

Diurnal activity budget and feeding activity of grivet monkeys (*Chlorocebus aethiops*) in Zegie Peninsula, Northern Ethiopia

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Research Article

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Abstract

Background

Grivet monkeys (*Chlorocebus aethiops*) are an Old World monkey with long white tufts of hair along the sides of the face. We collected data on the activity patterns of the members of the 2 neighboring focal groups on an average of 4 day per month from August 2021 to March 2022 covering both the wet and dry seasons. Scan sampling method at 15 minutes interval was used to collect data on diurnal activity patterns and feeding ecology of grivet monkeys.

Results

A total of 16707 individual behavioral scans were recorded for a total of 24 days; 12 days during the wet season (August, September and October) and 12 days during the dry season (January, February and March). Grivet monkeys spent 39.4% of time feeding, 29.6% moving, 19.9% resting, 4.4% grooming, 3.1% social play, 2.4% aggression, and 1% for other activities. The overall diet of grivet monkeys was dominated by fruit (61.2%), while young leaf accounted (22%), young shoot (8%), bark (4.6%), animal prey (2.9%), and others (1.1%). A total of 22 plant species were consumed by grivet monkeys in the study area. The top four plant species namely *Mimuscops kummel*, *Ficus sur*, *Strychanoss pinosa* and *Ficus vasta* accounted for more than 73% of their plant diet. According to the total percentage contribution of the plant food items eaten, *Mimuscops kummel* was the most frequently consumed species which accounted about 29%, *Ficus sur* was 17%, *Strychanoss pinosa* 16%, and *Ficus vasta* was 11%.

Conclusion

Grivet monkeys spent more time for feeding followed by, moving, resting, grooming, social play, aggression and other activities. Grivet monkeys are mostly feed on fruits and they also feed on young leaves, shoots, bark, animal preys and other food items.

Background

Grivet monkeys (*Chlorocebus aethiops*) are an Old World monkey with long white tufts of hair along the sides of the face [1]. The grivet has been identified in Ethiopia, Sudan, Eritrea, and Djibouti. Grivets are found throughout southern and eastern Africa, from Senegal to South Africa. They are habitat generalist [9]. They are highly successful African primates occupying a wide variety of habitats. The grivet needs to live around a source of water, especially during the dry season. It is able to adapt many environments [2]. The survival of a species is dependent on the availability of critical resources such as food and protection [4]. Grivet monkeys are opportunistic omnivores; mostly they are dependent on gum, flowers, fruits, leaves, seeds, and insects [3]. Being omnivorous they are capable of finding food in even the poorest of environments [5].

Grivet monkeys commonly live in troops and the number of adult males to adult females within a troop may vary. This flexibility of numbers, which is possibly related to diet, is one of the most interesting aspects of their social structure [7]; [8]. Grivets travel in packs and usually move on all fours or quadrupedally, except when using both hands for carrying, when they manage to walk and run quite comfortably on two legs [2]. Groups can range from five to over 70 [9]. The grivet is most active in the morning and early evening [10]. This study is essential for the people of Zegie and grivet monkeys. The study is mainly aimed to provide information about diurnal activity and feeding activities of grivet monkeys in Zegie Peninsula.

Results

Diurnal activity patterns

A total of 16707 individual behavioral scans were recorded for a total of 24 days both during the wet season and the dry season. The overall activity time budget of grivet monkeys in the study area is presented in Figure (1).

The percentage of time spent for different diurnal activity patterns in grivet monkeys indicated that on average 39.4% of their time devoted for feeding, 29.6% moving, 19.9% for resting, 4.4% grooming, 3.1% social play, 2.43 aggression and 1% for other activities such as watering, courtship behavior, looking at the observer and vocalizing.

Grivet monkeys on average spent more time feeding (40.3%) during the wet season than the dry season (38.5%). Grivet monkey on average spent more time moving (32.5%) during the dry season than the wet season (26.6%). They also spent on average more time resting during the wet season (21.6%) than the dry season (18.3%) (Fig. 2).

Feeding activity

At the time of each activity scan sample, the dietary data on individuals scored as feeding was recorded. A total of 9294 feeding behavioral records were obtained from scan sampling of the study groups within 24 days; 12 days during the wet season and 12 days during the dry season. The overall diet of grivet monkeys during the study period is presented in (Fig. 3). Fruit contributed 61.2% of the overall diet of grivet monkeys, young leaf, and young shoot made the second and third largest contributions to the overall diet of grivets. Mature leaves, stem, root, and flower were consumed rarely which are mentioned as others (1.1%) on the Fig. 3.

