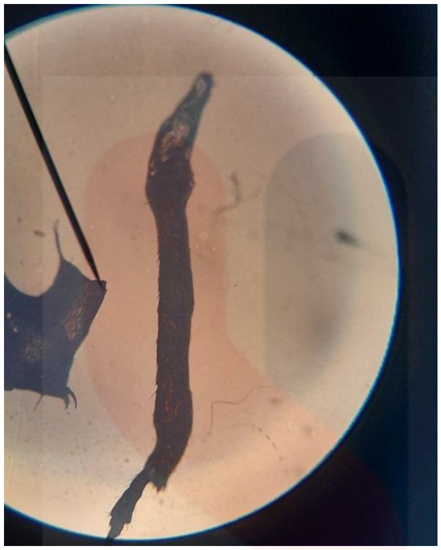


Leg of Order Diptera



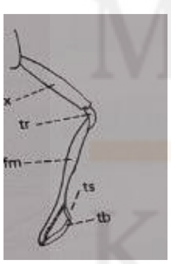
Wing of Order Diptera

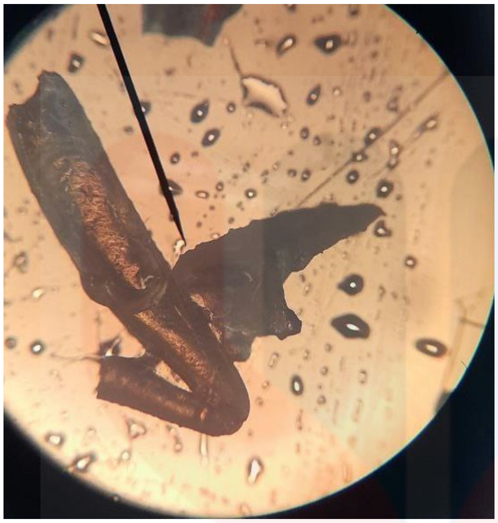




Leg of Order Blattodea

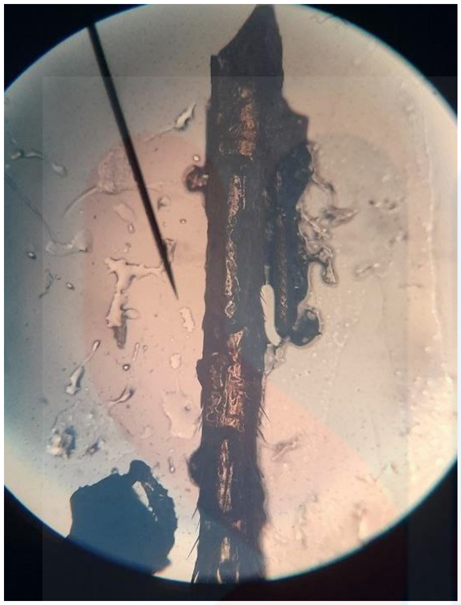
Leg of Order Blattodea



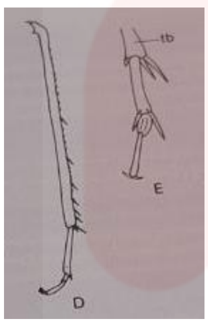


Leg of Order Hemiptera

Wing of Order Hemiptera



Leg of Order Orthoptera



Wing of Order Orthoptera

Figure 4.1: shows insects and part of character morphology like antenna, wing, and leg

