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Diurnal Activity Patterns, Feeding Ecology and Conservation Status of Colobus Monkey (Colobus guereza gallarum) in Gidabo Forest, Sidama Zone, Ethiopia

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MSc Thesis

By

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Mohammed Hussen

Advisor: Dessalegn Ejigu (PhD)

A Thesis submitted to the Department of Biology, Bahir Dar University, in Partial Fulfillment of the Degree of Masters of Science in Biology

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Approval Sheet

Department of Graduate Committee

Bahir Dar University

As members of the Examining Board of the Final MSc Open Defense, we certify that we have read and evaluated the thesis prepared by Mohammed Hussen entitled Diurnal Activity Patterns, Feeding Ecology and Conservation Status of Colobus monkey (Colobusguerezagallarum) in Gidabo Forest, Sidama zone, Ethiopia, and recommended that it be accepted as fulfilling the thesis requirement for the degree of Masters of Science in Biology.

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Dedication

This MSc thesis is dedicated to my father Hussen Beshir and my mother Meselech Biru for nursing me with affection and love, and to my wife Jemila Ibrahim and my child Emran Mohammed for their dedicated partnership in success of my life.

Statement of the Author

I, Mohammed Hussen, declare that this thesis is entitled "Diurnal Activity Patterns, Feeding Ecology and Conservation Status of Colobus monkey (Colobus guereza gallarum) in Gidabo Forest, Sidama Zone, Ethiopia", has been carried out by me. I further declare that this thesis is my original work and all sources of materials used for this thesis have been duly acknowledged. I solemnly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma or certificate.

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Date ofsubmission _____

As a thesis research advisor, I hereby certify that I have read and evaluated this thesis prepared, under my supervision, by Mohammed Hussen entitled "Diurnal Activity Patterns, Feeding Ecology and Conservation Status of Colobus monkey (Colobus guereza gallarum) in Gidabo Forest, Sidama zone, Ethiopia" I recommended the paper be summated as fulfilling the requirement of the degree of Master of Science in Biology.

_____ _____

Advisor Signature Date

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LIST OF ACRONYMS

IUCN: International Union for the Conservation of Nature and Natural Resources

SNNPR Southern Nations Nationalities and Peoples Region

NMA: National Meteorology Agency

NUPI: National Urban Planning Institute

DWRDO: Dale Wereda Rural Development Office

ABSTRACT

Study on diurnal activity patterns, feeding ecology and conservation status of *Colobus guereza gallarum* in Gidabo Forest, Sidama Zone, Ethiopia was carried out from October 2014 to June 2015. Activity pattern and feeding ecology were studied using scan sampling method for 5 minutes at 15 minutes interval. The conservation status was studied by focus group discussion. Data were collected for three months. Two study sites were selected for the study. The overall diet composition of *Colobus guereza gallarum* in group I was dominated by young leaves (52.35%) and mature leaves (26.88%). They were also feeding on flowers (4.71%), fruits (9.9%) and bark (5.66%). *Colobus guereza gallarum* in group II spent feeding on young leaves (49.32%), mature leaves (28.5%), flowers (4.52%), fruits (9.95%) and bark (7.69%). During the study period, a total of 15 and 13 plant species were consumed by group I and group II, respectively. Group I spent about 22.64% of time on feeding whereas time spent for feeding in group II was about 22.03%. Group I spent 55.76% of their time resting, 9.72% moving, 6.30% grooming and 4.91% socializing. The guerezas in group II spent 53.83% of their time resting, 12.36% moving, 7.17% grooming and 3.78% for socializing. The conservation status is observed as having no threats for the studied animals in the area. But there is a need to protect the forests in order to insure sustainable conservation of the species in the area.

Key words: *Colobus guereza*, diurnal activity patterns, Gidabo forest, scan sampling

1. INTRODUCTION

1.1. Background and justification

Across the world, there are 185 known species of primates and in Africa there are 175 species and sub-species of primates listed (Grubb, 2006). Ethiopia harbors different primate species and sub-species, and among these are the two sub-species of colobus guereza. Colobus guereza belongs to the order Primates, family Cercopithecidae, genus Colobus and the species Colobus guereza. The IUCN lists eight sub-species of C. guereza following the classification of Grove, (2001) and Grubb et al., (2003). Two sub species of C. guereza are found in Ethiopia. These are C. g. guereza which is found in forested areas of the Ethiopian highlands west of the Rift Valley and down in to the lowland reaches along the Awash River, the Omo River and in the Blue Nile gorges. The sub-species C. g. gallarum restricted to the Ethiopian highlands east of the Rift Valley (Kingdon et al., 2008).

The guereza is a large, sturdy colobus monkey with a black and white coat. Glossy black fur covers much of its body, but contrasts with short, white hair surrounding the face, and U-shaped, cape-like mantle of long white hair that extends down the shoulders and across the lower back (Jensz and Finley, 2011).The tail is either white or yellow color from the tip to base with a large white tuft at its tip (Kim, 2002). The face is gray and has no fur. At birth, the hair of infant guereza is completely white, in striking contrast with the predominantly black fur of the adult guereza (Jensz and Finley, 2011).

Guerezas are slightly sexually dimorphic with males weighing up to 1.19 times more than females (Kim, 2002).Average weights for males fall between 9.3 and 13.5 kg, while for

females is between 7.8 and 9.2 kg. Head and body length averages 61.5 cm in males and 57.6 cm in females (Gron, 2009).

The guereza thumb is rudimentary and greatly reduced like most members of the colobus family (Gron, 2009) and is either absent or represented by a small phalangeal tubercle that sometimes bears a nail. The loss of the thumb may be an adaptation for quick movements through the trees (Kim, 2002).

The guereza remains relatively wide spread and abundant, and owing to its tolerance of forest degradation and is considered to be one of the least threatened species of colobus monkeys. Although the species as a whole is a low priority for conservation, several sub species are in a more precarious state than others. Clearance of forests for agriculture is a major concern for some guereza populations, particularly those belonging to the sub species *C.g.gallarum* which have a relatively small range in east Africa (Kingdon et al, 2008; EOL, 2011).In the absence of recent survey works, it is not known how much pressure these populations are under and therefore the species is currently listed as Data Deficient on the IUCN Red list.