Grivet monkeys spent more time feeding on fruits (66.7%) during the dry season than the wet season (56.5%). The grivets forage young leaf (26.1%), young shoot (8.9%), and bark (5.4%) during the wet season while during the dry season (17.4%), (6.9) and (3.6%) respectively. Grivets spent more time feeding on animal prey (4.7%) during the dry season than the wet season (2%) (Fig. 4)

Individuals of grivet monkeys foraged 22 different plant species during the study period. From these plant species that contributed the overall diet of the study species, 17 were trees, and 5 plant species were shrubs (Table 1).

Table 1
The type of plant species consumed by grivet monkeys.

Scientific name	Common name	Growth form	Parts of plant consumed	Contribution%
<i>Mimuscops kummel</i>	Mimuscops	Tree	FR	29.0
<i>Ficus sur</i>	Fig tree	Tree	FR	17.0
<i>Strychanoss pinosa</i>	Water Berry	Tree	FR	16.0
<i>Ficus vasta</i>	Fig tree	Tree	FR	11.0
<i>Albiza gummifera</i>	Albiza	Tree	YL, YS	5.0
<i>Cordia africana</i>	Sudan Teak	Tree	FR, B	5.0
<i>Psidium guajava</i>	Guava	Tree	FR	2.6
<i>Prunus persicum</i>	Peach	Tree	FR	2.4
<i>Mangifera indica</i>	Mango	Tree	FR, YS	2.2
<i>Persea americana</i>	Avocado	Tree	FR	1.9
<i>Carica papaya</i>	Papaya	Shrub	FR	0.9
<i>Musa acuminate</i>	Banana	Shrub	FR	0.9
<i>Citrus aurantium</i>	Bitter Orange	Tree	FR	0.6
<i>Coffea arabica</i>	Coffee	Shrub	FR	0.5
<i>Croton marcostachyus</i>	Croton	Tree	FR	0.5
<i>Citrus medica</i>	Citron	Tree	FR	0.3
<i>Capparis tomentosa</i>	Capparis	Shrub	FR	0.3
<i>Jacaranda mimosifolia</i>	Jacaranda	Tree	YL, YS	0.2
<i>Millettia ferruginae</i>	Millettia	Tree	YL, YS	0.2
<i>Brucea antidysenterica</i>	Brucea	Shrub	FR	0.2
<i>Acacia busseai</i>	Acacia	Tree	YL	0.1
<i>Veronia abyssinica</i>	Veronia	Tree	FL	0.1
FR = Fruit; YL = Young Leaf; YS = Young Shoot; FL = Flower; B = Bark				

The top four plant species namely *Mimuscops kummel*, *Ficus sur*, *Strychanoss pinosa* and *Ficus vasta* accounted for more than 73% of their plant diet. According to the total percentage contribution of the

plant food items eaten, *Mimuscops kummel* was the most frequently consumed species which accounted about 29%, *Ficus sur* was 17%, *Strychanoss pinosa* 16%, and *Ficus vasta* was 11%.

Discussion

Grivet monkeys are most active early in the morning and late in the afternoon [2]. They spent more time for feeding followed by moving, resting, grooming, social play, aggression and others; it study is similar with the study conducted by [11]. They spent more time feeding during the wet season than the dry season as grivets need more food to satisfy their physiological demand during the wet season than the dry season. Grivets spent more time moving during the dry season than the wet season in order to search food and water. On the other hand grivets spent more time resting during the wet season than the dry season as they easily access food and water during the wet season.

In the present study the result of dietary data shows that fruit contributed more than other food types. This might be due to their feeding behavior; grivet monkeys are heavily dependent on fruit similar with the study conducted by [6]. Young leaf and young shoot made the second and third largest contribution from the overall diet of grivet monkeys this might be due to the presence of high protein content. Grivet monkeys spent more time feeding on fruit during the dry season than the wet season. This might be due to the availability of fruit during the dry season than the wet season in the study area. This study also reminds the fact that most plants produce ripen fruits during the dry season than the wet season conducted by the researcher [12]. As a result grivet monkeys are more dependent on ripen fruits and devoted more time feeding on fruits during the dry season. Grivet monkeys also devoted more time feeding on animal prey during the dry season than the wet season. This might be due to the absence of much more young leaf during the dry season. It leads to the grivet monkey devoted more time searching animal prey such as insects, arthropods and other small animals from the soil, inside bark, and underneath the stone during the dry season than the wet season as feeding option. The common animal prey consumed by grivet monkeys were beetles, termites, ants, moths, butterflies, grasshoppers, spiders, snails and mantis.

Individual of grivet monkeys foraged around 22 different types of plant species in the study area. From these plant species that contributed the overall diet of the study species, 17 were trees, and 5 plant species were shrubs. From the overall plant species four species such as *Mimuscops kummel*, *Ficus sur*, *Strychanoss pinosa* and *Ficus vasta* are mostly foraged by grivet monkeys. This might be because of these plant species produce large amount of fruit or have edible young leaf throughout the year in the study area.

