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Daily activity, feeding ecology and habitat association of Gelada baboon (*Theropithecus gelada*) around Debre-Libanos, Northwest Shewa Zone, Ethiopia

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Daily activity, feeding ecology and habitat association of Gelada baboon around Debre-Libanos was investigated using direct field observations from August 2012 to March 2013. Instantaneous scan sampling method was used to collect behavioral data from two selected study groups of gelada baboons on an average of 7 days per month. The focal groups were identified by the natural marking, size, coat color and facial features of some distinctive members of each of these groups. Data were analyzed using descriptive statistics, and responses were compared using Chi-square tests. On average, Gelada baboons spent more time on feeding (56.12%) than any other activity. They spent 16.76% of their time moving, 16.05% socializing, and 9.42% resting. Other activities such as vocalization, defecation and looking at the observer occurred infrequently (1.66%). They depended fully on grass during the wet season (82.1%), but during the dry season, they fed on roots (21.35%) and leaves (20.04%) in larger proportion. There was significant variation among the activity time budget of gelada baboons in the whole study period (χ^2=46.779, df=4, p<0.05). The vegetation type utilization and distribution of Gelada baboon of the study area indicated a marked preference for open cliffy grassland habitat. The overall gelada baboon's habitat utilization showed statistical difference in the study area (χ^2=742.660, df=2, p<0.05).

Key words: Foraging, Gelada baboon, habitat association, daily activity.

INTRODUCTION

The daily activity pattern of Gelada baboons is influenced by seasonal and climatic conditions. Departure from the sleeping site, the time spent traveling, the maximum distance covered per day, and the number and length of resting and feeding periods are all variable from one day to the next and among groups of baboons (Strum, 1987).

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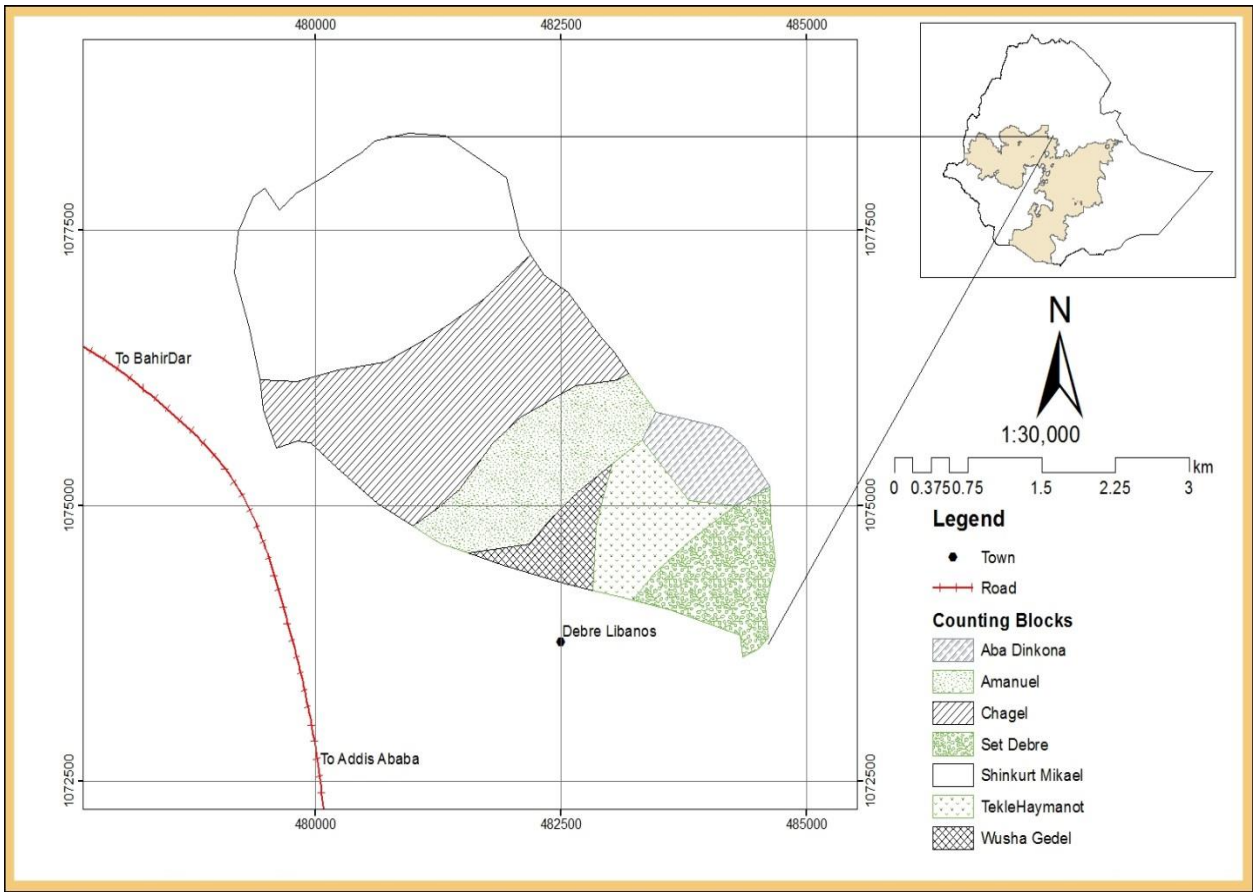