The behavior and ecology of colobus monkeys is influenced by fragmentation and other forms of human disturbance to their habitats. The sub species *C.g.gallarum*, like the other sub species of guereza had not get conservation attention. Moreover, the ecology, behavior and distribution of *C.g.gallarum* are not studied in detail. The main objective of this study was, therefore, to provide data on the diurnal activity patterns, feeding ecology and conservation status of *C.g.gallarum* in Gidabo forest, Sidama Zone, Ethiopia.

1.2. Objectives of the study

1.2.1. General objective

The main objective of this study was to investigate the diurnal activity patterns, feeding ecology and conservation status of colobus monkeys in Gidabo forest, Sidama Zone, Ethiopia.

1.2.2. Specific objectives

- To investigate the diurnal activity patterns of colobus monkeys in the Gidabo forest
- To determine the feeding ecology of colobus monkeys in the Gidabo forest
- To assess the conservation status of colobus monkeys in the study area

1.3. Significance of the study

Information obtained at the end of this research regarding the diurnal activity patterns, feeding ecology and conservation status were thoroughly investigated. Therefore, the purpose of this study is highly important for government bodies and local community to design strategies for sustainable conservation of the species. It is also valuable for other researcher who will try to conduct another research in the study area.

2. REVIEW OF RELATED LITERATURE

2.1. Habitat requirements

The guereza are predominantly found in forests and savanna woodlands, often extending in to highland or montane forests (Oates et al., 1994). Other habitat types include primary, secondary, riparian, gallery, and highland forests, rainforests, swamp forests and grasslands (Oates, 1977b; Oates, 1994; Harris and Chapman, 2007).

2.2. Diurnal activity patterns

Activity budgets of primates are commonly associated with strategies of energy conservation (Oates, 1977a; Dasilva, 1992) and affected by predator or human pressure; social structure, season, or availability, distribution and quality of food resources (Clutton-Brock, 1975; Kinnaird and O„Brien, 2000). Wasserman and Chapman (2003) found that *Colobus guereza* in disturbed areas were less active than those in undisturbed areas, and they can lower their activity levels to conserve energy in low food availability conditions. Increased resting levels among colobus monkeys have been linked to vegetation quality (Marsh, 1981).

The unique foregut anatomy of colobus allows for fatty acid fermentation, which is believed to be an adaptation to reduce leaf toxin levels prior to absorption (Oates, 1977a). An increase in resting activity thus may be explained by the induced need to reduce toxin levels (Dasilva, 1992). Travel and feeding activity also might 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 (Wasilewski et al., 2012).

Grooming is the most important behavior used by primates for maintaining social relationships (Schino, 2001). Grooming seldom exceeds 15% of day time activity for most social species because time is a limited resource for individuals to perform various behavioral activities besides grooming (Lehmann et al., 2007).

Despite being a diurnal species, the guereza spends over half the day resting, with the remaining hours of daylight devoted mostly to feeding and moving about. When active, this primarily arboreal species can be seen bounding through the trees, leaping from tree to tree (Vijtten et al., 2012).

The guereza sleeps during the night, with a single group generally occupying several adjacent trees nearby 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 neighboring 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; 2009; Jensz and Finley, 2011). While primarily arboreal, the species will descend to the ground to feed and to travel in cases where there are not suitable arboreal pathways (Oates, 1977b).

2.3. Diet and feeding behavior

Colobus guereza are diurnal primates, with trichromatic vision allowing them to see more shades of colors than other primates. This is good for spotting ripe and unripe fruit, but also young darker colored 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

monkey„s 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 (Teaf et al., 2005). Some authors found that their diet consist of 33-57% leaves and 43-28% fruit (Fashing, 2001a), while others found 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).

Plant leaves constitute 79-94% of the guereza diet (Chapman et al., 2007), consisting of mainly young leaves with about 12% mature leaves, 6-12% fruits and a small percent of leaf buds, blossoms, bark and wood, seeds, flowers, petioles, arthropods, plant sap and soil. However, the diet is highly varied seasonally and geographically; thus at times mature leaves may account up to 34% of their diet (Chapman et al., 2007).

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). They get water from dew and the moisture content of their diet, or rainwater held in the tree trunk hollows (Kim, 2002).

2.4. Social behavior

Colobus guereza generally live in small social groups of several adult females and a single adult male (Oates and Davies, 1994). Guerezas live in small, cohesive groups,

typically ranging in size from 3 to 15 individuals, but occasionally up to as many as 23. Thesesocial groups sometimes support several adult males, but normally comprise one adult male, accompanied by several reproducing females, adolescents and infants (Jensz and Finley, 2011).

The age for full sexual maturity in guereza is at least 6 years in males and 4 years in females. Each adult female produces one young every 20 months after a gestation period of about 6 months (Kim, 2002; Gron, 2009). Reproduction takes place at all times of the year, with the adult dominant male normally having exclusive access to the females in the group (Jensz and Finley, 2011). The ovarian cycle is around 24 days in guereza, with females receptive about 5 days before ovulation until 2 to 3 days after ovulation (Gron, 2009).

The core of mixed group consists of females, who remain in the group of their birth for life. These females are thought to be close relatives that display their friendly intragroup relationships, marked by mutual grooming and even infant transfer phenomenon. This consists of an infant being handled by several females in the group soon after birth and carried as far as 25 m from its mother. A mother may even suckle the infant of another female and her own simultaneously (Kim, 2002).

Unlike females, young males leave the group of their birth before they are fully matured. The adolescent guereza males leave their birth group either voluntarily or due to pressure from the adult male of the birth group. Upon leaving their natal group, young males lead a solitary life or temporarily associate with other solitary males. They may eventually take over their own harem and create a new group (Kim, 2002).