Conclusion

In the present study a total of 16707 individual behavioral scans were recorded. The percentage of time spent for different diurnal activity patterns in grivet monkeys ranked as feeding, moving, resting, grooming, social play, aggression and other activities from higher to lower. Diurnal activity patterns of

grivet monkeys such as feeding, moving and resting show differences between seasons. Grivet monkeys are mostly feed on fruits and they also feed on young leaves, shoots, bark, animal preys and other food items. According to the total percentage contribution of the plant food item eaten grivet monkeys are mostly dependent on the four plant species such as *Mimuscops kummel*, *Ficus sur*, *Strychanoss pinosa* and *Ficus vasta*.

Materials And Methods

Description of the study area

The study was conducted in Zegie Peninsula which is the largest peninsula along Lake Tana which is situated at (11° 40' to 11° 43' N and 37 °19' to 37 °21' E) and at average altitude of 1800 m asl. Zegie is located at 600kms northwest of Addis Ababa, the capital city of Ethiopia and is 31 km far away from Bahir Dar town the capital of Amhara National Regional State. The study area is partly enclosed by Lake Tana, the largest lake in Ethiopia. The peninsula is attached to dry land on its eastern part. Zegie is part of Bahir Dar City Administration which encloses rural Kebeles it includes a town called Zegie (Afaf) and two rural Kebeles, Ura and Yiganda with an area of 1347 ha. The study focuses on the two rural Kebeles Ura and Yiganda (Fig. 5).

Climate

Zegie lies in the moist 'Woina Dega' agro-climatic zone and it is covered by dense forest trees and shrubs. The mean minimum and maximum temperatures for 10 years (2010–2020) of meteorological data indicate 12.1°C and 28.43°C, respectively (Fig. 6), with the average annual rainfall of 1726.07 mm (Fig. 7) (ENMASNWS, 2020).

Fauna and Flora

In Zegie peninsula wild animals such as grivet monkey, porcupine, Nile monitor, jackal, bush pig, hyena, leopard, duiker, squirrel, hare, and bushbuck are common in the peninsula [13]. Zegie Peninsula possesses one of the very few remaining virgin tropical forests in Ethiopia [14]. The most dominant trees include *Mimuscops kummel*, *Ficus sur*, *Strychanoss pinosa*, *Ficus vasta*, *Cordia africana*, *Capparis tomentosa*, *Prunus africana*, *Croton marcostachyu*, *Albiza gummifera*, *Jacaranda mimosifolia*, *Millettia ferruginae*, *Podocarpus gracilis*, *Ficus thonningii*, *Acacia busseai* and *Grewia ferruginea*.

Livestock rearing, agricultural activity, sheep rearing, poultry production, Charcoal and fuel wood collection are common practices by most of the inhabitants [13]. The economy of Zegie Peninsula revolves around coffee production [14]. However at present, most families cultivate hop (*Rhaminus pyrinoids*), lemon (*Citrus limon*), citron (*Citrus medica*), orange, bitter orange and sour orange (*Citrus aurantium*), papaya (*Caraca papaya*) and guava (*Psidium guajava*). Few families also grow maize (*Zea*

mays), mango (*Mangifera indica*) and avocado (*Persea americana*) [13]. Most of the fruit crops in this area were introduced by CARE Ethiopia in the 1990s [13].

Sampling design

Based on the reconnaissance surveys, sample sites were identified and habitat types were classified based on the dominant vegetation type in to agricultural area, lakeshore, forest, and shrubs. Behavioral research was conducted on 2 groups habituated to 5–25 m of observers. We undertook group counts opportunistically when the grivet monkeys crossed a narrow forest gap or gathered on the tree during resting time. Based on repeated counts, the total size of group A was 25–30 individuals and group B was 28–33 individuals. We identified the focal groups by the natural markings, sizes, coat color, and facial features of distinctive members of each group. Instantaneous scan sampling methods was used to collect data on grivet monkeys [15].

Data collection

The study was conducted from August 2021 to March 2022 covering both the wet seasons (August, September, October), and the dry seasons (January, February and March). A preliminary survey was conducted in August 2021 to gather information about the habitats, weather condition, accessibility, fauna, flora, and topography of the study area. We collected data on the activity patterns of the members of the 2 neighboring focal groups on an average of 4 day per month from August 2021 to March 2022 (with the exception of November and December 2021, when no data were collected), covering both the wet and dry seasons. During scan sampling period the group was followed from dawn (06:00 AM) to dusk (6:00 PM) and activities of individuals were recorded for 5 minutes at 15 minutes interval [15]. The activity recorded for each individual was the first activity that lasted for 5 seconds once the grivet monkeys came into view. The group was scanned each time from left to right to avoid possible biases on eye-catching activities [16].

