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TITLE: ASSESSMENT OF FRUIT BATS POPULATION, ACTIVITY PATTERN AND FOOD PREFERENCE IN MUTULU TOWN, OROMIA REGION, ETHIOPIA.

A THESIS SUBMITTED TO THE DEPARTMENT OF ZOOLOGICAL SCIENCE IN PARTIAL FULFILLMENT FOR THE REQUIREMENT FOR THE DEGREE OF MASTERS OF SCIENCE IN ECOLOGICAL AND SYSTEMATIC ZOOLOGY

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ABSTRACT

Population size, activity pattern, and feeding habits Rousettus aegyptiacus fruit bats in mutulu town, west shoa, Oromia region, Ethiopia. Data was collected during wet and dry seasons. Direct observations were used as the species count. The number of individual was identified, such as adult and juveniles were identified, by using torch light and direct observation as well as their activity pattern and feeding habits were identified. The observations were made in mutulu town construction site that are abandoned and used by fruit bats. The results showed that a total of 200 individuals were observed of which 98 were adult and 102 were juveniles during wet season. The result during dry season showed that 84 adult and 82 juveniles. The activity pattern showed that feeding was the highest (75%) during the wet season and 48.2% during dry season followed by other activity. The feeding habits also showed that they mainly were observed feeding on fruit, nectar and insect. Bats play important ecological roles as prey and predator, arthropod suppression, seed dispersal; pollination, material and nutrient distribution recycle emphasized the need for conservation.

Key words: Population Size, Activity Pattern, Feeding Preference

CHAPTER ONE

1. INTRODUCTION

1. 1.Background of the Study

The order Chiroptera is the second most diverse among mammalian orders (Wilson and Reeder 2005) and exhibits great numerical, taxonomical, functional, and ecological diversity (Simmons and Conway 2003; Stevens and willing 2002). However, assessing the distribution of bat species and the composition of bat communities is challenge (Jaberg and Guisan 2001) because their nocturnal behavior, large home range, and the problems associated with species identification in flight (Walsh and Harris 1996) make accurate survey difficult.

There is some evidence that the foraging behavior of frugivorous bats is influenced by their social status (Fleming, 1982). Some studies pointed out those reproductively dominant males have different foraging patterns to other age-sex combinations. Harem males of both Carolliaper spicillata remain outside their day roost each night for a short period and forage within relatively short distances of their roost (Williams, 1970; Fleming, Heithaus and Sawyer, 1977; Jamieson, 1977; Heithaus and Fleming, 1978). In contrast, harem females and bachelor males spend most of the night outside the roost, even on night of bright moon. It is, therefore, expected that harem males will either leave the cave after harem females and young males and return with or before them, or leave the cave after harem females and young males and return to the roost before them

Evening emergence has been studied extensively in bats and it has been shown that the time of the first emergence is related to the time of sunset (Microchiroptera-Gaisler, 1963; Herreid and Davis, 1966; Swift, 1980: Megachiroptera-Jacobsen and Duplessis, 1976; Herzig-Straschil and Robinson, 1978; Zack, Czeschlik and Helmaier, 1979). Jacobsen and Duplessis (1976) reported that *Rousettus aegyptiacus*, ones the common of bats became active an hour before sunset, cleaning themselves mainly by licking and moving toward the entrance of the cave. The time of first emergence of Rousettus aegyptiacus was 20—40 min after sunset. Feeding usually continued throughout the night, with the bats returning to the cave between 02:00 and 05:00 hours. Eckert's.(1970) studied the locomotors activity of

Captive individual *Rousettus aegyptiacus* and showed that the bats had a monophasic activity pattern that was correlated to light conditions.

Various sampling techniques are used in studies of bat distribution and habitat preferences in order to describe the great complexity of bat communities. There are currently many different ways to sample bats, ranging from the examination of specimens kept in museum collections (Liopez-Gonzalez 2004) to the use of cutting-edge technology (such as bat detectors, Vaughan et al. 1997). However, most researchers now use a combination of techniques (Duffy et al. 2000; Jaberg and Guisan 2001). Now used by most researchers in habitat use analysis (Avila-Flores 2005; Vaughan et al. 1997; Wickramasinghe et al. 2004) and bat fauna censuses (Barataud 1998; Ciechanowski 2002; Pauza and Pauziene 1998), bat Ciechanowski 2002; Pauza and Pauziene 1998) and in analysis of habitat use (Avila-Flores 2005; Vaughan et al. 1997; Wickramasinghe et al. 2004). Despite their shortcoming (Hayes 2000), bat detectors frequently are used in annual monitoring programs (Walsh et al. 2001). However, scientists have become concerned with the validity of data derived from this method. Over the last decade a growing number of studies have examined the advantage and disadvantages of techniques using bat detectors (Ahlen and Baagoe 1990; Barclay 1999; Hayes) and various in an effort to develop more effective bat survey techniques, authors have examined bat sampling techniques (Duffy et al. 2000; Murray et al. 1999; O'Farrell and Gannon 1999). Although bat detectors do not stress out bats, the data they generate are skewed due to the underrepresentation of high-flying bats and bats that make low-intensity calls (Barchey 1999; Duffy et al. 2000).Other techniques should be considered in bat survey studies, finding roosts in man-made structures or in cave and mice's represents a useful survey method; several bat species can be inventoried in roosts or when they leave roosts, at sunset (Mitchell-Jones and Mcheisz 1999; Tuttle et al.(200).

1.2. Statement of the Problem

The Egyptian fruit bat (*Rousettus aegyptiacus*) plays a crucial role in its ecosystem as a seed disperser and pollinator, but there is lack of comprehensive data regarding their population, activity pattern and feeding habits. This study aims to address these gaps by systematically documenting the population, daily and seasonal activity pattern and feeding habits in their natural habitat.