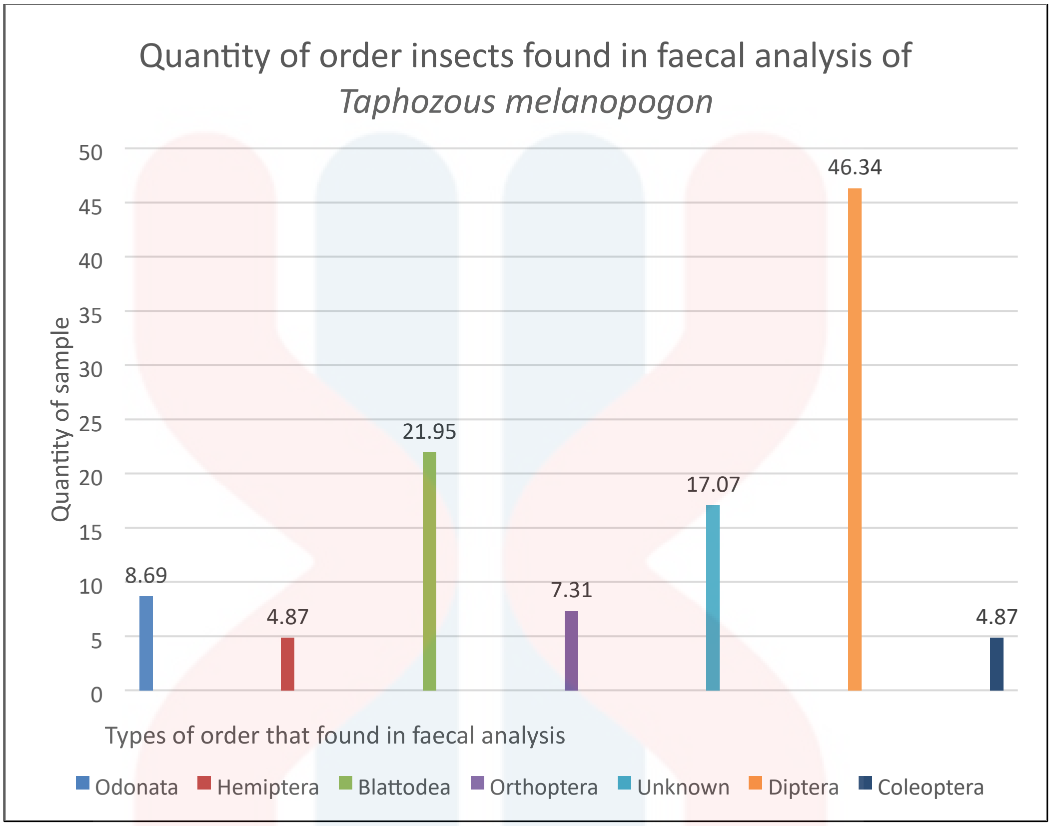


Figure 4.2: Type of order insects found in the fecal analysis.

Types of order	Percentage
Odonata	8.69 %
Hemiptera	4.87 %
Blattodea	21.95 %
Orthoptera	7.31 %
Unknown	17.07 %
Diptera	46.34 %
Coleoptera	4.87 %

Table 4.2: List the order types and percentages found in faecal analysis.

Order of insects found in feces Class: Insecta	
Types of order	**Number of individuals**
Odonata	4
Hemiptera	2
Blattodea	9
Orthoptera	3
Unknown	7
Diptera	19
Coleoptera	2
TOTAL	**46**

Table 4.2.1: Distribution of order insects found in the faecal analysis of *Taphozous melanopogon* bats on a sample test.

4.1.3 **Diet analysis of *Taphozous melanopogon* bats based on family categories**

The results of the analysis also obtained insects under the taxonomy of the family Curculionidae, better known as beetles, found when samples of bat feces were analyzed (Table 4.2.2). These results show that bats are those who ate in the habitat of these beetles. The Curculionidae family is recognized for its hard exoskeleton and characteristic mouth, and it is frequently linked to a variety of plants (May,2013). These insects' appearance in the feces suggests that the bats have been feeding in places with a lot of flora or in areas with large, rapidly growing plants. These results offer important new information about the feeding habits of the bat species under study, as well as their ecological connections.

Additionally, insects from the Hesperiidae family, also referred to as moths, have been recognized as a reminder of the taxonomy families discovered during the examination of bat feces samples. The existence of this insect suggests that bats of the *Taphozous melanopogon* species feed in the Hesperiidae family's area. According to (Campbell et al.,2000) Hesperiidae is known for its speedy flight pattern, small size, and tough body. The moth species' habitats belong to grassy and herbaceous ecosystems, showing that the bat species under investigation frequent these types of environments.

These results offer important new information about the feeding habits of the bat species under study. That brings attention to the ecological relationships that exist between bats and the insects they feed on, emphasizing that bats are involved in managing these insect populations. Developing an understanding of these eating patterns can help advance ecological research and guide conservation initiatives that support to ensure healthy bat populations and their habitats. Based on the results of the analysis obtained as a whole did not reach the level it should have, this is because it was influenced by taking insufficient samples and doing wrong steps when analyzing fecal samples in the laboratory.

Table 4.2.2: Distribution of families of insects found in the fecal analysis of *Taphozous melanopogon* bats on a sample test.