Diurnal activity patterns of grivet monkeys including feeding, moving, resting, grooming, social play, aggression and others were recorded. Feeding includes activities when the animal plucked food items, pulled food items towards the mouth, masticated and swallowed [17]; moving includes any locomotion behavior including walking or running that resulted in grivet monkeys changing its spatial position; resting is recorded when the animal was inactive, usually while sitting or lying down; grooming includes activities in which grivet monkeys used its hands to explore or to clean the body of another grivets; social play includes chasing, hitting, wrestling and other vigorous activities involving exaggerated movements and gestures by two monkeys that were clearly interacting with each other in a non-aggressive manner; all other activities such as watering, courtship and vocalization were recorded as others [16].

We initially calculated the activity budgets of the 2 neighboring study groups, A and B, individually. Because the results for each group showed the same general pattern; i.e. proportion of time spent engaging in different behaviors was similar; however, we then calculated the activity budget for the combined focal groups. To calculate the proportion of time engaged in each activity, we divided the number of behavioral records for each activity category by the total number of activity records. We then

used the behavioral records of the combined groups to calculate the activity budgets for each day and averaged within each month to construct monthly activity budgets. The grand mean proportions of the monthly budgets provided activity budgets for the wet and dry seasons, and also the overall activity budgets for the entire study period.

For each scan of feeding, the individuals that were feeding and the plant species and plant part they fed upon was recorded. In particular, we recorded the type of food item (young leaves, young shoot, barks, fruits, animal preys such as arthropods, insects and others) and the species. We recorded animal prey as the food item when we observed grivet monkeys scratching tree bark, exposing curled leaves, or masticating and ingesting invertebrates. Our direct observations revealed that whenever it was possible to determine what the grivet monkeys were foraging for when scratching tree bark and exposing curled leaves, the food item proved to be invertebrates. We determined dietary composition by calculating the proportion of different food items and species consumed by the grivet monkeys. The dietary composition of groups A and B were initially calculated individually. After the results showed the same general pattern, i.e., proportion of time spent feeding on different food items/species was similar between groups, however, we calculated the dietary composition for the combined focal groups. We summed the daily food items consumed by the combined focal groups within each month to determine the monthly proportion of the diet devoted to each food item. We calculated the monthly proportion of each food item in the diet as the total number of monthly individual scans for each food item divided by the total number of monthly scan records for all food items. We used the grand means of the monthly proportion of food items and food species consumed to calculate the overall wet and dry season diets as well as the overall diet for the entire study period.

Abbreviations

ENMASNWS

Ethiopian National Metrology Agency Service North West Station

Declarations

Data Analysis

Data were analyzed using SPSS computer program version 23 and Excel software. Descriptive statistics and Chi-square tests were employed.

Ethical statement

The study was approved by institutional review board (IRB) guideline and regulation of college of Sciences at University of Gondar, Ethiopia. Permission for the study to be conducted was also obtained from office of Zegie kebele and from Bahir Dar city Administration office.

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Authors' contributions

YY, EA and MM, proposed the research idea and collected the data from the respondents. YY organized the data in computer, did the analysis, interpretation, and identification, and wrote the manuscript. EA and MM revised the manuscript for scientific content and did the language check. All authors read and approved the final manuscript.

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Availability of data and materials

The data used and analyzed during the current study is available in the hand of corresponding author for further request if request is available from reviewers without disclosure of the interviewees.

Ethics approval and consent to participate

The study was approved by an ethics committee from University of Gondar (reference number RCS/2870/2022), and permission was also obtained from Bahir Dar City Administration office. Therefore, we did not consent from guardian/parents.

Consent for publication

This manuscript does not contain any individual person's data, and further consent for publication is not required.

Competing interests

On the behalf of all authors there is no competing interest.

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Supplementary

Plate 1 is available in the Supplementary Files section.