1.3. Objectives

1.3.1. General Objective of the study:

The general objectives of this to study are to understand fruit bats (*Rousettus aegyptiacus)* population size, activity patterns, and food preference in mutulu town.

1.3.2. Specific Objectives of the study:

- Assess the population size of fruit bat species in Mutulu town.
- Assess the activity patterns of fruit bats.
- To identify the food items fruit bat forage.

1.4. Research question

1. What is the size of the fruit bat population in the study area?

2. What are the daily and seasonal activity patterns of fruit bats?

3. What is the diet composition of fruit bats in the study area?

1.5. Significance of the Study

Bats are one of the most important and less studied mammalian species. Though often feared and loathed as sinister creatures of the night, bats are vital to the health of our environment and our economy. Understanding, why bats are so essential, the threats they are facing, how we are conserving bats and how you can create a bat, friendly environment is important. Bats play an essential role in pest control, pollinating plants and dispersing seeds. Recent studies estimate that bats eat enough pests to save more than $1 billion per year in crop damage and pesticide costs in the United States corn industry alone. While many bats eat insects, others feed on nectar and provide critical pollination, for a variety of plants like peaches, cloves, bananas and agaves.

The current research will help to:

- ✓ Develop a knowledge and understanding of bats population, activity pattern and forage behaviour of fruit bats in study area.
- ✓ Identify the effect of season on the activity pattern and foraging behaviour of the bats.
- ✓ Create awareness and appreciation the benefit of the bats and help in their conservation.

CHAPTER TWO

2. LITERATURE REVIEW

2.1. Physical characteristics of bats

Bats are the mammals that can fly. They have fur on their bodies, sometimes including their head. Their wings, however, do not have fur. Bats can be a range of colors, including red, tan, brown, and gray. Bats ears are very important because bats use them to hunt for food. Fruit bats /*Rousettus aegyptiacus* are medium sized bats with dorsal pelage ranging from dark brown to medium gray. Both sexes have ventral pelage, which are several shades paler than their dorsal coloring. A collar of light yellow or orange fur is frequently visible around the neck. There is no color difference between genders; however, males have well-developed stiff hairs along the throat that, in comparison to females, are more identifiable (Kwiecinski and Griffiths, 1999). Short fur completely covers the head almost to the end of the muzzle, with the exception of the forehead, where the fur is slightly longer. Ears are around the length of the muzzle, with blunt tips and dark coloration when compared to dorsal pelage (Paula. Racey 1998).

Egyptian fruit bats (figure 1) have large eye adapted for twilight and night vision. The dark brown wing membranes have short fur that reaches the fore arm's proximal half. A claw is present on both the first and second digits, whiles all other digits have cartilage. Egyptian Rousettus have fives toes on both hind limbs, each with claws (Kwiecinski and Griffiths, 1999). Males are typically larger than females with a total body length ranging from 14 to 19.2cm, while females ranging 12.1 to 16.7cm. Adults may weigh 80 to170g and have a wing span close to 60cm. The forearm varies between 85 to 101.9mm in males and 88.1 to 99 mm in females (Kwiecinski and Griffiths, 1999; Grzimek, 2003). (Grzimek, 2003; Kwiecinski and Griffiths, 1999).

Figure 1. Egyptian fruit bats (Rousettus aegyptiacus)

Source : internet website

2.2. Taxonomy and Classification

Rousettus aegyptiacus, commonly known as the Egyptian fruit bat, is a species within the family Pteropodidae. It belongs to the genus Rousettus, which comprises several species of fruit bats found primarily in Africa and parts of the Middle East. This species is one of the most widespread and well-studied members of its genus.

Family: Pteropodidae Genus**:** Rousettus Species: *Rousettus aegyptiacus*

2.3. Communication and perception of bats

Rousettus aegyptiacus, commonly known as the Egyptian fruit bat, employs a variety of communication and sensory mechanisms that are crucial for their social interactions and navigation. While *Rousettus aegyptiacus* primarily relies on visual and olfactory cues for foraging, they have some echolocation capability, though it is not as advanced as in insectivorous bats. Echolocation is used in conjunction with other senses to detect the presence of obstacles or to navigate in dark environments. Fruit bats have relatively good night vision, which is essential for their nocturnal activities. Their large eyes are adapted to low-light conditions, enhancing their ability to see and locate fruit in the dark. Olfaction plays a critical role in their foraging behavior. Egyptian fruit bats have a highly developed sense of smell, which helps them identify ripe fruit and detect food sources from distance. Their acute hearing aids in detecting calls from other bats and picking up environmental sounds. This sense is crucial for both social interactions and foraging. Their wing membranes and facial structures are sensitive to touch, which helps in maneuvering and interacting with their environment, especially when feeding or moving through dense vegetation *(Morris, P*. (2010).One of only three species in the Rousettus genus that uses echolocation in addition to visual orientation is the Egyptian Rousettus fruit bat. This species uses a series of rough, brief tongue clicks against the side of the mouth to produce echolocation (Roberts, 1975; Holland et al, 2004).These short, impulsive paired clicks assist in navigation in the dark. The frequency range is usually 12 to 70 kHz, with click structure and duration most similar to dolphins. This form of echolocation has evolved independently from the echolocation system used by other echolocation bats, such as vespertilionids (Roberts, 1975; Holland et al., 2004; and Waters, 2007). (Holland and Waters, 2007; Holland, et al., 2004; Roberts, 1975) Most bats produce echolocation sounds by contracting their larynx [voice box].The are two main types of echolocation:

1. Low-duty-cycle echolocation, allows bats to estimate their distance from an object based on the difference between the times a sound is emitted and when the echo returns.
2. High- duty- cycle echolocation gives bats information about the motion and three dimensional location of prey. For this type of echolocation, a bat emits a continuous call while listening to the change in the frequency of the returned echo. Bats avoid deafening themselves by emitting a call outside their frequency range. The echo is lower in frequency, falling within the optimal

range for their ears... Typically, the frequency range is 12 to 70 KHz, and the duration and click structure are most similar to those of dolphins. This form of echolocation has evolved independently from the echolocation system used by other echolocation bats, such as vespertilionids (Roberts, 1975; Holland et al, 2004; Holland and Waters, 2007).