Family of insects found in feces	
Types of family	**Number of individuals**
Curculionidae	2
Hesperiidae	2
TOTAL	**4**

4.1.4 Factor influencing the analysis samples

The variation in the number of order types found in the *Taphozous melanopogon* bat feces analysis samples collected for this study could be attributed to several variables related to the bats' environment at the Banding Lakeside Inn Hotel. One of these is the variety of habitats and food supplies in the forest-encircled area surrounding the hotel, which produces a variety of insects that these bats primarily eat. Furthermore, variations in the season and environment can have an impact on the availability of insects, which can lead to year-round variations in the diet of bats. Furthermore, the kinds of insects that are present in the hotel area have an impact on the bats' food.

The kinds of insects that are available are also significantly influenced by the accurate placement of nearby bat habitats. A range of habitats for insects is provided by the local ecological diversity surrounding the hotel, which results in a diversity of order types in bat feces samples. The variations in the number of order types found in the bat fecal analysis in this study area can be explained by these factors taken together.

4.2 Discussion

The fecal sample analysis performed represents excellent and reliable information about insect diversity which can be identified as a higher taxonomic category that is Order level and try to identify up to Family level. The variety of foods identified from the study location found only a few insect orders in food which may be influenced by the area of residence, but Diptera is the highest on average. Environmental factors including temperature play an important role in regulating the abundance of insects (Neuza et al. 2009).

Some of the food items are dominated by one group of insects in a particular season. Different authors publish different results from different geographical areas (Kunz et al. 2002, Arlettary et al. 2000) with a major part of the order rich in species such as Coleoptera, Diptera, Hymenoptera, Orthoptera, and Lepidoptera. However, this study represents a very low number of Hemiptera and Coleoptera.

This data has documented all orders of insects eaten by the black-bearded tomb bat as a new record for the Lakeside Inn Banding. Since it is a new record, it is not easy to compare the type of insect species eaten at Banding Lakeside Inn with the state of the area being surrounded by forest until it becomes a wasteland. The study of food habits can be done either through direct observation or indirect observation techniques (Mickleburgh et al., 2002)

The data obtained only focus on one species, which is *Taphozous melanopogon* which is found to be the most in the studied area. Whitaker (2004) observe a pattern comparable to this but among the three Myotis species feed along riparian corridors in Indiana. One of the northern bat species, is expected to show dietary variation when compared to the other two Myotis species.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

In conclusion, the study investigates the diet to find out the type of insect according to the order level taxonomy in bat excrement samples, with a focus on *Taphozous melanopogon.* The results have identified that there are several orders of insects in the sample which highlights the rich biodiversity in the study area. However, our sampling is limited, which may cause the results obtained in the sample analysis to show a lack of representation of the types of order insects. The examination of feces provides light on the diet, well-being, and habitat of the species, highlighting the necessity of preserving and safeguarding their surroundings for both the species' long-term health and the health of the larger ecological community.

5.2 Recommendation

Additional research should focus on several areas to have a more thorough understanding of the *Taphozous melanopogon* population at the Banding Lakeside Inn Hotel. To determine bat populations' size, density, and demographic makeup, a thorough population survey is necessary. These surveys ought to be carried out regularly to track any alterations in the population over time and to find any possible dangers. Behavioral studies are also crucial to comprehend *Taphozous melanopogon's* daily and seasonal behaviors. Their roosting behaviors, social interactions, and breeding habits should be the main topics of these investigations. By using the method of testing faeces through dna, researchers can find out the type of insects eaten by *Taphozous melanopogon* bats more accurately.

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APPENDIX

<table>
<tr>
<td>Study area
Hotel Banding
Lakeside Inn</td>
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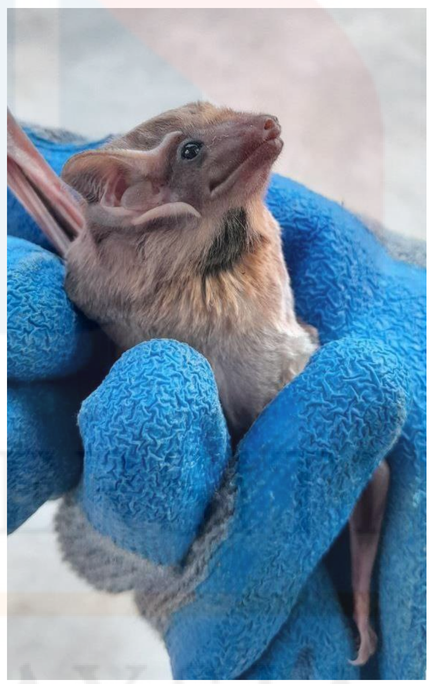
Feacal of *Taphozous melanopogon*	
Taphozous melanopon male	

Taphozous melanopogon female