Figures

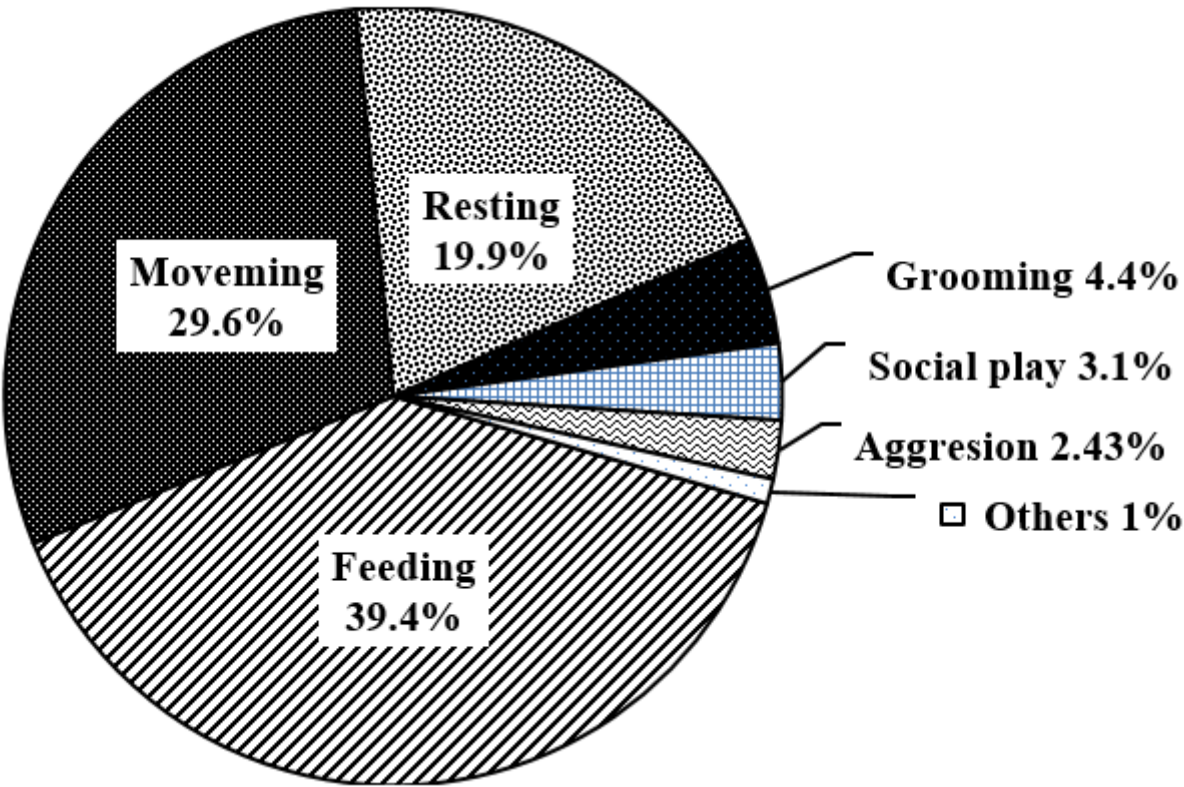


Figure 1

Overall percentage of diurnal activity patterns of grivet monkeys

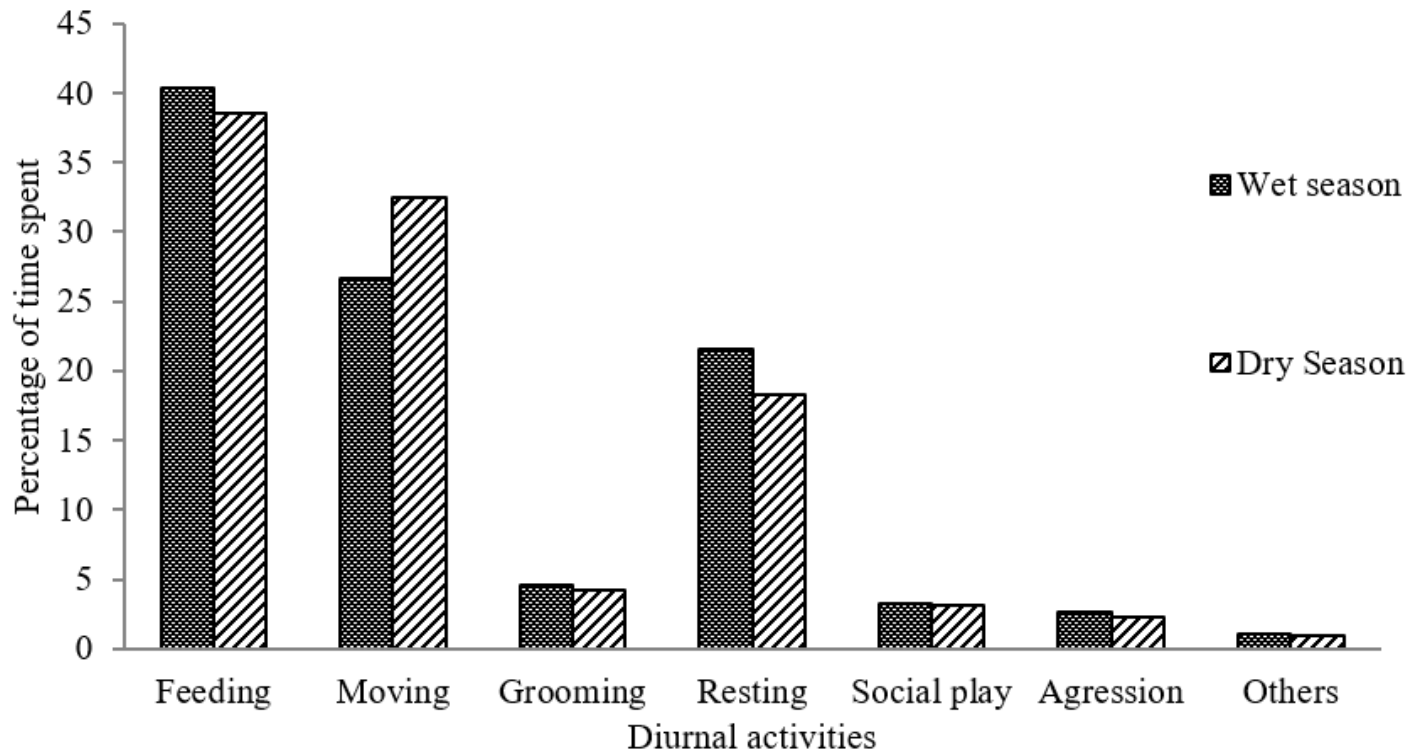


Figure 2

