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Ecology, behaviour and conservation of Boutourlini's blue monkey (*Cercopithecus mitis boutourlinii*) in the Jibat Forest, Ethiopia

Thesis Submitted to the School of Graduate Studies of Addis Ababa University in Partial Fulfillment of the Requirements for the Degree of Master of Science in Biology

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ABSTRACT

Boutourlini's blue monkey (*Cercopithecus mitis boutourlinii*) is listed as a vulnerable sub-species, which is endemic to south western parts of Ethiopia. This study was carried out from July 2009 to April 2010 to provide data on the habitat use, feeding behaviour, activity and ranging patterns of *C. mitis boutourlinii* blue monkey in the Jibat Forest. Jibat forest constitutes different habitat types including tree and bamboo dominated forests and bushlands with the surrounding farmlands. Study on two selected groups (Group I and II) of the monkey was carried out in different habitat types. Activity pattern, feeding ecology and ranging behaviour were studied with 15 minutes interval scan sampling. Vegetation composition in the home range was determined by quadrat sampling method. The majority of their activity time was spent in feeding 49.9 % and 47.3% by Group I and Group II, respectively; followed by moving (20.14%) and resting (20.57%) by Group I. Group II spent 16.26% of total time moving and 22.5% resting. Monkeys of Group I spent 9.4% of their time for socializing while Group II spent 13.9%. The time spent in other activities was very limited (<1%) in both groups. The overall diet composition of Boutourlini's blue monkey was dominated by fruits, which accounted for 52.5% in Group I. Foraging on animal preys and young leaves constituted 14.7% and 11.1% of their time, respectively. They also feed on shoots (8.7%), flowers (7.3%), mature leaves (3.1%), bark (1.7%), seeds (0.6%) and other parts (0.4%). Monkeys in the Group II spent more time (29.8%) feeding on shoots. This group also spent 17.1% of their time feeding on young leaves, 17.0% on fruits, 13.1% on animal preys, 9.6% on seeds, 6.8% on flowers, 4.4% on mature leaves, 1.5% on bark, 0.7% on other plant parts and 0.1% on stem. A total of 24 and 33 plant species were consumed by Group I and II, respectively. Home range size was 72 ha for Group I and 61.2 ha for Group II. Anthropogenic effects were widely observed as a threat.

Keywords: Boutourlini's blue monkey, diet, habitat preference, home range, Jibat Forest.

1. INTRODUCTON

Ethiopia has long been recognized for its richness in natural resources (Jacobs and Schloeder, 2001). Ethiopia possesses a diverse mammalian fauna of 284 species of 52 families (Cole *et al.,* 1994) of which 31 species are endemic (Jacobs and Schloeder, 2001). The high level of endemicity in the fauna of Ethiopia is related to the large extent of high lands. The variations in temperature and rainfall in different habitats have led to the diversity of species (Yalden, 1983). Africa has the largest primate fauna. There are 175 species and sub-species of primates listed in Africa (Grubb, 2006).

Ethiopia herbours different primate species and sub-species and among them are the two subspecies of blue monkey (*Cercopithecus mitis stuhlmanni*) (Fairgrieve and Muhumuza, 2003) and the boutourlini's blue monkey (*Cercopithecus mitis boutourlinii*) (Yalden, *et al.,* 1996; Kingdon, 1997).

The blue monkey (*C. mitis*) is a species of Old World monkey native to Central and East Africa (Groves, 2005). They are also known as the diademed monkey because they have a prominent row of forward pointing white fur just above the brow line (Rudran, 1978; Foerster and Cords, 2005). The face is nearly naked, usually dark in colour (infrequently blue), and has a well-developed musculature. White whiskers are well developed in males (Lawlor, 1979). Males are larger than females. The canines of males are also slightly larger than those of females. They are catarrhine; the nostrils are close together facing downward. They have cheek pouches to store food while foraging (Rudran, 1978).

The blue monkey is a generalist feeder and a forest dwelling guenon (IUCN, 2008). They are frugivorous and folivorous in nature, feeding mainly on fruits and leaves. They also consume seeds and arthropods (Cords, 1987a). Additionally, they tend to

concentrate their invertebrate feeding on slow-moving slugs and worms (Rudran, 1978). Dietary flexibility is also observed in *C. mitis* (Chapman *et al.,* 2002).

They are more arboreal than some cercopithecine species, like macaques, vervets and baboons (Estes, 1991; Cords, 1987a, 2000a, 2002). They are also diurnal (Estes, 1991). They differ in their social organization from other cercopithecines. They live in one-male multi-female groups and have a weakly differentiated dominance hierarchy among females. Their rank may not be related to measures of affiliative behaviour or reproductive success (Cords, 1987a, 2000a). Females are permanent members of the natal group whereas young males leave their natal groups as they approach adulthood. For most of the year, only one adult male is present in the group, though additional males may compete to join the group during the mating season (Cords 1987b; Cords, 2000b). They have a polygamous mating system. Males are larger in size than females (Michael, 1988).

The genus *Cercopithecus* appeared in the fossil record about 2.9 million years ago (Leakey, 1988). They had a semi-terresterial frugivorous ancestor, inhabiting woodland habitats. However, once they became rainforest specialists, they started to diversify as a result of repeated isolation and divergence of populations as a consequence of the recurring division of continuous forests into fragments associated with glacial or interglacial cycles (Chapman, 1984; Hamilton, 1988). During isolation, populations of *Cercopithecus* species inhabited different fragments. The divergence of other sub-species from an ancestral *Cercopithecus mitis* occurred during one of these isolations (Twinomugisha *et al.,* 2003).

Cercopithecus mitis boutourlinii is a sub-species of *Cercopithecus mitis*, endemic to Ethiopia. Boutourlini's blue monkey received its name from a Russian Count, Augusto Boutourline. He travelled Asia and Africa between 1884-1887 and named this sub-

species during his visit to Shewa, southwestern Ethiopia, where this sub-species is widely distributed (Watkins and Grayson, 2009). Blue monkey as a species are widely distributed and not threatened (Lawes, 1990). However, there are highly localized sub-species, some of which are threatened or endangered (Oates, 1996). Boutourlini's blue monkey is one of them and is restricted to Ethiopia, occurring from Lake Tana southwards along the western side of the Ethiopian Rift Valley, but does not reach Lake Turkana (IUCN, 2008; Yalden *et al.,* 1977). Bailey (1977) recorded Boutourlini's blue monkey at the gorge of the Blue Nile River, near Bichena area. It is strictly associated with primary tropical deciduous and riverine forests (Yalden *et al.,* 1977).

The taxonomy of Boutourlini's blue monkey remains vague and inconclusive. According to Grubb *et al.* (2003), Boutourlini's blue monkey is classified as a subspecies of *C. mitis,* which contains 16 subspecies. On the other hand, Groves (2005) classified this taxon as one of only seven subspecies of *C. mitis*. According to IUCN (2005), 17 sub-species are recorded in different parts of Africa.

Tropical forests and the fauna they support are being threatened by accelerated rates of forest conversion and degradation (Chapman and Lambert, 2000). As a result, conserving the world's primates is becoming a complex endeavour to address the long-term conservation of all primate species and their habitats (Wallis and Lonsdorf, 2009). Blue monkeys are classified by IUCN (2008) as a species of Least Concern (LC) or not threatened. Eventhough, some subspecies of *C. mitis* are locally common, others are threatened (IUCN, 2008). Boutourlini's blue monkey is listed as Vulnerable (VU) because of the extensive and uncontrolled destruction of its forest habitat for both timber and agriculture. There are different factors at work in the forest reserves, which indicates an uncertain future for the long-term survival of several species of monkeys. These include, intensive exploitation of the forest resources, harassing of monkeys during actual or suspected crop raiding and trapping of monkeys either for sale or for food, or because they are considered to be agricultural pests. The local farmers harass monkeys indiscriminately by throwing stones or using sling shots on them in response

to crop raiding (Chism and Cord, 1998). The main reasons for the global decline of primate populations are hunting, emergent diseases, habitat conversion and fragmentation (Oates, 1996; Cowlishaw and Dunbar, 2000; Nunn and Altizer, 2006). As a result, more than half of the world's primate species are currently threatened by extinction (Chapman and Peres, 2001).

The ecology, behaviour and distribution of Boutourlini's blue monkey are not well studied compared to other sub-species of the species *C. mitis*. Indeed, detailed studies on the habitat use, feeding ecology and activity and ranging patterns of Boutourlini's blue monkey are lacking. The goal of the present study is to provide data on the habitat use, feeding ecology, activity and ranging patterns of *C. mitis boutourlinii* in Jibat Forest, Ethiopia.

2. OBJECTIVES

General objective

The objective of the present study is to provide information on the habitat use, feeding ecology, activity and ranging patterns and conservation status of Boutourlini's blue monkey in Jibat Forest, Ethiopia.

Specific objectives:

- To examine the habitat use of Boutourlini's blue monkey in the Jibat Forest.
- To determine the activity patterns of Boutourlini's blue monkey in the Jibat Forest.
- To examine the feeding ecology of Boutourlini's blue monkey in the Jibat Forest.
- To examine the ranging patterns of Boutourlini's blue monkey in the Jibat Forest.
- To determine the conservation status of Boutourlini's blue monkey in the Jibat Forest.

3. STUDY AREA

3.1. Location and topography

The Study Area

Jibat Forest is situated in western Ethiopia in the Oromia Regional State and located at 37° 15' – 37° 30'E; 8° 35' – 8° 50'N, about 200 km from Addis Ababa (Fig. 1). The forest covers an area of 27,000 ha. It is one of the National Forest Priority and Important Bird Areas of the country (BirdLife International, 2001). It is a remnant humid forest (Tamrat Bekele, 1994), consisting of tree-dominated forest, bamboo forest, plantations of *Junipurus* and other trees, and farmland in the surrounding areas (Fig. 2 and 3). Tree cutting in the area is prohibited; however, livestock grazing is allowed throughout the forest. The altitude ranges from 1800 – 2984 m asl.

