Hindawi
International Journal of Ecology
Volume 2022, Article ID 5090212, 8 pages
https://doi.org/10.1155/2022/5090212

Research Article

Population Status, Diurnal Activity Pattern, Feeding Ecology, and Habitat Association of Colobus Monkey (*Colobus guereza*) in Saja Forest, Kaffa Zone, Southwest Ethiopia

Misganaw Mola, Aklilu Ayiza, Muluye Asnakew, and Tiruye Abuye

Mizan Tepi University, College of Natural and Computational Science, Department of Biology, P.o.box 121, Tepi, Ethiopia

Correspondence should be addressed to Misganaw Mola; misganawmola@gmail.com

Received 14 February 2022; Revised 11 August 2022; Accepted 14 September 2022; Published 13 October 2022

Academic Editor: Daniel I. Rubenstein

Colobus monkeys (*Colobus guereza)* are endemic to the Ethiopian plateau, distributed in different ecological habitats such as moist and deciduous forests, savanna woodlands, and montane forests. The population status, diurnal activity pattern, feeding ecology, and habitat association of *Colobus guereza* were investigated in Saja Forest, southwest Ethiopia, from June 2019 to February 2020, covering both wet and dry seasons. A total of 39 different types of transect were systematically established, distributed in both dense forest and in shrubland. Data were collected for 60 days in total across a wet and a dry season, both at dawn and in the afternoon. A total of 246 ± 39.1 individuals were recorded, of which 132 ± 24.4 and 114 ± 14.7 individuals were recorded during the wet and dry seasons, respectively. The population and group sizes did not statistically differ between the wet and dry seasons but shrubland habitat had fewer individuals and smaller groups than forest. Out of the recorded *Colobus guereza*, 33.5% were adult males, 34.5% were adult females, 28% were sub-adult males, 14.5% were sub-adult females, and 12.5% were juveniles/young. Feeding (29.5%) and resting (19.5%) were the most recorded daily activities for *Colobus guereza*. Young leaves were the largest (31%) contributor to the diet followed by mature leaves (22%) in both seasons. Other common dietary items were shoots (20%), barks (13%), fruits (11%), and flowers (3%). *Colobus guereza* were observed feeding on a diverse diet of 26 plant species belonging to 21 genera within 21 families. The habitats of these primates are currently diminishing due to anthropogenic activities such as agricultural expansion, human settlement, livestock grazing, and other forms of human wildlife conflict. Furthermore, guerezas are hunted for their skin and are also major sources of meat for the Menja people in the study area. Therefore, awareness creation for local people towards wildlife conservation is needed.

1. Introduction

Africa is a continent of particular concern in terms of global monkey species conservation for many reasons. Among fifteen countries worldwide scoring highest for monkey species richness, nine are in Africa including Cameroon, Democratic Republic of Congo (DRC), Nigeria, People's Republic of Congo, Equatorial Guinea, Central African Republic, and Ethiopia [1]. Ethiopia is an important regional center for biological diversity due to its diversity in physical features, climatic types, topography, habitat, vegetation types, and fauna [2]. The country is well known by its faunal diversity with 320 species of mammals including endemic primate species, over 860 species of birds including 25 endemic species, 200 species of reptiles, 63 amphibians, and 145 fish species [3]. Also, the country has numerous species/sub-species of primates. Previous studies showed that there are 326–550 species of primates in the world, 175 species\sub-species of which are in Africa [4]. Ethiopia has 11 known species of primates [5] including gelada *(Theropithecus gelada)*, Boutourlini's blue monkey (*Cercopithecus mitis boutourlinii*), the Bale monkey (*Chlorocebus djamdjamensis*), and colobus monkeys, which are unique primate species to the country, and more are being discovered [6, 7].

Guerezas are arboreal monkeys which have black and white color [8]. They are distributed in moist and deciduous

forests, savanna woodlands, and highland or montane forests [8, 9]. They can also exist around wetland areas alongside rivers and water edges [9]. The suitability of their habitat depends on the level of canopy coverage of the forest. The suitability of such habitat is related to food availability for these animals [10]. They also use agricultural land and plantation areas such as eucalyptus plantations as habitat [11].

An analysis of the population status of mammals on a global scale shows that monkey species are among the most threatened mammals making them indicators for investigating vulnerability to biodiversity threats. Monkey species are not evenly distributed across the globe or across regions and vary greatly in population status across time due to several factors [12]. Mittermeier et al. [13] concluded that, globally, monkey populations are being dramatically impacted by activities such as logging, deforestation, hunting, and other such factors. As a result, wild populations of most non-human primate species (NHPs) are decreasing all over the world and many thousands of monkey species are killed every year for different purposes.

