Feeding ecology of Omo River guerezas (*Colobus guereza guereza*) in natural versus plantation forests in the central highlands of Ethiopia

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INCLUSION AND DIVERSITY STATEMENT

The author list includes contributors from the location where the research was conducted, who participated in study conception, study design, data collection, analysis, and/or interpretation of the findings.

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AUTHORS CONTRIBUTIONS

DY, AB, PJF, NN and AMe originally formulated the idea and designed this study, DY carried out the fieldwork, organized and analyzed the data, and DY, AB, PJF, NN, HI, AMo, TME, and AMe wrote the manuscript.

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Abstract: Understanding the impacts of habitat modification on primate feeding ecology is essential for designing effective conservation management strategies. The dietary guild (e.g., frugivore, folivore, insectivore, and omnivore) of primates and their degree of ecological flexibility impacts their ability to cope with human-modified habitats. The Omo River guereza (*Colobus guereza guereza*) is a subspecies of eastern black-and-white colobus monkey endemic to the western Rift Valley forests of Ethiopia, where it faces increasing anthropogenic change. While there is some understanding of how this subspecies copes with anthropogenic pressures, we aimed to compare the feeding ecology of Omo River guerezas in natural and human-modified habitats. Specifically, we collected data on two neighbouring guereza groups inhabiting adjacent plantation and natural forest habitats over 12 months in Wof-Washa Natural State Forest in the central highlands of Ethiopia. Furthermore, we conducted vegetation surveys on the botanical composition and vertical structure of both habitat types. The monthly food availability index of young leaves was higher in the natural forest than in plantation forest habitat. We observed guerezas feeding on 30 plant species in the natural forest but only 18 species in the plantation forest. Guerezas in both forest types consumed mostly young leaves, but the natural forest group relied more on mature leaves and shoots, and less on fruits and stems, than the plantation forest group. *Maesa lanceolata* leaves contributed a greater proportion of the overall diet for the plantation forest group, while *Vernonia leopoldi* accounted for the largest proportion of the guereza diet for the natural forest group. The top five species consumed comprised 83% of the diet in the plantation forest group and 70% in the natural forest group, indicating that relatively few plant species dominate guereza diets in these habitats. Conservation of both natural and plantation forests, especially the plant species most intensively exploited by guerezas, should be prioritized to assist in Omo River guereza conservation efforts.

Keywords: Colobus monkeys, Ethiopia, guereza, human-modified habitat, Wof-Washa Natural State Forest.

INTRODUCTION

The exponential growth of human populations and the consequent impact on natural environments have led to degraded and fragmented habitats across landscapes, driving native fauna to either adapt or become locally extirpated (Estrada et al. 2017; Estrada et al. 2019; Mekonnen et al. 2017; Mekonnen et al. 2018a). Among the diverse fauna faced with anthropogenic habitat loss and fragmentation are nonhuman primates (hereafter primates), a large taxonomic order whose populations are declining globally, with many taxa listed within the threatened categories (i.e., Vulnerable, Endangered and Critically Endangered) of the IUCN Red List (Estrada et al. 2017; Fernández et al. 2022; Torres-Romero et al. 2023)

Understanding how animals cope with habitat degradation and fragmentation is urgently needed given the alarming rate at which natural habitats are being altered, ultimately limiting the ability of some species to either persist within a habitat fragment or move between fragments (Marsh and Chapman 2013; Galan-Acedo et al. 2019). The type and intensity of land-use changes (both historical and present day) are major determinants of biodiversity in many landscapes (Galan-Acedo et al. 2021; Redei et al. 2020; Torres-Romero et al. 2023). Extensive transformation of natural habitats to agroecosystems (e.g., cultivation, plantations, etc.) and urbanization invariably erodes wild food resources (McLennan and Hockings 2014). In turn, this may pose a threat to dietary specialists putting them at higher risk of local extirpation when compared to dietary generalists (Boyle and Smith 2010; Eppley et al. 2020; Machado et al. 2022; Mekonnen et al. 2018b). Despite these challenges, some species can persist in human-modified habitats by incorporating agricultural crops and exotic (non-native) flora into their diet (Eppley et al. 2017; Eppley and Goodman 2022; Estrada et al. 2012; McLennan and Hockings 2014). Still, natural forests harbour higher wildlife biodiversity than plantations. For example, many plantation forests have only one or a few tree species per hectare, while natural forests may have ≥300 species, with the latter supporting greater faunal diversity (Brockerhoff et al. 2008; Kessler et al. 2005; Onyekwelu et al. 2008). While plantation forests can provide timber and other utilitarian materials, natural forests are often considered critical for ecosystem services which are not effectively met by plantations (Sobuj and Rahman 2011).

Whether a species is able to cope with various anthropogenic and natural pressures can potentially be predicted by their dietary guild (Boyle and Smith 2010; Eppley et al. 2020, 2022; Machado et al. 2022). While primates as a whole consume a diverse array of resources, including leaves, fruits/seeds, flowers, gum/sap, bark, and insects (Ibrahim et al. 2023; Lim et al. 2021; Mekonnen et al. 2010; Tesfaye et al. 2021), many species can be narrowly classified as belonging to a specialized dietary guild (Eppley et al. 2020; Hawes and Peres 2014; Kappeler and Heymann 1996; Mekonnen et al. 2018b). Dietary specialists typically have anatomical and gastrointestinal specializations that allow them to consume and digest food items that may not be as easily digested by other species (Lambert 1998, 2011). For example, folivorous monkeys often consume young leaves and leaf buds as they have gastrointestinal specializations allowing them to more easily digest leaves compared to frugivorous taxa which often possess shortened, simple digestive tracts (Chapman and Chapman 2002; Cristóbal-Azkarate and Arroyo-Rodríguez 2007; Hanya and Chapman 2013). Beyond a species' dietary guild, however, preferred food resources vary in their nutritional composition and geographic distribution, with habitat quality potentially playing an influential role in a species' feeding ecology (Lambert 2011; Rothman and Bryer 2019).

Among the most well-known primate folivores are the colobines, large-bodied monkeys from the subfamily Colobinae that are geographically distributed across sub-Saharan Africa and southern Asia. For instance, in Africa, this taxonomic group is represented by three genera: *Colobus*, *Procolobus,* and *Piliocolobus* (Fashing 2022). Among the most easily recognizable is the eastern black-and-white colobus (*Colobus guereza*), also referred to as the guereza; it is a large-bodied, forest-dependent monkey with a wide, yet patchy, distribution throughout equatorial Africa with, according to most experts, eight subspecies (Fashing and Oates 2013; Zinner et al. 2019). It lives in groups of variable size of up to 23 individuals, and has specialized digestive adaptations to exploit foliage, like other colobines (Chivers 1994; Fashing 2022). Guerezas appear to cope relatively well with low to moderate habitat disturbance, surviving in forest fragments, selectively logged forests, and plantation forests, in addition to natural forest habitats (Fashing et al. 2012; Fashing and Oates 2013; Oates 1977a,b; Onderdonk and Chapman 2000). However, the feeding strategies they follow to cope with some of these disturbed and non-native habitats, particularly plantation forests, are not well known (Fashing et al. 2012). Two of the eight subspecies of guerezas are endemic to Ethiopia: the Omo River guereza (*C. g. guereza*) and the Djaffa Mountains guereza (*C. g. gallarum*). Compared to other guereza subspecies, the ecology and behaviour of these Ethiopian taxa are relatively little known, with previous research having been carried out in only a few localities (Dunbar and Dunbar 1974; Dunbar 1987; Tesfaye et al. 2021). The most intensive study of Omo River guerezas to date found that they relied on more whole fruits and flowers, and devoted more feeding time to exotic species, when inhabiting anthropogenically-disturbed forest habitats (forest fragments and disturbed continuous forest) than in large, undisturbed continuous forest habitat (Tesfaye et al. 2021).

Over the past century, Ethiopia has experienced rapid deforestation, which has resulted in habitat fragmentation, landscape/soil degradation, and biodiversity loss (Fashing et al. 2022;

Nyssen et al. 2014). The country's forest cover shrunk from 40% at the beginning of 20^{th} century to 2.4% in 2000 and 1.1% in 2010 (Gebru 2016). Furthermore, from 2010-2020, Ethiopia's annual percentage of forest wood removal (3.0%) was the highest in Africa (FAO 2020). With anthropogenic pressures increasing, and relatively little known about the feeding ecology of the endemic Omo River guereza (though see Tesfaye et al. 2021), it is imperative to obtain broad ecological data for this subspecies, and to evaluate how it is coping in this changing landscape. Accordingly, we aimed to 1) determine dietary preferences of Omo River guerezas in two habitats, i.e., a plantation forest and a natural forest, and 2) determine food availability in these two habitats. We hypothesized that the expected lower plant species diversity in the disturbed plantation forest would force guerezas to feed on a more limited array of plant species than in the more intact natural forest. Based on this, we predicted that plantation forest would have lower food availability than natural forest, and 2) guerezas in plantation forest would have lower dietary diversity than conspecifics in natural forest.