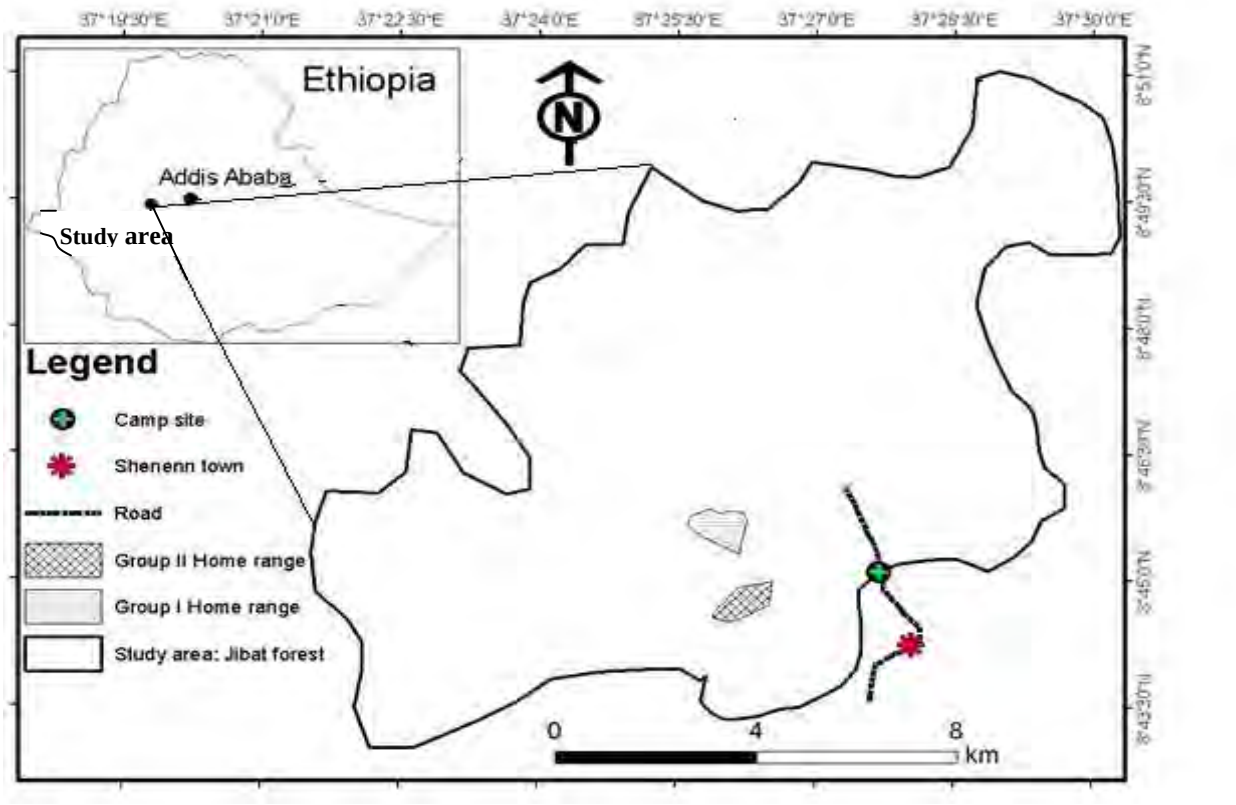

Figure 1. Map of the study area (Jibat Forest).

Plate 1. View of bamboo dominated forest (Photo: Dereje Tesfaye, April 2010).

Plate 2. View of tree dominated forest (Photo: Dereje Tesfaye, April 2010).

3.2. Climate

The monthly mean rainfall and temperature data from 1997 to 2006 were obtained from the Ethiopian Meteorological Agency, from the nearest weather station, Tikure Inchini. This is 25 km away from the study area at an altitude of about 2500 m asl. Rain occurs throughout the year in the Jibat Forest (Tamrat Bekele, 1994). Mean annual rainfall was 1474mm. Heavy rain occurs from April to October; but with two peaks in July (355 mm) and August (344 mm). Minimum rainfall was recorded in the months between November - March. The lowest mean rainfall recorded was during December (18 mm). Wet season includes July - October, March and April and the Dry season includes November - February. The average mean monthly minimum temperature is 5.3℃ in December and the average mean monthly maximum is 26.4℃ in February (Fig. 2).

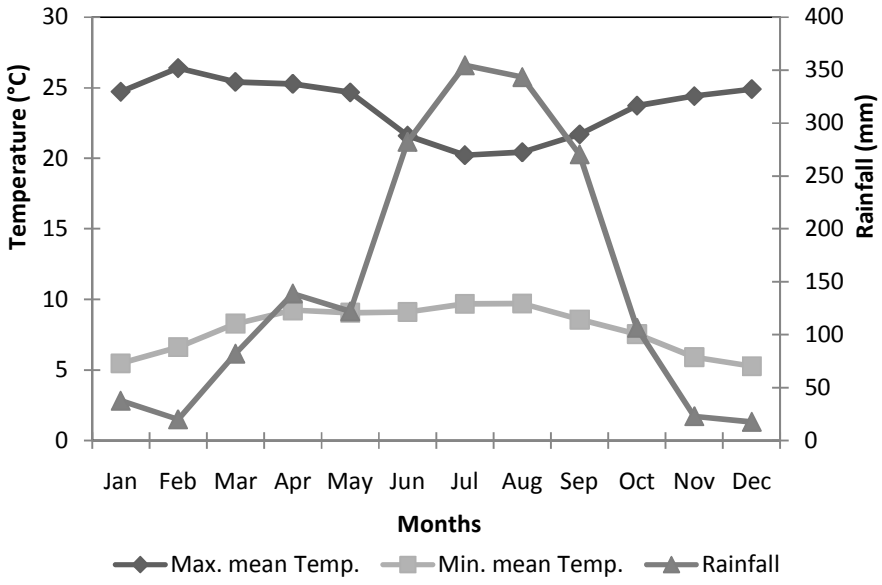

Figure 2. The mean monthly minimum and maximum temperature and rainfall of the study area in the years between 1997 - 2006. **(Source: Ethiopian Meteorological Agency)**

3.3. Fauna

According to personal observation and personal communications, the following large mammal species are known to occur in the study area: Menelik's bushbuck (*Tragelaphus scriptus meneliki*), spotted hyaena (*Crocuta crocuta*), black and white colobus monkey (*Colobus guereza*), anubis baboon (*Papio hamadryas anubis*), grivet monkey *(Chlorocebus aethiops),* bush pig (*Potamochoerus larvatus*), leopard (*Panthera pardus*), porcupine (*Hystrix spp.*), squirrel (*Xerus spp.*), common duiker (*Sylvicapra grimmia*) and aardvark (*Oryteropus afer*). In addition, the area contains many birds, amphibians and snakes.

4. MATERIALS AND METHODS

4.1. Materials

Materials used for this study were binoculars, a digital photographic camera, a Garmin Global Positioning System (GPS) 72, a tape measure, flagging and a plant press.

4.2. Preliminary surveys

The present study was conducted during July 2009 - April 2010. A preliminary survey was conducted for a week in July 2009 to identify the study sites and study groups. Suitable study sites were identified and habitat types were also assessed. Two different Boutourlini's blue monkey troops at two separate sites were selected for the study of their activity, diet and ranging patterns. The first troop (Group I) was located in tree dominated forest with low disturbance while the second troop (Group II) inhabited a tree and bamboo dominated habitat type. The habitat of Group II was partly surrounded by farmland and is characterized by relatively high human and livestock disturbances. The study troops were partially habituated to human observers for two weeks by following the group throughout the day to approach the monkeys to within 10-25 meters.

4.3. Detailed studies

4.3.1. Vegetation Description

Vegetation studies were carried out by laying transects within the study groups' home ranges using random stratified sampling method (Krebs, 1989). From the transects, four 50 x 10 m quadrats were placed at random in the home range of each of the two study groups (I and II). In each quadrat, for all sampled plants, the species and number of individuals were recorded (Siex, 2003).

From the vegetation data collected, the density of plant species was calculated for plants including herbs, shrubs, lianas and trees. In addition, plant species diversity was

calculated using the Shannon-Wiener index, *H',* and plant species evenness was calculated using the evenness index, J (Krebs, 1989) to determine whether the dietary species are evenly distributed or not in the study group's home ranges.

4.3.2. Habitat use

The habitat use of Boutourlini's blue monkeys in Jibat Forest was assessed during scan sampling on the selected study groups. Habitat types were recorded during scan sampling for the activity pattern study. This was undertaken every 15 minutes as the group moved from one point to another in their habitats (Vié *et al*., 2001). The difference in time they stayed in a particular habitat indicated the use of one habitat over the other.

Habitat use was analyzed by calculating the proportion of the number of group scans the groups spend in different habitats (Wallace, 2006). The habitat use of Boutourlini's blue monkeys was analyzed from the scan samples data. The proportion of time spent in a particular habitat type was obtained from scan samples collected in each group. The analysis of habitat use was determined from the expected number of group sightings in each habitat type based on the proportion of each habitat that was actually used.

4.3.3. Activity pattern

The instantaneous scan sampling method was used to collect behavioural data on multiple group members (Altmann, 1974). Activity and dietary data were collected from each of the two study troops (Group I and II) for 5 consecutive days per month covering both the wet and dry seasons (Fashing, 2001a).

During activity scan sampling, the activities of monkeys were recorded for 5 minutes at 15 minute intervals during 07:00-17:30 h (Fashing, 2001a; Wong and Sicotte, 2007). In addition, group spreads (in meters) the study groups were estimated and recorded every fourth scan (i.e. once/hour). The activity recorded for each visible individual was

the first activity that lasted for 5 seconds. Data were collected for the first 1-5 visible adults, sub-adults or juveniles (ignoring infants) at the time of each scan. The group was scanned each time from left to right to avoid possible biases towards eye-catching activities like grooming, fighting or mating (Fashing, 2001a). The identity of the scanned individual was recorded and assigned to one of the following age/sex classes: adult male, adult female, sub-adult male, sub-adult female, juvenile male or juvenile female. An individual scanned was recorded as performing one of the following behavioural records on the standardized data sheet: feeding, moving, resting, playing, aggression, grooming, sexual activity and others (Fashing, 2001a). The behavioural activities were recorded when the monkeys perform defined activities belonging to the one of the behavioural activities. Feeding was recorded when monkeys manipulated, masticated, or ingested a particular food item. Moving was recorded when monkeys changed spatial position, including walking, jumping, or running. Resting was recorded when monkeys were inactive, either sitting or lying down. Playing included chasing, hitting, and other vigorous activities involving exaggerated movements and gestures by a monkey interacting with others in a nonaggressive manner. Aggression was recorded when a monkey chased, bit, grabbed, displaced, threatened another monkey, or vocalized in an aggressive context. Grooming was recorded when a monkey used its hands to explore or to clean its body or the body of another monkey. Sexual activities was recorded when an individual engaged in copulatory behaviours. Others was recorded when a monkey performed activities such as vocalizating or defecating that did not fit into the main categories (Addisu Mekonen *et al.,* 2010).