Within multi-male groups, one male is dominant to the others and interactions between the adult males are aggressive, with some males eventually being forced out. There are definite indications of infanticide in consequence of the threat of male replacements within mixed groups (Kim, 2002).

The home range is variable; with full home range estimates ranging from just over 0.01 km² to 1 km² and most estimates at the lower end of this range (Gron, 2009). In long-term studies, single-group day range averages were between 252 and 734 m, ranging as small as 62 m in a day to over 1360m (Oates, 1977a; Fashing, 2001a). Although territories may overlap marginally, they are vigorously defended by males with leaps and cries, hand-to-hand communication, roars, and occasional chasing and fighting. Displays of the white fringe fur flapping up and down serve as warning to other monkeys of the same or different species. Some groups, however, do share water holes and other essential resources (Kim, 2002).

Male guerezas roar loud nocturnal and dawn choruses as a means of spacing groups (Gron, 2009). In addition to vocal communication, visual signals, such as flapping of fringe fur, facial expression, and body posture are used in aggressive communication between groups. Tactile communication in this species includes grooming, playing, and fighting (Kim, 2002).

The guereza is often found living in sympathy with a number of other primate species (Gron, 2009). Infant guerezas have been observed playing with infant vervets (Chlorocebus aethiops) (Chapman and Chapman, 1996). Births peaks are observed in

most species of colobus including guerezas, in some species, peaks coincide with rainy months (Struhsaker and Leland, 1987).

2.5. Threats to colobus monkeys

Africa contains a number of the world's biodiversity hotspots, including the Western African Forests and the Eastern Arc and Coastal Forests of Tanzania and Kenya, all crucial habitats of colobus monkeys (Myers et al., 2000). In addition to ongoing deforestation; hunting, diseases and climate change are major threats to colobus monkey populations in these forests (McGoogan et al., 2007).

In East African tropical forests rapid human population growth has had a drastic effect. These forests are increasingly used for bush meat, fuel wood, poles, timber and charcoal production and are leveled for growing crops and exotic trees. This 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).

The African cherry tree (Prunus africana), a sometimes favored food for guerezas, has exhibited a notable decline across sub-Saharan Africa, predominantly due to the harvesting of its bark for medicines, (Fashing, 2004). The decline of this plant negatively affects the guereza populations that rely upon it (Jinsz and Finley, 2011)

3. MATERIALS AND METHODS

3.1. Description of the study area

This study was conducted in Gidabo forest, which is located around Yirgalem town. Yirgalem is found in Southern Nations Nationalities and Peoples Region at about 310 km from Addis Ababa, and 47 km from Hawassa, essentially in the eastern edge of the Rift Valley of Ethiopia (NUPI, 2000). The town has developed linearly on a narrow strip of land bounded by deeply incised valleys of Gidabo River and its tributaries.

The town is geographically located at 6° 45′ 40″ latitude North and 38° 28′ 10″ longitude East at an altitude of 1765 m asl (Figure 1). Yirgalem town has an area of 1140 hectares and contains rivers, hot spring and fragments of forests including coffee plantations, and Gidabo forest is found at the edge of Gidabo River (DWRDO, 2010).

Figure1 Location map of the study area

3.1.1 Flora and Fauna

The study was undertaken at two sites; Gidabo forest and inside Yirgalem hospital. The forest and Yirgalem hospital are 4 km away from the center of the town. Gidabo forest is crossed by Gidabo River and its tributary. The forest contains few number of plant species that are protected by Dale Wereda Natural Resource Protection Department (personal communication).

The main species of plants that are found in the study sites include *Albizia gummifera*, *Cordia africana*, *Prunes africana*, *Ficus vasta*, *Ficus sur*, *Eucalyptus grandis*, *Psidium guajava*, *Jacaranda mimosifolia*, *Spathodaecampanulata*, *Dombeya torrida*, *Celtis africana*, *Vernonia amygdalina*, *Millettia ferruginae*, *Podocarpusfalcatus*, *Dracaena steudneri*, *Perseaamericana*, *Diospyrosabssinica* and *Casimiroa edulis*, (Tables 4 and 5). Some of the animal species inside the forest are colobus monkey, grivet monkey, rodents and a number of bird species.

3.1.2 Climate

Yirgalem falls in "woina dega" climate as it experiences annual rainfall of 1235 mm, which adapt for eight rainy months from March to October (NMA, 2002). Yirgalem has a tropical climate. In winter, there is much less rainfall than in summer. The mean annual temperature is 18.8°C. About 1235 mm of precipitation falls annually in the study area (Figure 2 and 3).

The warmest month of the year is March, with average temperature of 20°C. In July, the average temperature is 18.3°C. It is the lowest average temperature of the whole year (Figure 2 and 3).

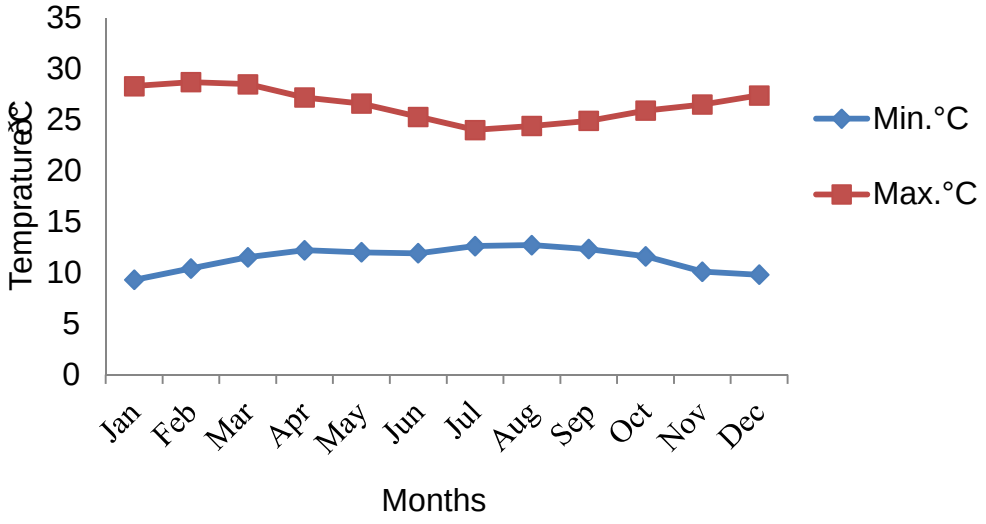

Figure 2: The minimum and maximum annual temperature of the study area, year 2000-2012(source http://en.climate-data.org).