Diurnal activity pattern of grivet monkeys during the wet and dry seasons

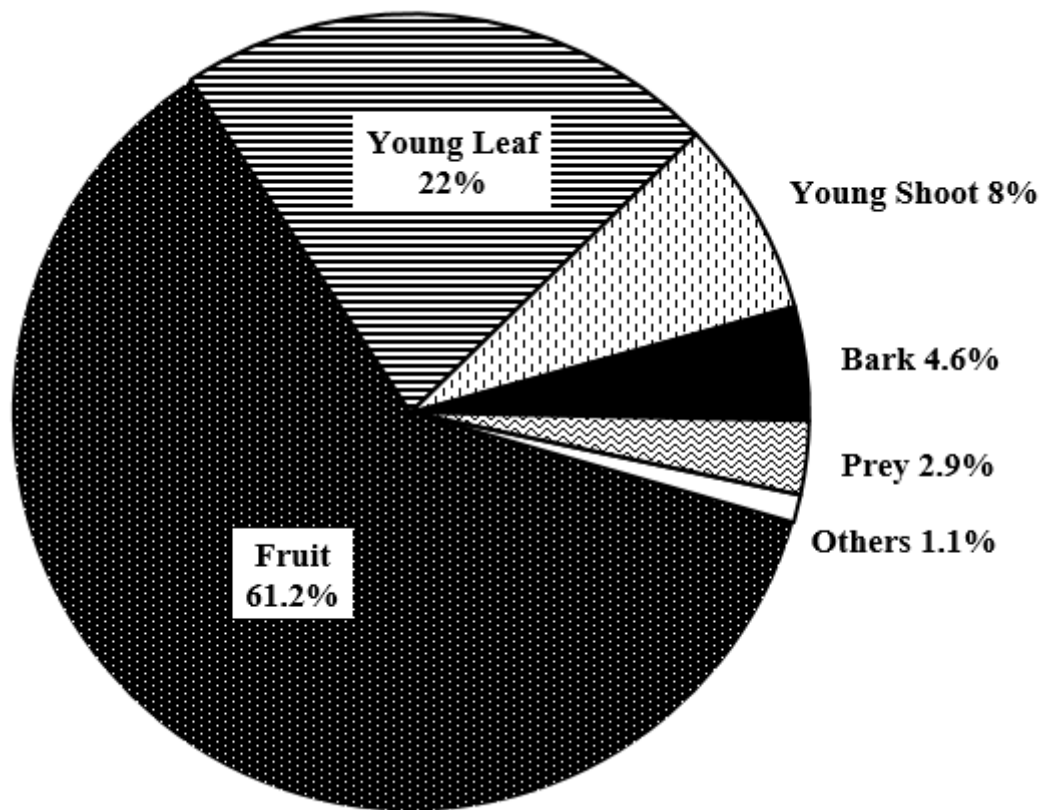


Figure 3

The overall percentage of different food items foraged by grivets during both wet and dry seasons.