Activity time budget was calculated by dividing the proportion of the number of behavioural records for each activity category by the total number of activity records each day. Then it was summed within each month to construct monthly proportions of time budgets. The grand mean proportion of the monthly budgets provides the overall wet and dry season time budgets, as well as the overall time budgets during the entire study period (Di Fiore and Rodman, 2001).

4.3.4. Feeding ecology

During the activity scan sampling described above, if the monkey was observed feeding, the type of food item it consumed was recorded as young leaves, mature leaves, roots, stems, flowers, fruits, seeds, shoots, barks, unknown plant parts or animal prey. The type of species consumed was also recorded (Fashing, 2001b; Fairgrieve and Muhumuza, 2003; Di Fiore, 2004). Shoots are the newly grown aerial parts of plants including buds. Unidentified species were collected for further taxonomic identification in the National Herbarium, Addis Ababa University. Animal prey was recorded when a monkey was observed scratching tree bark, exposing curled leaves, or masticating and ingesting invertebrates or vertebrates (Dietz *et al.,* 1997).

Diet composition was evaluated by calculating the proportion of different food items and species consumed by the monkeys. The daily food items and type of species consumed by the groups was summed within each month to construct monthly proportion of food items and food types consumed. The monthly proportion of each food item was also calculated as the total number of monthly individual scans for each food item divided by the total number of individual scans for all food item individual scans spent for the groups. The relative proportion of plant species used as food for blue monkeys was calculated from the monthly percentage contribution of different species (Fashing, 2001b; Di Fiore, 2004).

4.3.5. Ranging pattern

The geographic centre of the study groups was recorded during the scan sampling at 15 minute intervals as described by Fashing (2001b). GPS locations were recorded even if activity data were not recorded when there was poor visibility of the whole group. To confirm a group's probable location during poor visibility, different cues were used such as tree branches moving, leaves or fruits falling and vocalizations (Addisu Mekonnen, 2008).

Day range lengths were calculated based on full-day follows only (Fashing, 2001a; Kaplin, 2001). Each day range was drawn on a GIS-system generated map (ArcMap version 9.1) by connecting the consecutive GPS location records and calculating the total distances travelled per day. These distances were calculated from the map by using the GIS software ArcGIS'9. The minimum convex polygon method (MCP) was used to determine the home range sizes of blue monkeys using GIS software (ArcMap version 9.1). To estimate home range size, all ranging data points from the day ranges were combined to generate both 95% and 100% MCPs. The area was calculated by GIS ArcView 9.1.

4.4. Data analysis

Data were analyzed using the SPSS 15.0 software for Windows Evaluation Version. Statistical tests used were two-tailed with 95% confidence intervals. Chi-square test was used to compare between groups and between seasons.

5. RESULTS

5.1. Vegetation

A total of 62 plant species were recorded in the home range of Group I and 53 plant species were recorded in the home range of Group II (Tables 1 and 2). The plant species diversity in the home ranges of the study groups were 2.02 and 0.80 for Group I and Group II, respectively. The home ranges' plant species evenness was 0.20 for Group I and 0.07 for Group II.

5.2. Habitat use

Out the total of 10,610 scan samples for Group I (n=4473), 89.7% of behavioural scans were obtained in the tree dominated forest, while 10.4% were in the bushland dominated by *Rubus apetalus* species with few scattered trees. The monkeys in Group II inhabited four different habitat types. The scan samples for Group II (n=6137) indicated that 37.3% were sampled in tree dominated forest, 25.8% in bushland, 26.8% in bamboo forest and 10.1% in farmland (Table 3).

5.3. Activity pattern

There were 9-11 individuals in Group I and 20-23 individuals in Group II. They live in groups of one male and many females with their juveniles and infants.

The overall activity time budgets of the two groups are given in fig. 3. Boutourlini's blue monkeys in Group I spent 49.9% of their time in feeding, 20.1% moving and 20.6% resting. The corresponding values for Group II were: 47.3% feeding, 16.3% moving and 22.5% resting. Time spent while socializing by Group I was 2.7% playing, 1.3% aggression, 5.2% grooming and 0.2% sexual activities.

Table 1. The relative abundance of plants within the home range of Group I.

Local name	Scientific name	Family	Type	No. of stem in study quadrats	Relative abundance
Baqari	*Satureja simensis*	Laminaceae	H	6,000	29.51
Maxxane boffa	*Agrocharis incognite*	Apiaceae	H	5525	27.17
Kichu	*Pilea bambuseti*	Urticaceae	H	3000	14.75
Hedda Hantuta	*Ipomoea eriocarpa*	Convolvulaceae	C	1500	7.38
Insosila	*Impatiens rothii*	Balsaminaceae	H	1,500	7.38
Darru	*Pentas lanceolata*	Rubiaceae	H	625	3.07
Goraa	*Rubus apetalus*	Rosaceae	S	365	1.80
Gursuma	*Laggera crispate*	Asteraceae	H	362	1.78
Adamo guracha	*Oxyanthus speciosus*	Rubiaceae	T	253	1.24
Lumanguri	*Pluchea dioscoidis*	Asteraceae	H	225	1.11
Hedda abagawa	*Mikania cordata*	Asteraceae	H	201	0.99
Hedda annanno	*Periploca linearifolia*	Asclepiadaceae	L	115	0.57
Lankisa	*Urera hypselodendron*	Urticaceae	C	101	0.50
Doobi	*Girardinia bullosa*	Urticaceae	H	77	0.38
Malakata	*Solanecio manni*	Asteraceae	S	58	0.29
Karoo	*Pteridium aquilinum*	Polypodiaceae	F	45	0.22
Adamo	*Gallineira coffeoides*	Rubiaceae	T	43	0.21
Hedda ature	*Rhynchosia resinosa*	Leguminaceae	C	42	0.21
Gebo	*Landolphia buchananii*	Apocyanaceae	C	40	0.20
Hanquu	*Embelia schimperi*	Myrsinaceae	W	33	0.16
Hedda ichelbee	*Jasminum abyssinicum*	Oleaceae	L	29	0.14
Karoo	*Drynaria volkensii*	Polypodiaceae	Ep	25	0.12
Bosoqa	*Senecio gigas*	Asteraceae	H/T	23	0.11
Koshmfola	*Argomulera macrophylla*	Euphorbiaceae	S	15	0.07
Hedda boffa	*Cyphostemma adenanthum*	Vitaceae	C	14	0.07
Measa	*Ilex mitis*	Aquifoliaceae	T	14	0.07
Muka dimma	*Droguetia iners*	Urticaceae	H	11	0.05
Baddeessaa	*Syzygium guineense*	Myrtaceae (T)	T	10	0.05
Tefik qarare	*Ajuga integhifolia*	Laminaceae	H	10	0.05
Abagowa	*Cyathula uncinulata*	Amaranthaceae	H	8	0.04
Meexxi	*Dracaena afromontana*	Dracaebaceae	T/S	6	0.03
Chachunge	*Discopodium penninervium*	Solanaceae	W	4	0.02
Hibamaracha	*Lactuca paradoxa*	Asteraceae	H	4	0.02
Lolichisa	*Bersama abyssinica*	Melianthaceae	T	4	0.02
Dhora	*Pentas lanceolata subsp. Lanceolata*	Rubiaceae	S	4	0.02

(Continued)

Kumbala	*Apodytes dimidiate*	Icacinaceae	T	3	0.01
Qomogno	*Brucea antidysentrica*	Simaroubaceae	S	3	0.01
Reejji	*Vernonia myriantha*	Asteraceae	S	3	0.01
Shimela	*Arundinaria alpina*	Poaceae	B	3	0.01
Inchini	*Triumfetta brachyceras*	Tiliaceae	S	3	0.01
Hedda fitti	*Clematis hirsute*	Ranunculaceae	C	3	0.01
Odobada	*Myrsine melanophloeos*	Myrsinaceae	T	3	0.01
Arbuu	*Ficus sur Forssk*	Moraceae	T	2	0.01
Dannisa	*Dombeya torrid*	Sterculiaceae	T	2	0.01
Homi	*Prunus africana*	Rosaceae	T	2	0.01
Mixo	*Rytigymia neglecta*	Rubiaceae	T	2	0.01
Samat'e	*Galium spurium*	Rubiaceae	S	2	0.01
Andode	*Phytolacca dodecandra*	Phytolaccaceae	S	1	0.00
Bokolo Worabesa	*Arisaema glandulosus*	Laminaceae	H	1	0.00
Bakaninsa	*Croton macrostachys*	Euphorbiaceae	T	1	0.00
Hexxo	*Hagenia abyssinica*	Rosaceae	T	1	0.00
Korati seere	*Acanthus eminens*	Acanthaceae	S	1	0.00
Soolee	*Olinia rochetiana*	Oliniaceae	T	1	0.00
Imala	*Albizia gummifera*	Fabaceae	T	1	0.00
Geja	*Olea hochstettri*	Oleaceae	T	1	0.00
Serera	*Allophyllus abyssinicus*	Sapindaceae	T	1	0.00
Sombo	*Ekebergia capensis*	Meliaceae	T	1	0.00
Luqqe	*Schefflera abyssinica*	Araliaceae	T	1	0.00
Hadheesa	*Vepris dainelli*	Ruraceae	T	1	0.00
Abayyi	*Maesa lanceolata*	Myrsinaceae	T	0	0.00
Digalu	*Oliverella hildebrandtii*	Loranthaceae	E	0	0.00
Hedda addi	*Zehneria scabra*	Cucurbitaceae	C	0	0.00

T-Tree, S-Shrub, C- Climber, H-Herb, WH-Woody herb, Ep-Epiphyte, F-Fern, B-Bamboo

Group II spent 3.3% of its time playing, 2.6% aggression, 7.7% grooming and 0.4% sexual activities. Chi-square test showed that there was no significant difference in time spent between the two groups while feeding, moving, resting and socializing ($P>0.05$).

Table 2. The relative abundance of plants within the home range of Group II.

