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POPULATION STATUS AND BEHAVIOURAL ECOLOGY OF GRIVET MONKEYS (*CHLOROCEBUS AETHIOPS*) IN THE MAIN CAMPUS OF BAHIR DAR UNIVERSITY, BAHIR DAR, ETHIOPIA

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ABSTRACT: Population status and behavioral ecology of grivet monkeys (*Chlorocebus aethiops*) were studied to determine if interventions are necessary to reduce conflict between the residents of Bahir Dar University main campus and the grivet monkeys. Structured questionnaire was administered to residents to understand their opinion on the overall ecological impact of grivet monkeys in the campus. Results from the present study were compared to 2008/2009 assessments of the grivet's population status and behavioral ecology to investigate if there was any significant change in the population or behavioral ecology of the species. The grivet monkey population has grown to around 80. Feeding habits of grivets have also changed since 2009 to increase dependence on human foods and garbage. Actions and responses of local students and residents toward grivet monkeys indicate that they are to be educated on the ecological benefits of grivets. Further research is necessary to determine the degree of impact of grivets on the prevalence of mosquito and other insect populations, and the spread of invasive plant species.

Key words/phrases: Behavioural ecology, Feeding habits, Grivet monkeys, Population status.

INTRODUCTION

The grivet monkey (*Cholorocebus aethiops*), also known as the savannah monkey, and the African green monkey, is a species of Old World Monkeys found throughout eastern Africa. 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 (Cawthon-Lang, 2006). Alike the more predominant vervet monkey, the grivet is mostly herbivorous, but eats a variety of plant components (Kingdon and Butynski, 2008).

The grivet monkey has been observed feeding on fruits, seeds, leaves, bark, gum, sap, and flowers of various indigenous and invasive plant species (Dessalegn Ejigu and Afework Bekele, 2010). In addition, they have been

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observed consuming various types of invertebrates, including insects and spiders, and even occasionally prey upon small vertebrate species (Kingdon, 2004; Chris and Stuart, 2006). However, in human inhabited urban areas, farms and settlements, the most significant non-plant portion of grivet monkey's diet has frequently been garbage (Dessalegn Ejigu and Afework Bekele, 2010) Grivet monkeys have been observed feeding on eggs, bread, rice, flour, and all kinds of human food (Lee, 1979).

Even though Grivet monkeys belong to the genus *Cholorocebus*, they are commonly referred to as the vervet monkey, which is a separate species *Chlorocebus pygerythrus*, also known as the African vervet (Grubb *et al*., 2003). Grivet monkeys and vervet monkeys have distinctly different phenotypes and notably separate morphological characteristics. While the vervet monkey has dark hands and feet, short facial whiskers and a grey coat, and dark tufts of reddish hair at the underside of the tail tip, the grivet monkey is phenotypically distinct, with a greenish-brown coat, lighter and more prominent facial whiskers, lighter arms, legs, hands and feet, and the absence of any dark fur on the tail (Kingdon *et al*., 2008).

Both the vervet monkeys, and the grivet monkeys, however, have white fur on their undersides, black faces, and pale blue skin on their bellies (Kingdon, 1997). In addition, males of both species are characterized by their light blue testicles and bright red genitalia (Parker, 1983). From their distinctive morphological characteristics, the monkeys found in the Bahir Dar University main campus were identified as *Chlorocebus aethiops*. The main purpose of the present study was to record general information about the grivet monkey population in the campus, with special emphasis on their population status and behavioural ecology.

MATERIALS AND METHODS

Description of the study area

This study was conducted at the main campus of Bahir Dar University, located at latitude of 11°57′ N, and a longitude of 37°39′ E, at approximately 565 kilometres northwest of Addis Ababa, Ethiopia. The campus has an area of approximately 1.5 km^2, located southeast of the city of Bahir Dar, and is bordered on the east by the Abay River. Topographically, the area is relatively flat, and has a mean elevation of 1796 m a.s.l.

The study area is characterized by wet and dry seasons in which the wet season extends from June to September or October while the remaining months remain dry. The coldest temperatures generally occur in December or January and the hottest in March, or April. However, in many localities, July has the coldest temperatures because of the influence of rainfall. During the heaviest months of rain in July and August, mean monthly rainfall can reach 400 mm or greater.

