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Comparison of rodent community between natural and modified habitats in Kafta-Sheraro National Park and its adjoining villages, Ethiopia: implication for conservation

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Abstract

Background: Distribution and diversity of rodents vary across habitats due to different environmental factors. An ecological comparative study on diversity and abundance of rodents was conducted in Kafta-Sheraro National Park and its nearby villages from August 2017 to April 2018.

Materials and methods: Modified and natural habitats were randomly selected and two representative live trapping grids were set at each habitat to collect rodents using Sherman live trap.

Results: In 2352 trap nights of trapping, a total of 185 individuals of 7 species of rodents were trapped from the modified and natural habitats. The identified species were *Mastomys natalensis* (38.9%), *Stenocephalemys albipes* (29.7%), *Rattus rattus* (17.8%), *Mastomys awashensis* (9.2%), *Acomys cahirinus* (1.6%), *Mastomys erythroleucus* (1.6%), and *Arvicanthis dembeensis* (1.1%). The overall abundance of rodents was high in modified habitat 95 (51.4%) and low in natural habitat 90 (48.6%). The distribution and abundance of each species varied between habitats and seasons. In modified habitat, the most abundant species were *Mastomys natalensis* 49 (51.6%) and *Rattus rattus* 21 (22.1%), respectively. *Stenocephalemys albipes* 46 (51.1%) was the most abundant species in natural habitat, followed by *Mastomys natalensis* 23 (25.6%) and both *Acomys cahirinus* and *Arvicanthis dembeensis* were the least abundant species 1 (1.1%). Higher abundance was recorded during the wet season (64.3%) than the dry season (34.7%).

Conclusions: Kafta-Sheraro National Park and its adjoining areas support a diverse rodent fauna. Ecological- or habitat-based management of rodents is important for conservation.

Keywords: Abundance, Diversity, Modified habitat, Natural habitat, Rodents, Kafta-Sheraro

Background

Rodents have diverse ecological, economic, social, medical, cultural, educational, and research values (Habtamu & Bekele, 2008; Nimwegen, Kretzer, & Cully, 2008). They have global distribution and are found in almost all terrestrial habitats ranging from deserts to tropical forests to tundras to mountains including human habitations (Kingdon, 1997; Yalden & Largen, 1992). Rodents exhibit many adaptations to the environment, which allow them to occupy different ecological niches. Availability of food sources and shelter, habitat heterogeneity and stability, seasonal variation of climatic conditions, predator status, and other ecological requirements influence distribution and abundance of rodents (Datiko & Bekele, 2014; Massawe, Rwamugira, Leirs, Makundi, & Mulungu, 2006). Habitat selection has been considered as an important factor in community dynamics of rodents and they show habitat preference, in which some rodents are restricted to a specific habitat, but others live in a wide range of

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habitats (Fitzherbert, Gardner, Caro, & Jenkins, 2006; Kasso, Bekele, & Hemson, 2010).

The faunal inventory of Ethiopia indicated that it possesses 84 species of rodents, of which 36 are endemic that comprise 65.5% of the total endemic mammal species of the country (Bekele, 1996; Lavrenchenko and Bekele, 2017). Despite their high diversity and endemism, studies on Ethiopian rodents in different localities including human settlements are few (Bekele & Leirs, 1997; Habtamu & Bekele, 2008; Yihune & Bekele, 2012). A comparative study of rodents between modified and natural habitats helps to reveal how the modified habitats contribute for distribution of local fauna and provides a clue for conservation. This study aimed to determine and compare the diversity and abundance rodent community between modified and natural habitats in Kafta-Sheraro National Park and its adjoining villages to contribute for conservation.

