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DIURNAL ACTIVITY PATTERNS, FEEDING ECOLOGY AND CONSERVATION STATUS OF COLOBUS MONKEYS (*Colobus guereza gallarum*) IN GIDABO FOREST, SIDAMA ZONE, ETHIOPIA

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Study on diurnal activity patterns, feeding ecology and conservation status of colobus monkeys *(Colobus guereza gallarum)* in Gidabo forest, Ethiopia, was carried out from September 2014 to May 2015. Scan sampling method at 15 minutes interval was used to collect data on diurnal activity patterns and feeding ecology of the study species, and focus group discussions were used to study its conservation status. *Colobus g. gallarum* spent 22.64% of time for feeding, 55.76% for resting, 9.72% for moving, 6.30% for grooming, 4.91% for socializing, and 0.67% for other activities. The overall diet composition of colobus monkeys was dominated by young leaves (52.35%) and mature leaves (26.88%). They were also feeding on flowers (4.71%), fruits (9.9%) and barks (5.66%). A total of 15 plant species were consumed by *Colobus g. gallarum* in the study area. Different anthropogenic activities mainly agricultural expansion, overgrazing, fire wood cutting and logging are severely destructing the forest ecosystem in the present study area. There is a need to protect the forest in order to ensure sustainable conservation of biodiversity in general and colobus monkeys in particular.

Keywords: *Colobus guereza*, conservation status, Gidabo forest, grooming, scan sampling

INTRODUCTION

There are 185 known species of primates worldwide of these 175 species and sub-species of primates are listed in Africa (Grubb, 2006). Ethiopia harbours different primate species and sub-species. Colobus monkeys belong to the order Primates, family Cercopithecidae, genus *Colobus* and species *Colobus guereza*. Following the classification of Grove (2001) and Grubb *et al*. (2003), the IUCN lists eight sub-species of *C. guereza* of which two sub-species occur in Ethiopia. These subspecies are *C. g. gallarum* which occurs East of the Rift Valley, and *C. g. guereza* occurs West of the Rift Valley (Kingdon *et al*., 2008).

Activity budgets of primates are commonly associated with strategies of energy conservation (Oates, 1977; Dasilva, 1992) and are affected by predator or human pressure; social structure, season, distribution, availability and quality of food resources (Clutton-Brock, 1975; Kinnaird and O'Brien, 2000). Wasserman and Chapman (2003) found that *Colobus guereza* in disturbed habitats are less active than in undisturbed habitats, and they can lower their activity levels to conserve energy in areas where food availability is low. Increased resting levels among colobus monkeys have also been linked to vegetation quality (Marsh, 1981).Travel and feeding activity might also be influenced by the availability of seasonal food sources. Different food items such as flowers, fruits or seed pods often available in widely dispersed food trees might require more travel or even feeding time than typically more abundant leaves (Wijtten *etal.,* 2012).

Despite being a diurnal species, guereza spends over half of the day for resting, with the remaining hours of daylight devoted mostly for feeding and moving. They sleep during the night with a single group generally occupying several adjacent trees nearby as a source of food. To communicate, the guereza employs various vocalizations, the most

distinctive being impressive loud roar usually made by the dominant adult male and echoed by males in neighbouring groups. These roaring bouts, which usually take place during the night or at dawn are thought to play a role in male-male competition and help maintain spacing between groups (von Hippel, 1998; Gron, 2009; Jensz and Finley, 2011).

Colobus monkeys' trichromatic vision is allowing them to see more shades of colours than other primates. This is good for spotting ripe and unripe fruit, but also young darker coloured leaves. They spend a large part of their day foraging for food in high to low light conditions (Yamashita *et al.,* 2005). About 35-75% of colobus monkeys' diet consists of young leaves which are easier to digest and are less toxic (Usongo and Amubode, 2001). At times when they have shortage in the availability of young leaves, they have to feed on mature leaves which are more difficult to digest. However, they possess a multi-chambered stomach with special microbes that break down cellulose over an extended time allowing fermentation to occur (Tovar *et al.,* 2005). Some authors found that their diet consisted of 33-57% leaves and 42-58% fruit (Fashing, 2001), while others described that seeds accounted for 33% of their diet (Davies *et al.,* 1999). Either way, although a lot of observations of colobus foraging may be of leaf eating, some populations' diets come from multiple sources (Chapman *et al.,* 2002).