2.3. Feeding behavior and micro-habit

2.3.1. Feeding behavior of bats

In order to survive, bats need to eat, water to drink, place to sleep, and raise their young/called roosts/, and places to hibernate. Places where bats hunt food are called foraging habitats. Bats are the most active at night between the hours of dusk to dawn (Paul A. Racey (1988). Bats hunt at night and roost during the in trees, bat boxes, under caves and in buildings where they can gain access through open spaces in roofs, attics or walls. Most bats active in the during wet season, many bats migrate or hibernate during the dry season (Nigel C. Bennett 2006). As night approaches, bats begin to increase their activity. After taking off and flying around their cave, they will depart in pursuit of food and water. Bats locate each food by echolocation, and then they trap it with their wing or tail membranes and reach down to take the food into their mouth. The erratic flight is the result of both this action and the chase Harris (2005).

The Egyptian fruit bat is a frugivore that primarily eats leaves and fruit. At dusk, it departs from its roost to go foraging. Fruit bat has a flexible diet, consuming any soft, pulpy fruit from fruiting trees, comprising Persian lilacs, loquat, figs, and wild dates. The type of fruit consumed is influenced by overall availability depending on the season and habitat type. Its dietary flexibility includes eating unripe fruits or those damaged by insects or fungi, allowing them to persist in habitats where ripe fruits are not perennially available (Kwiecinski, G., T. Griffiths, 1999).

The Egyptian fruit bat usually makes multiple, short flights from its roost to various fruiting trees. It prefers to pick fruit and carry it back to the roost or another tree before eating it. To get their diet, they will travel distances of about 10-24 m. while eating, it will hold the fruit tightly against its body to prevent theft by other bats (Brunet-Rossini, A.k.2004). Bats use two types of echolocation calls, such as search phase calls and feeding buzzes. Bats produce the search phase call to scan the environment for obstacles and their next meal. Once food is located, bats use feeding buzzes to capture the food. Bats will typically feed for about an hour or two, rest for a bits, then feed again before day break (Kunz, T.H., and L.F.Lummsden, 2003).

2.3. 2.Micro-habitat of Bats

Almost everywhere in the world is home to bats (Thomas H. Kunz, "Ecology of Bats," 1982). Generally speaking, bats look for a range of daytime hiding places, including caverns, cracks in the rock, abandoned buildings, bridges, mines, and trees. The primary habitats of bats in my research area are old buildings construction site. The micro-habitat preferences of *Rousettus aegyptiacus* are shaped by their need for suitable roosting conditions, access to food, and protection from predators. Their choice of roosting sites such as caves, trees, and buildings reflects their adaptability and ecological versatility. Foraging areas are closely tied to the availability of fruiting vegetation, which is crucial for their diet and survival *Morris, P*. (2010).

2.4. Mating, Reproduction and Life Cycle

Polygynandrous (promiscuous, meaning both males and females breed with multiple mates) and polygynous (one male mates with multiple females) mating systems are both possible in Egyptian fruit bats (Story, JF).Bhatt, H. and Kunz TH.2000).

There are two breeding seasons for Egyptian fruit bats: the first runs from April to August, and the second from October to February. When the breeding season begins, the bats within the colony separate based on sex (E. E. Williams and C. E. Williams1989). The males gather together to from bachelor groups while the females from maternity colonies. To lessen the impact of temperature variations, these bats roost in close proximity to one another. This close contact enables communication with one another throughout the day when roosting (Paul E. Racey and S. M. Entwistle 1999). Being nocturnal, Egyptian fruit bats are busier in the late afternoon and at night when there is more frequent grooming. Because female bats are in charge of copulation, male Egyptian fruit bats will give a nuptial gift to the female in order to boost the likelihood of mating. The fruits that the male lets the female scrounge are the nuptial gifts. Giving the female the freedom to scrounge it strengthens the bond between the pair, thus increasing the probability of the female copulating with a given male. Females typically give birth to only a single offspring each year (called “pup”), but twins are occasionally born, after a gestation period of around 115 to 120 days (Heithaus, 1982).

Newborn Egyptian fruit bat pups are altricial at birth with their eyes shut until they are nine days old. The female carries the pup until it is six weeks old, which is when it can hang in the roost on its own. Afterwards, the pup is left in the roost while the mother forages. The mother takes the pup to the same tree several times before leaving it to roost there, where it spends the night while the mother goes on her hunt. The pup learns this location and visits it first when at about three months of age, the pup will leave the roost on its own to forage for its food. The only become independent from their mothers after nine months, once they have finally reached their adult physique. Offspring typically stay with the same colony as the parents for their entire lives (Hem era 1981, Thomas 1984).

In the wild, the average lifespan of the Egyptian fruit bat ranges from 8 to 10 years, while in captivity its lifespan is about 22 years with proper care (Kunz, T.H., C.D.Wemmer, and V.Hayssen.1996). The main cause of the notable lifespan difference between Egyptian fruit bats in the wild and those kept in captivity is the greater exposure of the wild bats to predators and vitamin D deficiency (Wilkinson and South 2002;Gaisler et al, 2003).