Lake Tana, Ethiopia's largest inland lake and the main reservoir for the Blue Nile River, is located just north of the city of Bahir Dar. The soils of the western highlands are volcanic and highly fertile euriticnitrosols and andosols, which contribute to some of the floral diversity of the region (FAO, 1984).

Bahir Dar University campus, as an area within the biome of the western highlands of Ethiopia, contains montane tropical vegetation with dense, luxuriant forests and rich undergrowth. The campus is home to at least 64 species of woody plants belonging to 34 different families (Berhanu Abraha *et al*., 2006). Both indigenous and exotic species are common in the campus. Although floral diversity remains high, faunal diversity has gradually declined in the campus. Animals once considered common, such as pythons and other reptiles and shrews have become rare (Dessalegn Ejigu and Afework Bekele, 2010). However, while terrestrial animal populations are declining or migrating, the campus is still home to a wide variety of birds, including hawks, owls, hornbills, and ibis.

Methods

Direct observation, questionnaire, interview, and informal focus group discussions were used to collect data on grivet monkeys. Surveys and data collection took place during July 2015. During the survey, a selection of 20 questions were delivered in English, and translated to Ethiopian Amharic, via written or verbal interview. The questions included demographic information, scientific literacy and background knowledge on the grivet monkeys, and gauged participants' overall opinions and beliefs about activities of the grivet monkeys. Questionnaire data were collected from a total of 97 individuals, and included male and female students, teachers, cafeteria employees, security guards and residents. As the study area was relatively small and enclosed, and the animals studied congregated so densely, total count was determined (Western and Grimsdell, 1979; Sutherland, 1996).

During the census, an imaginary border across which the grivet monkey troops regularly transverse (most often a road) was selected, and the number of monkeys that crossed the line in one direction was counted. This total was recorded, and the mean, median, and highest recorded totals of all trials were selected and used to form an estimation of the number of monkeys in the study area. In addition, detailed observations of the grivet troops were made in order to classify individuals into the age groups of adult, sub-adult/juvenile, and infant. Adult individuals were further sub-classified by sex.

Morphological markers such as the blue scrotum and mostly erected bright red penis of the adult male grivet were used to differentiate it from adult females and juveniles. The pair of nipples present in adult females distinguishes it from juveniles. Differentiating juvenile and infant monkeys involved the consideration of physical and behavioural traits. Juveniles are larger and leaner than infant monkeys, with more elongated heads. More significantly, juvenile and infant monkeys were distinguished by their behaviour and interactions with each other. While juveniles tend to be more active and exploratory in nature, infants have a tendency to remain near, or attached to adult females. Often, infant monkeys can be seen straddling the underside of an adult female while traversing through trees and along the ground. These behavioural indicators were used to differentiate juveniles from infants.

Behavioural ecology of grivets was recorded using scan sampling methods at 5 minute intervals throughout the day, from 07:00–19:00 h (Altman, 1974; Colina and Louis, 1990). Observations were collected daily, from July 7th to July 24th. At the time of each scan, activity data were collected for each age group. Troops were scanned from a consistent orientation typically from top/bottom, left/right where environment permitted to minimize double counting and undercounting. During each scan, activities including foraging, climbing on trees/building, resting in trees/rooftops, chasing/fighting, grooming, walking/running, and other activities such as calling, yawning, urinating, defecating and mating/courtship displays were recorded.

Diurnal activity patterns involving foraging were assessed at 5 minute intervals during different periods of the day (07:00–10:00 h, 10:00–13:00 h, 13:00–16:00 h and 16:00–19:00 h). For each 5-minute interval, food preference was identified and recorded. Foraging preferences were aggregated into different categories, including insects, bark, leaves, flowers, fruits, stems, and garbage. The genus of the species of plant from which

monkeys foraged was recorded. Plants were identified using prior knowledge, signs and characteristic markers, and with the aid of local people. Plant species were also matched with previous species identified in the Herbarium of Addis Ababa University (Dessalegn Ejigu and Afework Bekele, 2010).