The difference in precipitation between the driest month and the wettest month is 134 mm. The driest month is December, with an average of 29 mm of rainfall. Most precipitation falls in September, with an average of 163 mm (Figure 3).

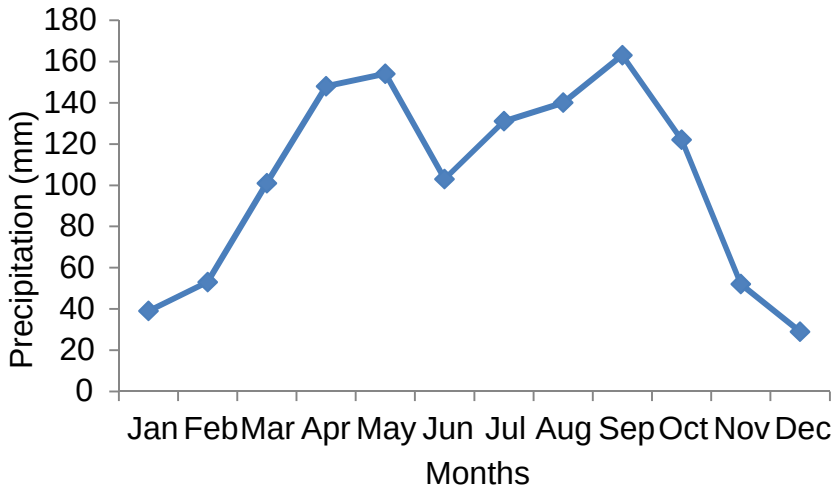

Figure 3: Mean monthly Rainfall of the study area, years 2000-2012(source http://en.climate-data.org)

3.2. Samples and sampling techniques

In order to carry out the proposed research objectives two separate sites were selected. Group I (the first troop) located in forest with low disturbance, while the second troop (Group II) located in tree and shrubs dominated habitat type with certain disturbances (inside Yirgalem Hospital compound). Representative samples were collected from the two sites using scan sampling techniques.

3.3. Methods

The instantaneous scan sampling methods was used to collect data on selected group members (Altmann, 1974). The diurnal activity patterns such as feeding, moving, resting, grooming, social play and others were recorded for 5 minutes at 15 minutes interval. Feeding includes instances when a monkey plucked food items, pulled food items towards the mouth, masticated and swallowed; moving includes any locomotor behavior including walking or running that resulted in a monkey changing its spatial position; resting includes instances when a monkey was inactive, usually while sitting or lying down; grooming includes instances in which one monkey used its hands to explore or to clean the body of another monkey; 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 (Fashing, 2001a).

Data were collected for three consecutive study days per week for three months (January to March, 2015) for group I and group II. Data were collected one day for one group and the next day for the other group for 3 consecutive days per week. The activity recorded

during a scan sample was the first activity that is held for three or more seconds once they were sighted. According to Fashing (2001a), this requirement had prevented eye catching, ephemeral activities from being over represented in the data set.

3.3.1. Method in diurnal activity patterns

The diurnal activity patterns such as resting, feeding, moving, grooming, and social play were considered in the study. The groups were followed from dawn (08:00h) to dusk (17:30) and diurnal activities of individuals were recorded for 5 minutes at 15 minutes interval (Altmann, 1974; Fashing, 2001a; Harris and Chapman, 2007).

3.3.2. Method in feeding ecology

For each scan of feeding behavior, the individuals that were feeding and the plant species and plant part they fed up on was noted. 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 monkeys.

3.3.3. Method in conservation status study

For studying the conservation status of *C. g. gallarum* in the studied area, focus group discussion was conducted to collect information from communities living around the study area. The selection of participants was made based on the proximity of their residence from the study area. In order to collect information, designed open-ended semi structured questionnaire was used. Information was collected based on the presence or absence of conflict between the local people and colobus monkeys around the forest,

the causes of conflicts, their attitudes towards colobus monkeys, and how both local communities and colobus monkeys are benefited from the forest area.

Two focus group discussions were conducted. Group size of individuals in each discussion varied. In the first group 6 individuals and in the second 4 individuals were participated. Participants were selected based on their age and duration of residency in the area. Community leaders were approached in advance and requested to organize meetings two days ahead to hold discussion with the researcher by involving communities on the issue.

3.4. Data analysis

Diurnal activity time budget was calculated by dividing the proportion of the number of behavioral records for each activity category by the total number of activity records per day. Then it was summed within each month to construct monthly proportions of time budgets. The overall percent of time budgets for the studied activity patterns during the entire study period was then calculated. Dietary compositions were calculated for both group I and II. Each food item was summed per plant species. The monthly percentage of each food item and plant species consumed were calculated in the diet as the number of monthly individual scans for each food item and plant species divided by the total number of monthly 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 eaten.

The percentages of different variables were then calculated from these sums in Excel. Data were analyzed using ANOVA (one way ANOVA) at $\alpha = 0.05$ level of and SPSS 20 software was used to run the analysis.

4. RESULTS

4.1. Diurnal activity patterns

The percent of time allocated for different daily activity patterns by C.g.gallarum was mainly devoted for resting. In both studied groups of C.g.gallarum much of their diurnal activity pattern time (50%) was devoted for resting, followed by feeding (20%). Moving, grooming and social play activities took the third, fourth and fifth places, respectively (Figure 4).