Different factors such as deforestation, hunting, diseases and climate change are major conservation threats to colobus monkeys populations in their natural habitats (McGoogan *et al.,* 2007). Rapid human population growth had a drastic effect on the forest ecosystem as the demand for fuel wood, construction, timber and charcoal production are increased, which has led to widespread forest fragmentation. Colobus monkeys being highly arboreal are especially vulnerable to these threats as they require leaves, fruits and seeds for survival (Anderson *et al.,* 2007).

Clearance of forests for agriculture is a major concern for some colobus monkeys populations, particularly those belonging to the sub-species *C. g. gallarum* which have relatively small habitat range (Kingdon *et al,* 2008). The sub-species *C. g. gallarum* is currently listed as Data Deficient on the IUCN Red list and thus it does not get conservation attention. As a result, the behaviour and ecology of colobus monkeys is highly influenced by fragmentation and other forms of human disturbance to their natural habitats. Moreover, its ecology and behaviour are not studied so far in Ethiopia. The main objective of this study was to investigate diurnal activity patterns, feeding ecology and conservation status of *C. g. gallarum* in order to ensure its sustainable conservation.

MATERIALS AND METHODS

Description of the study area

This study was conducted in Gidabo forest, which is located around Yirgalem town, Sidama Zone. Gidabo forest is found in Southern Nations Nationalities and Peoples Region at about 310km South of Addis Ababa, and 47km from Hawassa in the eastern edge of the Rift Valley. The area has a narrow strip of land bounded by deeply incised valleys of Gidabo River and its tributaries. Geographically, it is located at 6°40′ latitude N and 38°28′longitude E at an altitude of 1765 m a.s.l. The area encompasses rivers, hot springs and fragments of forests including coffee plantation.

The main species of plants in the study area include *Albiza gummifera, Cordia africana, Prunes africana, Ficus vasta, Ficus sur, Eucalyptus grandis, Psidium guajava, Jacaranda mimosifolia, Spathodae campanulata, Dombeya torrida, Celtis africana, Vernonia amygdalina, Millettia ferruginae, Podocarpus falcatus, Dracaena steudneri, Persea americana, Diospyros abssinica*and and *Casimiro aedulis*. Different faunal species including grivet monkeys, rodents and a number of bird species are residing in the forest. The study area experiences annual rainfall of 1235mm, which adapt for eight rainy months from March to October and the mean annual temperature record is 18.9 °C. (National Meteorological Agency, 2002).

METHODS

The instantaneous scan sampling methods was used to collect data on colobus monkeys (Altmann, 1974). Diurnal activity patterns of colobus monkeys including feeding, moving, resting, grooming, social play and others were recorded. Feeding includes activities when the animal plucked food items, pulled food items towards the mouth, masticated and swallowed; moving includes any locomotor behaviour including walking or running that resulted in colobus monkeys changing its spatial position; resting is recorded when the animal was inactive, usually while sitting or lying down; grooming includes activities in which colobus monkeys used its hands to explore or to clean the body of another colobus monkey; social play includes chasing, hitting, wrestling and other vigorous activities that involving exaggerated movements and gestures by two monkeys that were clearly interacting with each other in a non-aggressive manner; all

other activities were recorded as others (Fashing, 2001).

The activity recorded during scan sampling period was the first activity that is held for three or more seconds once they were sighted. This requirement had prevented eye catching; very brief activities from being over represented in the data set (Fashing, 2001). To gather data on diurnal activity patterns, the groups were followed from dawn (08:00h) to dusk (17:30) and activities of individuals were recorded for 5 minutes at 15 minutes interval (Altmann, 1974; Fashing, 2001; Harris and Chapman, 2007). For each scan of feeding behaviour, the individuals that were feeding and the plant species and plant part they fed upon was recorded. The plant food item was categorized as young leaves, matured leaves, flowers, fruits and barks (Harris and Chapman, 2007). Diet composition was determined by calculating the proportions of different food items and plant species consumed by the colobus monkeys.