RESULTS

A total of 82 grivet monkeys were recorded in a troop consisting of 7 adult males, 32 adult females, 15 unidentified sub-adults/juveniles, and 28 infants. Though the total population is estimated at 82 individuals, this troop exhibits a tendency to split into multiple sub-troops, usually with populations of 10–15 individuals, of various proportions. The ratio of adult males to adult females was 1:4.60, and the ratio of infants to adult females was 1:1.14.

During the day, the grivet monkeys spent 26.66% of their time foraging 25.25% of their time resting, 23.97% of their time climbing on trees and buildings, 12.16% of their time chasing and fighting each other, 7.99% of their time walking, 3.78% of their time grooming, and less than one percent (0.18%) engaged in other activities (Fig. 1).

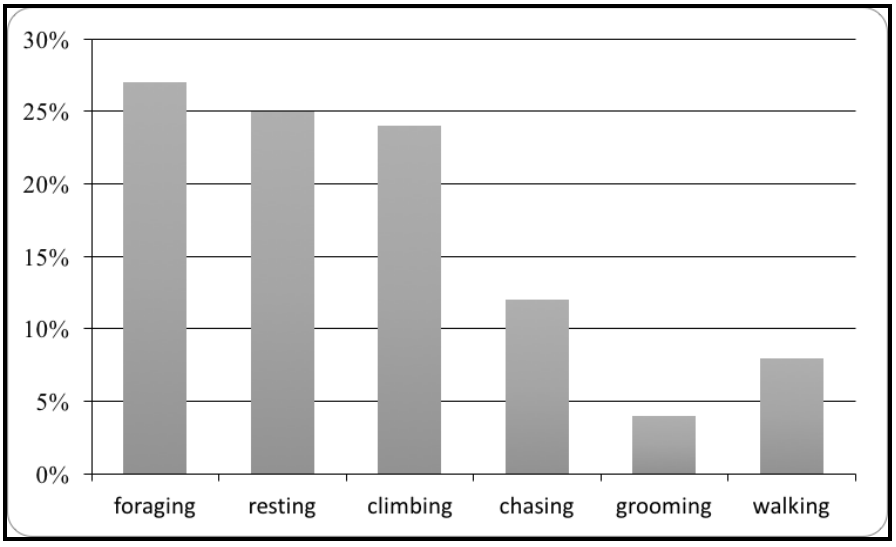

Fig. 1. Diurnal time budget spent by grivet monkeys for different activities.

Though foraging, resting and climbing occurred similarly over the course of the day, they each had very distinct patterns in which the activities were observed. Resting rarely occurred before noon, and occurred in inverse

proportion to the number of monkeys currently eating (Fig. 2). Climbing was more frequent in the morning but remained relatively frequent throughout. Feeding surged during the morning and fell during the late afternoon only to increase slightly towards the end of the day. This pattern was consistent across multiple observations held over several days.