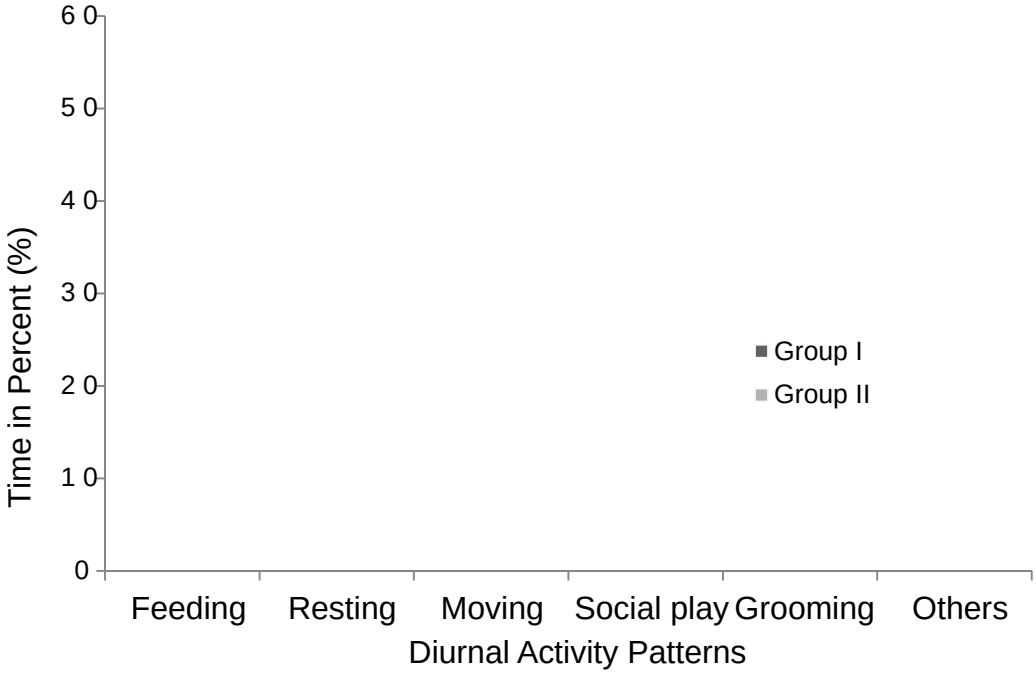

Figure 4: Percentage time spent by C.g.gallarum (group *f* and group *ff*) to different diurnal activity patterns.

During the study period individuals of C.g.gallarum in group *f* had the greatest proportion of activity time budget spent for resting (55.77%), followed by feeding (22.64%), moving (9.73%), grooming (6.30%), social play (4.92%) and other activities such as urinating, defecating and roaring comprised (0.64%) (Tables 1 and 2).

The highest proportion of daily activity time budget allocated by individuals of C.g.gallarumin group II for resting was (53.96%) followed by feeding (21.99%), moving (12.41%), grooming (7.12%), social play (3.75%) and other activities (0.78%) of their time budget, (Tables 1 and 2).

Table 1 Percentage time budget by C.g.gallarum(group *I* and group *II*) for their diurnal activity patterns.

		Study period			
Activity pattern	Group	January	February	March	Mean
Feeding	I	21.47%	22.15%	24.29%	22.64%
	II	21.58%	20.27%	24.11%	21.99%
Resting	I	54.49%	56.68%	56.15%	55.77%
	II	51.64%	55.48%	54.76%	53.96%
Moving	I	10.26%	10.10%	8.83%	9.73%
	II	12.30%	13.62%	11.31%	12.41%
Social play	I	5.45%	5.21%	4.10%	4.92%
	II	4.92%	3.65%	2.68%	3.75%
Grooming	I	7.05%	5.54%	6.31%	6.30%
	II	8.20%	6.31%	6.85%	7.12%
Others	I	1.28%	0.33%	0.32%	0.64%
	II	1.37%	0.66%	0.30%	0.78%

Table2: Summarized diurnal activity time budgets of the two groups of C.g.gallarum(in terms of percentage total activity samples); group I: n=936 a group II: n=1003.

Activity pattern	Group I Mean	Group II Mean
Feeding	22.64%	21.99%
Resting	55.77%	53.96%
Moving	9.73%	12.41%
Social play	4.92%	3.75%
Grooming	6.30%	7.12%
Others	0.64%	0.78%

According to the result of one way ANOVA (Table 3), some activity patterns of C.g.gallarum were statistically significant between the two groups. There were significant differences in time spent for moving and social play activities ($P<0.05$) between individuals of the two groups. However, there were no significant differences between individuals of the two groups in the time spent for the activities such as feeding, resting, grooming and others ($P>0.05$).

Table3: Result of one way ANOVA for different activity patterns by individuals of C.g.gallarum(group I and group II):

Source of variation		Sum of squares	df	Mean square	F-value	P-value
Feeding records	Between groups	0.113	1	0.113	0 .112	0.740
	Within groups	37.476	37	1.013		
	Total	37.590	38			
Resting records	Between groups	5.290	1	5.290	2.089	0.157
	Within groups	93.684	37	2.532		
	Total	98.974	38			
Moving records	Between groups	19.386	1	19.386	14.243	0.001
	Within groups	50.358	37	1.361		
	Total	69.744	38			
Social play records	Between groups	2.645	1	2.645	4.791	0.035
	Within groups	20.432	37	0.552		
	Total	23.077	38			
Grooming records	Between groups	2.385	1	2.385	3.906	0.056
	Within groups	22.589	37	0.611		
	Total	24.974	38			
Other records	Between groups	0.069	1	0.069	0.234	0.631
	Within groups	10.905	37	0.295		
	Total	10.974	38			

4.2. Feeding ecology

The proportion of time spent for feeding on different food items by *C. g. gallarum* was dominated by foraging on leaves; feeding on young leaves in particular accounted for the highest proportion of time spent for feeding. The result indicated that *C. g. gallarum* in both group *f* and group *ff* fed more on leaves than other plant parts. Moreover both groups spent more time feeding on young leaves than mature leaves.