For studying the conservation status of colobus monkeys in the studied area, focus group discussion was conducted to collect information from communities living around the area. Two focus group discussions were conducted, and group size of individuals in each discussion was varied. So that six individuals were participated in the first group and four individuals were in the second group. Participants were selected based on their age and duration of residency in the area. Community leaders were approached in advance and requested to organize the focal group discussions. Information was collected based on the presence or absence of conflict between the local people and colobus monkeys in the area, the causes of conflicts, the attitudes of the local people towards colobus monkeys, and how both local communities and colobus monkeys are benefited from the forest habitat.

DATA ANALYSIS

Time budget spent for diurnal activity patterns of colobus monkeys was calculated by dividing the proportion of the number of behavioural records for each activity category by the total number of activity records. The overall percent of time budgets for the studied activity patterns during the entire study period was then calculated. Dietary compositions of the study animal were calculated. Each food item was summed per plant species. The percentage of each food item and plant species consumed were calculated in the diet as the total number of individual scans for each food item and plant species divided by the total number of scan records for all food items and plant species. The overall percentage of each food item and plant species consumed during the study period was calculated related to all food items and plant species consumed. Data for diurnal activity patterns among the various diurnal activity patterns were analyzed using chi-square test at p=0.05 level of significance, and SPSS version 20 software was used to run the analysis.

RESULTS

Diurnal activity patterns

The percentage of time spent for different diurnal activity patterns in *C. g. gallarum* indicated that more time (55.77%) was devoted for resting; this was followed by feeding (22.64%). Moving, grooming and social play activities took relatively less time compared to resting and feeding. There were significant differences in time spent by *C.g. gallarum* for resting and feeding compared with other diurnal activities (P<0.05) (Figure 1).

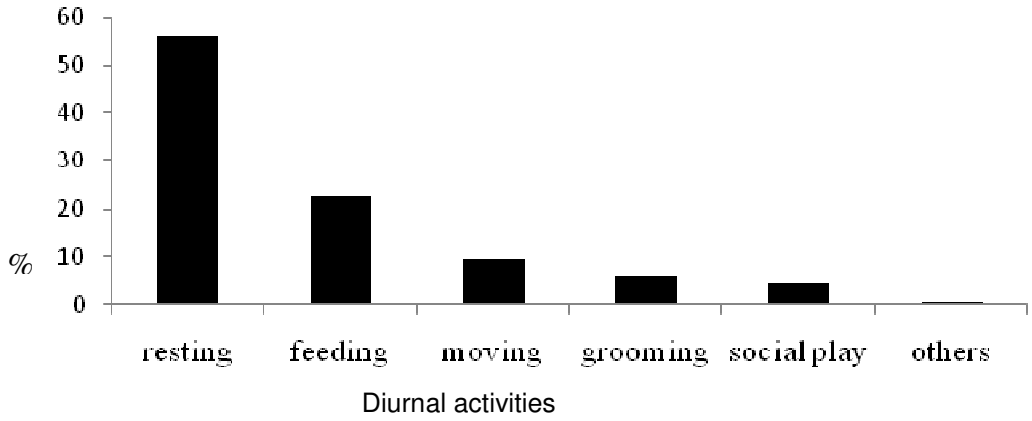

Figure 1: Percentage time spent by *C.g.gallarum* for different diurnal activity patterns

Diurnal activities

FEEDING ECOLOGY

The proportion of time spent for feeding on different food items by *C.g.gallarum* indicated that more time was spent for foraging on young leaves than other plant parts. They spent 52.39% of time foraging on young leaves and the least time (5.68%) was spent on barks (Figure2)