2.5. Population Status

The fruit bat, *Rousettus aegyptiacus*, has a wide geographical distribution. It is found in Africa, along the Nile valley up to the Mediterranean coast, with its northernmost distribution reaching southern Turkey. It occupies a wide range of habitats, which makes it the most successful fruit bat in the sub-order Megachiroptera (Kulzer, 1979). Its diet includes a wide variety of soft fruits, buds, young leaves, nectar and pollen (Kulzer, 1979). The bat may travel between 10 and 24 m from its cave seeking food (Thomas and Fenton, 1978; Jacobsen, Viljoen and Ferguson, 1986). This species is the only fruit bat of 32 bat species in Israel; it is characterized by a mainly Mediterranean distribution, but it is also found in arid areas (Harrison, 1964). *Rousettus aegyptiacus* roosts in natural caves or man-made constructions which are relatively dark and humid. Colony sizes vary from a few to thousands of bats (Fleming, 1982). They are characterized as bimodality polyestrous, with reproductive and sucking periods during wet season. The females generally raise one neonate during wet season (Makin, 1990).

CHAPTER THREE

3. MATERIAL AND METHODS

3.1. Description of study area

Mutulu town is located in the west shoa, Oromia region, Ethiopia. It is situated at a distance of 135 km from Addis Ababa. Mutulu town is bounded on the east by Ginbi, on the west by Toke Irecha, on the South by Dire Incinii, and on the North by Guder town. Its geographical coordinates are 8^0.17`S to $9^0$.60` N Latitude and 37^0.17`W to $38^0$.45`E Longitude. The town has an altitude of 2240m above sea level.

3.2. Materials

The materials that were used during the study period were hand Torches to observe the bats, mobile phone to measure the time during their activities and data sheet, spare bulbs, batteries, pencil and other stationary materials to record data during the study period.

3.3. Methods

3.3.1. Preliminary survey

Ecological survey of bats in and around mutulu town was carried out to gather relevant information. In this survey, an overall view of bats specifically to fruit bats of the area was conducted. Information was collected from local people living around the study area.

3.3.2. Data collection

Data were collected in the evening (7:45—9:30 pm) and late midnight (3:30—5:30 pm). Torch light as well as naked eye observation was used. Field data sheet was used to record fruit bats population size, activity pattern and food preference.

Based on the information collected and site selected during preliminary survey, field data were gathered. Data were taken on monthly basis (total 70 days: 55 days during dry seasons from February to May, and 15 days during wet season from June to August. Data on population size was collected when the bats were roosting. Activity pattern and Food preference data was collected when most fruit bats are active and engaged in foraging activity.

Population size

The population sizes of fruit bats were observed during dry and wet season.

Dry season data was collected from February to May; total of 55 days, Wet season June to August data was collected for a total of 15 days.

Populations were observed by using torch light and direct observation for total 70 days.

Activity pattern

The diurnal activity patterns of bats were collected during both dry and wet seasons. Activities were recorded by using torch light and direct observation throughout the study period (Barataud1998; Ciechanowski 2002; Pauza and Pauziene1998). During the observation period, a group or an individual bat was followed at a distance of 10-24m. The observations were made from evening to late midnight dividing the night into two timeslots; evening: 7:45 pm to 9:30 pm and late midnight 3:30 pm to 5:30 pm. The activities were divided into six major categories. Namely:

1. Feeding: The act of consuming food. For fruit bats, feeding primarily involves eating fruits, nectar, and sometimes insects.

2. Grooming: The process of cleaning and maintaining the body. In fruit bats, grooming involves the use of their claws, tongue, and sometimes other bats to clean their fur, remove parasites, and manage their hygiene.

3. Resting: The state of being inactive or resting, typically to recuperate energy.

4. Preening: The act of tidying and arranging feathers or fur. This behavior helps to keep their fur clean, remove dirt and parasites, and ensure that it is in good condition. Proper preening also helps in thermoregulation and maintaining a healthy appearance.

5. Flying: The act of moving through the air using wings.

6. Others activities such as calling, alert, copulation and etc.

Food preference

To collect data about the diet composition of bats, repeated observation were carried out during the dry season February to May and wet season June to August. Observation was made with the aid of torch light and direct observation. Group or individual bat was followed from a distance of 10-24m. Observation was made under good weather conditions, avoiding bad weather conditions (heavy raining). Data were collected in the evening (7:45—9:30 pm) and late midnight (3:30—5:30 pm), when most of the bat species were engaged in feeding activities (Buskirkand McDonald, 1995).

3.3. Data Analysis

In analyzing the data, the researcher used quantitative approach. The data which was collected using field observation were analyzed and presented in from of descriptive statistics. Following this each item population, activity pattern and feeding habits were interpreted through numerical forms along with the relevant table and figure. All analyses were performed using Microsoft excel.

CHAPTER FOUR

4. RESULT

4.1. Population size

In the study area the population size of fruit bats differ between wet and dry season's months. November recorded the highest population (200 individuals) and December and January recorded the lowest population (50 individuals each). High population was recorded during wet season than dry season because; increase in the number of fruit bats during the wet season compared to the dry season is primarily due to the availability of food. (Figure 2).