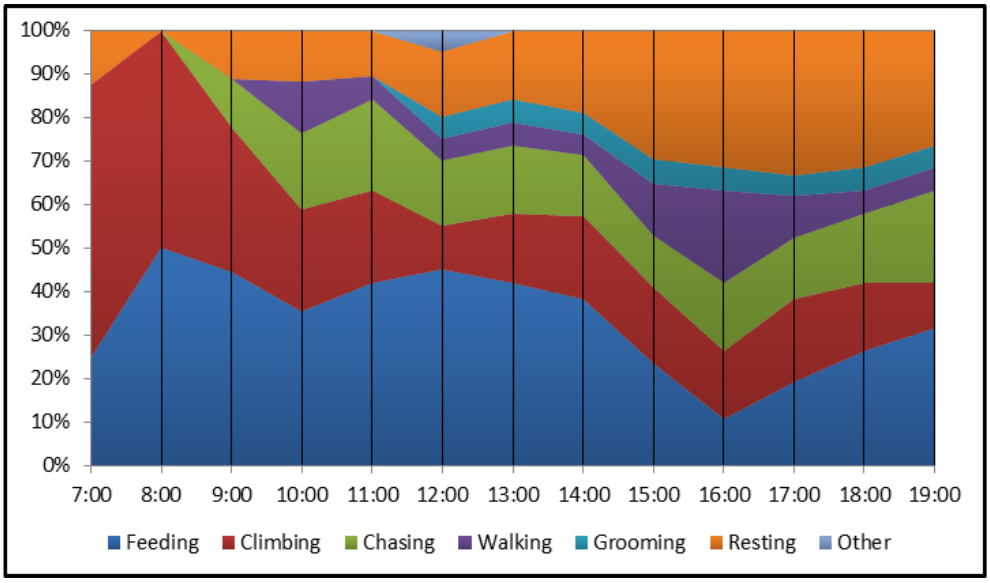

Fig. 2. Diurnal activity patterns of grivet monkeys.

Foraging data revealed that the grivet monkeys spent a majority of their time in foraging garbage, which was 51% greater than any other portion of their diet combined. They were also observed spending 31% of their time foraging for fruit/seeds, 9% foraging for leaves, 6% feeding on bark/stems, and just under 3% feeding on flowers (Fig. 3). Insect foraging was not included in this chart, since it was observed only on a single instance. Of the human food waste consumed, the majority included discarded fruits, vegetables, bread, injera, and barley flour.

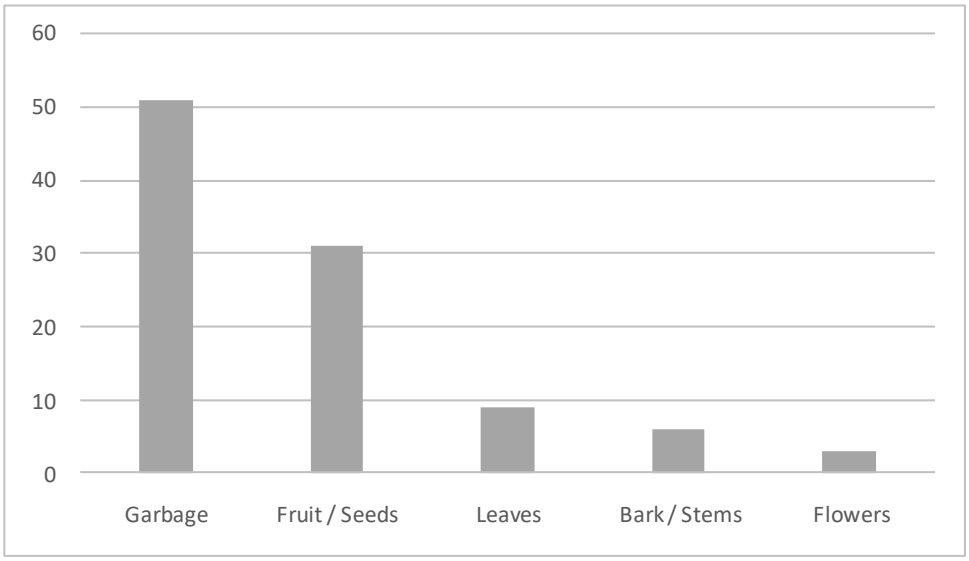

Fig. 3. Percentage of daily time spent by grivet monkeys on different food items.

When they were not feeding on garbage, they were depending on leaves, flowers, bark, stems, fruits, and seeds of a variety of plants. *Ficus vasta*, *Cordia africana*, *Psidium guajava*, *Mangifera indica*, *Rubus apetalus*, *Dovyalis abyssinica*, *Acacia sieberiana*, *Coffea arabica* and *Leucaena leucocephala* comprised the majority of the plants consumed by the grivet monkeys but they were observed consuming a total of 16 plant species (Table 1).

Table 1. Plant species in Bahir Dar University campus commonly foraged by grivet monkeys.