Materials and methods

Study area

The study was carried out in Kafta-Sheraro National Park and its adjoining villages, Northern Ethiopia. Kafta-Sheraro National Park covers an area of 2176.43 km^2 situated between 14°03′17′′ and 14°27′52′′ N and 36°41′43′′ and 37°40′31′′ E at an average altitude of 870 m. asl (Fig. 1). The park consists *Combretum-Terminalia*, *Acacia-Commiphora*, savanna grassland, and riparian woodlands vegetation types, which support diverse species of fauna include mammals, birds, reptiles, and others. On the south side of the park six villages—Adebay, Wuhdet, Edris, Adigoshu, Mayweini, and Mykeyh—are located at an average distance of 5 km. Sesame, maize, sorghum, bultug, teff, dagussa, and various fruits and vegetables are cultivated inside the park as well as in the fields of the nearby villages. The climate of the area is typically semi-arid with uni-modal rainfall, with the long rains from middle of May to beginning of September. The mean annual rainfall is 600 mm. The minimum temperature was 17 °C in July–August and the maximum 41 °C in May.

Sampling design and rodent trapping

A total of 49 Sherman live traps (7.6 × 8.9 × 22.9 cm) were set per grid at 10 m distance from each other in an

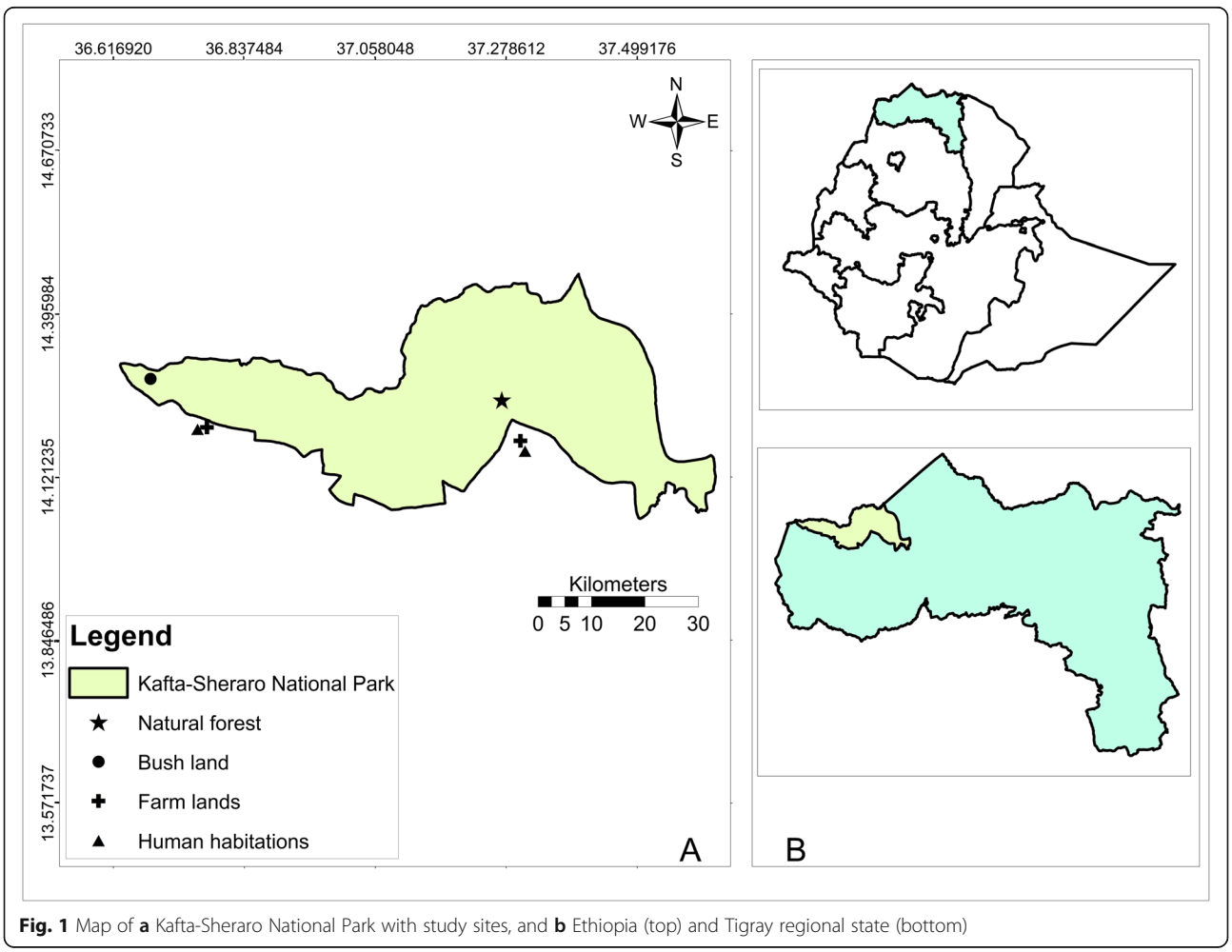

Fig. 1 Map of **a** Kafta-Sheraro National Park with study sites, and **b** Ethiopia (top) and Tigray regional state (bottom)

area of 4900 m^2 (70 m × 70 m), except when trapping in human houses where they were placed according to the owners' wishes. Rodent trapping was conducted in four trapping sessions involving both during the wet (August and October 2017) and dry (January and April 2018) seasons. Trap grids were set in two habitat types representative of the natural habitat in park and two areas in modified habitats, which were subjected to different forms of human use. We selected bushland and forest habitat types to represent natural habitat, and farmland and human habitation to represent the modified habitat. Traps were baited with peanut butter mixed with crushed maize. During each trapping session, traps were placed for three consecutive days and checked twice a day early in the morning (7:00 to 9:00 am) and in the late afternoon (5:00 to 6:00 pm).