Estimation of population density plays a major role in conservation management [14]. Also, knowing the population status, activity pattern, and feeding ecology of a species can serve as a key for developing conservation strategies [15]. Information on activity pattern is especially important to understand the behavior and habitat use of primates [16]. There is an information gap on the population structure, diurnal activity, feeding ecology, and habitat association of guerezas in Ethiopia. Mekonnen and Hailemariam [17] conducted a study on the ecology and population structure of *C. guereza* in Harena Buluk District, southeast Ethiopia. Also, Ejigu and Hussen [18] studied the activity budgets, feeding ecology, and conservation status of *C. g. gallarum* in Gidabo Forest, Ethiopia, and showed that *C. g. gallarum* spent 22.64% of time for feeding, 55.76% for resting, 9.72% for moving, 6.30% for grooming, 4.91% for socializing, and 0.67% for other activities. The Saja Forest is one of the largest and most accessible forests of the four UNESCO-recognized biosphere reserves in Ethiopia's western highlands. Also, the forest is home to six monkey species including *Colobus guereza*. There are different conservation threats for colobus monkeys such as hunting, deforestation, diseases, and climate change [19]. Today, this natural forest is endangered by anthropogenic activities such as agricultural expansion, logging, human settlement, and livestock grazing. The behavior and ecology of monkey species are highly influenced by these anthropogenic activities. In addition to this, guerezas are threatened species at the study area as they are overhunted for their skin and major sources of meat for the Menja people (https://www.kafa-biosphere.com). Although the population and behavioral ecology of guerezas in natural forests have been the focus of several overseas and national researchers, the population and behavior of guerezas have not been properly studied in natural forests due to the lack of infrastructure and poor accessibility of the areas. As a result, the aim of this study was to understand the population status, diurnal activity patterns, feeding ecology, and habitat preferences of *Colobus guereza* in Saja Forest, Kaffa Zone, southwest Ethiopia, and formulate effective and realistic management policy to control illegal activities.

2. Materials and Methods

2.1. Description of the Study Area. The Saja Afromontane Forest is situated in the Kaffa Zone, southwest Ethiopia, which is located 460 km away from the capital, Addis Ababa. The Kaffa Zone is known as the birth place of coffee and the origin of *Coffea arabica*, grown in an area known as Mankira under the shade of trees in Kaffa's humid agroecological zone [20]. It is one of the demarcated forests found in Gewata District on the main road of Diri Masha which crosses the forest and covers 1968 ha ($7^{\circ}22'$–$8^{\circ}3'$ *N*, $35^{\circ}9'$–$36^{\circ}3'$ *E*, Figure 1). The Saja Forest is one of the 701 biosphere networks in the global scale and attained the status in March 2011 [21]. The area harbors several animal species, including different primate species such as Guereza guereza, the grivet monkey (*Chlorocebus aethiops*), hamadryas baboon (*Papio hamadryas*), and eastern black and white colobus monkey and gelada monkey (*Theropithecus gelada*). Moreover, the study area includes diverse vegetation such as *Olinia rochetiana*, *Teclea nobilis, Syzygium guineense*, and *Cordia africana*. The rainfall distribution pattern of the study area is characterized by eight months of wet season from late April to November. The mean annual rainfall of the study area is 2115.1 mm. The temperature ranges from a mean monthly minimum of 11.69°C in February to a mean monthly maximum of 23.52°C in November [22].

2.2. Preliminary Survey. A preliminary survey was conducted for a week in April 2019 to collect information about forest coverage, vegetation type, agricultural activities, and the geography of the study area. Also, additional information was gathered from local people. In addition to this, habitat locations and their altitudinal range were recorded by the Global Positioning System (GPS).

2.3. Sampling Design. The study area was classified into different habitats (forest or shrubland), based on the dominant vegetation type and suitability of the area for guerezas. Depending on forest density, accessibility, and monkey visibility, line transects and point count transects were laid in each habitat. In forest areas, 21 line and 6 point transects were used and 12 line transects were used in shrubland. A total of 39 transects were systematically (blocks in each) established to represent each habitat and used to estimate the population of *Colobus guereza.* Depending on topography and accessibility of habitats, each transect line was 100 to 300 m long and 25 to 50 m wide.

2.4. Data Collection. Data were collected for 60 days across dry and wet seasons, including three wet months (June, July, and August in 2019) and three months in the dry season (December, January, and February in 2020). During scan sampling, the numbers of individual *Colobus guereza* were recorded for 5 minutes by 15-minute intervals to reduce