Vernacular name (Ethiopian Amharic)	**Scientific Name**	**Parts eaten**
"Avocado"	*Persea americana*	Fruit
Bamba	*Ficus gnaphalocarpa*	Fruit
Bisana	*Croton macrostachyus*	Fruit
Buna	*Coffea arabica*	Fruit
Dewani-girar	*Acacia sieberiana*	Gum, Leaf, Fruit, Flower
Digta	*Calpurnia subdecanra*	Leaf
"Elephant grass"	*Pennisetum* spp.	Bud, Fleshy Stem/Shoot
Kimo	*Rhus vulgaris*	Flower
Koshim	*Dovyalis abyssinica*	Fruit
"Mango"	*Mangifera indica*	Fruit
Safani	*Leucaena leucocephala*	Leaf
Wanza	*Cordia africana*	Flower, Fruit
Warka (Shola)	*Ficus vasta*	Fruit
Yedega-injori	*Rubus apetalus*	Fruit
Yeregnakolo	*Lantana camara*	Flower
Zeyitun	*Psidium guajava*	Fruit

There were 97 respondents. Among the residents surveyed, 97% responded that they had seen grivet monkeys in the campus of Bahir Dar University. Of those respondents, 68% replied that when they encountered grivets, by chasing or by throwing objects. Nine (9%) respondents have revealed that they had killed grivets. Among the respondents, 67% believed that grivets caused disturbances to the local residents. Only 69% of residents held a positive or neutral opinion of the monkeys, and only 56% of residents believed that the monkeys had a positive effect on the environment. Twenty one (22%) of them agreed that if they were informed of the positive effect of grivets on the environment, they would change their opinion in favour of monkeys.

DISCUSSION

The grivet monkey population in the Bahir Dar University main campus has increased dramatically in the six years, since the first population study in 2008/2009 (Dessalegn Ejigu and Afework Bekele, 2010). The population observed and recorded in the first study was a total of 44 individuals, including 11 adult males, 16 adult females, 13 juveniles and 4 infants. The present findings concluded that the grivet monkey troop has increased to a total of 82 individuals, consisting of seven adult males, 32 adult females, 15 unidentified sub-adults/juveniles and 28 infants. The ratio of adult males to adult females dropped in the intervening years between the two surveys, from 1 male for every 1.50 females, to a far more unbalanced 1 male for every 4.60 females (Dessalegn Ejigu and Afework Bekele, 2010). This shift to a more female-biased population could be explained by the relative aggression and curiosity of males when interacting with human populations.

Killing of male grivet monkeys is one of the factors for reduced male population in the study area. However, there has been an overall growth of this population in the recent past, which could be due to increased food availability resulting from increased population density in the area around the main campus of Bahir Dar University, but the actual mechanism for such mainly female population growth is unclear, and needs further investigation.

This grivet monkey population appeared to be feeding on the flowers of the invasive plant *Lantana camara*. This is significant because of the chemical activity of *L. camara*. It is a highly prolific invasive species of flowering plant native to Central and South America, but has been found in more than 50 different countries throughout America, Africa, Europe and Asia (Sharma and Harinder, 1988; Day, 2003).

Lantana camara has a tendency to release toxic chemicals that can poison livestock and wildlife, and inhibit the growth of nearby plants, damaging farmland and reducing local biodiversity (Kohli, 2006). This toxicity has been discovered to be harmful to many species of animals including cattle, sheep, horses, and goats causing liver damage, and photosensitivity among other effects (Ross, 1999). However, studies have been inconclusive on whether the seeds are harmful to humans or actually edible when ripe. This is noteworthy because initially on July 11, 2015, and on several occasions thereafter, grivet monkeys were observed consuming the flowers and seeds of *L. camara*. If this consumption can be substantiated and documented over a period of time, it may be possible to affirm that the grivet monkeys are some of the few species of mammals that are immune to the toxic effects of the pentacyclic triterpenoids of *Lantana camara* (Ghisalberti, 2000; Barceloux, 2008).

If it is true that the grivet monkeys consume seeds of *L. camara* without suffering any ill effects, and that their consumption destroys the seed capsule instead of spreading the seeds, as in some species, it would be possible to make a plausible argument that the grivet monkeys help to reduce the spread of this prolific and toxic plant. This is important because 78% of the individuals surveyed noted that they were not certain that the grivet monkeys had a positive effect on the environment. In the recent past, the Bahir Dar University has adopted some rules for the conservation and protection of grivets and all fauna and flora present in the campus. This may be a positive attempt from the officials for biodiversity conservation, which may be inherited through the generations to come.

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