Figure 1. Map of the study area.

Although, over 90% of gelada baboon's diet is grass blades, Gelada baboons are flexible foragers; they change their diets in response to changes in available resources (Hamilton et al., 1978; Barton and Whiten, 1993). When the availability or nutritional value of available grass changes, they shift to flowers and digging for rhizomes and roots and foraging for herbs (Richard, 1985; Dunbar, 1998). Baboons consume a variety of grasses, fruits, flowers, seeds, pods, leaves, gum and underground plant parts such as corms, bulbs, rhizomes and tubers (Rowell, 1966; Altmann and Altmann, 1970).

Ecological factors, such as food distribution and availability are among the most important determinant of the social organization of gelada baboons. It also has an impact on social structure and mating system. Gelada baboons form large groups or aggregations on a permanent or regular basis. These large groupings can be determined by various ecological needs such as predation avoidance, optimal habitat use and foraging, male mate defense and infanticide avoidance (Dunbar, 1983).

Gelada baboons need cliffs for sleeping and the use of relatively treeless and montane grasslands for foraging (Yalden et al., 1996). Gelada baboons prefer the gorge side that provides refugia from the incursion of man, protection from predators, and a habitat to which the species is particularly well adapted (Jolly, 1972; Dunbar, 1980).

Even though, the gelada baboon population is recorded in the northwest Shewa zone of Oromia Regional State, no research has been conducted on daily activity, feeding ecology, habitat association, and other relevant issues about the species in the area. Therefore, the intention of this research was to fill this gap and provide relevant baseline information for different stakeholders.

MATERIALS AND METHODS

Description of the study area

The present investigation was conducted at Debre-Libanos area, which is located in the central highlands of Ethiopia (9° 43' 0" North, 38° 52' 0" East). Debre-Libanos is found in the Oromia Regional State, within the Northwest Shewa zonal administration (Figure 1). It is located 104 km northwest of the capital city, Addis Ababa and 16 km from the zone capital (Fiche). The area has extremely steep

Table 1. Major activities of Gelada baboons recorded during the study period.

Major activity	Observed characteristics
Feeding	Manipulated, masticated, and ingested a particular food item
Moving	Walking, jumping or running at a steady pace
Resting	Sitting or lying
Grooming	Using hands to explore or to clean its body or the body of another gelada baboon
Playing	Chasing, hitting, and other vigorous activities involving exaggerated movements and gestures by two or more gelada baboons interacting in a non-aggressive manner
Aggression	Chasing, biting, grabbing, displacing, or threatening another gelada baboon or crying as a result of aggression
Sexual activity	Groomed the sexual organs, mounted another gelada baboon, or engaged in mating activity
Other activities	Performing activities such as vocalization, defecation, looking towards the observer, or other activities that do not fit in any of the above categories

escarpments leading up to a strip of plateau, with altitude ranging from 2150 to 2650 m above sea level.