Local name	Scientific name	Family	Type	No. of stem in study quadrats	Relative abundance
Baqari	*Satureja simensis*	Laminaceae	H	22400	82.82
Shimela	*Arundinaria alpina*	Poaceae	B	1698	6.28
Aja'a	*Plectranthus garckeanus*	Lamiaceae	H	1095	4.05
Qorichamichi	*Plectranthus glandulosus*	Laminaceae	H	775	2.87
Lumanguri	*Pluchea dioscoidis*	Asteraceae	H	200	0.74
Darru	*Pentas lanceolata*	Rubiaceae	H	127	0.47
Hedda annanno	*Periploca linearifolia*	Asclepiadaceae	L	121	0.45
Hidi worabesa	*Solanum incanum*	Solanaceae	H	100	0.37
Abagowa	*Cyathula uncinulata*	Amaranthaceae	H	75	0.28
Gursuma	*Laggera crispate*	Asteraceae	H	61	0.23
Goraa	*Rubus apetalus*	Rosaceae	S	57	0.21
Muka dimma	*Droguetia iners*	Urticaceae	H	50	0.18
Lankisa	*Urera hypselodendron*	Urticaceae	C	40	0.15
Malakata	*Solanecio manni*	Asteraceae	S	35	0.13
Hedda boffa	*Cyphostemma adenanthum*	Vitaceae	C	26	0.1
Doobi	*Girardinia bullosa*	Urticaceae	H	24	0.09
Reejji	*Vernonia myriantha*	Asteraceae	S	18	0.07
Hibamaracha	*Lactuca paradoxa*	Asteraceae	H	18	0.07
Hedda addi	*Zehneria scabra*	Cucurbitaceae	C	18	0.07
Insosila	*Impatiens rothii*	Balsaminaceae	H	15	0.06
Chachunge	*Discopodium penninervium*	Solanaceae	WH	11	0.04
Lolichisa	*Bersama abyssinica*	Melianthaceae	T	11	0.04
Samat'e	*Galium spurium*	Rubiaceae	S	10	0.04
Bosoqa	*Senecio gigas*	Asteraceae	H/T	9	0.03
Measa	*Ilex mitis*	Aquifoliaceae	T	9	0.03
Koshmfola	*Argomulera macrophylla*	Euphorbiaceae	S	7	0.03
Karoo	*Pteridium aquilinum*	Polypodiaceae	F	2	0.01
Qomogno	*Brucea antidysentrica*	Simaroubaceae	S	6	0.02
Bakanisa	*Croton macrostachys*	Euphorbiaceae	T	4	0.01
Soolee	*Olinia rochetiana*	Oliniaceae	T	3	0.01
Heda fitti	*Clematis hirsute*	Ranunculaceae	C	2	0.01
Hedda ature	*Rhynchosia resinosa*	Leguminaceae	C	2	0.01
Homi	*Prunus africana*	Rosaceae	T	2	0.01
Inchini	*Triumfetta brachyceras*	Tiliaceae	S	2	0.01
Illibu	*Bothriocline schimperi*	Asteraceae	H	**2**	0.01
Luqqe	*Schefflera abyssinica*	Araliaceae	T	2	0.01
Qawwisa	*Buddleja polystachya*	Loganiaceae	T/S	2	0.01
Worqe	*Enset ventricosum*	Musaceae	H	2	0.01
Hedda buqe	*Ampelocissus schimperiana*	Vitaceae	C	1	0

(Continued)

Adamo	*Gallineira coffeoides*	Rubiaceae	T	1	0.00
Abbayyi	*Maesa lanceolata*	Myrsinaceae	T	1	0.00
Digalu	*Oliverella hildebrandtii*	Loranthaceae	Ep	1	0.00
Serera	*Allophyllus abyssinicus*	Sapindaceae	T	1	0.00
Dhora	*Pentas lanceolata subsp. Lanceolata*	Rubiaceae	S	1	0.00
Hedda hantuta	*Ipomoea eriocarpa*	Convolvulaceae	C	0	0.00
Garbu	*Hordeum vulgare*	Poaceae	H	0	0.00
Qamadi	*Triticum aestivum*	Poaceae	H	0	0.00
Sombo	*Ekebergia capensis*	Meliaceae	T	0	0.00
Kumbala	*Apodytes dimidiate*	Icacinaceae	T	0	0.00
Karoo	*Drynaria volkensii*	Polypodiaceae	Ep	0	0.00
Hedda abagowa	*Mikania cordata*	Asteraceae	H	**0**	0.00
Tefiki qarare	*Ajuga integhifolia*	Laminaceae	H	0	0.00
Mixo	*Rytigymia neglecta*	Rubiaceae	T	0	0.00

T-Tree, S-Shrub, C- Climber, H-Herb, WH-Woody herb, Ep-Epiphyte, F-Fern, B-Bamboo

Table 3. Percentage of scan samples of Boutourlini's blue monkeys in different habitat types.

	% time spent			
Group	Tree dominated forest	Bushland	Bamboo forest	Farmland
I	89.7	10.4	0.0	0.0
II	37.3	25.8	26.8	10.1

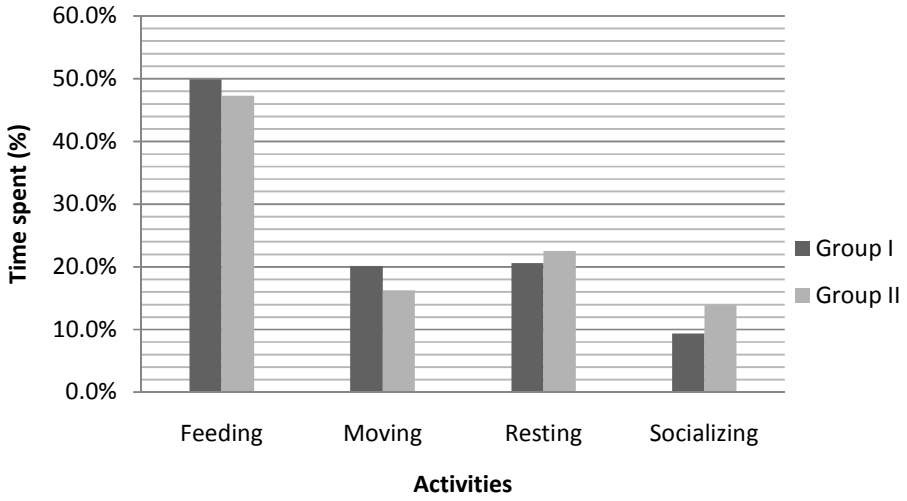

Figure 3. Overall activity time budgets for Boutourlini's blue monkeys in Groups I and II.

Individuals in Group I, on average spent more time in feeding (52.3%) during the dry season than during the wet season (48.1%). They spent more time moving (21.5%) and resting (21.3%) during the wet season than during the dry season (18.3%) and (19.7%), respectively. They spent more time in social activities such as playing (3.0%) and aggression (1.8%) during the dry season than during the wet season, where they spent (2.4%) playing and (1.0%) aggression. However, only small amounts of time were spent in sexual activities (0.4%) during the wet season and none during the dry season (Table 4).

Individuals in Group II on average spent almost equal time in feeding during the wet season (47.5%) and the dry season (47.1%). This group spent more time moving during the wet season (18.6%) than during the dry season (13.1%). More time was also spent on other activities such as resting (23.4%), playing (4.9%), aggression (3.3%) and grooming (8.1%) during the dry season than during wet season, resting, 21.9%; playing, 2.1%; aggression, 2.1% and grooming, 7.4%. Sexual activities took 0.5% of their daily time during the wet season and 0.2% during the dry season (Table 4).

The chi-square test value for both groups (Group I and II) showed that there was no significant difference in time spent between the two seasons in any of the major activities ($P>0.05$).

Table 4. Seasonal activity time budgets for Boutourlini's blue monkeys in Groups I and II.

		Activities (%)								
Group	Season	Feeding	Moving	Resting	Playing	Aggression	Grooming	Sexual Activaty	Drinking	Others
I	Wet	48.1	21.5	21.3	2.4	1.0	5.4	0.4	0.0	0.0
I	Dry	52.3	18.3	19.7	3.0	1.8	4.9	0.0	0.0	0.0
II	Wet	47.5	18.6	21.9	2.1	2.1	7.4	0.5	0.0	0.0
II	Dry	47.1	13.1	23.4	4.9	3.3	8.1	0.2	0.0	0.0

5.4. Feeding ecology

The two groups inhabited partly different habitat types. The home range of Group I is tree dominated forest composed of small patches of bushlands. Individuals in Group II range through four habitat types: tree dominated forest, bushland and bamboo dominated forest and partly surrounding farmlands.

Group I depended more on fruits, which accounting for 52.5% of the overall diet (n=2232 feeding records). Animal prey (14.7%) and young leaves (11.1%) made the second and third largest parts of their diet. Other important food items consumed were shoots (8.7%) and flowers (7.3%). Members of this group consumed other food items such as mature leaves (3.1%); seeds (0.6%); bark (1.7%) and unidentified food items (0.4%) rarely (Table 5).

Table 5. Percentage contribution of feeding time to feed upon different food items by the Boutourlini's blue monkeys

	Percent of time	
Food items	Group I (n=2232)	Group II (n=2903)
Shoots	8.7	29.8
Young leaves	11.1	17.1
Mature leaves	3.1	4.4
Bark	1.7	1.5
Roots	0	0
Stems	0	0.1
Flowers	7.3	6.8
Fruit	52.5	17
Seeds	0.6	9.6
Animal prey	14.7	13.1
Others	0.4	0.7
Total	100	100

n=number of observations

The most frequently consumed food items by Group II was shoots, which accounted for 29.8% of the overall diet (n=2903 feeding records) during the study period. Young leaves, fruits and animal prey were the next most often consumed food items, accounting for 17.1%, 17.0%, and 13.1% of the diet, respectively. Seeds, flowers and

mature leaves constituted for 9.6%, 6.8% and 4.4% of the diet, respectively. Other food items such as bark 1.5%, unknown food items 0.7% and stem 0.1% were eaten rarely (Table 5). Their animal diets were insects and their larvae, spiders, ants, birds and their eggs.

Chi-square test showed that there were significant differences in time spent feeding on fruit, shoot and seeds ($P<0.05$) between individuals of the two groups. However, there were no significant difference between the two groups in time spent feeding on young leaves, mature leaves, bark, flowers, animal prey and unknown or other food items ($P>0.05$).