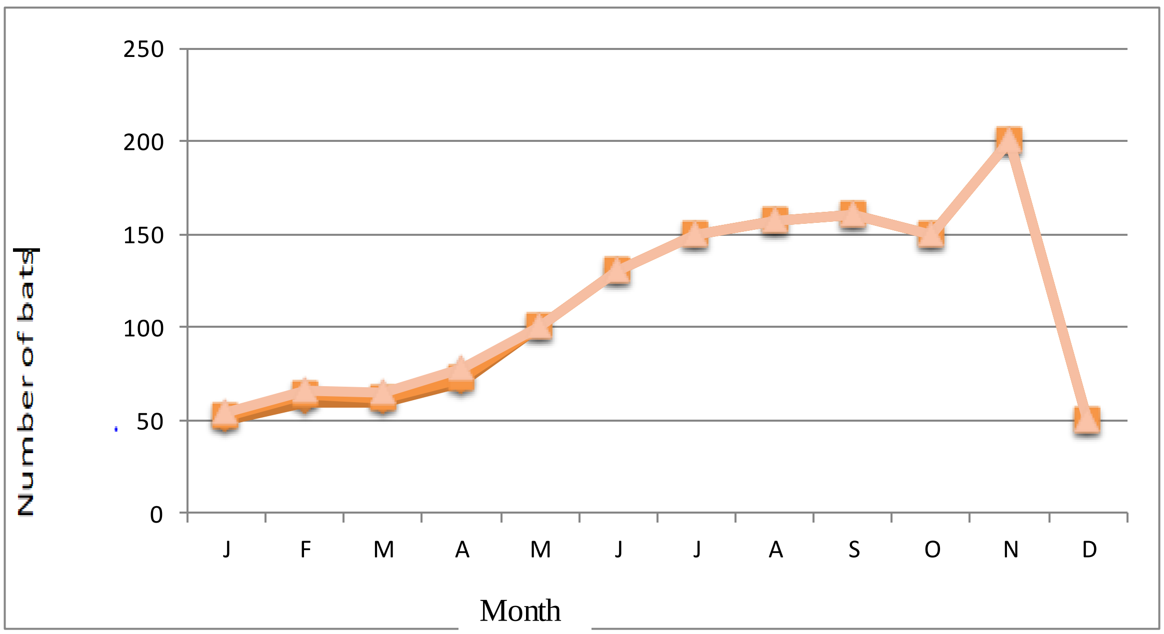

Figure 2. Population size of *Rousettus aegyptiacus* in the mutulu town in 2022

In 2023, October recorded the highest population (200 individuals) and March and December recorded the lowest population (30 individuals each).The dramatic decline in the population size from 200 individuals in October to 30 individuals in March and December suggests that there may be specific factors or seasonal changes influencing the population. Specific factors or seasonal changes which influencing the population size of fruit bats was seasonal changes, environmental factors, human impact and reproductive cycles (Figure 3).

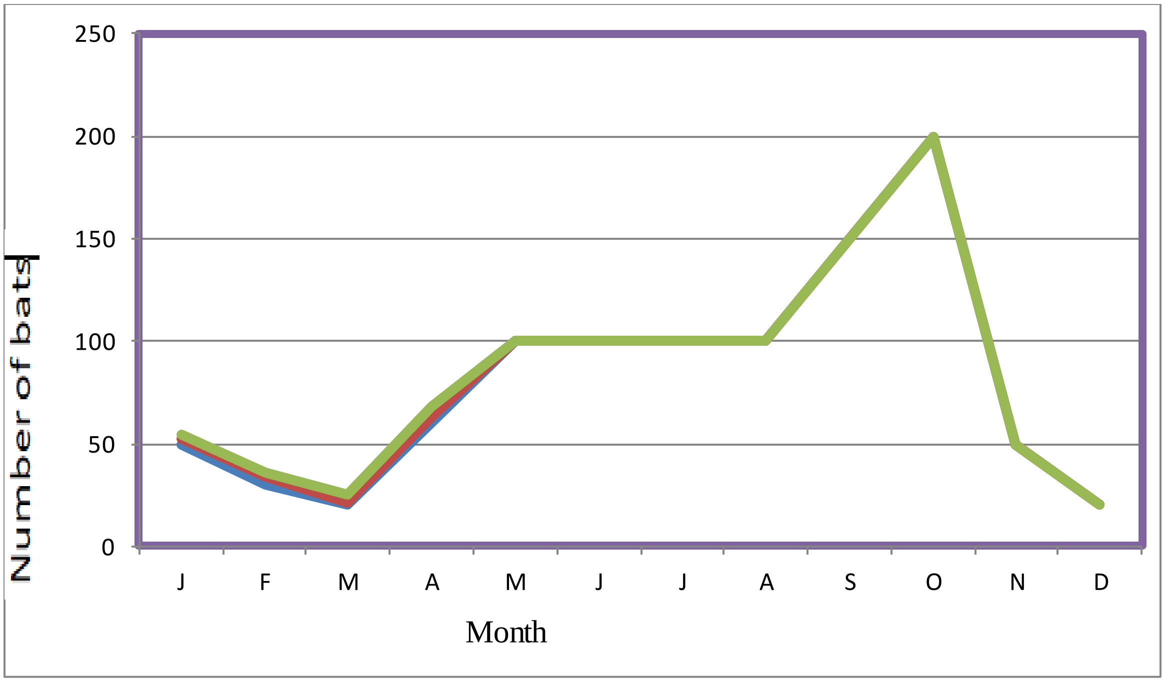

Figure 3.Population size of Rousettus aegyptiacus in the mutulu town in 2023

The analysis of the population during the wet season reveals a fairly balanced distribution between adult (49%) and juvenile (51%). The mean population size per category is 100, indicating a relatively symmetrical distribution. The percentages highlight that juvenile make up a significant portion of the population.