It has a bi-modal rainfall pattern, with rainfall ranging from 800 to 1200 mm during May to September. The dry season is from December to March. The annual average maximum and minimum temperature of the study area are 23 and 15°C, respectively.

Data collection methods

The study was conducted from August 2012 to March 2013 to cover both wet and dry seasons. Quantitative and qualitative data were collected on the diurnal behavioural activity patterns, feeding behaviour, and habitat utilization of gelada baboon.

A preliminary survey was conducted in the study area in the first week of August 2012. During this period, the distribution of gelada baboon in the study area was assessed and vegetation type was classified. The survey revealed that the vegetation cover and topography of the study area was not homogenous.

Instantaneous scan sampling method was used to collect behavioural data on multiple group members (Altmann, 1974). Activity types and dietary data were collected from two selected and partially habituated neighbouring study groups of gelada baboons, Groups A and B, on an average of 7 days per month from August 2012 to March 2013. The focal groups were identified by natural markings, size, coat colour and facial features of some distinctive members of each of these groups.

The behaviour of gelada baboon was investigated by approaching the individual as much as possible with binoculars to observe activities and food items consumed. All identifiable daily activity was recorded on separate behavioural data sheets (Sutherland, 1996). To record the activity pattern of gelada baboon, the methods described by Dunbar (1992) and Mekonen et al. (2010) were used. The activity of each gelada baboon individual in each group under observation was recorded at 15 min intervals from 07:00 to 12:00 and 13:00 to 18:00 when the animals were most active and visibility was good (Dunbar, 1992).

The major activities were recorded following Fashing (2001a, b). Major activities displayed by Gelada baboons during the study were identified (Table 1).

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 provided 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).

During instantaneous scan sampling, feeding data were collected at 15-min intervals on members of the study groups. An animal was followed during active feeding time to observe the plant species that were consumed. Focal animals were observed with the naked eye and with binoculars depending on the distance between the observer and gelada baboons. During activity scan sampling, if geladas were observed feeding, the type of food item was recorded on a standardize data sheet (Fashing et al., 2007). The species consumed was noted in the field if possible and unidentified species were collected for further taxonomic identification in the National Herbarium, Addis Ababa University.

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

Grand means of the monthly proportions of food items and species consumed were used to calculate the overall wet and dry season diets as well as the overall diets for the entire study period. The percentage contribution of food items and the species consumed by the combined study groups between seasons were compared by using Chi-square test.

During each census, the type of vegetation where the animals were observed and the food taken were recorded for each season (Campton et al., 1988). Utilized vegetation type refers to the habitat where most gelada baboons were observed grazing alone or in groups at a definite time (Andere, 1981). The method of Norton-Griffiths (1978) was used to describe the dry and wet season's distribution and utilization of the vegetation type.

Data analysis

The data were pooled and SPSS software for Windows Evaluation Version 20 was used for statistical analysis using descriptive statistics and Chi-square test. Statistical tests used were two-tailed with 95% confidence intervals. Chi-square test was used to compare behavioural ecology of gelada baboons between wet and dry seasons.

Table 2. Percentage of time spent in each activity during wet and dry seasons.

Activity	Wet season	Dry season	Average	χ2	df	P-value
Feeding	54.14	58.1	56.12	6.967	1	0.008
Moving	15.03	18.50	16.76	12.409	1	0.000
Socializing	18.12	13.98	16.05	11.782	1	0.001
Resting	11.13	7.70	9.42	12.399	1	0.001
Others	1.60	1.73	1.66	0.269	1	0.604