METHODS

Study area

We conducted this study from May 2015-April 2016 in Wof-Washa Natural State Forest (WWNSF), located in the central highlands of Ethiopia. This protected area is located on a forested escarpment that forms part of the Awash River catchment, which drains into the Danakil plains in the northern section of the Rift Valley (Bekele 1993; Yazezew et al. 2022). Geographically, it extends between 9º42′ and 9º47′ N latitude and between 39º43′ and 39º49′ E longitude, situated at elevations between 1650–3700 m asl (Fig. 1). The study area experiences mean annual low and high temperatures of 6.3ºC and 22.0º C, respectively, and a typically seasonal rainfall pattern, with mean annual precipitation of 1840 mm.

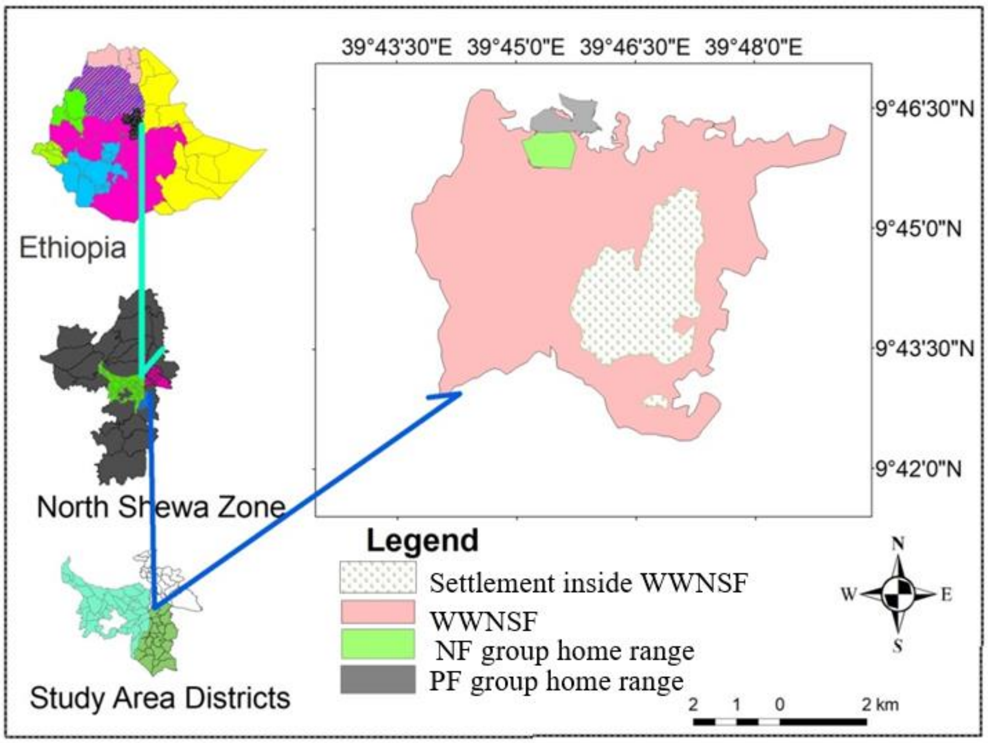

Fig. 1 Map of the study area and the home ranges of two study groups (NF=Natural Forest and PF=Plantation Forest) of Omo River guerezas (*Colobus guereza guereza*) at Wof-Washa Natural State Forest, Ethiopia, in 2019.

WWNSF is home to one of the few remaining dry evergreen Afromontane forests and the oldest natural state forests in the Ethiopian central highlands. It was set aside by the Shewan King Zera Yaqob, one of the country's most important early rulers, as the King's forest (or Crown forest) in the 15th century (ca. 1434-1468). The steep terrain along with the history of royal protection have limited forest access throughout modern times and contributed to its preservation (Veronika 2008). Furthermore, Emperor Menelik II established the first forest policy in Ethiopia and declared Wof-Washa Forest as a State Reserve Forest in the 1880s. Though agricultural encroachment and tree felling for fuel and construction have been problems for centuries, the forest has never been commercially exploited. Unable to exploit the forest for fuelwood, local farmers supplement their private fuelwood with cow dung, which unfortunately decreases its availability for use as fertilizer. Accordingly, local agricultural production is low due to poor soil fertility and unable to meet the population's subsistence needs, a situation which has been exacerbated by recurrent drought (Ayalew 2018; Veronika 2008).

There is more natural forest (3,197 ha) than plantation forest (61 ha) at WWNSF (Ayalew 2018), with the plantation forest serving as a buffer between the remaining natural forest and local settlements. The plantation forest at WWNSF was established between 1985-2000 by planting exotic tree species, including *Cupressus lucitanica* (Cupressaceae), *Eucalyptus globulus* (Myrtaceae), and *Pinus patula* (Pinaceae), as part of a strategy to rehabilitate degraded areas of natural forest (Ayalew 2018). It thus represents an anthropogenically altered area of forest consisting of a mix of naturally growing indigenous and planted exotic species.

Study groups

We selected two groups of Omo River guerezas, one from a plantation forest and the other from the relatively intact natural forest, for behavioural ecology data collection. The potential caveat of only observing two groups is the direct comparison limits our ability to determine whether any dietary variation is caused by habitat type, other variables, or simply reflects variation between groups. Researchers and trained local field assistants habituated guerezas over three months (February-April 2015) via daily follows. We initially identified the study groups by individual members that had unique pelage markings or other identifiable features. The two groups were of similar size. At the start of the study, the plantation forest group consisted of seven individuals (two adult males, two adult females, one sub-adult male and two juveniles), and this increased to nine individuals after two infants were born in September and

October 2015. The natural forest group consisted of six individuals (three adult males, two adult females and one sub-adult male) at the beginning of the study, then increased to eight individuals after two infants were born in October and November 2015. The home ranges of the guereza groups slightly overlapped, with the home range of the plantation forest group being smaller (2.98 ha) than that of the natural forest group (5.40 ha) (Yazezew et al. in prep.).

Vegetation composition

To characterize the botanical composition and diversity of the home ranges for each group, we conducted vegetation surveys along randomly created transects (Yazezew et al. in prep.). Specifically, we created two transects totalling 400-500 m in length and then generated six 50 m x 10 m (0.3 ha) vegetation quadrats to systematically sample all plant species present (Teelen 2007). Within each quadrat, we recorded all trees with DBH ≥10 cm and all climbers with DBH ≥5 cm, and (when possible) identified them to species level. Furthermore, we measured tree height (m), canopy size/diameter (m) (i.e., mean of canopy diameters measurements along two perpendicular axes from 180 and 234 tree measurements in the natural and plantation forests, respectively), and canopy/crown cover (%) (i.e., visual estimation of the level of canopy coverage that obstructs sunlight from reaching the forest floor) (Buchi et al. 2018; Gallegos and Glimskär 2009). We identified plant species *in situ*, and collected and preserved (i.e., pressed) specimens of unidentified or questionable taxa. For the latter, we recorded local names and transported specimens to the Addis Ababa University National Herbarium for further taxonomic identification.

We used quadrats within the home range of each study group to quantify and characterize the vegetation in each habitat type. We calculated plant species density by dividing the total number of stems recorded per hectare. We calculated plant species diversity of trees ≥10 cm DBH using the Shannon-Wiener diversity index (*H′*), Simpson's Dominance index (*D*), and the evenness index (*J*) (Krebs 1999). We used Sørensen indices (Ss coefficient) to assess the similarity in plant species richness between the two home ranges. Ss coefficients range from 0 to 1, with 0 representing zero species shared and 1 representing all species shared (Krebs 1999). We calculated the basal area (BA) of each tree species to estimate the biomass of each species in each home range (Fashing 2001; Felton et al. 2008) and determine the dominant tree species in each home range (Kool 1989). We used the Importance Value Index (IVI) to quantify the dominance, occurrence, and abundance of a given plant species in relation to other species in each home range (Kent and Coker 1992). IVI = RD + RF + RDO, where RD is relative density, RF is relative frequency, and RDO is relative dominance of the corresponding species *i* in the group's home range.