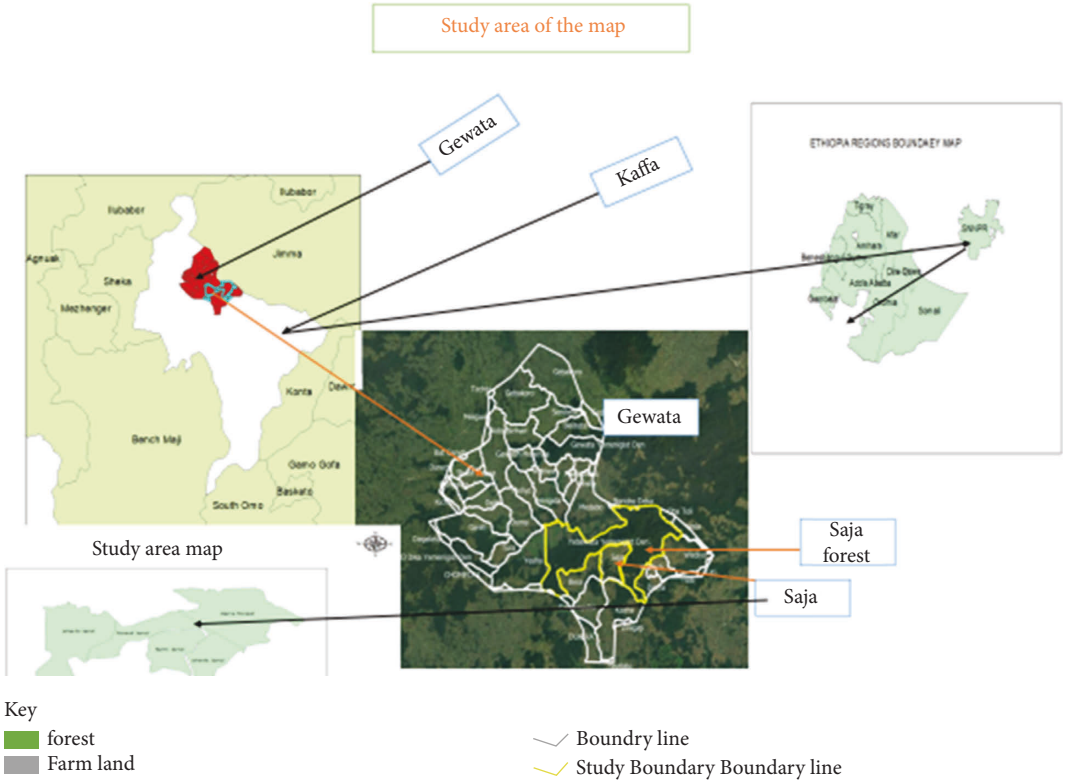

Figure 1: Location map of the study area.

miscounting and double counting. In addition, group spread of guerezas was estimated and recorded every fourth scan (i.e., once/hour). Data on activity patterns were collected by following the group from morning (08:00) to evening (17:30) and recording activities of all visible group members for 5 minutes at 15-minute intervals (feeding, sleeping, moving, agrregassion, grooming, and sexual activity) [11, 23, 24]. During these hours of the day, *Colobus guereza* are active, feeding, and moving at an average speed of 1 km/hr in the forest or 2 km/hr in the shrubland [25, 26].

The counted individuals were classified by their sex and age (adult male, adult female, sub-adult male, sub-adult female, and young/unidentified juvenile), following previous studies [24, 27, 28]. Ischial callosities were used for sex identification. For males, there is an unbroken ring of white hair surrounding their fused gray-colored ischial callosities, but females have separated gray-colored ischial callosities. Age estimations were based on size, body appearance, and their behavior. Infants are small and dependent on their mother for any activity. Infants have white color with pinkish skin on their face, ears, hands, and feet; after 3 to 4 months, they gradually change to adult coloration. When the distance between individuals was less than 50 meters, they were considered members of the same group [29]. A total of twelve study groups were observed, six in each of the two habitats. Focal animals were selected on a rotating basis, alternating focus on each age/sex class [30].

A scan sampling method was used to collect activity budget data. This task was done for ten consecutive days per month. Scan samples were collected at interval of 15 minutes for up to five minutes in length since 07:00 to 17:30. The percentage of activity time devoted to a specific activity item was calculated as the total time spent in that activity divided by the total amount of continuous observation time in the entire activity of all individuals [31].

Data on foraging and diet were collected by the instantaneous scan sampling method [23]. The scan interval for data recording was set at 10 minutes with five-minute stabilization collected on ten days per month for all 6 months of the study period. For each scan of feeding behavior, the individuals that were feeding and the plant species and plant part they fed upon were recorded. The plant food item was categorized as young leaves, matured leaves, flowers, fruits, shoots, and barks. The sample of consumed plant species was taken to Addis Ababa University for identification and identified by botanists. Diet composition was determined from the relative proportion of feeding time devoted to different food items and species.

2.5. Data Analysis. SPSS software version 24 was used to analyze all collected data. One-way ANOVAs, *t*-tests, and means and frequencies were used to compare the local migration of individuals in each habitat. Descriptive analyses were used to analyze time budgets and the species and plant parts consumed by *Colobus guereza*.

3. Results

3.1. Population Size and Groups of Colobus guereza. A total of 246 ± 39.1 individual guerezas were recorded across the two habitat types during the study period. The population size

Table 1: Population and group size of *Colobus guereza* recorded during wet and dry seasons in study habitats.

Seasons		Habitats		Total
		Forest	Shrubland	
Wet	Population size	96 ± 24.4	36 ± 24.4	132
	Group size	13 ± 3.7	4 ± 3.7	17
Dry	Population size	75 ± 14.7	39 ± 14.7	114
	Group size	10 ± 2.4	4 ± 2.4	14

Table 2: Age and sex class composition of the *Colobus guereza* population in the study area.