Members of group *f* guerezas spent 26.91% of their feeding time on mature leaves, 52.39% for young leaves, 6.98% flowers, 15.54% fruit and 5.68% of their feeding time was spent on barks. Members of group *ff* guerezas spent 29.50% of their time feeding on mature leaves, 48.10% on young leaves, 6.25% on flowers, 0.38% on fruits and 7.86% on barks (Figure 5).

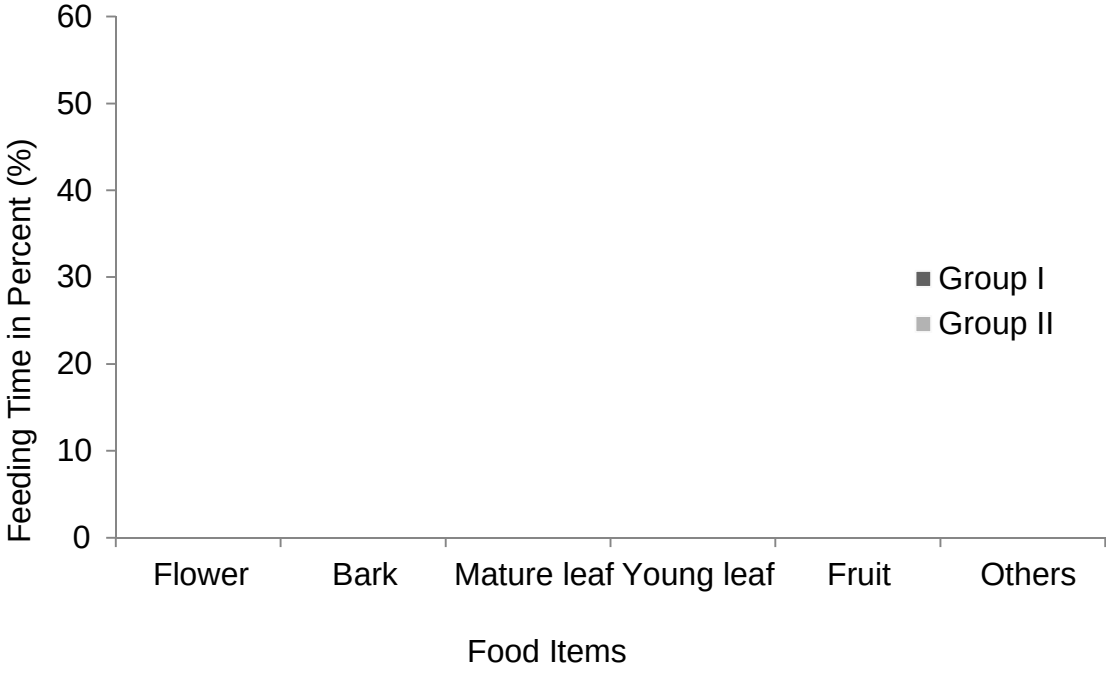

Figure5: Percentage of feeding time spent by *C. g. gallarum* (group *f* and group *ff*) on different food items.

Individuals of C.g.gallarum in group *f* consumed a total of 15 different plant species during the study period (Table 4). From these plant species that contributed the overall diet of group *f* during the study period, the top three plant species that were frequently consumed accounted for more than 55% of their plant diet. According to the total percentage contribution of the plant food items eaten in group *f*, Prunes africana was the most frequently consumed species which accounted about 26.42%, Celtis africana 16.98% and Ficus vasta 10.85% (Table 4).

Table 4: List of plant food items consumed and the percentage contribution of plan the diet of C.g.gallarum (group I).

Scientific name	Family	Type	Local name	Plant Part consumed	% contribution
Prunes africana	Rosaceae	tree	Tikur enchet	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%
Spathodae campanulata	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%

Psidiumguajava	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%
Dombeyatorrida	Sterculiaceae	shrub	Wulkeffa	YL,ML	1.89%
Ficussur	Moraceae	tree	Sholla	YL,ML, FR	1.42%
TOTAL					100%

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

The C.g.gallarumin group *ff* consumed a total of 13 different plant species during the study period (Table 5). In the case of group II individuals the top three highly consumed plant species consumed accounted for more than 58% of their overall plant diet during the studyperiod. According to the total percentage contribution of these plant species consumed Prunes africana accounted about 36.65% of their time, Ficus vasta 14.03% and Albiza gummifera 8.14% (Table 5).

Table5: List of plant food items consumed and the percentage contribution of plants the diet of C.g.gallarum (group II).

Scientific name	Family	Type	Local name	Plant Part consumed	% contribution
Prunes africana	Rosaceae	tree	Tikur enchet	YL,ML, BK	36.65%
Ficus vasta	Moraceae	tree	Warka	YL,ML, FR	14.03%
Albiza gummifera	Fabaceae	tree	Sesa	YL,ML, FL	8.14%
Spathodae campanulata	Bignoniaceae	tree	Aballo	YL,ML, FL, BK	5.43%
Ficus sur	Moraceae	tree	Sholla	YL,ML, FR	4.98%
Psidium guajava	Myrtaceae	tree	Zeytun	YL,FR,BK	4.98%
Casimiroa edulis	Rutaceae	tree	Casimer	YL,FR	4.52%
Eucalyptus grandis	Myrtaceae	tree	Key bahirzaf	YL,FR,BK	4.07%
Jacaranda mimosifolia	Bignoniaceae	tree	Jacaranda	YL,FL	4.07%
Diospyros abssinica	Ebenaceae	tree	Selechegn	YL,ML	4.07%
Cordia africana	Boraginaceae	tree	Wanza	FR	3.17%
Persea americana	Lauraceae	tree	Abokado	YL,FR	3.17%
Dombeya torrida	Sterculiaceae	shrub	Wulkeffa	YL,ML	2.71%
TOTAL					100%

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

In general, there was a great deal of similarity in the plant parts eaten by the two groups of C.g.gallarum in the studyarea. Both groups of C.g.gallarum fed plant food items primarily on young leaves. Some of the differences that were seen between the two groups were likely resulted from the differences in the availability of varied species of plants in the studied areas which were used by members of the two groups of C.g.gallarum for feed.