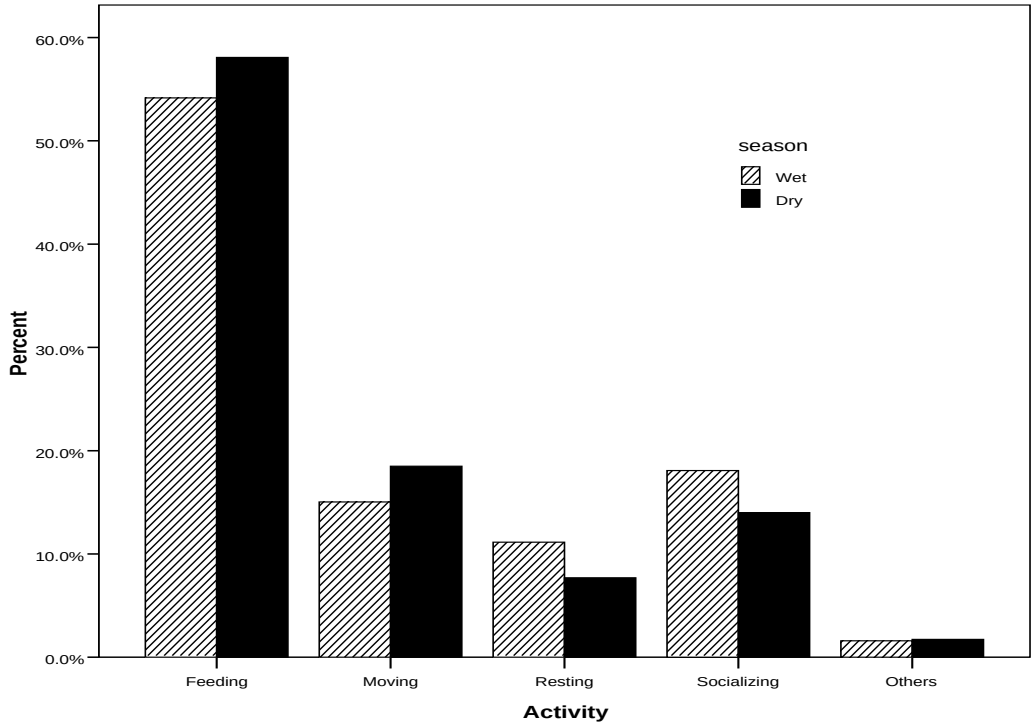

Figure 2. Activity time budget of gelada during wet and dry seasons during 2012-2013.

RESULTS

A total of 5600 individual behavioural observations on the various activities were recorded throughout the study period. Feeding accounted for the >50% of the activities in both the wet and dry seasons (Table 2).

During the study period, gelada baboons spent more time in feeding (58.1%) during the dry season than during the wet season (54.14%). The difference was statistically significant. There was a significant difference in moving, resting and socializing between wet and dry seasons. However, as compared to the whole activities, only less amount of time was spent in other activities like vocalization, defecation and looking at the observer (1.60%) during the wet season and (1.73%) during the dry season (Figure 2).

A total of 3150 feeding behaviour observations were recorded from scan sampling of the total activities of the two combined study groups. Gelada baboons depended on variety of food resources that are important for overcoming harsh conditions. A total of 19 species were identified in the study area as a major feeding item of gelada baboons (Table 3).

The average time spent feeding on grass (63.23%), herb leaves (13.25%), herb roots (11.59%), corms (3.07%), unidentified food items (6.4%) and others(2.48%) is shown in Table 4.During the wet season, the feeding habit covered nearly 82.1% grass, of which long grass blades, short grass blades, and grass roots formed 19.01, 36.6 and 26.39%, respectively, and 6.45% herb leaves, 1.82% herb roots, 0.74% of corms, 6.2% of unidentified tubers and 2.7% on others. Roots

Table 3. List of plat species consumed by gelada baboons in the study area (L, leave; R, root; FR, fruit; SGB, short grass blade; LGB, long grass blade).

Local name	Scientific name	Family	Food items consumed
Agam	*Carissa spinarum*	Apocynaceae	FR
Akrma	*Eleusine floccifolia*	Gramineae	L
Arum	*Anthricus sylvestris*	Apiceae	L, R
Chifrg	*Sidas chimperiana*	Malvaceae	L
Dhittacha	*Dodonea angustifolia*	Sapindaceae	L
Embacho	*Rumex nervosus*	Polygoneceae	*L,R*
Girar	*Acacia negrii*	Fabaceae	L
Kega	*Rosa abysinica*	Rosaceae	FR
Koshim	*Dovyalis abysinica*	Flacourtiaceae	FR
Kulkual	*Opuntia ficusindica*	Cactaceae	FR
Mech	*Guizotia scabra*	Asteraceae	L, F
Qarasoo	*Hyparrhenia hirta*	Poaceae	SGB, R
Serdo	*Cynodon dactylon*	Gramineae	L
Serdo	*Andropogon zdistachyos*	Poaceae	LGB, R
Serdo	*Cyperus erectus*	Cyperaceae	SGB, R
Serdo	*Isole piscostata*	Cyperaceae	SGB, LGB, R
Serdo	*Brachiaria comate*	Poaceae	SGB, LGB
Warka	*Ficus vasta*	Moraceae	FR, L
Weyra	*Olea europaea*	Oleaceae	FR