Season		Age and sex composition					
		Adult male	Adult female	Sub-adult male	Sub-adult female	Juvenile	Total
Wet	Sum	45	31	25	18	13	132
	%	34%	23.5%	19%	13.5%	10%	100%
Dry	Sum	22	38	31	11	12	114
	%	19.3%	33.4%	27.2%	9.6%	10.5%	100%
Total	mean	33.5	34.5	28	14.5	12.5	246
	%	26.65%	28.45%	23.1%	11.55%	10.25%	100%

did not statistically differ between seasons ($P > 0.05$). The mean number of individuals in the area during wet and dry seasons was 132 ± 24.4 and 114 ± 14.7, respectively. Also, these individuals were grouped into 17 ± 3.7 in wet season and 14 ± 2.4 dry season, respectively. The highest number of individuals was recorded in forest habitat (96 ± 24.4) followed by shrubland habitat (36 ± 24.4) during wet season. The same is true in dry season; the number of individuals was the highest in forest habitat (74 ± 14.7) followed by shrubland habitat (39 ± 14.7). The variation in the mean number of individuals in wet and dry seasons was not statistically significant ($F = 0.34$ df = 1, $P = 0.21$), but groups were significantly smaller in shrubland than in forest habitat ($F = 1.23$, df = 1, $P = 0.01$) (Table 1).

3.2. Age and Sex Class Composition. Out of the total number (246) of *Colobus guereza* recorded during this study, 34.5 (28.45%) were adult males, 33.5 (26.65%) were adult females, 28 (23.1%) were sub-adult males, 14.5 (11.55%) were sub-adult females, and 12.5 (10.25%) were juveniles/young (Table 2). During the wet season, most individuals were adult females (34%) followed by adult males (23.5%), while the remaining 19%, 13.5%, and 10% were sub-adult males, sub-adult females, and juveniles, respectively. During the dry season, 33.4% were adult males while sub-adult males accounted for 27.2% of the population, and 19.3%, 9.6%, and 10.5% were adult females, sub-adult females, and juveniles, respectively. There was no significant difference among the age and sex groups counted across seasons (df = 1, $P < 0.05$).

3.3. Diurnal Activity Pattern. There was no significant difference in feeding rates between dry and wet seasons ($P > 0.05$). During the wet season, guerezas were involved more in moving (18%) than the dry season (16%). Furthermore, they spent 23% of the time resting during wet season and 16% of the time during the dry season. The distribution of activity budgets is shown in Figure 2.

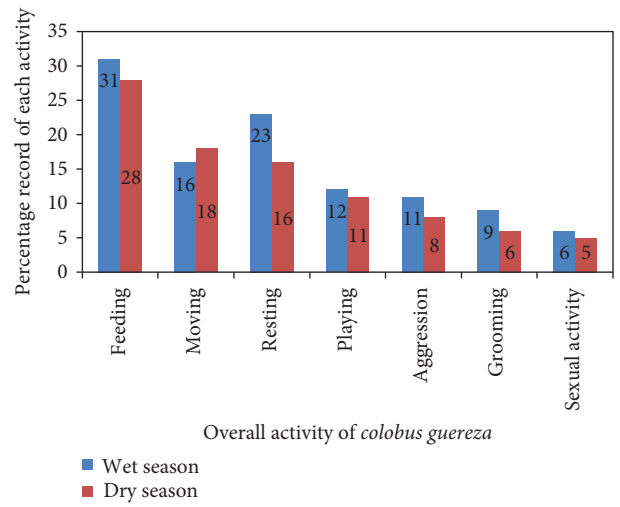

Figure 2: Percentage time spent by *Colobus guereza* for different diurnal activity patterns.

3.4. Diet Composition. A total of 1,465 feeding observations were obtained from scan sampling data. The feeding habits of guerezas, including the plant species and part they consumed, are shown in Table 3. In this study, a total of 26 trees, shrubs, and herbs consumed by guerezas were identified and documented. The species included 18 (69.23%) trees, 7 (26.92%) shrubs, and 1 (3.85%) herb, distributed in 21 genera and 21 families. The dominant family guerezas consumed was Moraceae, which contributed 4 species (19.05% of feeding observations), followed by Fabaceae and Apocynaceae with 2 species each (9.52% of feeding observations). *Olinia rochetiana* (17% of feeding observations) ranked first as source of food for guerezas, followed by *Teclea nobilis* (15.7%). *Colobus guereza* spent the least amount of

Table 3: Plant species and parts consumed by *Colobus guereza* and the percentage contribution of plants to the diet in Saja Forest.