From the monthly percentage contribution of different food items of the plants to the diet of group *f* individuals, young leaves were the top food item eaten (range 45.59-62.34%), followed by mature leaves (range 23.88-30.88%), fruit (range 13.43-17.65%), flower (range 0-7.46%) and bark (range 5.19-5.97%). The overall leaf diet of individuals in group guereza accounted about 79.31% of the total plan items eaten (Table 6).

Table6: Percentage contribution of different food items to the diet of C.g.gallarum in group I during the study period.

Plant part	January	February	March	Mean
ML	23.88%	30.88%	25.97%	26.91%
YL	49.25%	45.59%	62.34%	52.39%
Overall leaf	73.13%	76.47%	88.31%	79.31%
FL	7.46%	-	6.49%	6.98%
FR	13.43%	17.65%	-	15.54%
BK	5.97%	5.88%	5.19%	5.68%

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

The monthly percentage contribution of different food items from different plant parts to the diet of group *f* C.g.gallarum is also shown in table 7. In this group also, young leaves

were the top food items consumed (range 34.03‡60.49%), followed by mature leaves (range 23.46‡40.98%), fruit (range 2.47‡14.75%), bark (range 6.33‡9.84%) and flowers (range 0‡6.33%). The overall leaf diet of individuals in this group constituted about 77.59% from the total plant food items that were consumed (Table 7).

Table 7: Percentage contribution of different food items to the diet of *C.g.gallarum* in group II during the study period.

Plant part	January	February	March	Mean
ML	24.05%	40.98%	23.46%	29.50%
YL	49.37%	34.43%	60.49%	48.10%
Overall leaf	73.42%	75.41%	83.95%	77.59%
FL	6.33%	-	6.17%	6.25%
FR	13.92%	14.75%	2.47%	10.38%
BK	6.33%	9.84%	7.41%	7.86%

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

According to the result of one way ANOVA any of the food items eaten by *C.g.gallarum* in the studied areas were not significantly varied between the two different groups ($P>0.05$). There were no significant differences between individuals of the two groups in the time spent for feeding on mature leaves, young leaves, flowers, fruits and barks of different plant species that were eaten ($P>0.05$).

Table8: Table 8: Result of One way ANOVA for different food items eaten by C.g.gallarum(group I and group II):

Source of variation		Sum of squares	df	Mean square	F- value	P -value
ML	Between groups	0.219	1	0.219	0.210	0.649
	Within groups	38.550	37	1.042		
	Total	38.769	38			
YL	Between groups	1.927	1	1.927	0.656	0.423
	Within groups	108.739	37	2.939		
	Total	110.667	38			
FL	Between groups	0.007	1	0.007	0.018	0.893
	Within groups	13.737	37	0.371		
	Total	13.744	38			
FR	Between groups	0.000	1	0.000	0.000	0.990
	Within groups	57.589	37	1.556		
	Total	57.590	38			
BK	Between groups	0.465	1	0.465	0.907	0.347
	Within groups	18.971	37	0.513		
	Total	19.436	38			

ML=mature leaf; YL=young leaf; FL=flower; FR=fruit; BK=bark.

4.3. Focus group discussion (FGD)

The result presented here summarizes the views and interests of discussants that were held within each studied area. The result of discussion held with FGD in the study areas showed that there were no conflicts between people of the local communities and C.g.gallarum around the study area. C.g.gallarum that live in the forest area were not

involved in crop damage and posing problems to the communities. According to the discussants, it is the grivet monkeys that live in the area which raided their crops, but not the guerezas. Local people in the area do not kill C.g.gallarum in fighting for their crop pests. According to the participants, C.g.gallarum was killed for their beautiful skin and hair long ago, (before 20 to 25 years ago).

According to the discussants, the forest is the home of wild animals that local people want to protect the forest. They all agreed that before many years ago they developed a negative attitude towards the conservation of primates such as grivet monkeys and C.g.gallarum because some of them raided their crops. But now a days they understood that the forest and the wildlife that live there are important for the ecological balance of nature. So, they are ready to protect and conserve the forest and its wildlife including C.g.gallarum.

5. DISCUSSION

The *C.g.gallarum* in the present study spent more than 50% of their time resting, (group *ff* individuals had 55.77% of their activity time budget devoted for resting and group *ff* individuals spent 53.96% of their activity time for rest). In another study species of black and white colobus monkey have been found to spend 46.4% of their time resting (Teichroeb et al., 2002). Thus, the result obtained in the study area is agreed with the study by the other researcher. Diet that consists of a large amount of low quality food such as mature leaves may lead to more time needed for resting (Chapman et al., 2007).

The reason for more than 50% of *C.g.gallarum* time budget spent for resting and a high percentage of time for feeding on mature leaves in their diets could be linked to the reason that the groups were observed during two dry season months (January and February) and one early rainy season month (March), that made more mature leaves to be available and being fed in the dry months.

The increased resting level among colobus monkeys is linked to vegetation quality (Marsh, 1981). The unique foregut anatomy of colobus allows for fatty acid fermentation, which is believed to be an adaptation for reducing leaf toxin levels to ingestion (Oates, 1977a). An increase in resting activity of colobus thus may be explained by the induced need to reduce toxin levels (Dasilva, 1992). Since in this study the *C.g.gallarum* depended more on mature leaves due to the season of the study period (two drier months of the study period when more mature leaves were available), they tended to take longer rests (more than 50% of their time budget) in order to ferment what they ate, which will

help them reduce leaf toxin levels. Therefore, *C.g.gallarum* in the study area had spent more than 50% of their day light activity time for rest.