The analysis for the dry season shows a notable imbalance in the population distribution. Adult males constitute approximately 50.61% and juvenile (49.39%) respectively. The mean population size per category is 83.

4.2. Activity pattern

About 30 minutes of sunset, activity in the colony began to increase. Sound produced by individual bats merged together. Within 15 to 20 minutes of sunset, most adult left the roost. Fruit bats were observed engaged in daily activities of feeding, grooming, and flying, preening, resting, and showing other antagonistic activities. The recorded data indicated variation in night time duration among the most commonly observed activities in the wet and dry season. During wet season Feeding activity comprised highest (75%) followed by flying (11%), grooming (5%), resting (2%), preening (2.5%) and other (4.5%) (Figure 4).

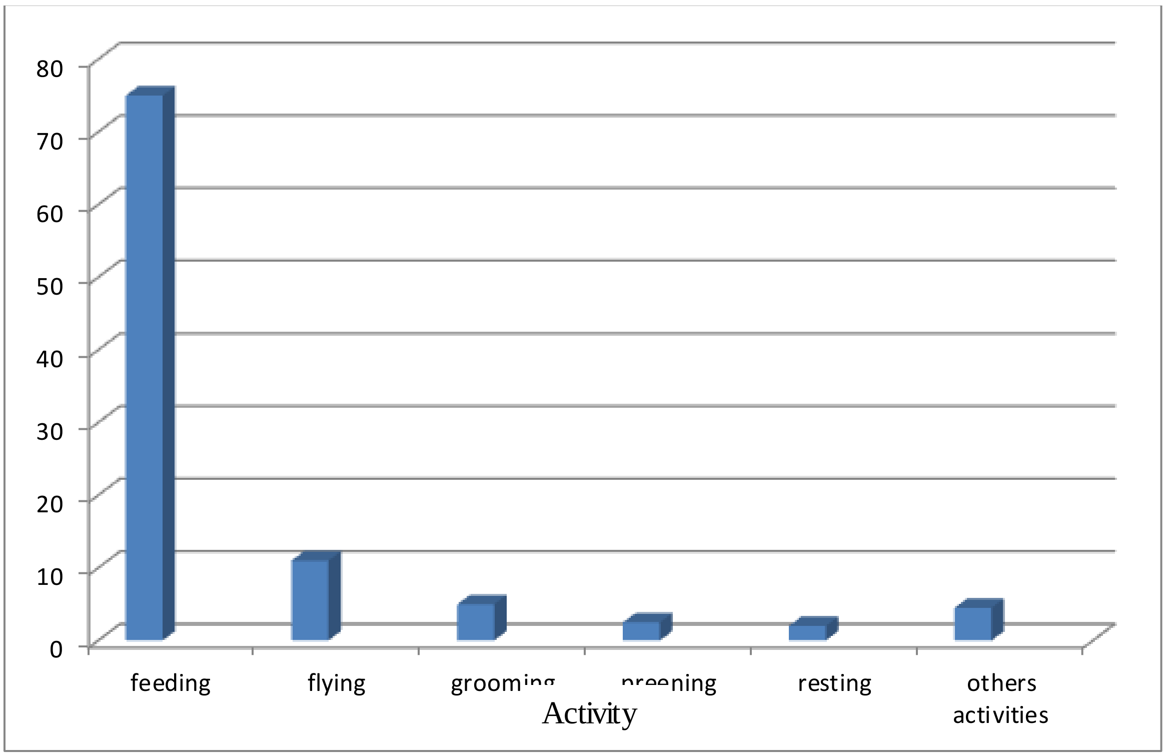

Figure 4. Activity patterns of fruit bats

During dry season Feeding activity comprised highest (48.2%) followed by grooming (18.07%), resting (15.06%), preening (9.04%), flying (6.02%) and other (3.61%) (Table1).

Table 1. Activity pattern of fruit bats during dry season

Population	Activity pattern	Frequency	Mean	Percentage
	Feeding	80		48.2
	Grooming	30		18.07
	Resting	25		15.06
	Preening	15		9.04
	Flying	10		6.02
	Other activity	6		3.61
Total	6	166	27.67	100

4.3. Forage behavior of fruit bat

The diet of fruit bats in percentage frequency consisted of fruit (90%), nectar (7.5%), and insect (2.5%) during wet season (figure 5).