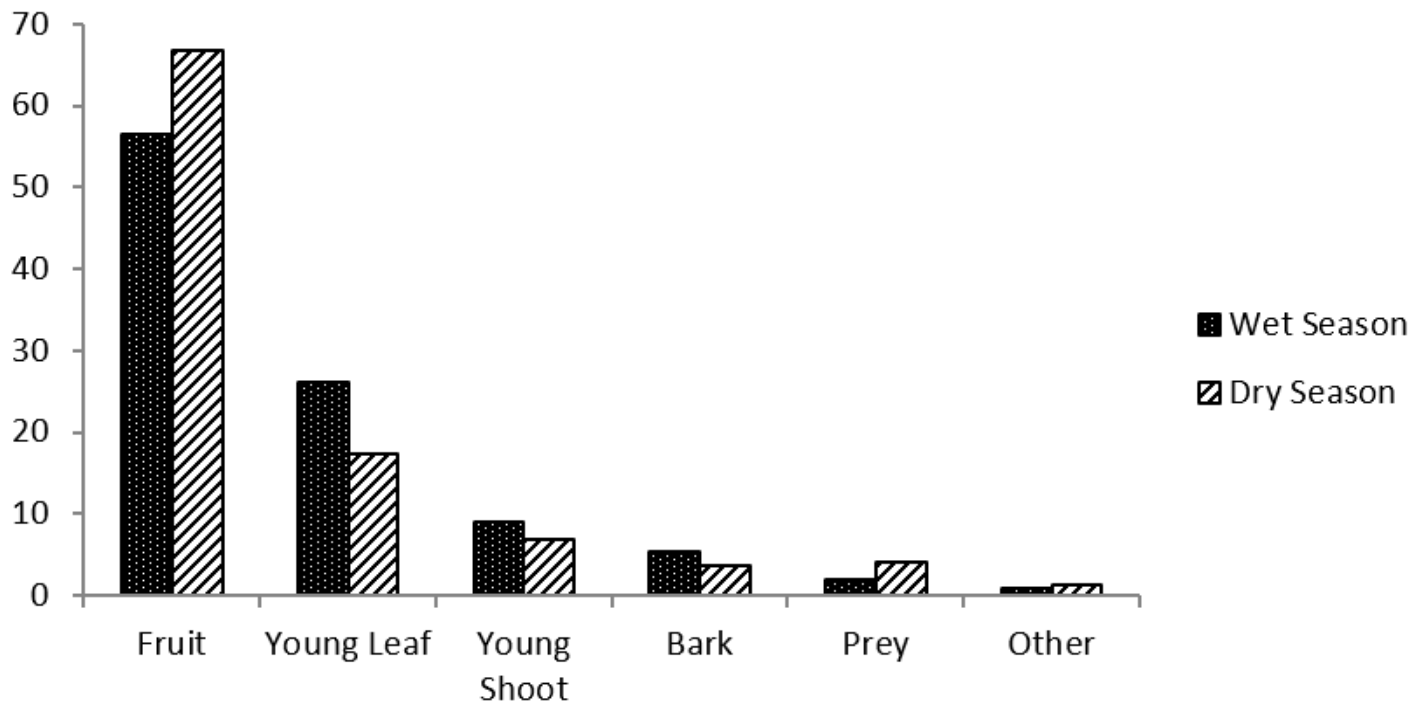


Figure 4

Percentage and types food foraged by grivet monkeys during wet and dry seasons



Figure 5

Partial view of Zegie Peninsula which enclosed by Lake Tana (photo by: Yibelu Yitayih, 2021).