During the study period, Boutourlini's blue monkeys in Group I consumed a total of 24 plant species which accounted for more than 85% of their diet and individuals of Group II consumed 33 plant species, which accounted for more than 83% of their diet. The percentage contribution and the food items are presented in Table 6 and 7.

Of the 24 plant species that contributed for the overall diet of Group I, the top five species accounted for 68% of the plant diet (Table, 6). Based on total percentage contribution of plant food items, *Ficus sur* was the most consumed species accounting for 39.87%, *Ilex mitis* 15.14%, *Syzygium guineense* 7.66%, *Rubus apetalus* 2.69% and *Landolphia buchananii* 2.64%. In the case of Group II, the following five highly consumed plant species accounted for 48% of their total plant diet. *Arundinaria alpina* contributed for 20.63%, *Ilex mitis* 9.27%, *Rubus apetalus* 7.54%, *Triticum aestivium* 6.10% and *Prunus africana* 5.24% (Table 7).

The monthly percentage contribution of different food items from different plants to the diet of Group I is also shown in Table 8. Fruits were the top food item for most months (range 24.5–80.7%) during the study period. Animal prey (2.3-39.6 %) or young leaves (2.2–20.3%) were the second most highly consumed food items in most months. Shoots

(0.0-35.0%), flowers (0.0-35.9 %) and mature leaves (0.0-15.1 %) were consumed in significant amounts for a few months only.

The monthly percentage contribution of different food items from different plants to the diet of Group II is also shown in Table 8. Unlike Group I, this group spent much of the time during most months of the study predominantly foraging on shoots (range 15.6-48.1%). They also consumed fruits (1.7-42.3%), young leaves (8.1-33.5%) and animal prey (8.6-27.2%) during almost all months of the study period.

Table 6. List of plants, food items consumed and the percentage contribution in the plant diet of Boutourlini's blue monkeys (Group I).

Local name	Scientfic name	Family	Type	Plant parts consumed	% contribution
Arbuu	*Ficus sur*	Moraceae	T	BA, FR	39.87
Measa	*Ilex mitis*	Aquifoliaceae	T	SH, YL, ML, BA, FL	15.14
Gumari	*Syzygium guineense*	Myrtaceae	T	YL,ML,BA,FR,SD	7.66
Goraa	*Rubus apetalus*	Rosaceae	S	SH, FL, FR,	2.69
Gebo	*Landolphia buchananii*	Apocyanaceae	C	YL, ML, FR	2.64
Hedda ture	*Rhynchosia resinosa*	Leguminaceae	C	YL, ML	2.46
Kumbala	*Apodytes dimidiate*	Icacinaceae	T	YL, ML, FR	2.20
Hedda boffa	*Cyphostemma adenanthum*	Vitaceae	C	YL, ML, FR	2.20
Lankisa	*Urera hypselodendron*	Urticaceae	C	SH, FL, FR,	1.79
Homi	*Prunus africana*	Rosaceae	T	SH, YL, ML	1.30
Chachunge	*Discopodium penninervium*	Solanaceae	WH	YL,ML	1.25
Soolee	*Olinia rochetiana*	Oliniaceae	T	FR	1.08
Shimela	*Arundinaria alpina*	Poaceae	B	SH, YL	0.76
Insosila	*Impatiens rothii*	Balsaminaceae	H	SH, FL	0.72
Sombo	*Ekebergia capensis*	Meliaceae	T	SH, BA	0.67
Karoo	*Drynaria volkensii*	Polypodiaceae	Ep	ML	0.58
Qomogno	*Brucea antidysentrica*	Simaroubaceae	S	FR	0.49
Hedda addi	*Zehneria scabra*	Cucurbitaceae	C	YL	0.49
Mixo	*Rytigymia neglecta*	Rubiaceae	T	YL, ML	0.36
Serera	*Allophyllus abyssinicus*	Sapindaceae	T	YL, ML, BA	0.22
Hibamaracha	*Lactuca paradoxa*	Asteraceae	H	YL, ML,FL	0.18
Dannisa	*Dombeya torrid*	Sterculiaceae	T	BA	0.09
Digalu	*Oliverella hildebrandtii*	Loranthaceae	Ep	FR	0.04
Hedda anano	*Periploca linearifolia*	Asclepiadaceae	L	SD	0.04
					84.92

- T-Tree, S-Shrub, C- Climber, H-Herb, L- liana, WH-Woody herb, Ep-Epiphyte, B-Bamboo
- SH-Shoot, YL-Young leave, ML-Mature leave, BA-Bark, FL-Flower, FR-Fruit, SD-Seed

Table 7. List of plants, food items consumed and the percentage contribution in the plant diet of Boutourlini's blue monkeys (Group II).

Local name	Scientific name	Family	Type	Plant parts consumed	% contribution
Shimela	*Arundinaria alpina*	Poaceae	B	SH, YL, ML,	20.63
Measa	*Ilex mitis*	Aquifoliaceae	T	SH, YL, ML, FL	9.27
Goraa	*Rubus apetalus*	Rosaceae	S	SH, YL, ML, FL,FR	7.54
Wheat	*Triticum aestivum*	Poaceae	H	SD	6.10
Homi	*Prunus africana*	Rosaceae	T	SH, YL,ML, FR	5.24
Qomogno	*Brucea antidysentrica*	Simaroubaceae	S	FR	3.13
Arbuu	*Ficus sur*	Moraceae	T	SH, FR	3.34
Darru	*Pentas lanceolata*	Rubiaceae	H	SH, YL, ML	2.86
Hedda ture	*Rhynchosia resinosa*	Leguminaceae	C	YL, ML, FL	2.82
Soolee	*Olinia rochetiana*	Oliniaceae	T	YL, ML,BA, FR, SD	2.65
Karoo	*Drynaria volkensii*	Polypodiaceae	Ep	YL, ML, BA, ST	2.58
Aja'a	*Plectranthus garckeanus*	Lamiaceae	H	FL	2.55
Garbu	*Hordeum vulgare*	Poaceae	H	SD	2.48
Hibamaracha	*Lactuca paradoxa*	Asteraceae	H	YL	2.24
Lankisa	*Urera hypselodendron*	Urticaceae	C	SH, FL, FR	1.83
Qorichamichi	*Plectranthus glandulosus*	Laminaceae	H	YL, FR	1.62
Serera	*Allophyllus abyssinicus*	Sapindaceae	T	BA, FR	1.65
Chachunge	*Discopodium penninervium*	Solanaceae	WH	SH, ML	1.14
Illibu	*Bothriocline schimperi*	Asteraceae	H	YL, ML	0.83
Digalu	*Oliverella hildebrandtii*	Loranthaceae	Ep	FR, SD	0.83
Sombo	*Ekebergia capensis*	Meliaceae	T	SH, ML, BA, FR	0.76
Hedda boffa	*Cyphostemma adenanthum*	Vitaceae	C	SH, YL, FR	0.72
Insosila	*Impatiens rothii*	Balsaminaceae	H	YL, FL	0.72
Kumbala	*Apodytes dimidiate*	Icacinaceae	T	YL, ML, BA, FR	0.69
Bakanisa	*Croton macrostachys*	Euphorbiaceae	T	BA, SD	0.34
Samat'e	*Galium spurium*	Rubiaceae	S	YL, ML, FL	0.34
Luqqa	*Schefflera abyssinica*	Araliaceae	T	BA	0.34
Hedda addi	*Zehneria scabra*	Cucurbitaceae	C	YL	0.24
Lolichisa	*Bersama abyssinica*	Melianthaceae	T	SH, BA	0.17
Mixo	*Rytigymia neglecta*	Rubiaceae	T	FR	0.17
Worqe	*Enset ventricosum*	Musaceae	H	FR	0.14
Adamo	*Gallineira coffeoides*	Rubiaceae	T	SH, FR	0.10
Hedda fitti	*Clematis hirsute*	Ranunculaceae	C	YL	0.10
					86.16

- T-Tree, S-Shrub, C- Climber, H-Herb, WH-Woody herb, Ep-Epiphyte, B-Bamboo
- SH-Shoot, YL-Young leave, ML-Mature leave, BA-Bark, ST-Stem, FL-Flower, FR-Fruit, SD-Seed

Table 8. Percentage contribution of different food items to the diet of Boutourlini's blue monkeys during the study period (July 2009 – 2010). of Groups I and II.

Group I

	% of food Items										
Month	Shoots	Young leaves	Mature leaves	Bark	Roots	Stems	Flowers	Fruit	Seeds	Animal prey	Others
Jul	-	20.3	6.9	8.4	-	-	-	58.0	0.6	5.6	-
Aug	0.9	20.2	15.1	6.9	-	-	-	48.2	5	2.3	1.4
Sep	32.0	3.0	3.5	0.5	-	-	5.5	39.5	-	16.0	-
Oct	35.0	5.5	8.6	0.5	-	-	10.5	24.5	-	14.1	1.4
Nov	14.5	11.4	-	0.7	-	-	35.9	29.1	-	8.3	-
Dec	1.7	18.6	-	-	-	-	8.8	55.8	-	14.9	-
Jan	1.7	17.8	-	0.7	-	-	1.7	70.7	-	6.6	0.7
Feb	-	2.2	-	0.4	-	-	0.9	80.7	-	15.8	-
Mar	0.4	5.5	-	1.3	-	-	-	52.8	0.4	39.6	-
Apr	-	6.9	-	-	-	-	-	68.8	-	24.3	-
Group II											
Jul	48.1	27.1	-	1.9	-	-	1.2	8.5	3.5	8.9	0.8
Aug	42.3	8.1	14.8	4.9	-	-	2.0	13.0	3.8	10.1	0.9
Sep	43.9	9.7	19.9	4.6	-	-	1.4	1.9	-	14.8	3.7
Oct	46.6	18.8	0.3	0.3	-	-	23.2	1.7	-	9.1	-
Nov	20.6	33.5	0.3	-	-	-	24.9	6.2	5.9	8.6	-
Dec	15.6	18.2	1.7	-	-	0.9	4.3	8.7	41.1	9.5	-
Jan	16.4	10.8	-	-	-	-	3.4	26.5	33.3	9.6	-
Feb	16.8	11.3	-	1.0	-	-	-	42.3	8.2	20.3	-
Mar	23.7	10.5	0.9	-	-	-	-	34.6	3.1	27.2	-
Apr	15.7	23.5	-	0.5	-	-	-	40.7	-	18.6	0.9

Individuals in Group I spent more time feeding on fruit during the dry season (57.9%) than during the wet season (47.9%) (Table 9). They spent more time feeding on flowers (12.8%) and young leaves (12.7%) during the dry season than during the wet season. During the wet season, they spent more time consuming animal prey (17.9%) and shoots (11.8%). Time spent feeding on flowers (2.8%) and young leaves (9.7%) during the wet season. The monkeys in this group devoted 5.7% of their time feeding on mature leaves during the wet season but they did not feed on mature leaves during dry season. For Group I, Chi-square tests showed that there were no significant differences in time spent feeding on shoots, young leaves, mature leaves, bark, fruits, seeds,

animal prey and other plant parts between the two seasons (P>0.05). However, time spent feeding on flowers showed significant difference between the two seasons (P<0.05).