Phenology

We assessed phenology for selected food plant species in the home ranges of both plantation and natural forest groups monthly during the 12-month study. Based on preliminary observations during the habituation period, we selected and marked the 10 most frequently consumed plant species (trees/shrubs ≥10 cm DBH and climbers ≥5 cm DBH) abundant (>10 individuals/species) in each group's home range. We recorded phenological data from these marked species 1-2 days per month, after we had collected monthly dietary data for each group. We monitored each marked tree for the relative abundance of young leaves, mature leaves, flowers, and whole fruits (Fashing 2001; Ganzhorn et al. 2011; Tesfaye et al. 2021). We assigned each plant food item a relative abundance value (score) that ranged from 0 to 8, in intervals of 1 (Mekonnen et al. 2017). An abundance score of zero indicates that a tree showed 0% of its potential abundance (i.e., the item was absent from the plant) during the assessment, while 8 indicates an abundance of 87.5-100% (where 100% indicates the plant was fully laden with the item).

Based on tree species diversity in both habitats and on our behavioural observations during the habituation phase, we analysed phenological data from 13 botanical species. Specifically, we monitored 10 trees (*Olinia rochetiana, Cupressus lusitanica, Podocarpus falcatus, Allophylus abyssinicus, Galiniera saxifraga, Ilex mitis, Juniperus procera, Maesa lanceolata, Pittosporum viridiflorum*, and *Bersama abyssinica*), two shrubs (*Vernonia leopoldi* and *Discopodium penninervium*), and one climber (*Embelia schimperi*). We calculated food availability from the mean availability scores of the different food item categories (i.e., young leaves, mature leaves, flowers, and fruits) for each of the 13 marked tree species. Specifically, we calculated the monthly food availability index (FAI) for each food item by multiplying the mean phenology scores of species *i* with the mean basal area of species *i* and density of species *i* per ha (Fashing 2001; Mekonnen et al. 2018b; Tesfaye et al. 2021).

Feeding ecology

We collected feeding ecology data on each guereza group for five consecutive days per month from 06:00 to 18:00 h. We commenced daily observations at the sleeping site where we left the group on the previous evening. We recorded the activities of individuals using instantaneous scan sampling every 15-minutes (Altmann 1974) with sampling periods of up to 5 minutes (Eustace et al. 2015; Fashing 2001; Mekonnen et al. 2018b; Pinheiro and Mendes 2015). We recorded the first behaviour engaged in for $\geq$5 seconds during each scan. We recorded feeding when an individual manipulated food items, including when they obtained the item, moved the item(s) towards their mouth, or masticated it (Eustace et al. 2015; Pinheiro and

Mendes 2015). For each feeding scan, we collected data on food species consumed, plant part, and maturity of the item. We recorded plant parts as young leaves, mature leaves, stems, flowers, fruits, shoots, and bark, as well as insects as animal prey. We identified and recorded plant species consumed *in situ* if known, and collected unknown species so that botanists at the Addis Ababa University National Herbarium could identify them later.

We collected 22,618 individual behavioural records during 1,268 observation hours (plantation forest group = 650 h; natural forest group= 618 h). We evaluated dietary composition by calculating the daily and monthly proportions of different dietary items and plant species in the feeding scans (Felton et al. 2008; Mekonnen et al. 2010). To determine the dietary preference or selection ratio for specific plant species, we divided the percentage of food items from each species by its percentage density in the transect sample. Ratios above 1 indicate positive selection (Fashing et al. 2014; Dunham 2017; Mekonnen et al. 2018b; Tesfaye et al. 2021). We calculated dietary diversity using the Shannon-Wiener index, *H′*, and evenness via the evenness index, *J* (Krebs 1999). We also calculated the percentage overlap in the consumption of each dietary item for each plant species between the two groups (Fashing 2001; Dunham 2017).

Statistical Analysis

We compared the diversity indices of food plant species between the two habitats using the Diversity *t* test. We tested the relationship between the availability indices of plant food items and the percentage of feeding time on the same items using Pearson correlations. We also tested for differences in FAI between habitats using Mann–Whitney U tests. We set statistical significance level at $P \leq 0.05$. We conducted all statistical tests using PAST software version 3.26 (Hammer et al. 2001) or SPSS software version 26 (IBM SPSS Inc., Chicago, IL, USA).

Ethical note

The Ethiopian Wildlife Conservation Authority and Amhara Region Forest and Wildlife Enterprise granted permission to conduct this research. This project also adhered to the legal requirements of Ethiopia and complied with the American Society of Primatologists' Principles for the Ethical Treatment of Nonhuman Primates.

Data availability: The data sets summarized and analysed for this study are available from the corresponding author on reasonable request.

RESULTS

Habitat description and resource availability

The home range of the plantation forest group contained 12 species from 10 families (8 trees, 1 liana/climber, 1 tree/shrub and 2 shrubs), while the home range of the adjacent natural forest group had 21 species from 19 families (12 trees, 6 shrubs and 3 tree/shrubs). Six plant species were common in the home range of the natural forest group but did not occur in the plantation forest group's home range (Table S1). The home range of the natural forest group had a higher stem density than the plantation forest group's home range (Table 1).

The plant species similarity index in the two home ranges was moderate (9 of 24 species; Sørensen S_s coefficient 0.55). The vegetation in the home range of the natural forest group was more diverse than in that of the plantation forest group (Table 1). The Shannon-Wiener diversity index (PAST diversity t test: $t = -7.1$, $df = 23$, $p = 0.019$) and Simpson's diversity index ($t = 6.3$, df = 23, p = 0.013) were significantly higher in the home range of the natural forest group than in that of the plantation forest group (Table 1 and Table S1). Species evenness was higher and dominance was lower within the home range of the natural forest group than in the home range of the plantation forest group (Table 1 and Table S1).

Table 1. Overview of vegetation characteristics in the home ranges of Omo River guereza groups inhabiting plantation and natural forests in Wof-Washa Natural State Forest, Ethiopia, from May 2015-April 2016.

Habitat variables	Plantation forest	Natural forest
Taxa recorded	12	21
Large tree (≥10 cm DBH) stem density per ha	600.0	780.0
Large tree (≥10 cm DBH) species richness	40.0	70.0
Shannon-Wiener	1.60	2.30
Simpson's species diversity index	0.70	0.90
Large tree (≥10 cm DBH) species evenness	0.64	0.77
Large tree (≥10 cm DBH) species dominance index	0.29	0.12

Maesa lanceolata, *Juniperus procera*, *Podocarpus falcatus*, and *Cupressus lusitanica* were the most dominant species in the home range of the plantation forest group, while *Olinia rochetiana*, *Erica arborea*, *Allophylus abyssinicus*, *J. procera*, and *M. lanceolata* were the most dominant species in the home range of the natural forest group (Table S2).

Phenology

Plant food item availability varied over time (Fig. 2). Young, and to a lesser extent mature leaves, were the most abundant items throughout the year, while fruit was more seasonal. The monthly food availability indices for young leaves

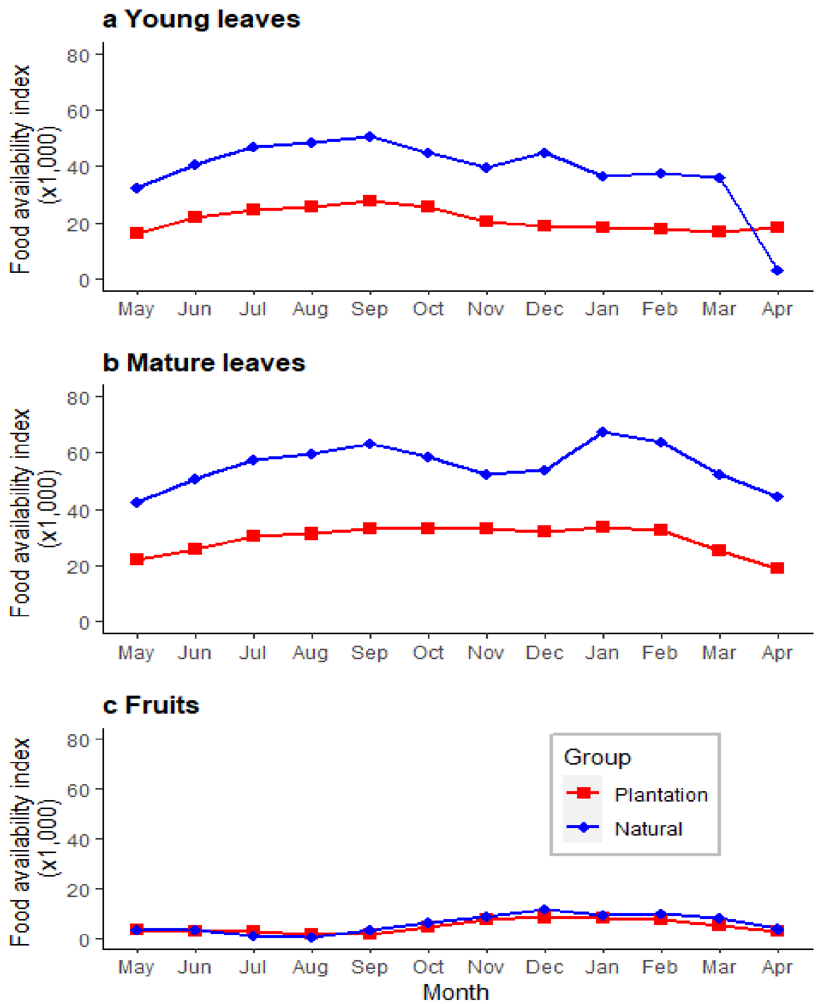

Fig. 2 Monthly food availability indices (young leaves, mature leaves and fruits) for plantation and natural forest groups of Omo River guerezas in Wof-Washa Natural State Forest, Ethiopia, from May 2015-April 2016.