Species	Family	Life forms	Parts consumed	% contribution
Acanthus sennii Chiov.	Acanthaceae	S	FL	0.2
Albizia gumifera	Fabaceae	T	YL, ML, B	0.9
Albizia schimperiana Oliv.	Fabaceae	T	YL, ML, B	6.8
Allophylus abyssinicus (Hochst.) Radlkofer.	Sapindaceae	T	YL, ML	6.2
Bersema abyssinica Fresen	Melianthaceae	T	YL, B	6.4
Carissa edulis Wahl.	Apocynaceae	S	FR	1.7
Carissa *spinarum* L.	Apocynaceae	S	FR	0.2
Cordia africana Lam.	Boraginaceae	T	YL, ML, FR, FL	8
Dombeya torrida (J.F.Gmel.) P.Bamps.	Sterculiaceae	T	YL, ML, B	0.8
Dovyalis abyssinica (a. Rich.) Warb.	Flacourtiaceae	S	FR	0.2
Ekebergia capensis Sparm.	Meliaceae	T	YL, ML, FR	4.4
Ficus carica L.	Moraceae	T	YL, ML	0.8
Ficus ovata(Vahi).	Moraceae	T	YL	0.4
Ficus sur Forssk.	Moraceae	T	YL, ML, FR, FL	4.2
Ficus sycomorus L.	Moraceae	T	FR, YL	0.3
Grewia ferruginea Hochst. ex A. Rich.	Tiliaceae	T	FR	2.3
Hordeum vulgare L.	Poaceae	H	FL	0.3
Maytenus arbutifolia (A.Rich) Wilczek.	Celastraceae	S	YL, ML	2.2
Nuxia congesta R.Br.ex Fresen.	Loganiaceae	T	FL, B	0.3
Olea europaea subsp.cuspidata L.	Oleaceae	T	YL, ML, FR	3.1
Olinia rochetiana	Oliniaceae	T	YL, FL, FR	17
Opuntiaficus-indica (L.) Miller.	Cactacea	S	LE, FR	0.3
Prunus Africana (Hook.f.) Kalkman	Rosaceae	T	YL, ML, B, FL	7.3
Rumex nepalensis Spreng.	Polygonaceae	S	YL	0.2
Syzygium guineense (Wild.) Dc. Subsp	Myrtaceae	T	YL, ML, FR	9.8
Teclea nobilis Del.	Rutaceae	T	YL, ML, FR, B	15.7

YL: young leaves; ML: mature leaves; FL: flowers; FR: fruits; S: shoots; B: barks; S: shrubs; T: trees.

time consuming *Rumex nepalensis*, *Carissa spinarum*, *Dovyalis abyssinica*, *and Acanthus sennii* (0.2% each; Table 3).

From the total plant parts that consumed by colobus guereza young leaves were the most feeding item 450 (31%) records. Out of the plant parts used by *Colobus guereza*, 20% were shoots, 11% were fruits, 3% were flowers, 13% were barks, and 22% were mature leaves (Figure 3).

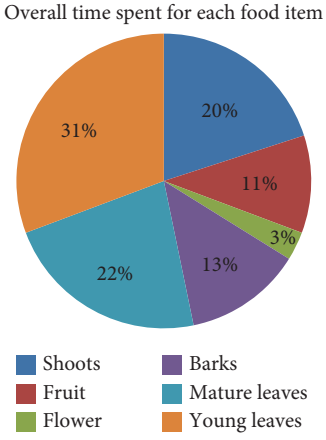

Figure 3: Overall percentage of feeding observations devoted to different food items by *Colobus guereza*.

4. Discussion

Colobus guereza remains relatively widespread and abundant due to its tolerance of forest degradation, and it is considered to be one of the least threatened species of colobus monkey [32]. In the Saja Forest, there are more edible herbs and seedlings under a canopy during the wet season, but the local guereza population did not change significantly between seasons, agreeing with the findings of Gebeyehu and Bekele [33]. This also indicates fairly steady food quality and availability across seasons (Chapman and Chapman [34] found that densities of primates are related to food quality and availability). However, we found that population and group size were both lower in shrubland than in forest, indicating that shrubland is a less suitable habitat for guerezas. The age structure of *Colobus guereza* showed that adults are most numerous, followed by subadults, while juveniles are the least. The size of a population and its age and sex composition may indicate its viability [35]. In the current study, the number of adult females is greater than adult male individuals. A female-biased sex ratio and a fairly high proportion of juveniles indicate a healthy population [36].

Group size in primates is associated with various benefits and costs in relation to food availability and predators [35, 37]. Large groups should face greater within-group competition for food than smaller groups [38]. When group size increases, the individual probability of being the target of a given attack by predators decreases [35, 37]. Since the population and group size did not significantly change across seasons, this indicates that food availability and predation risk did not greatly change across seasons.

However, during the dry season, we found that most groups moved to an area with plenty of fruits and leaves (food availability was limited to a certain area at that time). We observed that two or three groups merged together and foraged together at this time, when food availability is low. Rather than disaggregating, they apparently congregated around the dwindling resources. Ohsawa [39] found that the largest guereza groups happened to be in the middle of the dry season, perhaps for similar reasons. Shrublands had fewer individuals, perhaps to avoid open habitats due to seasonal removal of leaf shading with higher predation risk [37], but group size was also smaller in shrubland, indicating that individuals were not adjusting group size as expected according to predation risk. Predation risk and feeding competition have been found to affect the survival of African colobines, but we found that they do not seem to adjust group size to either of these factors [24].