Table 9. Percent of time spent by the two groups of Boutourlini's blue monkeys feeding on different food items at different seasons.

Time spent by individuals of Group I (%)		
Diet	Dry season	Wet season
Shoot	5.0	11.8
Young leaves	12.7	9.7
Mature leaves	0.0	5.7
Bark	0.5	2.6
Stem	0.0	0.0
Flowers	12.8	2.8
Fruit	57.9	47.9
Seeds	0.0	1.1
Animal prey	10.8	17.9
Others	0.2	0.5
Total	100	100

Time spent by individuals of Group II (%)		
Diet	Dry season	Wet season
Shoot	17.5	38.5
Young leaves	19.3	15.4
Mature leaves	0.4	7.4
Bark	0.2	2.4
Stem	0.2	0.0
Flowers	9.4	5.0
Fruit	20.7	14.3
Seeds	20.4	1.7
Animal prey	11.8	14.1
Others	0.0	1.2
Total	100	100

Group II spent more time feeding on shoots (38.5%) during the wet season than during the dry season (17.5%) (Table 9). They spent more time feeding on seeds (20.4%); young leaves (19.3%); animal prey (11.8%) and flowers (9.4%) during dry season. Time spent feeding on young leaves was (15.4%); animal prey (14.1%) and mature leaves (7.4%) during the wet season. In Group II, Chi-square tests showed that there were no significant differences in time spent feeding on young leaves, mature leaves, bark, fruits, animal prey and other unidentified plant parts between the two seasons (P>0.05). However, time spent feeding on shoots and seeds showed significant differences between seasons (P<0.05).

The major food items in the diet of Group I were fruits of *Ficus sur*, which accounted for 39.46% of the diet (Table 10). Animal prey, the second most often consumed item accounted for 14.7%. Shoots and flowers of *Ilex mitis* contributed for 6.40% and 5.04%, respectively. Fruits of *Syzygium guineense* contributed for 6.27% of the diet of Group I.

The major food items in the diet of Group II were the shoots of *Arundinaria alpina,* which accounted for 20.18%. Animal prey accounted for 13.1% of the diet. Seeds of *Triticum aestivum* accounted for 6.10% and fruits of *Rubus apetalus* for 5.63% of their diet (Table 11). Shoots of *Ilex mitis* accounted for 4.38%, young leaves of *Prunus Africana* for 3.60 % and the fruits of *Brucea antidysentrica* for 3.13% of their diet (Table 11).

Table 10. Percent of time spent feeding on specific food items (n=1896) by Group I.

Species name	Family	Type	Percent of time									
			Shoot	Young leave	Mature leave	Bark	Root	Stem	Flower	Fruit	Seed	Total
Ficus sur	Moraceae	T	-	-	-	0.41	-	-	-	39.46	-	39.87
Syzygium guineense	Myrtaceae	T	-	0.20	0.31	0.32	-	-	-	6.27	0.56	7.66
Discopodium penninervium	Solanaceae	WH	-	1.08	0.17	-	-	-	-	-	-	1.25
Dombeya torrid	Sterculiaceae	T	-	-	-	0.09	-	-	-	-	-	0.09
Oliverella hildebrandtii	Loranthaceae	E	-	-	-	-	-	-	-	0.04	-	0.04
Landolphia buchananii	Apocyanaceae	C	-	0.9	0.26	-	-	-	-	1.48	-	2.64
Rubus apetalus	Rosaceae	S	0.50	-	-	-	-	-	0.11	2.08	-	2.69
Rhynchosia resinosa	Leguminaceae	C	-	1.89	0.57	-	-	-	-	-	-	2.46
Cyphostemma adenanthum	Vitaceae	C	-	2.06	0.05	-	-	-	-	0.09	-	2.20
Lactuca paradoxa	Asteraceae	H	-	0.05	0.08	-	-	-	0.05	-	-	0.18
Periploca linearifolia	Asclepiadaceae	L	-	-	-	-	-	-	-	-	0.04	0.04
Zehneria scabra	Cucurbitaceae	C	-	0.49	-	-	-	-	-	-	-	0.49
Prunus africana	Rosaceae	T	0.52	0.69	0.09	-	-	-	-	-	-	1.30
Impatiens rothii	Balsaminaceae	H	0.02	-	-	-	-	-	0.70	-	-	0.72
Apodytes dimidiate	Icacinaceae	T	-	0.26	0.11	0.68	-	-	-	1.15	-	2.20
Drynaria volkensii	Polypodiaceae	Ep	-	-	0.58	-	-	-	-	-	-	0.58
Urera hypselodendron	Urticaceae	C	0.26	-	-	-	-	-	1.40	0.13	-	1.79
Ilex mitis	Aquifoliaceae	T	6.40	3.15	0.52	0.08	-	-	5.04	-	-	15.14
Rytigymia neglecta	Rubiaceae	T	-	0.18	0.18	-	-	-	-	-	-	0.36
Brucea antidysentrica	Simaroubaceae	S	-	-	-	-	-	-	-	0.49	-	0.49
Allophyllus abyssinicus	Sapindaceae	T	-	0.04	0.09	0.09	-	-	-	-	-	0.22
Olinia rochetiana	Oliniaceae	T	-	-	-	-	-	-	-	1.08	-	1.08
Ekebergia capensis	Meliaceae	T	0.35	-	-	0.09	-	-	-	0.23	-	0.67
Arundinaria alpine	Poaceae	B	0.65	0.11	-	-	-	-	-	-	-	0.76
Animal prey	-	-	-	-	-	-	-	-	-	-	-	14.70
Others	-	-	-	-	-	-	-	-	-	-	-	0.36

T-Tree, S-Shrub, C- Climber, H-Herb, L- liana, WH-Woody herb, Ep-Epiphyte, B-Bamboo

Table 11. Percent of time spent feeding on specific food items (n=2499) by Group II.

			Percent of time									
Species name	Family	Type	Shoot	Young leave	Mature leave	Bark	Root	Stem	Flower	Fruit	Seed	Total
Gallineira coffeoides	Rubiaceae	T	0.04	-	-	-	-	-	-	0.06	-	0.10
Plectranthus garckeanus	Lamiaceae	H	-	-	-	-	-	-	2.58	-	-	2.58
Ficus sur	Moraceae	T	2.74	-	-	-	-	-	-	0.60	-	3.34
Croton macrostachys	Euphorbiaceae	T	-	-	-	0.06	-	-	-	-	0.28	0.34
Discopodium penninervium	Solanaceae	WH	0.04	1.10	-	-	-	-	-	-	-	1.14
Pentas lanceolata	Rubiaceae	S	0.49	2.30	0.07	-	-	-	-	-	-	2.86
Oliverella hildebrandtii	Loranthaceae	E	-	-	-	-	-	-	-	0.17	0.66	0.83
Hordeum vulgare	Poaceae	H	-	-	-	-	-	-	-	-	2.48	2.48
Rubus apetalus	Rosaceae	S	0.91	0.04	0.07	-	-	-	0.89	5.63	-	7.54
Rhynchosia resinosa	Leguminaceae	C	-	2.44	0.28	-	-	-	0.10	-	-	2.84
Cyphostemma adenanthum	Vitaceae	C	0.03	0.64	-	-	-	-	-	0.05	-	0.72
Lactuca paradoxa	Asteraceae	H	-	2.24	-	-	-	-	-	-	-	2.24
Zehneria scabra	Cucurbitaceae	C	-	0.24	-	-	-	-	-	-	-	0.24
Clematis hirsute	Ranunculaceae	C	-	0.10	-	-	-	-	-	-	-	0.10
Prunus africana	Rosaceae	T	0.58	3.60	0.16	0.14	-	-	-	0.76	-	5.24
Bothriocline schimperi	Asteraceae	H	-	0.33	0.07	-	-	-	-	0.43	-	0.83
Impatiens rothii	Balsaminaceae	H	-	0.02	-	-	-	-	0.70	-	-	0.72
Apodytes dimidiate	Icacinaceae	T	-	0.16	0.16	0.27	-	-	-	0.10	-	0.69
Drynaria volkensii	Polypodiaceae	Ep	-	0.19	2.30	0.02		0.04	-	-	-	2.58
Schefflera abyssinica	Araliaceae	T	-	-	-	0.34	-	-	-	-	-	0.34
Bersama abyssinica	Melianthaceae	T	0.04	-	-	0.13	-	-	-	-	-	0.17
Urera hypselodendron	Urticaceae	C	0.34	-	-	-	-	-	0.20	1.29	-	1.83
Ilex mitis	Aquifoliaceae	T	4.38	2.40	0.94	0.13	-	-	1.42	-	-	9.27

(Continued)

Rytigymia neglecta	Rubiaceae	T	-	-	-	-	-	-	-	0.2	-	0.17
Brucea antidysentrica	Simaroubaceae	S	-	-	-	-	-	-	-	3.13	-	3.13
Plectranthus glandulosus	Laminaceae	H	-	0.74	-	-	-	-	0.88	-	-	1.62
Allophylus abyssinicus	Sapindaceae	T	-	-	-	0.03	-	-	-	1.62	-	1.65
Galium spurium	Rubiaceae	S	-	0.25	0.06	-	-	-	0.03	-	-	0.34
Olinia rochetiana	Oliniaceae	H	-	0.03	0.12	0.06	-	-	-	2.35	0.09	2.65
Ekebergia capensis	Meliaceae	T	0.12	-	0.14	0.12	-	-	-	0.49	-	0.76
Arundinaria alpine	Rubiaceae	B	20.18	0.41	0.04	-	-	-	-	-	-	20.63
Enset ventricosum	Musaceae	T	-	-	-	-	-	-	-	0.14	-	0.14
Triticum aestivum	Poaceae	H	-	-	-	-	-	-	-	-	6.10	6.10
Animal prey	-	-	-	-	-	-	-	-	-	-	-	13.12
Others	-	-	-	-	-	-	-	-	-	-	-	0.69

T-Tree, S-Shrub, C- Climber, H-Herb, L- liana, WH-Woody herb, Ep-Epiphyte, B-Bamboo

5.5. Ranging pattern

Home range

The area ranged by Group I during wet and dry seasons together had an extent of 72 ha and that of Group II had 61.2 ha (Fig. 4). The wet and dry season ranges were overlapped in the area of both these groups. Home range areas for Group I showed little variation between the dry and wet seasons. It was 53.4 ha during the dry season and 52.1 ha during the wet season. A Chi-square test showed no significant difference in home range size for Group I between the two seasons ($P>0.05$). The home range size for Group II was 57.6 ha during the dry season and 23.6 ha during the wet season. The home range areas of Group II showed significant differences between the dry and wet seasons ($P<0.05$).