(Mann Whitney U; Z = -4.16, P < 0.001) and mature leaves (Z = -4.15, P < 0.001) were statistically significantly higher in the home range of the natural forest group than in that of the plantation forest group. However, there was no statistically significant difference in fruit FAI between the home ranges of the two groups (Mann Whitney U; Z = 0.98, P = 0.350). Fruit was at peak availability during December in both groups' home ranges. The overall annual young leaf availability per hectare was 32% higher in the home range of the natural forest group than in that of the plantation forest group, and mature leaf availability per hectare was 30% higher. Moreover, the overall annual availability of fruit was 10% higher in the home range of the natural forest group than in that of the plantation forest group (Fig. 3).

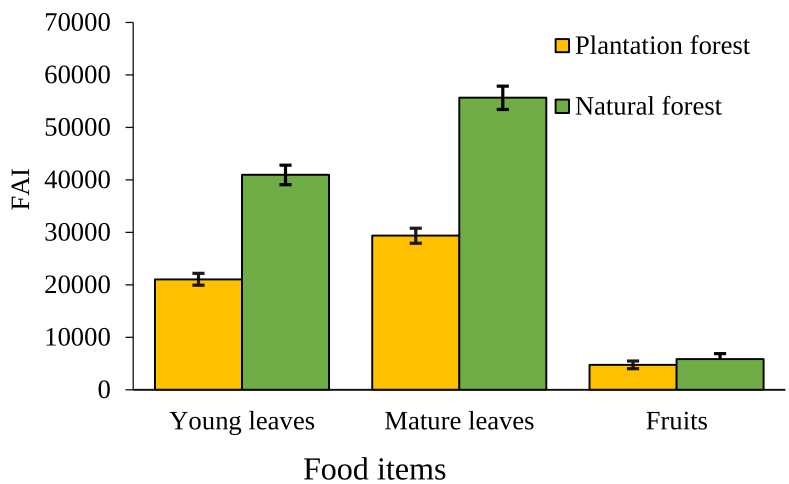

Fig. 3 Comparison of total food availability index (FAI) values of food items in the home ranges of Omo River guereza groups in plantation and natural forest (mean ± SE) in Wof-Washa Natural State Forest, Ethiopia, from May 2015-April 2016.

Juniperus procera contributed the highest abundance of both young and mature leaves in the home ranges of both groups, although its consumption rank was only 6th in plantation forest and 9th in natural forest (Table 2). Young leaves and mature leaves of *Maesa lanceolata* were the second most abundant foods in the home ranges of both groups and the species ranked first in plantation forest and second in natural forest in consumption (Table 2). *Vernonia leopoldi* was not an abundant item in either group's home range even though it accounted for the highest percentage of feeding time scans in the natural forest group and ranked fourth in the diet of the plantation forest group.

Food item consumption

Overall, leaves accounted for most of the guereza diet in both the plantation forest (80%) and natural forest (86%) groups. There were no significant differences between groups in the monthly consumption of young leaves (t = 0.5, df = 11, p = 0.644), mature leaves (t = 1.5, df = 11, p = 0.151), and stems (t = 2, df = 11, p = 0.056) (Fig. 4). However, the plantation forest group spent significantly more time monthly feeding on fruits (16.1% vs. 5.5%; t = 2.2, df = 11, p = 0.037) and less time on shoots (1.2% vs. 6.1%; t = 3.6, df = 11, p = 0.001) than the natural forest group.

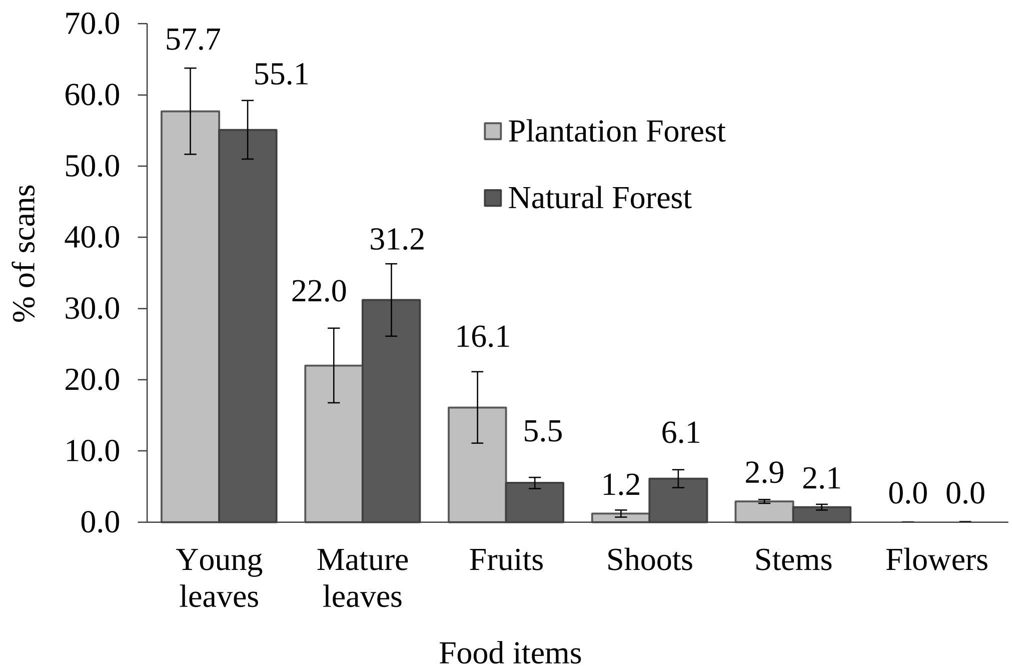

Fig. 4 Annual percentage of plant part contribution to the diets of two groups of Omo River guerezas (mean ± SE) inhabiting different forest types in Wof-Washa Natural State Forest, Ethiopia, from May 2015-April 2016.

Food availability indices of young leaves in phenology tree species and total feeding time scans on young leaves (for all phenology plant species in each group's range) were significantly correlated for the natural forest group (r=0.63, P = 0.004; Fig. 5B) but not for the plantation forest group (r=0.33, P = 0.06; Fig. 5A).

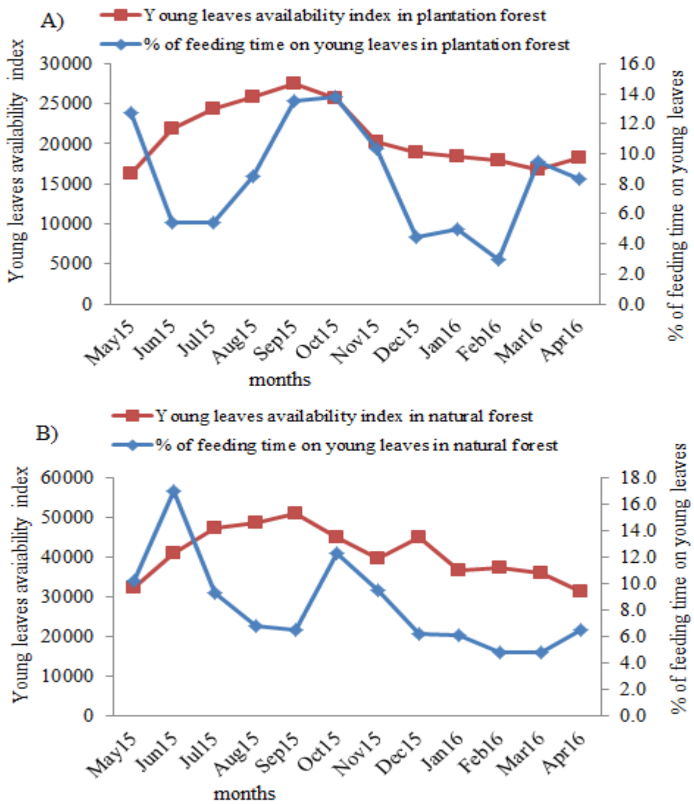

Fig. 5 Comparison of the availability of young leaves and their consumption by Omo River guerezas in (A) plantation forest and (B) natural forest in Wof-Washa Natural State Forest, Ethiopia, from May 2015-April 2016.