Primates can regulate their time budgets in response to seasonally low food availability and to climate change [40]. Studies showed that animals are exposed to more stressful conditions during the dry season [41]. Feeding time for guerezas was high during both seasons, which depends on high food availability and quality. Usually, the dry season affects forage availability. Iwamoto [42] stated that during dry season forage, protein content becomes decrease in response feeding time of colous guereza becomes increase. A possible reason that guerezas still spent more time feeding than on any other activities during the wet season could be that they require more energy for thermoregulation during the wet season like other primates [43]. The other study reported by Kifle et al. [43] in harsh areas found that feeding activity of primates such as geladas was low during the dry season. Oates et al. [44] reported that some primates such as *Ateles chamek* spent more time feeding during the rainy season. They found that guerezas travel short distances to conserve energy and mostly rest through the day, feeding on relatively abundant food items [45]. Similarly, guerezas in the Saja Forest spend more time resting and feeding than socializing and moving.

In the present study, 31% of guereza feeding observations were on young leaves, and 22% were on mature leaves, in line with Hussen and Ejigu [18] and Mekonnen and Hailemariam [17]. Another study found that plant leaves comprise an even greater proportion (78–94%) of the guereza diet [46]. Another study conducted in Cameroon indicated that 35–75% of their diet was on young leaves due to their high digestibility and low toxicity [47]. Oates and Davies [8] stated that colobus monkeys consume more than 30% mature leaves when there is food scarcity. Guerezas are therefore consistently highly folivorous. There is competition between primate species for ripe, fleshy fruits, but guerezas consume unripe fruits, presumably to avoid this competition [11, 27, 46, 47].

Guerezas in the Saja Forest consumed 26 plant species. Out of the food plant species in our study, 9 species were the same as Hussen and Ejigu's (2017) study in Gidabo Forest, 8 plants were the same as those reported in Petros et al.'s [47] study in Bale Mountains National Park, and 5 species overlapped [17]. The number of plant species consumed by guerezas in our study was much higher than that in Mekonnen and Hailemariam [17] (19 species), Hussen and Ejigu [18] (15 species), and Petros et al. [47] (8 species). A higher number of different plant species consumed is expected in the dry season, as plants are of lower nutritional quality and so colobus monkeys would have to forage from a greater variety to meet their nutritional needs [48].

Anecdotally, we found that local people are not a likely threat for survival for guerezas. Local communities have a more positive attitude towards *Colobus guereza* than towards other primate species because guerezas are not considered crop pests and are considered a holy animal. Some primates feed on fruits and seeds in the forest and play pivotal roles in the germination of forest seeds. This attitude bodes well for the long-term existence of *Colobus guereza* in the area. But they are overhunted for their skin and serve as major sources of meat for Menja people [49], which are tribes living in the area. Also, the habitats of these primates are currently diminishing due to the clearance of vegetation and extension of cultivated areas. Understanding the attitude of local peoples towards wildlife conservation is important for developing mitigation strategies against threats to wildlife.

5. Conclusion

The current study provided relevant information on the population status, diurnal activity patterns, feeding ecology, and habitat preferences of *Colobus guereza* in Saja Forest, Kaffa Zone, southwest Ethiopia. Population and group sizes were smaller in shrubland habitats than forests, indicating that shrubland is less suitable as guereza habitat. The population's sex and age composition indicates a healthy, stable population. Feeding and resting were the most frequent activities recorded. *Colobus guereza* mainly forage on leaves, especially young leaves, in line with previous studies. As the area provides a rich food base, but the local guereza population is small relative to other areas of similar size, a conservation area should be developed to protect the species in this valuable natural habitat. Therefore, attention should be given by the government officials and concerned bodies to protect the natural habitat of the species and the primates. Community leaders should also be given the opportunity to create awareness among the people living around the area in order to protect these primates.

Data Availability

The datasets used and/or analyzed during the current study are included in the article.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

Acknowledgments

The authors are thankful to the local community of Gewata District for their volunteered labour during data collection. Moreover, the authors would like to acknowledge Mizan-Tepi University, which supplied GPS units and binoculars for data collection.

References

[1] P. Grubb, T. M. Butynski, J. F. Oates et al., "Assessment of the diversity of African primates," *International Journal of Primatology*, vol. 24, no. 6, pp. 1301–1357, 2003.

[2] I. Friis, M. Thulin, H. Adsersen, and A. Burger, "Patterns of plant diversity and endemism in the Horn of Africa," *Biologiske Skrifter*, vol. 55, pp. 289–314, 2005.

[3] A. Bekele and D. W. Yalden, *The Mammals of Ethiopia and Eritrea*, Addis Ababa University Press, Addis Ababa, Ethiopia, 2013.

[4] P. Grubb, "Geospecies and superspecies in the african primate fauna," *Primate Conservation*, vol. 20, pp. 75–78, 2006.

[5] D. W. Yalden and M. J. Largen, "The endemic mammals of Ethiopia," *Mammal Review*, vol. 22, no. 3-4, pp. 115–150, 1992.

[6] A. Mekonnen, P. J. Fashing, A. Bekele, R. A. Hernandez-Aguilar, E. K. Rueness, and N. C. Stenseth, "Dietary flexibility of Bale monkeys (Chlorocebus djamdjamensis) in southern Ethiopia: effects of habitat degradation and life in fragments," *BMC Ecology*, vol. 18, p. 4, 2018.