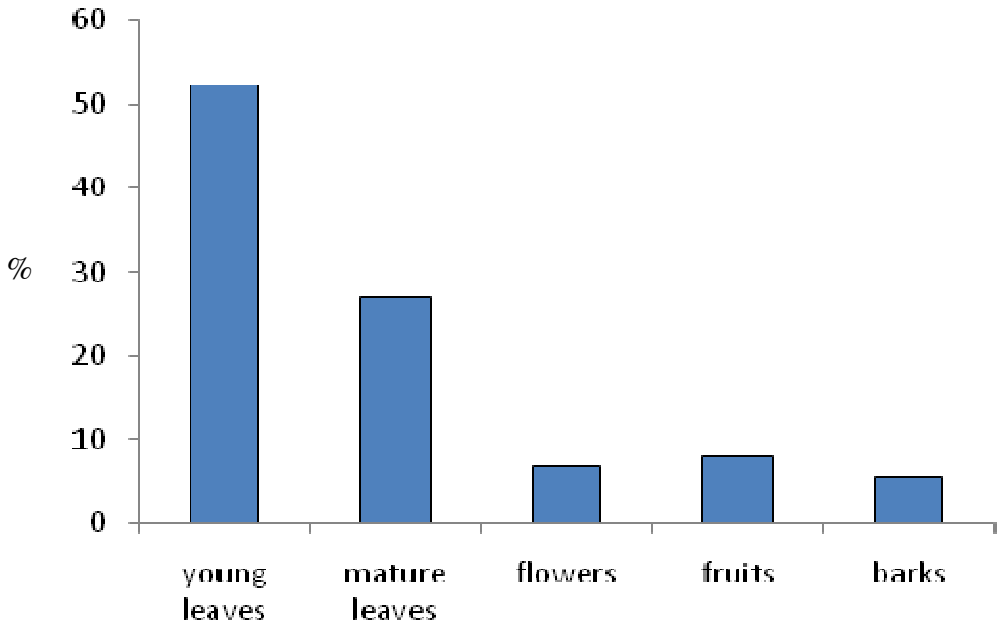

Figure 2: Contribution of plant parts to the proportion of scans at which *C. g. gallarum has* been observed feeding

Individuals of *C.g.gallarum* consumed 15 different plant species during the study period. From these plant species that contributed the overall diet of the study species, the top three plant species namely *Prunes africana, Celtis africana* and *Ficus vasta* accounted for more than 50% of their plant diet. According to the total percentage contribution of the plant food items eaten, *Prunes Africana* was the most frequently consumed species which accounted about 26.42%, *Celtis Africana* was 16.98% and *Ficus* vasta was 10.85% (Table 1).

Table 1: Plant species consumed by *C.g.gallarum* and the percentage contribution of plants to the diet of the species

Scientific name	Family	Type	Local name	Plant Part consumed	% contribution
Prunes africana	Rosaceae	tree	Tikurenchet	YL,ML,BK	26.42%
Celtis africana	Ulmaceae	tree	Ameleqa	YL,ML	16.98%
Ficus vasta	Moraceae	tree	Warka	YL,ML,FR	10.85%
Albiza gummifera	Fabaceae	tree	Sesa	YL,ML,FL	9.91%
Spathodaecampanulata	Bignoniaceae	tree	Aballo	YL,ML,FL, BK	7.08%
Jacaranda mimosifolia	Bignoniaceae	tree	Jacaranda	YL,FL	5.19%
Eucalyptus grandis	Myrtaceae	tree	Key bahirzaf	YL,FR,BK	3.77%
Vernonia amygdalina	Asteraceae	tree/ shrub	Girawa	YL,ML	3.30%
Cordia africana	Boraginaceae	tree	Wanza	FR	2.83%
Psidium guajava	Myrtaceae	tree	Zeytun	YL,FR,BK	2.83%
Podocarpus falcatus	Podocarpaceae	tree	Zigba	FR	2.83%
Dracaena steudneri	Dracaenaceae	shrub	Itsepatos	YL	2.36%
Millettia ferruginae	Fabaceae	tree	Birbira	YL	2.36%
Dombeya torrida	Sterculiaceae	shrub	Wulkeffa	YL,ML	1.89%
Ficus sur	Moraceae	tree	Sholla	YL,ML,FR	1.42%

YL: young leaves, ML: mature leaves, BK: bark, FR: fruit, FL: flower

FOCUS GROUP DISCUSSION

The result of discussions held with focal groups in the study area showed that there were no conflicts between the local communities and *C.g.gallarum* around the study area. Since the habitats of *C. g. gallarum* is in the forest habitats and it did raid crops and posing other problems to the communities. According to the respondents, it is other wildlife species such as the grivet monkeys raided their crops. Local people in the area did not kill *C.g.gallarum* as crop pests, but it was killed in previous years for its beautiful skin and long hair.