Grooming is the most important behavior used by primates for maintaining social relationships (Schino, 2001). Grooming seldom exceeds 15% of day time activity for most social species (Lehman *et al.*, 2007) because grooming requires time and time is a limited resource for individuals to rest, move and forage. In the present study *C.g.gallarum* in group *ff* groomed on average 6.3% of their time and group *fff* individuals 7.12%. This indicated that the result of the present study is less than 15% of day time activity which is in agreement with previous research findings.

All guereza groups are highly folivorous and rely heavily on leaves of plants (Harris and Chapman, 2007). This indicated that *Colobus guereza* primarily feed on plant food items particularly the leaves of plants. The guereza 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 stomach bacteria. Together, these and other morphological adaptations allow the species to feed on large quantities of leaves (Gron, 2009; Jensz and Finley, 2011). Plant leaves constitute 73-84% of the guereza diet (Chapman *et al.*, 2007) In the present study *C.g.gallarum* in group *ff* relied 79.31% of their diet on plant leaves, and group *fff* relied 77.59% of their total plant diet on leaves during the study period. Thus, the major part of *C.g.gallarum* diet in the studied areas heavily depended on plant leaves.

About 35-75% of guerezas diet consists of young leaves which are easier to digest and are less toxic (Usongo and Amubode, 2011). In the present study the guerezas in group *ff*

relied 52.39% of their diet on young leaves of plants while those in group *ff* relied 48.10% of their diet on young leaves of plants. Thus, *C. g. gallarum* in the present study fed mainly on young leaves of different plant species, which is in line with the study of other researchers. Again, during the month of January and February, both group *f* and *ff* individuals fed young leaves not more than 50% of their feeding time. However, in March both groups had devoted more than 60% of their feeding time which depended on young leaves. This dramatic increase in feeding on young leaves is related to the fact that the beginning of rainy season in March made young leaves to become more available for guerezas than during January and February.

According to Oates and Davies (1994), colobus monkeys in general rarely eat more than 30% mature leaves in their diet unless they are of good quality. Thus, Colobus guerezas diet consists of mature leaves food item which does not exceed 30% of their plant diet. In the present study individuals of *C. g. gallarum* in group *f* relied 26.91% of their diet on mature leaves and in group *ff*, on the other hand, relied 29.50% of their diet on mature leaves. Thus, data available in the present study is in agreement with the study of other researchers that were carried out before.

The diet of guereza is highly varied seasonally and geographically (Kim, 2002). During the study period, percentage of time spent by individuals of group *f* feeding on young leaves exceeded mature leaves. But in group *ff*, consumption of young leaves exceeded mature leaves in January and March only whereas mature leaves exceeded young leaves in the month of February alone. This might be related to differences in the type of plants between the two study areas, and the availability of that part of the plant for consumption by the individuals. During February, *C. g. gallarum* in group *f* did not include flowers in

their diet and in March they did not consume fruits at all. In the case of individuals of C.g.gallarumin group *ff*, during the month of February they did not eat fruits, but unlike group *f*, individuals in group *ff* consumed fruits in the month of March. This again may be linked to the variation in plant species of the two studied areas and in the plant parts being fed.

Though few variations in plant species according to the analysis of one way ANOVA the time spent for feeding the same type of food items did not show significant differences by the two groups of C.g.gallarumin the two study areas.

In order to conserve primates in the future, conservation practice involving local people is a must (Wallis and Lonsdorf, 2009). Colobus monkeys being highly arboreal are especially vulnerable to forest fragmentation as they require leaves, fruits and seeds for survival (Andersonet al., 2007a). Gidabo natural forest is threatened by agricultural land expansion. Grazing has a significant impact in the area in accelerating habitat degradation and completion with wild life.

Grivets steal foods; destroy materials, damage crops, vegetables and fruits (and Afework Bekele, 2010). According to the discussants, it is the grivet monkeys that live in the area which raided their crops, but not the guerezas. The present study indicated that C.g.gallarumis not directly threatened by the local people. The community around the area is aware of not considering them as their crop pests. This attitude has a promising impact on the long term conservation of C.g.gallarumin the study area. Understanding of how people„s view and perceive their interactions with primates, and particularly the factors that promote or dampen people„s tolerance of their presence and behavior need to

be examined as part of the process of developing mitigation strategies that are both effective and acceptable to the local people (Hill, 2004).

6. CONCLUSION AND RECOMMENDATIONS

CONCLUSION

Comparison of the time spent for various diurnal activities between group *f* and group *ff* indicated that only moving and socialization showed significant differences. Within the same activity, i.e. moving, individuals in group *ff* spent more time than individuals in group I. On the contrary more time is spent for socialization in group I than in group II. Resting, feeding and grooming activities did not show significant differences between the two groups.

During the study period, *C. g. gallarum* mainly forage for 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. Most of the trees that were being eaten by the two groups were similar. However, there were very little differences in the type of plant species they fed up on. The top three foraged plant species by individuals of group *f* were *Prunus africana*, *Celtis africana*, and *Ficus vasta*, and by group *ff* individuals were *Prunus africana*, *Ficus vasta* and *Albiza gummifera*. In both group *f* and group *ff* individuals, *Prunus africana* was the most foraged tree of all the plant species that were consumed.

Focus group discussion indicated that the conservation status of *C. g. gallarum* is not at risk of direct attack and threatening by the community living around the studied area.

RECOMMENDATIONS

The need for expanding agricultural land by people and also to get fire wood by individuals in the community may threaten the habitat and survival of *Galago gallarum* in the future. Therefore, attention should be given by government officials and concerned bodies to protect their 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 protect the forests properly.

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APPENDIX-1

Questionnaires for Focus Group Discussion (FGD)

1. Do you think that there is/are any conflict(s) between local communities and colobus monkeys around the forest area?
2. If thereis/are conflict(s), what is/are the causes of the conflict(s)?
3. What is the attitude of the local community towards colobus monkeys that live around the forest?
4. Do you think that the presence of colobus monkeys close to your area benefited the local community?
5. How both the local communities and the colobus monkeys will be benefited from the forest area?

PLATE -1

Photographs of Colobus guereza gallarum

(Photo by Mohammed Hussen, March 2015).