[7] J. Kingdon, T. Struhsaker, J. F. Oates, J. Hart, and C. P. Groves, "*Colobus guereza*," in *IUCN 2011. IUCN Red List of Threatened Species*, 2008.

[8] J. F. Oates and A. G. Davies, "What are the colobines?," in *Colobine Monkeys: Their Ecology, Behavior and Evolution. 1-9*, J. F. Oates and A. G. Davies, Eds., Cambridge University Press, Cambridge, UK, 1994.

[9] K. Kim, ""Colobus guereza" (On-line), animal diversity web," 2002, https://animaldiversity.ummz.umich.edu/site/accounts/information/Colobus_guereza.htm%20l.

[10] S. C. Thomas, "Population densities and patterns of habitat use among anthropoid primates of the ituri forest, zaire," *Biotropica*, vol. 23, no. 1, pp. 68–83, 1991.

[11] T. R. Harris and C. A. Chapman, "Variation in diet and ranging of black and white Colobus monkeys in Kibale National Park, Uganda," *Primates*, vol. 48, no. 3, pp. 208–221, 2007.

[12] J. C. Lovett, A. R. Marshall, and J. Carr, "Changes in tropical forest vegetation along an altitudinal gradient in the Udzungwa mountains national park, Tanzania," *African Journal of Ecology*, vol. 44, no. 4, pp. 478–490, 2006.

[13] R. A. Mittermeier, W. R. Konstant, M. E. Nicoll, and O. Langrand, *Lemurs of Madagascar: An Action Plan for Their Conservation 1993–1999*, Gland: IUCN/SSC Primate Specialist Group, Gland, Switzerland, 1992.

[14] P. K. Muoria, G. M. Karere, N. N. Moinde, and M. A. Suleman, "Primate census and habitat evaluation in the Tana delta region, Kenya," *African Journal of Ecology*, vol. 41, no. 2, pp. 157–163, 2003.

[15] S. M. Kivai, "Predation on an endemic and endangered tana river mangabey (*Cercocebus galeritus*) by a sympatric yellow baboon (*Papio cynocephalus*) in tana river national primate reserve, Kenya," *African Primates*, vol. 8, pp. 59–62, 2013.

[16] A. D. Fiore, "Ranging behavior and foraging ecology of lowland woolly monkeys (*Lagothrix lagotricha poeppigii*) in Yasuní national park, Ecuador," *American Journal of Primatology*, vol. 59, no. 2, pp. 47–66, 2003.

[17] S. Mekonnen and M. Hailemariam, "Population size, group composition and feeding ecology of the endemic and endangered colobus guereza gallarum in harenna forest, harenna buluk district, south east Ethiopia," *Egyptian Academic Journal of Biologucal Sciences*, vol. 13, 2021.

[18] M. Hussen and D. Ejigu, "Diurnal activity patterns, feeding ecology and conservation status of *Colobus guereza* (gallarum) in Gidabo forest, Ethiopia," *Palgo Journal of Agriculture*, vol. 4, 2017.

[19] K. McGoogan, T. Kivell, M. Hutchison et al., "Phylogenetic diversity and the conservation biogeography of African primates," *Journal of Biogeography*, vol. 34, no. 11, pp. 1962–1974, 2007.

[20] A. Tam, *Transforming Lives & Landscapes: Linking Agroforestry and NTFPs Farmers to the Market*, Addis Ababa, Ethiopia, 2004.

[21] NABU, *Biodiversity in a Changing Climate: Community-Based Strategies for the Protection, Management and Development of Wild Coffee's Region of Origin*, 2017.

[22] "Socio-economic report on boginda natural forest," *Forest Genetic Resources Conservation Project*, Institute of Biodiversity Conservation and Research, Portland, ME, USA.

[23] J. Altmann, "Observational study of behavior: sampling methods," *Behaviour*, vol. 49, no. 3-4, pp. 227–266, 1974.

[24] P. J. Fashing, F. Mulindahabi, J. B. Gakima et al., "Activity and ranging patterns of *Colobus angolensis* ruwenzorii in nyungwe forest, Rwanda: possible costs of large group size," *International Journal of Primatology*, vol. 28, no. 3, pp. 529–550, 2007.

[25] R. B. Wallace, R. L. E. Painter, and A. B. Taber, "Primate diversity, habitat preferences, and population density estimates in noel kempff mercado national park, santa cruz department, Bolivia," *American Journal of Primatology*, vol. 46, no. 3, pp. 197–211, 1998.

[26] C. A. Peres, "General guidelines for standardizing line transect surveys of tropical forest primates," *Neotrop. Primatol.* vol. 7, pp. 11–16, 1999.

[27] P. J. Fashing, *The Behavioral Ecology of an African Colobine Monkey: Diet, Range Use, and Patterns of Intergroup Aggression in Eastern Black-And-White colobus Monkeys (Colobusguereza).PhD Dissertation*, Columbia University, New York, NY, USA, 1999.

[28] K. H. Grimes, *Guereza Dietary and Behavioural Patterns at the Entebbe Botanical Gardens*, The University of Calgary, Calgary, Canada, 2000.