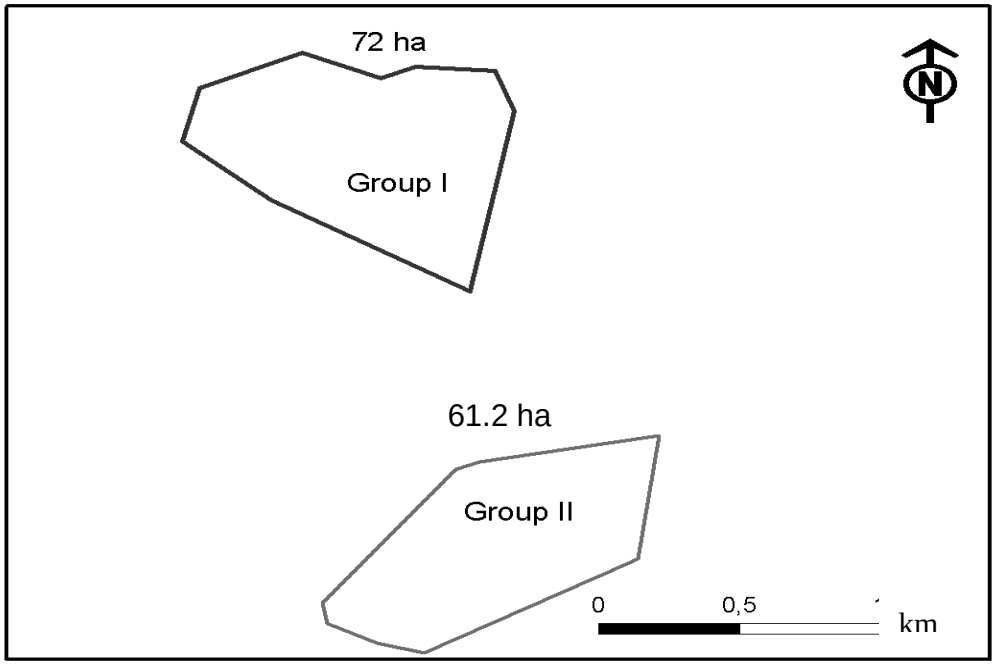

Figure 4. Home ranges of the two study groups of Boutourlini's blue monkey.

Daily range

The average daily range distance for Groups I and II during the study period was 799.0 m and 783.0 m, respectively. The combined mean daily range distance covered by the two study groups were found to be 787.1 m. The average daily range lengths for the wet and dry seasons for the study groups are shown in Table 12. The Chi-square test showed no significant difference in the daily range lengths of Boutourlini's blue monkeys of Group I between the wet and dry seasons ($P>0.05$). Group II showed significant difference in the daily range lengths between the two seasons ($P<0.05$).

Table 12. Mean daily travel distance and home range size of Group I and II during wet and dry seasons.

Season	Group	Mean distance travelled/ day (m) Mean (n)	Home range area (ha)
Wet	I	788.7(23)	52.1
	II	819.0(18)	23.6
Dry	I	806.6(18)	53.4
	II	734.1(13)	57.6

n=number of full day observations.

6. DISCUSSION

Most types of Old World monkeys of the genus *Cercopithecus* occupy varying forest habitats, from primary, secondary and gallery rain forest to bamboo forest, flooded and swamp forest (Jaffe and Isbell, 2007). The blue monkey (*C. mitis*) in particular are mostly distributed in tropical montane forests (Kaplin, 2001), moist, semideciduous forest and evergreen rainforest (Cords, 1986; Butynski, 1990). *C. mitis boutourlinii* is strictly associated with primary tropical deciduous and riverine forest (IUCN, 2008). However, the present study area is classified as humid Afromontane forest (Tamirat Bekele, 1994). Boutourlini's blue monkeys were observed in all the four types of habitats in the study area. Individuals of Group I entirely occupied tree dominated forests but were only rarely seen in bushlands while foraging. Members of the second group were also spent more of the time in the tree dominated forest (>37%) than in any habitat type. However, considerable amount of time was also spent by Group II in the bushland (>25%) and bamboo forest (>26%) but they were rarely seen in farmland (<11%). According to Jaffe and Isbell (2007), guenons living in open habitats become more vulnerable to predators. In the present study, the limited ranging in open areas might be related to the avoidance of predators.

Blue monkeys exhibited a tendency to spend more time in mature forest habitats, which may be linked to both fruit resource availability and structural characteristics such as larger fruit patches (Leighton, 1993) or a closed canopy for arboreal travel (Kaplin, 2001). Hence their primary tendency to use tree dominated forests in this study may be correlated with the availability of these resources especially potential fruiting trees in the forest than in other habitat types. Interestingly, it is also common to observe at least one sub-species of *C. mitis* in bamboo forest. For example, golden monkeys (*Cercopithecus mitis kandti)* were found to occupy bamboo forest and bamboo with mixed tree habitats at Mgahinga Gorilla National Park, Uganda (Twinomugisha *et al*., 2003).

The result of the present study also revealed that Boutourlini's blue monkey spend more time in feeding than moving and resting. This a common trend is also observed among most members of the geunon (Appendix I). In most cases, the activity time budget has

direct correlation with the availability of specific resources and dietary diversity. Blue monkeys showed high movement pattern to encounter fruit when there is fruit scarcity (Kaplin, 2001). Dry season is the time for most fruiting plants to bear fruits. The feeding time budget for Group I showed little variation between the two seasons. This variation might suggest that the availability of fruits during the dry season allowed them to take more time when foraging as it is their primary choice. The presence of ample resource would reduce the time spent for searching it. However, the feeding time budget for Group II was almost the same in both seasons. This group spent most of their time constantly feeding on bamboo shoots, leaves of different herbs, shrubs, lianas and trees during the study period. The probable reason could be the presence of very few fruiting trees in their range. The time spent for resting also showed little variation (insignificant) between the groups and seasons. The time budget for social activities, especially for playing, aggression and grooming took greater time during the dry season. This might be related to the sunlight that can induce them to perform social activities via playing and grooming.

Forest dwelling guenons exhibit a diverse dietary preference such as fruits, leaves, flowers, vertebrates and invertebrates to varying degrees. However, they are distinguished from leaf-eating monkeys (Colobinae) by morphological adaptations to frugivorous diets (e.g. low and rounded molar cusps, simple stomach and pouches in their cheeks for storing food) (Fleagle, 1999). Fruits constituted majority (24.5%-91%) of the diet of guenons (Jaffe and Isbell, 2007). The feeding ecology of Boutourlini's blue monkey also showed a similar pattern. They consume fruits as primary choice when present. They even partly shift their home ranges after 3-4 months to a nearby range in order to search and feed on fruiting plants.

The second group, Group II, occupied partially fragmented habitat. The difference in habitats significantly showed variation in the food items consumed in dietary composition between the two groups. This could be correlated with the high levels of dietary flexibility in *C. mitis* (Chapman *et al.,* 2002) and their ability to occupy diverse

habitat types (Jaffe and Isbell, 2007). Young leaves possess lower cellulose level and lower levels of toxic secondary compounds than mature leaves (Rechar, 1985; Strier, 2003). Low content in cellulose and secondary toxic compounds makes digestion easier for monkeys. Study by Cords (1987) on *C. mitis* and *C. ascanius* in Kakamega Forest, Kenya showed that leaves made up almost 23% and 10% of the plant diet, respectively. Individuals of Group II in the fragmented habitats were mostly relayed on leaves of herbs, trees and lianas because there were only very few fruiting trees. In this study, generally leaves contributed almost 14% and 21% of their overall diet for Group I and group II, respectively. For most guenons seeds can be difficult to digest because of secondary compounds they contain (Janson and Chapman, 1999), but they feed on them during irregular shortage of fruits (Brugiere *et al.,* 2002). Boutourlini's blue monkeys consumed seeds of barley (*Hordeum vulgare)* and wheat (*Triticum aestivum)* during cropping season. From wild plants, seeds of *Croton macrostachys* and *Syzgium guineense* contributed for only less than 1% of their diet composition. Still their seed consumption is very low. They also tended to feed on flowers of different plants when available.

Most of the forest guenons have been observed feeding on arthropods and other invertebrates (Butynski, 1982). Insects make up a large proportion of the diets of *C. mitis* at Kibale, Uganda (35.1-45.4%). It is probably to achieve their protein requirements. In the present study, animal diet was the second important components of Group I next to fruits. They were observed chasing even birds when approached them. They were also observed searching for eggs in the nest of birds. A comparison of the feeding ecology of Boutourlini's blue with other guenons is given in Appendix II.

The food preference of *C. mitis boutourlinii* suggests that a preference for a specific food items that the plant species provided while low selection ratio indicates the species is not preferred (Fashing, 2001b). Fruit is the most nutritionally rewarding component of the diet of the primates (Lawes, 1991; Richard, 1985). In Group I, however, fruiting trees were relatively fewer in densities, they contributed to major parts of the food items. In

this group, fruit was the most dominant food item for all months during the study period than any other food items (See Table 8). In general, the guenons known for their frugivorous nature (Jaffe and Isbell, 2007). Individuals in Group II consumed fruits as the third most preferred food items next to shoots and young leaves. The reason could be the presence of very few fruiting plants in their home range. As a result, they shifted their feeding habit into shoots of bamboo and young leaves of different plant species. Despite being highly frugivorous, the geunons also feed on leaves, seeds and animals (Jaffe and Isbell, 2007), which are otherwise less desirable foods in the absence of fruit (Brugiere *et al.,* 2002).