Ilex mitis was the most selected for plant species by the plantation forest group, followed by *Vernonia leopoldi*, and *Ficus sur* (Table 2). In contrast, *V. leopoldi*, *Ilex mitis* and *Pittosporum viridiflorum* were the top three most selected for plant food species by the natural forest group. *Maesa lanceolata* had a low selection ratio for both groups despite having the highest percentage contribution to the overall diet of the plantation forest group and the second highest contribution to the diet of the natural forest group.

Table 2. Dietary selection ratios based on stem density (individuals/ ha) and percentage of time spent feeding by groups of Omo River guerezas in plantation and natural forest habitats, in Wof-Washa Natural State Forest, Ethiopia, from May 2015-April 2016.

Plantation Forest					**Natural Forest**				
Rank	Species consumed	Annual diet %	% of stem density	Selection Ratio (rank)	Rank	Species consumed	Annual diet %	% of stem density	Selection Ratio (Rank)
1	*Maesa lanceolata*	30.6	44.4	0.7 (8)	1	*Vernonia leopoldi*	29.8	1.7	17.4 (1)
2	*Podocarpus falcatus*	16.1	8.3	1.9 (7)	2	*Maesa lanceolata*	15.6	12.8	1.2 (10)
3	*Ilex mitis*	14.1	1.1	12.8 (1)	3	*Pittosporum viridiflorum*	12.0	2.1	5.6 (4)
4	*Vernonia leopoldi*	13.5	1.7	7.9 (2)	4	*Olinia rochetiana*	7.3	19.2	0.4 (13)
5	*Discopodium penninervium*	8.6	2.2	3.9 (4)	5	*Ilex mitis*	5.7	0.4	13.3 (2)
6	*Juniperus procera*	3.9	27.8	0.1 (10)	6	*Galiniera saxifraga*	4.9	2.6	1.9 (6)
7	*Olinia rochetiana*	3.7	1.1	3.4 (5)	7	*Discopodium penninervium*	4.5	3.4	1.3 (9)
8	*Ficus Sur*	3.5	0.6	5.8 (3)	8	*Allophylus abyssinicus*	3.8	14.5	0.3 (14)
9	*Bersama abyssinica*	2.9	1.1	2.6 (6)	9	*Juniperus procera*	3.4	14.5	0.2 (15)
10	*Cupressus lusitanica*	1.5	8.3	0.2 (9)	10	*Cupressus lusitanica*	2.5	0.4	6.3(3)
					11	*Ficus sur*	1.9	0.6	3.2 (5)
					12	*Olea europapaea*	1.7	2.6	0.7 (11)
					13	*Bersama abyssinica*	1.5	0.9	1.8 (7)
					14	*Halleria lucida*	1.4	0.9	1.6 (8)
					15	*Podocarpus falcatus*	1.0	1.7	0.6 (12)

Note: SR=Selection Ratio is equals the percentage of a specific species in the diet divided by the availability percentage of that species (% of stem density) along sampled transects enumerated.

Dietary species richness and diversity

The two groups of guerezas consumed a total of 31 food plant species. The natural forest group obtained food from 30 species, while the plantation forest group obtained food from 18 species (Tables S3 and S4). The five most consumed species accounted for 83% of the overall diet of the plantation forest group, and 70% of the overall diet of the natural forest group. Ten plant species each accounted for ≥1.0% of the overall annual diet for the plantation forest group (Table 3) whereas 15 species each accounted ≥1.0% of the overall annual diet for the natural forest group (Table 4). *Maesa lanceolata* was the top food species for the plantation forest group (30.65% of the diet) and the second most consumed species for the natural forest group (15.64%). *Vernonia leopoldi* was the most consumed species by the natural forest group (29.77%) and the fourth most consumed species by the plantation forest group (13.55%).

Table 3. Percentage contribution of food items from the top 10 plant species in the diet of Omo River guerezas in plantation forest in Wof-Washa Natural State Forest, Ethiopia, from May 2015-April 2016.

Family	Species	*Growth form	Young leaves	Mature leaves	Fruit	Shoot	Stem	Total contribution
Myrsinaceae	*Maesa lanceolata*	T	20.51	8.48	0.05	0.55	1.06	30.65
Podocarpaceae	*Podocarpus falcatus*	T	3.61	0.38	12.06	0.08	-	16.12
Aquifoliaceae	*Ilex mitis*	T	10.62	2.77	-	0.28	0.45	14.13
Asteraceae	*Vernonia leopoldi*	S	8.98	3.96	-	0.13	0.48	13.55
Solanaceae	*Discopodium penninervium*	S	5.17	2.83	-	-	0.63	8.63
Cupressaceae	*Juniperus procera*	T	2.17	1.14	0.48	0.10	0.03	3.91
Oliniaceae	*Olinia rochetiana*	T	2.55	0.98	-	0.05	0.13	3.71
Moraceae	*Ficus sur*	T	0.03	-	3.51	-	-	3.53
Melianthaceae	*Bersama abyssinica*	T/S	1.79	0.96	-	-	0.10	2.85
Cupressaceae	*Cupressus lusitanica*	T	1.11	0.40	-	0.03	-	1.54

Note: * T= Tree, T/S= Tree /Shrub, S= Shrub,

Table 4. Percentage contribution of food items from the top 15 plant species consumed by Omo River guerezas in natural forest in Wof-Washa Natural State Forest, Ethiopia, from May 2015-April 2016.

Family	**Species**	**[*]Growth form**	**Young leaves**	**Mature leaves**	**Fruit**	**Shoot**	**Stem**	**Total contribution**
Asteraceae	*Vernonia leopoldi*	S	16.05	11.83	0.19	0.90	0.81	29.77
Myrsinaceae	*Maesa lanceolata*	T	8.40	4.71	0.99	1.15	0.40	15.64
Pittosporaceae	*Pittosporum viridiflorum*	T	7.13	2.94	1.18	0.59	0.15	11.99
Oliniaceae	*Olinia rochetiana*	T	4.46	2.11	0.12	0.46	0.12	7.28
Aquifoliaceae	*Ilex mitis*	T	3.00	2.29	-	0.37	-	5.67
Rubiaceae	*Galiniera saxifraga*	T	2.79	1.24	0.50	0.31	0.09	4.93
Solanaceae	*Discopodium penninervium*	S	2.04	1.49	0.19	0.46	0.28	4.46
Sapindaceae	*Allophylus abyssinicus*	T	2.51	0.90	0.09	0.22	0.03	3.75
Cupressaceae	*Juniperus procera*	T	2.29	0.65	0.25	0.15	0.03	3.38
Cupressaceae	*Cupressus lusitanica*	T	1.08	0.87	-	0.59	-	2.54
Moraceae	*Ficus sur*	T	-	-	1.89	-	-	1.89
Oleaceae	*Olea europaea*	T	1.02	0.53	0.03	0.12	-	1.70
Melianthaceae	*Bersama abyssinica*	T/S	0.81	0.37	0.06	0.22	0.06	1.52
Scrophulariaceae	*Halleria lucida*	T/S	0.59	0.34	-	0.34	0.09	1.36
Podocarpaceae	*Podocarpus falcatus*	T	0.84	0.09	-	-	0.03	0.96

Note: [*] T= Tree, T/S= Tree /Shrub, S= Shrub.

Overall, about half of the food items from the top nine plant species were consumed by both guereza groups. The overlap was highest for young leaves, followed by mature leaves (Table 5).

Table 5. Percentage overlap in species-specific food item (n=9 species) between two Omo River guereza groups in Wof-Washa Natural State Forest, Ethiopia, from May 2015-April 2016.