[29] E. Kibebew and K. Abie, "Population status, group size, and threat to boutourlini's blue monkeys (*Cercopithecus mitis* boutourlinii) in jibat forest, Ethiopia," *Journal of Ecosystem & Ecography*, vol. 7, no. 2, p. 230, 2017.

[30] J. A. Teichroeb, T. L. Saj, J. D. Paterson, and P. andSicotte, "Effects of group size on activity budgets of Colobusvellerosusin Ghana," *International Journal of Primatology*, vol. 24, pp. 743–758, 2002.

[31] C. A. Chapman, L. Naughton-Treves, M. J. Lawes, M. D. Wasserman, and T. R. Gillespie, "Population declines of colobus in western Uganda and conservation value of forest fragments," *International Journal of Primatology*, vol. 28, no. 3, pp. 513–528, 2007.

[32] K. Jensz and L. Finley, "Species profile for colobusguereza, latitude 42 environmental consultants pty ltd. hobart, Tasmania," 2011, https://nre.tas.gov.au/Documents/Colobusguereza_Species-Profile.pdf.

[33] G. Gebeyehu and A. Bekele, "Human-wildlife conflict in Zegie peninsula with emphasis on grivet monkey (Cercopithcus aethiops)," *Ethiopian Journal of Health Sciences*, vol. 32, no. 2, pp. 99–108, 2009.

[34] C. A. Chapman and L. J. Chapman, "Constraints on group size in red colobus and red-tailed guenons: examining the generality of the ecological constraints model," *International Journal of Primatology*, vol. 21, no. 4, pp. 565–585, 2000.

[35] S. Harris, *Mammalian Population Studies*, Department of Zoology, University of Bristol, Bristol, UK, 1998.
[36] Y. Doku, A. Bekele, and M. Balakrishinan, "Population status of plains zebra (Equus quagga) in nechisar plains national Park," *Tropical Ecology*, vol. 48, pp. 79–86, 2007.
[37] B. Majolo, A. B. Vizioli, and G. Schino, "Cost and benefits of group living in primates: group size effects on behavior and demography," *Animal Behaviour*, vol. 76, pp. 1235–1247, 2008.
[38] L. A. Isbell, T. P. Young, K. E. Jaffe, A. A. Carlson, and R. L. Chancellor, "Demography and life histories of sympatric patas monkeys (*Erythrocebus patas*) and vervets (*Cercopithecus aethiops*) in Laikipia, Kenya," *International Journal of Primatology*, vol. 30, no. 1, pp. 103–124, 2009.
[39] H. Ohsawa and R. I. M. Dunbar, "Variations in the demographic structure and dynamics of gelada baboon populations," *Behavioral Ecology and Sociobiology*, vol. 15, no. 3, pp. 231–240, 1984.
[40] Z. Y. Li and E. Rogers, "Habitat quality and activity budgets of white-headed langurs in fusui, China," *International Journal of Primatology*, vol. 25, no. 1, pp. 41–54, 2004.
[41] C. A. Hemingway and N. Bynum, "The influence of seasonality on primate diet and ranging," in *Seasonality in Primates: Studies of Living and ExtinctHuman and Non-human Primates*, D. K. Brockman and C. P. van Schaik, Eds., pp. 57–103, Cambridge University Press, Cambridge, UK, 2005.
[42] T. Iwamoto, "The ecology of eropithecus gelada," in *Eropithecus: e Rise and Fall of a Primate Genus*, N. G. Jablonski, Ed., pp. 441–453, Cambridge University Press, Cambridge, UK, 1993.
[43] K. Zewdu, B. Gurja, and B. Afewerk, "Population size, group composition and behavioral ecology of geladas and Huangelada conflict in Wonchit Vally, Ethiopia," *Pakistan Journal of Biological Sciences*, vol. 16, no. 21, pp. 1248–59, 2013.
[44] J. F. Oates, "The natural history of African colobines," in *Colobine Monkeys: Their Ecology, Behavior and Evolution*, A. G. Davies and J. F. Oates, Eds., pp. 75–128, Cambridge University Press, Cambridge, UK, 1994.
[45] C. A. Chapman, M. D. Wasserman, and T. R. Gillespie, *Behavioral Patterns of colobus in Logged and Unlogged Forests: The Conservation Value of Harvested Forests*, Springer, Berlin, Germany, 2006.
[46] L. I. Usongo and F. O. Amubode, "Nutritional ecology of preuss's red colobus monkey (*Colobus badius preussi*Rahm 1970) in Korup National Park, Cameroon," *African Journal of Ecology*, vol. 39, no. 2, pp. 121–125, 2001.
[47] I. Petros, S. Mekonen, H. Gena, and Y. Mesfin, "Feeding and ranging ecology of *Colobus guereza* gallarum in Bale Mountains national park, southeast Ethiopia," *J Biodivers Endanger Species*, vol. s2, 2018.
[48] D. Zinner, D. Tesfaye, N. C. Stenseth et al., "Is *Colobus guereza* gallarum a valid endemic Ethiopian taxon?" *Primate Biology*, vol. 6, no. 1, pp. 7–16, 2019.
[49] Status and Distribution of Faunal Diversity in Kafa Afromontane Coffee Forest.