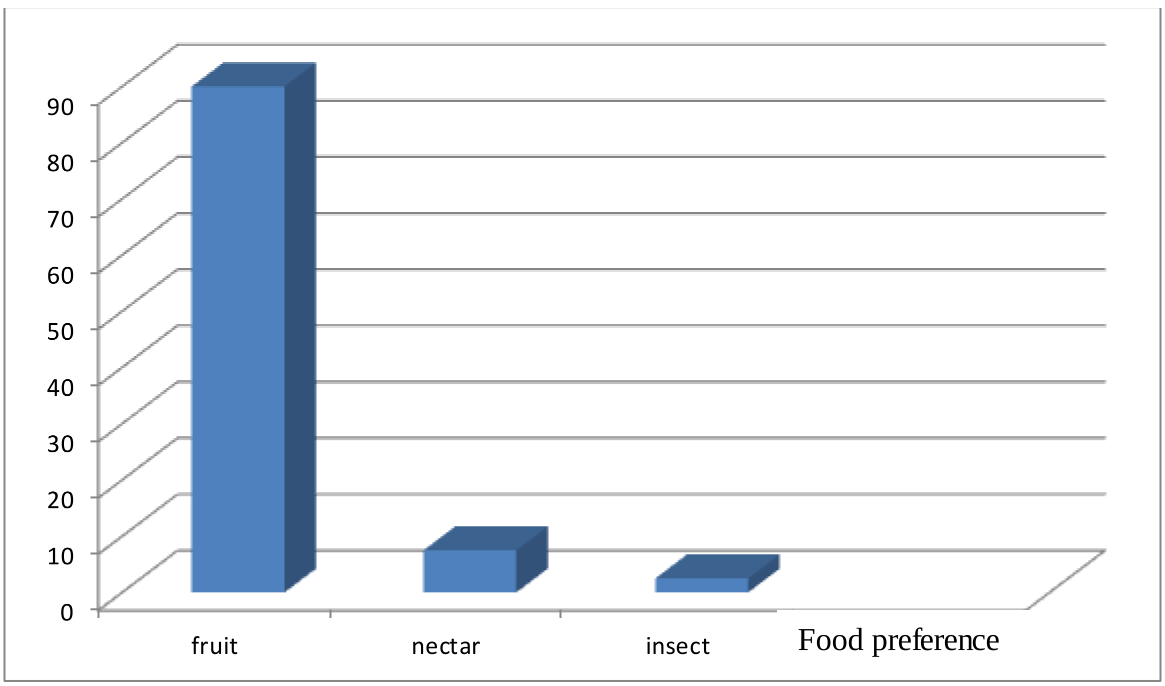

Figure 5. Diet of fruit bat during wet seasons.

During dry season the feeding habits of fruit bats consisted of fruit (60.24%), nectar (24.09%), and insect (15.67%) (Table 2).

Table 2.Feeding habits of fruit bats during dry season.

Population	Feeding habit	Frequency	Mean	Percentage
	Fruit	100		60.24
	Nectar	40		24.09
	Insect	26		15.67
Total	3	166	55.33	100

CHAPTER FIVE

5. Discussion

5.1. Population size of fruit bats *(Rousettus aegyptiacus)*

During the wet season, fruit bats benefit from the abundance of fruits and other food resources that come with the increased rainfall. This abundance of food supports higher reproductive rates and better overall health for the bats, leading to a larger population (Teshome Ayalew (2020). Conversely, in the dry season, the scarcity of food can lead to lower reproductive success and higher mortality rates, resulting in a smaller population of fruit bats. Generally, the increase in the population size of *Rousettus aegyptiacus* during the wet season is primarily due to enhanced food availability increased reproductive success, and better survival rates (Tesfaye Kassa (2018). The dramatic decline in the population size from 200 individuals in October to 30 individuals in March and December suggests that there may be specific factors or seasonal changes influencing the population (Voigt, C.C., and Kingston, T. (2016)). Specific factors or seasonal changes which influencing the population size of fruit bats was seasonal changes, environmental factors, human impact and reproductive cycles (Nowark, R.M.(1994)).

The population size of *Rousettus aegyptiacus* is influenced by a combination of ecological, environmental, and human factors. Variations in food availability, habitat quality, human activities, predation, disease, climate change, and social dynamics all play a role in shaping their population size. Effective conservation and management strategies must consider these factors to support the stability and growth of fruit bat populations, (Evelyn, M.J., and Racey, P.A. (2012)).

5.2. Activity pattern

The analysis reveals that feeding is overwhelmingly the most common activity during the wet season, comprising 75% of the total observed activities. Other activities, such as grooming, flying, resting, preening, and other activities, are relatively infrequent in comparison. The high standard deviation reflects significant variability in activity distribution, particularly due to the dominance of feeding, (Dejene Mulugeta and Abebe Tadesse (2021)).

The analysis of activity patterns during the dry season shows that feeding is the most prevalent activity, comprising 48.2% of the total activities. Grooming is the second most common activity, followed by resting and preening. Flying and other activities are the least frequent. Seasonal changes in temperature and the availability of fruit can influence their activity patterns. In regions with marked seasonal variations, their activity patterns may adjust according to changes in food supply and environmental conditions (Evelyn, M.J., and Racey, P.A. (2012)).

5.3. Forage behavior

Fruit bats/Rousettus aegyptiacus/ predominantly consumed fruits. The fruit bat diet is supplemented by nectar and insect (Kassa Melaku, Teshome Ayalew and Gashaw Biruk (2020)).

The analysis of feeding habits during the wet season shows that fruit is the dominant food source for fruit bats, comprising 90% of their diet. Nectar and insects are much less common, accounting for 7% and 3%, respectively. The analysis of feeding habits during the dry season indicates a strong preference for fruit, which constitutes 60.24% of the diet. Nectar and insects are less common, representing 24.10% and 15.66%, respectively.

The food preferences of *Rousettus aegyptiacus* are influenced by a complex interplay of factors, including seasonal and geographical availability of fruit, nutritional needs, fruit ripeness and quality, competitive pressures, foraging strategies, environmental conditions, and behavioral adaptations (Voigt, C.C., and Kingston, T. (2016)). These factors collectively shape their feeding behavior and dietary choices, allowing them to thrive in diverse habitats and adapt to changing conditions *(King don, J.* (1997)), (Kassa Yeshimebrat, Lemma Abebe and Asfaw Tesfaye (2019)).