Species	Young leaves	Mature leaves	Fruit	Stems	Shoots	Total
Maesa lanceolata	8.4	4.7	0.1	0.8	0.6	14.6
Vernonia leopoldi	9.0	4.0	0.0	0.5	0.1	13.6

Ilex mitis	3.0	2.3	0.0	0.0	0.3	5.6
Discopodium penninervium	2.0	1.5	0.0	0.3	0.0	3.8
Olinia rochetiana	2.6	1.0	0.0	0.1	0.1	3.8
Juniperus procera	2.2	0.7	0.3	0.0	0.1	3.3
Ficus sur	0.0	0.0	1.9	0.0	0.0	1.9
Cupressus lusitanica	1.1	0.4	0.0	0.0	0.0	1.5
Bersama abyssinica	0.8	0.4	0.0	0.1	0.0	1.3
Total	29.1	15.0	2.3	1.8	1.2	49.4

The mean monthly diversity of food species was significantly lower in the plantation forest group than the natural forest group (Mann Whitney U; Z = -2.3, P = 0.019; Table 6). Dietary diversity was highest in September and October and lowest in February for the plantation forest group, while it was highest in June and lowest in December for the natural forest group (Table 6). The mean monthly dietary evenness was also significantly lower for guereza groups inhabiting the plantation forest than for those in the natural forest (Mann Whitney U; Z = -4.2, P < 0.001; Table 6).

Table 6. Food species diversity and evenness indices of guerezas over 12 months study period in plantation and natural forest in Wof-Washa Natural State Forest, Ethiopia, from May 2015-April 2016.

Month	**Shannon-Wiener diversity index, *H'***			**Evenness index, *J***		
	plantation forest	**natural forest**	**mean**	**plantation forest**	**natural forest**	**Mean**
May15	1.77	2.44	2.11	0.36	0.44	0.40
Jun15	1.60	2.54	2.07	0.37	0.42	0.39
Jul15	1.66	2.31	1.99	0.40	0.48	0.44
Aug15	1.66	1.84	1.75	0.40	0.48	0.44
Sep15	2.19	2.40	2.30	0.36	0.49	0.43
Oct15	2.19	2.45	2.32	0.36	0.43	0.40
Nov15	2.00	2.00	2.00	0.37	0.44	0.41
Dec15	1.76	1.46	1.61	0.39	0.47	0.43
Jan16	1.85	1.98	1.92	0.36	0.46	0.41
Feb16	1.18	1.95	1.57	0.41	0.48	0.44
Mar16	1.50	1.68	1.59	0.38	0.46	0.42
Apr16	1.58	2.05	1.82	0.40	0.45	0.42
Mean	1.75	2.09	1.92	0.38	0.46	0.42

DISCUSSION

In our comparative study of Omo River guereza groups in natural forest versus plantation forest at WWNSF, we found that plant species richness and overall food availability were lower in the home range of the group inhabiting plantation forest than in the group inhabiting natural forest. The natural forest group often consumed food items from large tree species like *Pittosporium viridiflorum, Galiniera saxifraga,* and *Allophylus abyssinicus*, which did not occur in the plantation forest and were thus unavailable to the guerezas living there. Although plantations are generally less suitable habitats for many primates and other animals than natural forest habitats (Brockerhoff et al. 2008; Fashing et al. 2012; Merker and Yustian 2008), guereza groups nevertheless survived in both environments at WWNSF, consistent with previous studies showing that this species can persist in a variety of degraded and human-modified habitats (Fashing 2012; Chapman et al. 2000; Tesfaye et al 2021; Oates 1977b; Wasserman and Chapman 2003). In the plantation forest, tree species such as *Juniperus procera, Podocarpus falcatus, Olinia rochetiana, Maesa lanceolata, Ilex mitis*, and the exotic *Cupressus lusitanica* provide benefits to local people as timber and to guerezas as habitat and food sources (Gerard et al. 2015; Grimes and Paterson 2000; Konersmann et al. 2021). Like guereza, several other forest primate species, including slow lorises (*Nycticebus bengalensis*), southern bamboo lemurs (*Hapalemur meridionalis*), tarsiers (*Tarsius dianae*), howler monkeys (*Alouatta* spp.), and siamangs (*Hylobates syndactylus*), are also capable of inhabiting plantations, in some instances containing high densities of non-native trees (Eppley et al. 2015; Merker and Yustian 2008; Nowak and Lee 2013; Pliosungnoen et al. 2010).

Large tree stem density, species diversity, and species richness were all higher in the home range of the natural forest group than in that of the plantation forest group where a relatively small number of species accounted for most of the trees. These differences likely stem from the plantation forest's history as a heavily degraded area of natural forest to which several exotic species were added several decades ago (Ayalew 2018). In western Kenya, even forests established by planting a variety indigenous species over a half century earlier are known to not entirely mirror the tree composition of older natural forest nearby and contain lower densities of several monkey species, including guereza, than the natural forest (Fashing et al. 2012).

Seasonal changes in resource abundance and availability have fundamental effects on the behaviour and ecology of primates (Dunbar 1988). Guerezas in both forest types at Wof-Washa proved to be highly folivorous and their diet closely followed local resource phenology patterns. Guereza feeding time on their preferred resource (i.e., young leaves) was strongly influenced by temporal variation in their abundance and availability. Food abundance was significantly higher in the natural forest habitat than in the plantation forest, which may largely be due to the legacy of intensive human encroachment and habitat degradation in the plantation forest habitat (Ayalew 2018). Such factors reduce plant species richness, diversity, and structure, and are known to negatively affect many primate species (Boyle et al. 2012; Eppley et al. 2020). Although the guerezas spent most of their time feeding on *Maesa lanceolata*, *Vernonia leopoldi, Ilex mitis, Podocarpus falcatus, Discopodium penninervium* and/or *Pittosporum viridiflorum*, when the abundance of favoured food items on these plant species was reduced, guerezas fed more on fallback species (Marshall et al. 2009) such as *Juniperus procera* and *Allophylus abyssinica*. Some of these desirable plant species for guerezas (specifically, *M. lanceolata, J. procera, C. lusitanica*, and *P. falcatus*) had high importance value indices within plantation forest habitat, revealing that these tree species have been relatively resistant to the various anthropogenic pressures imposed by local communities (Ayalew et al. 2015).

Overall, we identified a total of 31 plant species as guereza foods in WWNSF, comprising 31 genera and 26 families. Comparable values have been reported in several studies of other *Colobus guereza* subspecies (Bocian 1997; Fashing 2001; Oates 1977a), as well as in other *C. g. guereza* populations in southern Ethiopia (Tesfaye et al. 2021). These low dietary species richness values seem to be characteristic of guerezas, including for populations inhabiting species-rich rain forest habitats (Table 7). While they typically exhibit a preference for young leaves (Oates 1977a; Tesfaye et al. 2021), guerezas feed on other food items when preferred resources are scarce, and there are sites where they seem to prefer fruits when available (Fashing 2001; Fashing et al. 2007; Oates 1977a; Plumptre 2006). This ecological flexibility to expand their diet when under pressure can be considered an asset for African colobines coping with the resource scarcity resulting from anthropogenic disturbance, including populations in forest fragments (Chapman and Chapman 1999; Eppley et al. 2017; Tesfaye et al. 2021) and plantation forests (this study).

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Table 7I. The diet of black-and-white colobus monkeys, *Colobus* spp., across their range in Africa.

Study species	Study site	Food items									Sampling type	References
		YL	ML	UL	TotL	FR	FL	SH	ST	#spp		
C. guereza guereza (plantation forest)	WWNSF, Ethiopia	57.7	22	-	79.7	16.1		1.2	2.9	18	Scan	This study
C. g. guereza (natural forest)	WWNSF, Ethiopia	55.1	31.2	-	86.3	5.5		6.1	2.1	30	Scan	This study
C. g. guereza	Aregash Forest, Ethiopia	51	11	0	62	20	5	-	-	37	Scan	Tesfaye et al. (2021)
C. g. guereza	Munessa, Ethiopia	57	26	0	83	3	1	-	-	27	Scan	Tesfaye et al. (2021)
C. g. guereza	Wondo Genet, Ethiopia	50	15	0	65	6	13	-	-	32	Scan	Tesfaye et al. (2021)
C. g. occidentalis	Kalinzu, Uganda	87	0	0	87	5	1	-	-	39	Scan	Matsuda et al. (2020)
C. g. occidentalis	Kibale, Uganda	65	14	1	80	12	6	-	-	-	Scan	Wasserman and Chapman (2003)
C. g. occidentalis	Kibale Forest, Uganda	57.7	12.4	2.5	72.6	13.6	2.1	-		43	Scan	Oates (1977a)
C. g. occidentalis	Ituri Forest, DRC	26.2	3.8	24.2	54.2	24.6	2.9	-	-	31	Scan	Bocian (1997)
C. g. matschiei	Kakamega Forest, Kenya	20.4	6.6	22.5	49.5	38.6	0.5	-	-	28+	Scan	Fashing (2001)
C. angolensis cottoni	Ituri Forest, DRC	23.5	2.4	22	47.9	5.4	7.2	-	-	37	Scan	Bocian (1997)
C. a. palliatus	Diani Forest, Kenya	58	13	0	71	5	14	-	-	110	Scan	Dunham (2017)

C. a. palliatus	Diani Forest, Kenya	21.1	35.4	4.1	60.6	9.5	27.6	-	-	42	Scan	Jansson (2011)
C. polykomos	Tiwai, Sierra Leone	29.7	26.4	-	56.1	34.6	1.7	-	-	56	Scan	Dasilva (1994)

YL = young leaves; ML = mature leaves; UL = unclassified leaves; TotL= total leaves; FR = fruit; FL = flowers; SH = shoots; ST = stems; # spp. = number of species consumed.