Proper understanding on habitat use and ranging patterns help to realize various aspects of animal behaviour and ecology, including feeding strategies, physiological and morphological specialization and social systems (Boinski, 1987). For arboreal frugivorous primates, the daily movement distances and the frequency in the use of habitats or quadrats are influenced by the food abundance and distribution (Bennett, 1986; Boinski, 1987; O'Brien and Kinnaird, 1997; Keplin, 2001). However, many primates maintain relatively consistent ranging patterns throughout the year. The consistency in ranging patterns is accomplished in most cases by a foraging pattern that facilitates resource monitoring (Olupot *et al.*, 1997), diet shift or both (Pollock, 1977). Boutourlini's blue monkeys in Group I inhabited a continuous forest leading to large home ranges compared to the second group, which inhabited a fragmented range. Group I showed no significant variation in habitat use (home range size) during the dry season and during the wet season. Their territorial nature and a combination of diet shift and resource monitoring allowed maintaining consistent ranging patterns. During wet season, there was low fruit availability in the forest and as a result, they spent more time feeding on animal resources, shoots and leaves. Conflicts between groups have also been observed when there is a home range overlap in the forest. Some *Cercopithecus* species showed more widely ranging during periods of fruit scarcity to encounter a greater diversity of resources (Keplin, 2001). However, Group I travelled longer distances during the dry season when excess fruit was available than fruit scarcity period during the wet season. During this time, the distantly dispersed *Ficus sur* plants

contain much fruit than other plants. They cover more than half of the fruit bearing plants and they took longer day range distance than fruit scarce time. They even travelled to a new range in which they never visited before fruits ripened.

Individuals of Group II showed significant differences in habitat use between the two seasons. Their day range length also showed significance difference during the two seasons. However, they extend their range during the dry season up to the main forest as agricultural fields become free from human activities following crop harvest. Their wider ranging behaviour could be correlated with the search for fruits in the main forest. They were also observed travelling longer distances to the forest to feed on fruits of *Ficus sur* and *Brucea antidysentrica* during the dry season, as there were very few fruiting trees in the fragmented ranges. Comparisons for day range lengths and home range sizes of Boutourlini's blue monkey with some of the members of the genus *Cercopithecus* from different parts of Africa is presented in Appendix III.

7. CONSERVATION

Currently, almost half of the world's primate species are considered to be threatened (listed as vulnerable, endangered or critically endangered) (Mittermeier *et al*., 2009). Habitat loss through deforestation is the primary threat for primates (Chapman *et al*., 2006). As forest size and quality decrease, reduction of food sources for forest-dwelling primates and local extinction might result (Lee and Hauser, 1998; Muoria *et al.,* 2003). In order to conserve these species and prevent future decline, conservation practice involving local people is a must (Wallis and Lonsdorf, 2009). Jibat Forest was severely threatened by agricultural land expansion and commercial timber production. Grazing has a significant impact in the area in accelerating habitat degradation and competition with wildlife. In addition, firewood collection from the forest also leads to disturbance of wildlife. Illegal bamboo cutting is also observed in addition to charcoal production activities.

In general, Boutourlini's blue monkey is the least threatened primate in the area as its habitat is protected and also not considered potential pest. However, birds predator like as long-crested eagle (*Lophaetus occipitalis*), were observed chasing the infant and juvenile monkeys during the study period. Awareness creation among the local community undergoing by the Finefine Forest Development Enterprise is appreciated for conservation of wildlife as whole in the Jibat Forest. Currently there are several activities going on to protect the forest. These are the promising implications for proper conservation and management of the habitat. The survival of the species is determined by the long-term plans in conserving and managing their immediate habitats and the surrounding environment.

Cattle grazing, firewood collection, bamboo cutting and charcoal production can have an accumulated effect in the long run. Trapping and killing are other problems for wild animals in the forest. If appropriate measures are not taken, it will pose a threat to the Boutourlini's blue monkeys and other mammals in the area in the future. Therefore, it is recommended that proper law enforcement should be implemented to prohibit the destructive activities to the forest.

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Appendix I. Comparison of percent activity time budget devoted to different activities by members of the genus *Cercopithecus* from studies in different parts of Africa.

	% of time contribution						Country, Site	Reference
Species	F	FR	MV	R	S	OS		
Cercopithecus mitis boutourlinii	48.4	-	17.9	21.7	12.0	0.0	Jibat Forest, Ethiopia	This study
C. lhoesti	45.1	2.5	23.0	14.0	10.0	5.0	Nyungwe Forest Reserve, Rwanda	Kaplin, 2001
C. mitis doggetti	44.6	2.4	20.0	16.0	11.0	0.0	Nyungwe Forest Reserve, Rwanda	Kaplin, 2001
C. m. stuhlmanni	46.6	-	14.4	35.9	1.4	1.6	Kekamega Forest, Kenya	Cords, 1987b
C. m. stuhlmanni	60.3	-	19.7	9.9	8.3	1.8	Kibale Forest (Kanyawara), Uganda	Butynski, 1990
C. ascanius	38.2	-	38.7	20.8	1.0	1.3	Kekamega Forest, Kenya	Cords, 1987b
C. campbeelli	48.5	-	28.0	18.0	5.2	0.3	Tai, Ivony Coast	Buzzard 2004; 2006
C. Diana	40.6	-	27.7	24.4	7.3	0.0	Tai, Ivony Coast	Buzzard 2004; 2006
C. lhoesti	47.6	-	22.7	13.6	10.4	5.8	Nyungwe Forest Reserve, Rwanda	Kaplin and Moermond, 2000; Kaplin, 2001

F = Feeding; FR = Foraging; M = Moving; R = Resting; S = Socializing; Os = Others

Appendix II. Comparison of percent feeding time devoted to different food items by members of the genus *Cercopithecus* from studies in different parts of Africa.

Species	YL	ML	TL	R	FL	FR	SH	AP	SD	BA	Country and site	Reference
Cercopithecus mitis boutourlinii	14.4	3.9	18.3	-	7.0	32.4	20.6	13.8	5.7	1.6	Jibat Forest, Ethiopia	This study
Cercopithecus lhoesti	-	-	35.2	-	4	24.5	-	8.8	17.8	-	Nyungwe Forest Reserve, Rwanda	Kaplin, 2001
C.m. doggetti	-	-	6.2	-	6.2	47.4	-	24.9	9.3	-	Nyungwe Forest Reserve, Rwanda	Kaplin, 2001
C. pogonias	13	0.1	12.6	-	4.7	26.9	-	-	49.8	-	Makand'e Forest, Gabon	Brugiere, 2002
C.nictitans	10	0.1	10.3	-	4.1	35.5	-	-	50.2	-	Makand'e Forest, Gabon	Brugiere, 2002
C. ascanius	-	-	34.7	-	2.7	44.6	-	17.6	-	-	Kibale at Sebatoli, Uganda	Chapman et al., 2002
C.ascanius	-	-	28.8	-	3.7	35.7	-	31.2	-	-	Kibale at Kanyawara, Uganda	Chapman et al., 2002
C. ascanius	-	-	15.8	-	8.2	59.7	-	20.6	-	-	Kibale at Dura River, Uganda	Chapman et al., 2002

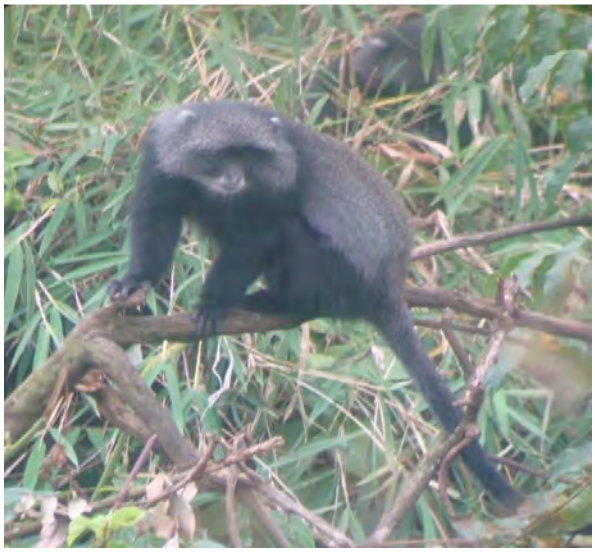
YL = Young leaves; ML = Mature leaves; TL= Total leaves; R = Root; S= Stem; FL = Flower; FR = Fruit; SH = Shoot; AP=Animal preys; SD=Seeds; BA= Bark. (-) No available data.

Appendix III. Comparison of day range lengths and home range areas of the genus *Cercopithecus* from studies in different parts of Africa.

Species	Mean day range length (m)	Total home range (ha)	Site, Country	Reference
Cercopithecus mitis boutourlinii	787.1*	66.6*	Jibat Forest, Ethiopia	This study
Cercopithecus lhoesti	2091.5	117.0	Nyungwe Forest Reserve, Rwanda	Keplin, 2001
C. mitis doggetti	1306.7	87.8	Nyungwe Forest Reserve, Rwanda	Keplin, 2001
C. m. stuhlmanni	1136.0	38	Kekamega Forest, Kenya	Cords, 1987
C. m. stuhlmanni	1216.0	36	Kibale Forest (Kanyawara), Uganda	Butynski, 1990
C. mitis kandti	898.0	67.5	Mgahinga Gorilla National Park, Uganda	Twinomugisha and Chapman (2008)

*The mean results from the two groups (Group I and II)

Appendix IV. Photos of Boutourlini's blue monkey, which were taken from Jibat Forest during the study period.



a) Adult male

b) Adult female grooming sub-adult female

c) Adult female with her offspring feeding on fruit of *Ficus sur*

d) Two adult females sit together

(Photos by: Dereje Tesfaye April, 2010)

DECLARATION

I, the undersigned, hereby declare that this thesis is my original work; it has not been presented in other University, College or Institutions. All sources of material used for the thesis have been duly acknowledged

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