CHAPTER SIX

6. Conclusion and Recommendation

6.1. Conclusion

According to the present study, population size of fruit bats was identified during dry season as well as wet season. In wet season the population was recorded 200 individuals and in dry season population size decline to 166 individuals. The variation in the population size of *Rousettus aegyptiacus* is influenced by a combination of factors including food availability, human activities, predation, disease, climate conditions, reproductive success, and social dynamics. Each of these factors can interact in complex ways to cause fluctuations in population size and distribution. According to the present study, activity pattern of fruit bats was feeding, grooming, flying, preening, resting and other activity like calling, alert, copulation. The activity patterns of *Rousettus aegyptiacus* are influenced by a combination of factors including food availability, roosting behavior, predation risks, social interactions, environmental conditions, reproductive cycles, human activities, and physiological needs. These factors collectively shape their nocturnal foraging behavior, social interactions within roosts, and overall daily activity patterns. Fruit bats *(Rousettus aegyptiacus)* predominantly consume fruits. The fruit bat diet is supplemented by nectar and insects. Food abundance and availability is an important factor that influences the foraging behavior of Fruit bat. The food preferences of *Rousettus aegyptiacus* are influenced by a complex interplay of factors, including seasonal and geographical availability of fruit, nutritional needs, fruit ripeness and quality, competitive pressures, foraging strategies, environmental conditions, and behavioral adaptations. These factors collectively shape their feeding behavior and dietary choices, allowing them to thrive in diverse habitats and adapt to changing conditions.

6.2. Recommendations

- Since the results of this study relied on data collected from one study area (mutulu town) over a period of two months and ten day, replication of such a study in other habitats for a longer time period will be important in acquiring large data sets for different populations. Furthermore, future studies for longer periods will be important to get more information about the fruit bats /*Rousettus aegyptiacus* and facilitate conservation measure.
- Deeper insight into the diet and feeding behavior of the fruit bat will require longer-term studies on the species. This will provide better understanding of dietary habitats and guide development of effective conservation strategies for the species.
- In the present study, it did not examine the detail effect of age and sex on the activity of fruit bat, despite the fact that differences in activity exist among age and sex classes; there should be future studies to clarify the differences in activity among the age and sex classes of fruit bat.

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Data Sheet for Population size of Bats

Data sheet 1. Data sheet for population size

Name of data collector**: Lemma Gizaw Mengesha** Date: 20/3/2022_20/9/2023

Season: wet

Habitat location and description: building

Start time: 7:30_______9:30 at evening and 3:30_____5:30 late midnight

Data collect: For **15 days from June to August**.

Table 3.Population size of Bats

Habitat	Population size of bats in study area		
Building	Adult	juvenile	Total
	98	102	200

Name of data collector: ________________________

Signature: __________

Date: _______________________

Name of Advisory: ____________________________

Signature: ______________

Date:_________________

Data Sheet for Population size of Bats

Data sheet 2. Data sheet for population size

Name of data collector**: Lemma Gizaw Mengesha** Date: 20/3/2022_20/9/2023

Season: dry season

Habitat location and description: building

Start time: 7:30_______9:30 at evening and 3:30_____5:30 at late midnight

Data collect: For **55 days from Febuary to May**.

Table 4 .Population size of fruit bats during dry season (2022-2023).

habitat	Population size of bats in study area		
building	Adult	juvenile	Total
	84	82	166

Name of data collector: ______________________________

Signature: ______________

Date: _____________________

Name of advisory: ____________________________________

Signature: _______________

Date: _____________________

Data sheet 3: ACTIVITY PATTERN OF BATS

Name of data collector**: Lemma Gizaw Mengesha**

Date: 20/3/2022_20/9/2023

Season: wet season

Start time: 7:30__8:30 at evening to 3:30__5:30 at late midnight

Data collect: For **15 days from June to August**.

Table 5. Activity pattern of Bats

Population	Activity pattern	Remark
	Feeding	
	Grooming	
	Flying	
	Resting	
	Preening	
	Other activity	

Name of data collector: ______________________________

Signature: _____________

Date: _____________________

Name of advisory: ___________________________________

Signature: ______________

Date: _____________________

Data sheet 4: ACTIVITY PATTERN OF BATS

Name of data collector**: Lemma Gizaw Mengesha**

Date: 20/3/2022_20/9/2023

Season: dry season

Start time: 7:30__8:30 at evening to 3:30__5:30 at late midnight

Data collect: For **55 days from February to May**.

Table 6. Activity pattern of fruit bats

Population size	Activity pattern	Frequency	Remark
	Feeding		
	Grooming		
	Flying		
	Resting		
	Preening		
	Other activity		

Name of data collector: ______________________________

Signature: _____________

Date: ____________________

Name of advisory: ___________________________________

Signature: ______________

Date: ____________________

Data sheet 5: Data Sheet on Foraging Behavior of Bats

Name of data observer: **Lemma Gizaw Mengesha**

Date: Date: 20/3/2022_20/9/2023

Season: wet season

Start time: 7:45___9:30 at evening to 3:30__5:30 at late midnight

Data collect: For **15 days from June to August**.

Observation: bats eat different forage such as insect, fruit and nectar

Majority of bats in **my study area** are **fruit bats**, therefore **90%** of bats **forage fruit**.

Table 7.Forage behavior of fruit Bats

Population size	Food item			
	Insect	Fruit	Nectar	Total

Name of data collector: ______________________

Signature: __________

Date: _____________________

Name of Advisory: __________________________

Signature: _____________

Date: _______________

Data sheet 6: Data Sheet on Foraging Behavior of Bats

Name of data observer: Lemma Gizaw Mengesha

Date: Date: 20/3/2022_20/9/2023

Season: dry season

Start time: 7:45___9:30 at evening to 3:30__5:30 at late midnight

Data collect: For **55 days from February to May**.

Observation: bats eat different forage such as insect, fruit and nectar

Majority of bats in my study area are fruit bats, therefore 60.24% of bats forage fruit.

Table 8.Forage behavior of fruit Bats

Population size	Food item			
	Insect	Fruit	Nectar	Total

Name of data collector: ______________________

Signature: __________

Date: _____________________

Name of Advisory: _________________________

Signature: _____________

Date: _______________