Table 4. Proportion of food intake during wet and dry seasons of 2012-2013.

Food items	Wet season (%)	Dry season (%)	Average (%)
Grass	82.10	44.35	63.23
Unidentified	6.20	6.60	6.40
Corms	0.74	5.40	3.07
Others	2.70	2.26	2.48
Herb leaves	6.45	20.04	13.25
Herb roots	1.82	21.35	11.59

and leaves are consumed more during the dry season than the wet season. During the dry season, the availability of grass was lower as compared to the wet season, so baboons fed on the roots of dried grass and leaves and roots of perennial plants in larger proportion.

During the dry season, grasses, herb leaves, and herb roots comprised most of the diet. There was a significant difference in time spent feeding on grass between the wet and dry seasons (χ^2=234.228, df=1, p<0.05)

Gelada baboons spent more time feeding on herb roots and leaves during the dry season as compared to the wet season. There were significant differences between wet and dry seasons in feeding on herb leaves (χ2=93.889, df=1, p<0.05) and herb roots (χ2=240.286, df=1, p<0.05). The difference in time spent for feeding on corms between wet and dry seasons was also statistically significant (χ2=51.194, df=1, p<0.05). There was a significant difference in time spent feeding on other food items between wet and dry seasons (χ2=1.282, df=1, p<0.05).

The distribution of gelada baboons across habitats is based on the availability of food and the distance from human settlement. They are distributed in open cliffy grassland. In Debre-Libanos area, Gelada baboons are distributed into three habitat types: open cliffy grassland, bushland and farmland (Table 5). The distribution varied between wet and dry seasons.

More than half of the population was encountered in open cliffy grassland. During the wet season, 79.54% of gelada baboons were counted in the open cliffy grassland area, 15.4% in the bushland with few scattered trees, and only 5.05% in farmland habitats. During the dry season,

Table 5. Number of Gelada baboons counted in different habitats during 2012-2013.

Season	Open cliffy grassland	%	Bushland	%	Farmland	%
Wet	1306	79.54	253	15.41	83	5.05
Dry	788	50.09	421	26.76	364	23.140
%	64.82		21.08		14.1	

their distribution in farmland increased (23.14%), because the farming land was abandoned. Their distribution showed a very high utilization for grass. They were observed primarily as grazers, mainly preferred to graze on grasses during both seasons. However, during the dry season, they fed on herb leaves and roots dominantly due to the less availability of grasses to satisfy their need. There was a significant difference on gelada baboon's habitat utilization in the study area (X^2=742.660, df=2, p<0.05).

DISCUSSION

According to Dunbar (1992), time spent for different activities in animals is an indication of balancing energy budget. Gelada baboons that can easily obtain food spend more time resting and grooming than feeding and moving. However**,** gelada baboons of Debre-Libanos spent more time feeding and moving than resting and socializing. Grooming maintains social relationships, and more time has to be devoted to grooming in order to maintain the cohesion of large groups, yet these activities accounted for a relatively small proportion of the time budget of the baboons in the study area. Gelada baboons in this study may have had to spend more time feeding, as the cliffy habitats did not appear to provide enough amount of food and other resources.