Primates often select foods based on their accessibility and availability throughout the year, as well as their nutritional content (Clink et al. 2017; Eppley et al. 2017; Fashing et al. 2007; Lambert and Rothman 2015). It is likely that guerezas in WWNSF selected food species based on a combination of these factors. Young leaves comprised a significant portion of the diet in both groups, similar to what has been reported for other *Colobus guereza* populations, including *C. g. guereza* inhabiting continuous and fragmented forests in southern Ethiopia (Bocian 1997; Oates 1977a; Tesfaye et al. 2021), a strategy thought to meet their nutritional requirements by ensuring high protein intake (Dasilva 1994; Ganzhorn et al. 2017). However, while young leaves tend to contain higher concentrations of protein, their overall nutritional quality can be highly variable (Ganzhorn et al. 2017; Ryan et al. 2013).

The mean monthly *H'* values of the two groups were similar to those in previous studies of other black-and-white colobus monkey species, such as *Colobus guereza occidentalis* (*H'* = 1.9) and *Colobus angolensis cottoni* (*H'* = 1.8) in Ituri, D.R. Congo (Bocian 1997) and *C. g. matschiei* (T-group, *H'* = 1.6; and O group, *H'* = 1.7) in Kakamega, Kenya (Fashing 2001). However, the mean food species evenness indices for both groups (plantation forest group, J = 0.38; natural forest group, J = 0.46) were considerably lower than those reported for *C. g. matschiei* in Kakamega (T-group, *J* = 0.71; O-group, *J* = 0.72; Fashing 2001) and *C. g. guereza* in southern Ethiopia (*J* = 0.85; Tesfaye et al. 2021). This difference might be due to the impact of deforestation in WWNSF, leading to the decline of some food tree species and dominance by others. If this is the case, reducing anthropogenic pressures on the forest is a critical part of an effective conservation management strategy at WWNSF. Indeed, previous research has shown that the basal area of big trees in WWNSF declined from 100.3 m^2/ha in 1993 to 64.32 m^2/ha in 2013 (Fisaha et al. 2013). This decline was likely due to selective logging for timber and other construction purposes resulting in the dominance of secondary vegetation, such as small-sized trees and shrubs, especially in the plantation forest and close to villages. These large trees are often food resources for guerezas, thus the continuation of this selective logging and progressive changes in resource abundance and availability will likely adversely affect guerezas, as well as other wildlife dependent on this habitat (Dunbar, 1988; Kamilar and Paciulli, 2008; Konersmann et al. 2021). For this reason, it will be important to create awareness campaigns on sustainable forest use and management targeting resource-dependent community members. There is a growing awareness that in many cases, including in Ethiopia, community participation in natural resource management can be more effective than traditionally strict protected areas (Ashenafi and Leader-Williams 2005; Estrada et al. 2022; Fashing et al. 2022). Facilitating critical reflection about livelihood priorities through participatory conservation approaches can effectively align community actions with natural resource management strategies that may improve conservation outcomes (Eppley et al. 2023; Wali et al. 2017).

Conclusion

While our results on feeding ecology show that Omo River guerezas at Wof-Washa were able to survive on the resources available largely in either natural or plantation forest, they also highlight the critical need for further studies of the dietary and habitat preferences of this subspecies so we can understand how it may respond to future climatic and anthropogenic pressures. Considering the increasing anthropogenic pressures and habitat degradation throughout the tropics, the ability of Omo River guerezas to persist in the less botanically diverse plantation forest habitat must be viewed as a positive. In terms of conservation strategies, plantation forests can provide effective (and critical) habitat buffer zones and corridors, allowing for genetic connectedness across the landscape. We strongly encourage community-led efforts aimed at reducing deforestation while increasing landscape-level reforestation, integrating both primate food and utilitarian tree species (Konersmann et al. 2021; Mekonnen et al. 2022).

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858 **Table S1** Results of enumeration of plants ≥ 10 cm DBH in the quadrats of transects within the home ranges of the natural and plantation forest study groups of Omo River guerezas at Wof-Washa Natural State Forest, Ethiopia (rank is based on abundance).

Rank	Family	Species	Stems/ ha	% total trees	Basal area/ ha(cm2/ha)	Origin	Utilitarian
Natural Forest (n=234 trees)							
1	Oliniaceae	*Olinia rochetiana*	150.0	19.2	801.4	Ind	Fn, FT, Fw, Tim
2	Ericaceae	*Erica arborea*	130.0	16.7	565.4	Ind	Ch, Fd, Fn, Fw
3	Sapindaceae	*Allophylus abyssinicus*	113.3	14.5	995.0	Ind	FT, Fw, Tim
3	Cupressaceae	*Juniperus procera*	113.3	14.5	4228.6	Ind	Fur, Fw, Tim
5	Myrsinaceae	*Maesa lanceolata*	100.0	12.8	1728.3	Ind	Fn, Fw
6	Solanaceae	*Discopodium penninervium*	26.7	3.4	402.3	Ind	FT, Fw,
7	Rubiaceae	*Galiniera saxifraga*	20.0	2.6	305.2	Ind	Fw, Tim
7	Loganiaceae	*Nuxia congesta*	20.0	2.6	1015.5	Ind	Ch, Fn, Fw
7	Oleaceae	*Olea europaea*	20.0	2.6	738.5	Ind	Fur, Fw, Tim
10	Pittosporaceae	*Pittosporum viridiflorum*	16.7	2.1	1557.9	Ind	FT, Fw, Tim
11	Podocarpaceae	*Podocarpus falcatus*	13.3	1.7	3024.9	Ind	Fur, Fw, Tim
11	Asteraceae	*Vernonia leopoldi*	13.3	1.7	847.8	Ind	Fw, MU
13	Santalaceae	*Osyris quadripartita*	10.0	1.3	277.6	Ind	Fw, Tim
14	Melianthaceae	*Bersama abyssinica*	6.7	0.9	376.8	Ind	Fn, Fw
14	Scrophulariaceae	*Halleria lucida*	6.7	0.9	364.3	Ind	Fw, MU
16	Cupressaceae	*Cupressus lusitanica*	3.3	0.4	588.8	Ex	Fur, Fw, Tim
16	Flacourtiaceae	*Dovyalis abyssinica*	3.3	0.4	261.7	Ind	Fn, Food, MU
16	Aquifoliaceae	*Ilex mitis*	3.3	0.4	669.9	Ind	Ch, FT, Fw, MU, Tim
16	Celastraceae	*Maytenus arbutifolia*	3.3	0.4	376.8	Ind	Fd, Fn, FT, Fw

16	Myricaceae	*Myrica salicifolia*	3.3	0.4	2936.6	Ind	Fw, Tim
16	Myrsinaceae	*Myrsine africana*	3.3	0.4	550.2	Ind	Fn, Fw, MU
Total			780.0	100.0	22613.3		
Plantation Forest (n = 180 trees)							
1	Myrsinaceae	*Maesa lanceolata*	266.7	44.4	1099.7	Ind	Fn, Fw, MU
2	Cupressaceae	*Juniperus procera*	166.7	27.8	1755.3	Ind	Fur, Fw, MU, Tim
3	Cupressaceae	*Cupressus lusitanica*	50.0	8.3	1519.8	Ex	Fur, Fw, Tim
3	Podocarpaceae	*Podocarpus falcatus*	50.0	8.3	462.9	Ind	Fur, Fw, MU, Tim
5	Solanaceae	*Discopodium penninervium*	13.3	2.2	277.6	Ind	FT, Fw
5	Fabaceae	*Erythrina brucei*	13.3	2.2	4906.0	Ind	Fd, Fn, Fur, Fw, MU
7	Asteraceae	*Vernonia leopoldi*	10.0	1.7	462.9	Ind	Fn, Fw, MU
8	Melianthaceae	*Bersama abyssinica*	6.7	1.1	261.7	Ind	Fn, Fw
8	Myrsinaceae	*Embelia schimperi*	6.7	1.1	167.5	Ind	Fw, MU
8	Aquifoliaceae	*Ilex mitis*	6.7	1.1	18463.2	Ind	Ch, FT, Fw, MU, Tim
8	*Oliniaceae*	*Olinia Rochetiana*	6.7	1.1	3168.9	Ind	Fn, FT, Fw, Tim
9	Moraceae	*Ficus Sur*	3.3	0.6	49112.2	Ind	Food, Fur, Tim
Total			600.0	100.0	81657.5		

Key: Ex=Exotic; Ind = Indigenous; Fw = Firewood; Tim = Timber; Fur = Furniture; FT = Farm Tools; Ch = Charcoal; Fd = Fodder; Fn = Fence, MU=Medicinal Use

Table S2. Important Value Index (IVI) of plant species occurring in the home ranges of Omo River guereza study groups in plantation forest and natural Forest at Wof-Washa Natural State Forest, Ethiopia.