DISCUSSION

The *C.g.gallarum* in the present study area spent more than 50% of their time resting. Similar study has also showed that colobus monkey spend 44–64% of their time resting (Teichroeb *et al.,* 2002). Diet that consists of low quality food such as mature leaves may lead to more time needed for resting (Chapman *et al.,* 2007).The increased resting level among colobus monkeys is associated with vegetation quality (Marsh, 1981). The unique foregut anatomy of colobus monkeys allows for fatty acid fermentation, which is believed to be an adaptation for reducing leaf toxin levels prior to absorption (Oates, 1977). An increase in resting activity thus might be explained by the induced demand to reduce toxin levels (Dasilva, 1992). Grooming is the most important behaviour used by primates for maintaining social relationships (Schino, 2001). Grooming seldom exceeds 15% of day time activity for most social species (Lehmann *et al.,* 2007) because grooming requires time, which is a limited resource for individuals to rest, move and forage. In the present study time spent for grooming by *C.g.gallarum* is less than other diurnal activities. This is because the species require more time for resting and feeding than other diurnal activities including grooming.

All guereza groups are highly folivorous and rely heavily on leaves of plants (Harris and Chapman, 2007). It possesses large and multi-chambered stomach which allows them to better digest plant fibers including foliage. This

ability to digest plant material is also assisted by bacteria in the stomach. Together, these and other morphological adaptations allow the species to feed on large quantities of leaves (Gron, 2009; Jensz and Finley, 2011). In the present study, *C. g. gallarum*in relied 79.31% of their diet on plant leaves. This result is in agreement with other study conducted in other areas as it shows that plant leaves constitute 78–94% of the guereza diet (Chapman *et al.,* 2007). Thus, the major part of the species diet is heavily depended on plant leaves. Fleshy fruits are usually consumed by guereza when unripe, with consumption being reduced as they fully ripen, likely to avoid competition with other primate species that prefer ripe fruit (Fashing, 1999; Chapman *et al*., 2006; Harris and Chapman, 2007).

In the present study, 52.39% of gureza's diet consists of young leaves. Study in Cameron indicated that about 35–75% of guereza's diet consists of young leaves which are easier to digest and are less toxic (Usongo and Amubode, 2001). Thus, *C.g.gallarum* in the present study fed mainly on young leaves of different plant species in order to maximize their physiological demand and minimize toxicity from mature leaves and other plants parts. *C. g. gallarum* spent 26.91% of their diet on mature leaves, which in agreement with Oates and Davies (1994), as they examined colobus monkeys in general rarely include more than 30% mature leaves in their diet unless they are of good quality. However, the diet of guereza is highly varied seasonally and geographically (Kim, 2002).

In order to conserve primates in the future, conservation practice involving participation of the local people is mandatory (Wallis and Lonsdorf, 2009). Colobus monkeys being highly arboreal are especially vulnerable to forest fragmentation as they require leaves, fruits and seeds for their survival (Anderson *et al.,*2007a). Gidabo natural forest is threatened by agricultural expansion, and grazing has a significant negative impact in the area as it accelerates habitat degradation and competition of wild life with livestock.

The present study indicated that *C. g. gallarum* is not directly threatened by the local people. Moreover, the local community does not consider the species as crop pests. This attitude has a positive impact for long term conservation of the colobus monkeys in the area. Understanding about the local people's attitude towards wildlife and particular factors promoting people's tolerance about conservation need to be examined as part of the process of developing mitigation strategies (Hill, 2004).

CONCLUSION AND RECOMMENDATIONS

CONCLUSION

Comparison of the time spent for various diurnal activities of *C.g.gallarum* indicated that time spent for resting showed significant differences with other diurnal activities. *C.g.gallarum* mainly forage on leaves of which young leaves were the most consumed plant food item, and their foraging activities for the most part occurred in five tree species. The top three foraged plant species were *Prunus africana, Celtis africana,* and *Ficus vasta* which contribute more than 50% its diet. Focus group discussion with the local people indicated that the conservation status of *C.g.gallarum* is not at risk. There is no direct attack and threatening of the species by the community living around the area. However, destruction of forest by various anthropogenic activities are the main conservation problems of colobus monkeys in the Gidabo forest.

RECOMMENDATIONS

The need for expanding agricultural land by the local people and also to get fire wood by individuals in the community may threaten the habitat and survival of *C.g. gallarum* in the future. Therefore, attention should be given by the government officials and concerned bodies to protect the species natural habitat and the primates that are living there. Community leaders should also be given the opportunity to create awareness among the people living around the area in order to address protection of the forests ecosystem.

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