In the study area, gelada baboons spent more time feeding during the dry season than the wet season. The possible reason may be due to a reduction in availability and quality of food during the dry season. Gelada baboons spent more time moving during the dry season as compared to the wet season as well. This might be due to the restriction in small and cliffy areas during the wet season. As crops are harvested, the farmland becomes free during the dry season. When they feed, they do not forage in one place for a long time, rather they move from one place to another. As a result, moving takes the second position in their daily activity patterns. Ayalew (2009) also obtained similar results on the activity time budget of gelada baboons. During the dry season, due to shortage of food, baboons covered a greater distance in search of food. The seasonal difference in activity time budgets of animals may be due to environmental variables (Shah, 2003). Food availability, weather condition, nutritive demand and protection from predation may be the determining factors for slight variation during the wet and dry season's activity patterns (Delany and Happold, 1979; Roberts and Dunbar, 1991).

Gelada baboons are efficient grazers. Grasses are the most preferable diet of gelada baboons. However, when the availability of grasses is restricted, they shift their food preference to herb leaves, roots and corms. As reported by Iwamoto (1993), Gelada baboons predominantly feed on grasses, but during the dry season, when the availability of grass decreases, they shift to leaves and roots of herbs. They are forced to feed on young leaves and roots of herbs, even though gelada baboons preferred grass.

Dunbar (1983) showed that gelada baboons prefer open grassland habitats; however in Debre-Libanos gelada baboons preferred cliffy habitats. This may be due to the anthropogenic effect on the area. During the wet season, they were able to get enough food and water, and also most of the study area was farmed. As a result, gelada baboons concentrated themselves on cliffy part of the study area. During the dry season, the farmland was harvested and consequently they had more space to move around. Availability and quality of food deceases during dry season, therefore, gelada baboons migrated to different areas adjacent to the study site, as food can be limited at the edges of the cliff (Wallace, 2006). Their distribution is based on the availability of food and distance from humans. To avoid human conflict and other predators such as leopards, they are concentrated at the edge of the cliff. The change in the quality of the habitat could be the major factor for differences in distribution across habitats during wet and dry seasons. The difference in food requirements also forced them to move to different parts of the study area.

Conclusion

Due to high altitude and isolation from the surrounding habitats, the Ethiopian highlands are confounded with endemism (Kingdon, 1989). Debre-Libanos is a part of the Ethiopian highlands and is the home for *Theropithecus gelada* which is an endemic primate of the country. The data collected in the present study provides information on daily activity, feeding behaviour and ecology of gelada baboons. Their distribution in the habitats varied during the wet and dry seasons, likely to

meet the food intake demands when the habitat quality decreased in the dry season. Conservation efforts of Gelada baboons must include the protection of habitats used during both seasons.

RECOMMENDATIONS

The following points are suggested to reduce the problems and conserve the population of gelada baboon properly:

1. Public awareness and develop sense of ownership showed be created among the local community.
2. The area should be demarcated and declared as a community conservation area.
3. Buffer zones should be established to reduce the movement of wildlife and as a result it would reduce human-wildlife conflicts during the crop growing period.
4. The local people should be resettled to the buffer zone to reduce negative anthropogenic impacts in the study area.
5. Prior to this study, no comprehensive Gelada baboon census of the area has been carried out. Gelada baboon population censuses should be carried out in the future to determine the population trends at Debre-Libanos.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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REFERENCES

Addisu M, Afework B, Hemson G, Fashing PJ, Anagaw A (2010). Diet, activity patterns, and ranging ecology of the Bale monkey (*Chlorocebusdjamdjamensis*) in Odobullu Forest, Ethiopia. Int. J. Primatol. 31:339-362.

Altmann J (1974). Observational study of behavior: sampling method. Behavior 49:227-267.

Altmann SA, Altmann J (1970). Baboon Ecology. Chicago, USA: University of Chicago Press, pp. 287-305

Andere DK (1981). Wildebeest *Connochaetes taurinus* (Burchell) and its food supply in Amboseli Basin. Afr. J. Ecol. 19:239-250.

Ayalew Y (2009). Population status, distribution and ecology of gelada baboon (*Theropithecus gelada*) in Azwa and Arego, South Wollo, Dessie, Ethiopia. MSc. thesis, Addis Ababa University, Addis Ababa, pp. 45-54.

Barton RA, Whiten A (1993). Feeding competition among female olive baboons, *Papio anubis*. Anim. Behav. 46:777-789.