Plantation Forest				**Natural Forest**			
Species	Relative Dominance	IVI	%IVI	Species	Relative Dominance	IVI	% IVI
Maesa lanceolata	35.1	80.0	54.5	*Olinia rochetiana*	8.5	27.9	22.8
Juniperus procera	8.8	36.7	25.0	*Erica arborea*	3.5	20.3	16.6
Cupressus lusitanica	0.9	9.3	6.3	*Allophylus abyssinicus*	2.9	17.5	14.3
Podocarpus falcatus	1.0	9.4	6.4	*Juniperus procera*	3.2	17.8	14.6
Discopodium penninervium	0.1	2.3	1.6	*Maesa lanceolata*	2.8	15.7	12.8
Erythrina brucei	0.1	2.3	1.6	*Discopodium penninervium*	0.2	3.6	3.0
Vernonia leopoldi	0.0	1.7	1.2	*Galiniera saxifraga*	0.1	2.7	2.2
Bersama abyssinica	0.0	1.1	0.8	*Nuxia congesta*	0.1	2.7	2.2
Embelia schimperi	0.0	1.1	0.8	*Olea europaea*	0.1	2.7	2.2
Ilex mitis	0.0	1.1	0.8	*Pittosporum viridiflorum*	0.1	2.2	1.8
Olinia rochetiana	0.0	1.1	0.8	*Podocarpus falcatus*	0.0	1.8	1.4
Ficus Sur	0.0	0.6	0.4	*Vernonia leopoldi*	0.0	1.8	1.4
		146.8		*Osyris quadripartita*	0.0	1.3	1.1
				Bersama abyssinica	0.0	0.9	0.7
				Halleria lucida	0.0	0.9	0.7
				Cupressus lusitanica	0.0	0.4	0.4
				Dovyalis abyssinica	0.0	0.4	0.4
				Ilex mitis	0.0	0.4	0.4
				Maytenus arbutifolia	0.0	0.4	0.4
				Myrica salicifolia	0.0	0.4	0.4
				Myrsine africana	0.0	0.4	0.4

Table S3. Contribution of food items from each plant species consumed by Omo River guerezas in plantation forest at Wof-Washa Natural State Forest, Ethiopia (n=3972).

Family	Species	*Growth form	Young leaves	Mature leaves	Fruit	Shoot	Stem	Total spp. contribution
Myrsinaceae	*Maesa lanceolata*	T	20.51	8.48	0.05	0.55	1.06	30.65
Podocarpaceae	*Podocarpus falcatus*	T	3.61	0.38	12.06	0.08	-	16.12
Aquifoliaceae	*Ilex mitis*	T	10.62	2.77	-	0.28	0.45	14.13
Asteraceae	*Vernonia leopoldi*	S	8.98	3.96	-	0.13	0.48	13.55
Solanaceae	*Discopodium penninervium*	S	5.17	2.83	-	-	0.63	8.63
Cupressaceae	*Juniperus procera*	T	2.17	1.14	0.48	0.1	0.03	3.91
Oliniaceae	*Olinia rochetiana*	T	2.55	0.98	-	0.05	0.13	3.71
Moraceae	*Ficus sur*	T	0.03	-	3.51	-	-	3.53
Melianthaceae	*Bersama abyssinica*	T/S	1.79	0.96	-	-	0.1	2.85
Cupressaceae	*Cupressus lusitanica*	T	1.11	0.4	-	0.03	-	1.54
Oleaceae	*Jasminum abyssinicum*	L/C	0.55	-	-	-	-	0.55
Ranunculaceae	*Clematis hirsuta*	L/C	0.3	0.03	-	0.03	-	0.35
	Unidentified mosses	E	0.18	-	-	-	-	0.18
Myrsinaceae	*Embelia schimperi*	L/C	0.08	-	-	-	-	0.08
Rosaceae	*Rubus steudneri*	S	0.05	0.03	-	-	-	0.08
Scrophulariaceae	*Halleria lucida*	T/S	0.05	-	-	-	-	0.05
Myrsinaceae	*Myrsine africana*	S	0.03	-	-	-	0.03	0.05
Oleaceae	*Olea europaea*	T	0.03	-	-	-	-	0.03
Total			57.8	21.94	16.12	1.24	2.9	100

Note: *Growth form T= Tree, T/S= Tree /Shrub, S= Shrub, H= Herb, L/C= Liana/Climber, E= Epiphyte.

Table S4. Contribution of food items from each plant species consumed by Omo River guerezas in natural forest at Wof-Washa Natural State Forest, Ethiopia (n=3228).

Family	Species	*Growth form	Young leaves	Mature leaves	Fruit	Shoot	Stem	Total spp. contribution
Asteraceae	*Vernonia leopoldi*	S	16.05	11.83	0.19	0.9	0.81	29.77
Myrsinaceae	*Maesa lanceolata*	T	8.4	4.71	0.99	1.15	0.40	15.64
Pittosporaceae	*Pittosporum viridiflorum*	T	7.13	2.94	1.18	0.59	0.15	11.99
Oliniaceae	*Olinia rochetiana*	T	4.46	2.11	0.12	0.46	0.12	7.28
Aquifoliaceae	*Ilex mitis*	T	3.00	2.29	-	0.37	-	5.67
Rubiaceae	*Galiniera saxifraga*	T	2.79	1.24	0.50	0.31	0.09	4.93
Solanaceae	*Discopodium penninervium*	S	2.04	1.49	0.19	0.46	0.28	4.46
Sapindaceae	*Allophylus abyssinicus*	T	2.51	0.90	0.09	0.22	0.03	3.75
Cupressaceae	*Juniperus procera*	T	2.29	0.65	0.25	0.15	0.03	3.38
Cupressaceae	*Cupressus lusitanica*	T	1.08	0.87	-	0.59	-	2.54
Moraceae	*Ficus sur*	T	-	-	1.89	-	-	1.89
Oleaceae	*Olea europaea*	T	1.02	0.53	0.03	0.12	-	1.70
Melianthaceae	*Bersama abyssinica*	T/S	0.81	0.37	0.06	0.22	0.06	1.52
Scrophulariaceae	*Halleria lucida*	T/S	0.59	0.34	-	0.34	0.09	1.36
Podocarpaceae	*Podocarpus falcatus*	T	0.84	0.09	-	-	0.03	0.96
Loganiaceae	*Nuxia congesta*	T	0.28	0.50	-	0.09	-	0.87
Myrsinaceae	*Myrsine africana*	S	0.43	0.12	-	0.03	-	0.59
Flacourtiaceae	*Dovyalis abyssinica*	S	0.34	0.03	0.03	-	-	0.40
Ranunculaceae	*Clematis hirsuta*	L/C	0.28	0.06	-	-	-	0.34
Meliaceae	*Turraea holstii*	S	0.19	0.03	-	-	-	0.22
	Unidentified mosses	E	0.22	-	-	-	-	0.22
Myrsinaceae	*Embelia schimperi*	S	0.09	0.03	-	-	-	0.12
Ericaceae	*Erica arborea*	T/S	0.06	0.03	-	0.03	-	0.12
Celastraceae	*Maytenus arbutifolia*	T/S	-	0.06	-	-	-	0.06
Anacardiaceae	*Rhus natalensis*	T	0.06	-	-	-	-	0.06
Balsaminaceae	*Impatiens tinctoria*	H	0.03	-	-	-	-	0.03
Oleaceae	*Jasminum abyssinicum*	L/C	-	-	-	0.03	-	0.03

Lamiaceae	*Plectranthus lactiflorus*	H	0.03	-	-	-	-	0.03
Urticaceae	*Urera hypselodendron*	L/C	0.03	-	-	-	-	0.03
Cucurbitaceae	*Zehneria scabra*	L/C	0.03	-	-	-	-	0.03
Total			55.08	31.23	5.51	6.07	2.11	100

884 *Note:* *Growth form T= Tree, T/S= Tree /Shrub, S= Shrub, H= Herb, L/C= Liana/Climber, E= Epiphyte.