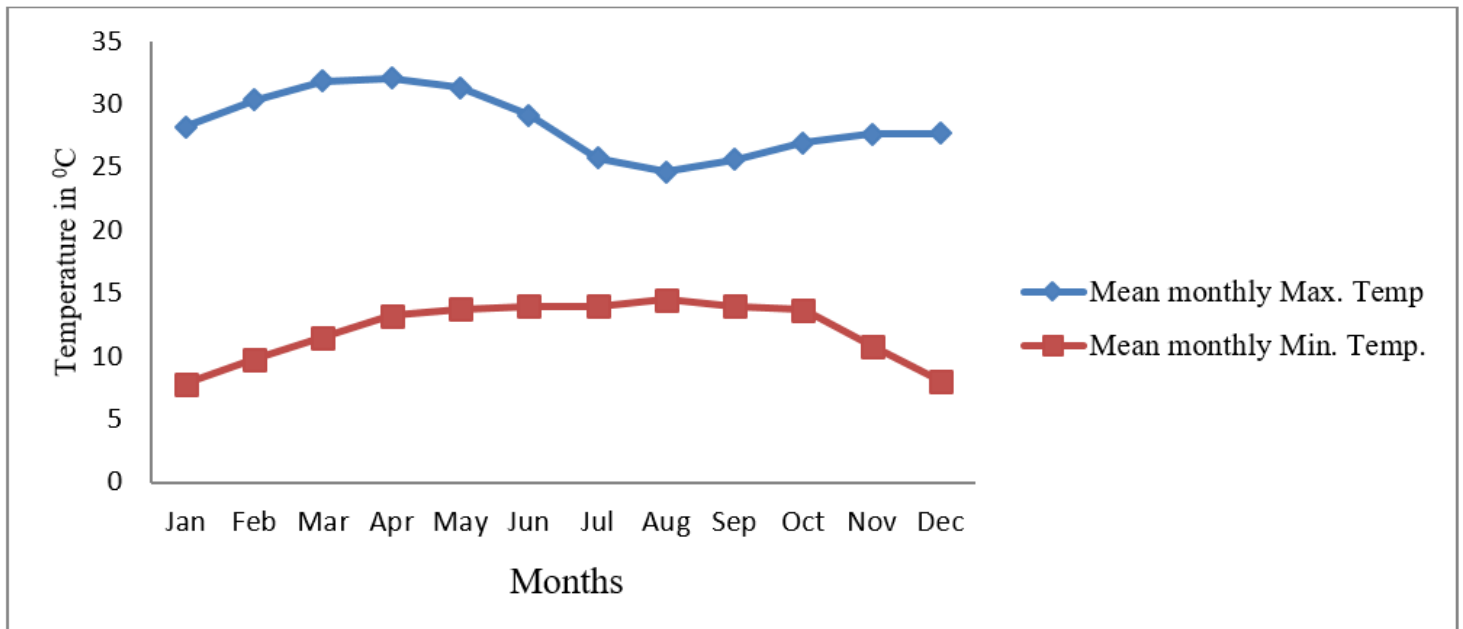


Figure 6

Mean monthly minimum and maximum temperature of the study area (2010–2020).

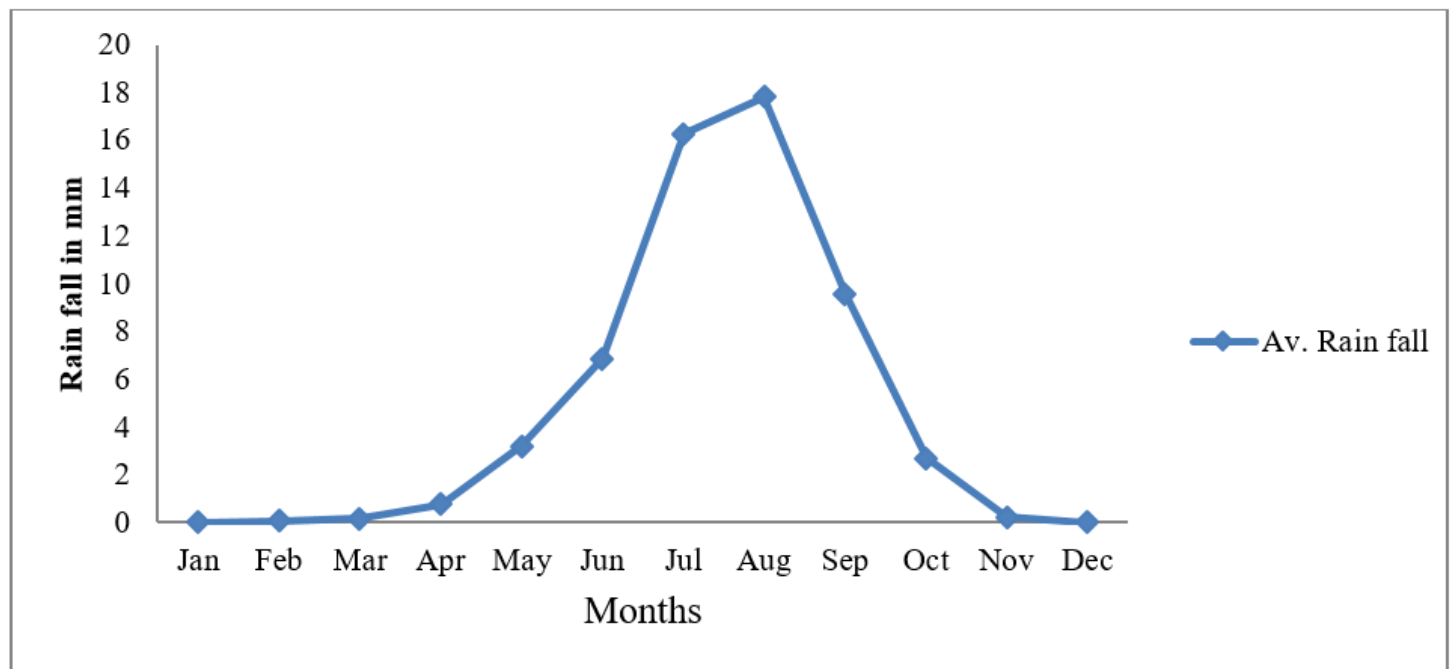


Figure 7

Mean monthly rainfall (mm) of the study area (2010–2020).

Supplementary Files

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