Campton BB, Mackie RJ, Dusek GL (1988). Factors influencing distribution of white-tailed deer. J. Wildl. Mgt. 52:544-548.

Delany MJ, Happold DCD (1979). Ecology of African Mammals. New York, USA: Longman Inc., pp. 186-231.

Di Fiore A (2004). Diet and feeding ecology of woolly monkeys in a western Amazonian rain forest. Int. J. Primatol. 25:767-801.

Di Fiore A, Rodman PS (2001). Time allocation patterns of lowland woolly monkeys (*Lagothrix lagotrich apoeppigii*) in a Neotropical Terra Firma Forest. Int. J. Primat. 22:449-480.

Dunbar RIM (1980). Determinants and evolutionary consequences of dominance among gelada baboons. Beh. Ecol. Social.7:253-265.

Dunbar RIM (1983). Structures of gelada baboon reproductive units. Male relationship with his females. Anim. Behav. 31:565-575.

Dunbar RIM (1992). Neocortex size as a constraint on group size in primates. J. Hum. Evol. 20:469- 493.

Dunbar RIM (1998). Impact of global warming on the distribution and survival of the gelada baboon: a modeling approach. Gl. Chan. Biol. 4:293-304.

Fashing PJ (2001a). Activity and ranging pattern of guerezas in the Kakamega forest: intergroup variation and implications for intragroup feeding competition. Int. J. Primatol. 22:549-577.

Fashing PJ(2001b). Feeding ecology of guerezas in the Kakamega Forest, Kenya: the importance of Moraceae fruit in their diet. Int. J. Primatol. 22:579-609.

Fashing PJ, Mulindahabi F, Gakima J, Masozera M, Mununura I, Plumptre AJ, Nguyen N (2007). Activity and ranging patterns of *Colobus angolensisruwenzorii* in Nyungwe Forest, Rwanda: possible costs of large group size. Int. J. Primat. 28:529-550.

Hamilton WJ, Buskirk RER, Buskirk WH (1978). Omnivory and the utilization of food resources by chacma baboons, *Papioursinus.* Am. Nat. 112:911-924.

Iwamoto T (1993). The ecology of *Theropithecus gelada*.I n: *Theropithecus:* the rise and fall of a primate genus. (Jablonski, N. G., ed.). Cambridge University Press, Cambridge. pp. 52- 441.

Jolly CJ (1972). The classification and natural history of *Theropithecus* baboon of the African plio-pleistocene. Bullet. Br. Mus. Nat. Hist. 22:1-123.

Kingdon J (1989). Island Africa: The evolution of Africa's rare animals and plants, Princeton, USA: Princeton University Press, Pp. 321-352.

Norton-Griffith M (1978). Counting Animals. Nairobi, Kenya: Africa Wildlife Leadership, pp. 109-147.

Richard AF (1985). Primates in Nature. New York, USA:W. H. Freeman and Co. 201-254.

Roberts SC, Dunbar RIM (1991). Climate influences on the behavioral ecology of Chanler's mountain reedbuck in Kenya. Afr. J. Ecol. 29:316-329.

Rowell TE (1966). Forest living baboons in Uganda. J. Zool. 149:344-365.

Shah NF (2003). Foraging strategies in the two synaptricmangabey species (*Cercocebus agilis* and *Lophocebusalbigena*). PhD. dissertation, Stony Brook University, Stony Brook, Pp. 40-47.

Strum SC (1987). Almost human: a journey into the world of baboons. University of Chicago Press, Chicago.

Sutherland WJ (1996). Ecological Census Techniques. Cambridge, US: Cambridge University Press, pp. 287-301.

Wallace RB (2006). Seasonal variations in black-faced black spider monkey (*Ateles chamek*) habitat use and ranging behavior in a Southern Amazonian Tropical Forest. Am. J. Primat. 68:313-332.

Yalden DW, Largen MJ, Kock D, Hilman JC(1996). Catalogue of the Mammals of Ethiopia and Eritrea. Vol. 7. Revised Checklist, Zoogeography and Conservation. J. Trop. Zool. 9:73-164.