Trapped animals were collected and transferred into transparent plastic bags and weighted using a Pesola spring balance. External body measurements including head and body, tail, hindfoot, and ear lengths were taken with a digital caliper. Representative species were collected for voucher specimen preparation (skin and skull) and the animal was marked by toe-clipping and released back at the site from where they were captured. Skull and skin of the representative rodents were prepared for further identification purposes. Standard references were used for species identification (Bekele, 1996; Kingdon, 1997; Lavrenchenko, Likhnova, Baskevich, & Bekele, 1998). Moreover, the prepared specimens were identified by comparison with specimen in National Zoological Science Natural History Museum of Addis Ababa University and then deposited in this national Museum. One-way ANOVA was used to test the significant variation of abundance of rodents between habitats and seasons. Trap success was assessed as the number of individuals trapped by total trap nights. Shannon-Wiener Diversity Index (H') was used to estimate the species diversity between habitats using the PAST software.

Results

In an overall trapping effort of 2352 trap nights between modified and natural habitats, a total of 185 captures of rodents containing 7 species were trapped. The Natal multimammate mouse *Mastomys natalensis* (Smith, 1834) was the most abundant species captured consisting 38.9% of captures of all other rodent species trapped in both habitats, followed by the Ethiopian white-footed mouse *Stenocephalemys albipes* (Rüppell, 1842) (29.7%) and the Black rat *Rattus rattus* (Linnaeus, 1758) (17.8%), while the Dembea grass rat *Arvicanthis dembeensis* (Rüppell, 1842) was the least abundant species (1.1%) (Table 1). Other rodent species that were sighted, but not trapped, in the study area include *Xerus rutilus*, *Lemniscomys striatus*, and *Hystrix cristata.*

A total of 95 individuals of 7 species of rodents were trapped in modified habitat. *Mastomys natalensis* (51.6%), *Rattus rattus* (22.1%), and *Mastomys awashensis* (12.6%), respectively, were the most abundant species. The least abundant species were *Arvicanthis dembeensis* and *Mastomys erythroleucus* (1.1%). Similarly, in natural habitat, 90 individuals of the 7 species were captured. *Stenocephalemys albipes* was the most abundant species, constituting 51.1% of the total catch, followed by *Mastomys natalensis* (25.6%) and *Rattus rattus* (13.3%), respectively, while *Acomys cahirinus* and *Arvicanthis dembeensis* were rare species (Table 1). Overall, there was a statistically significant difference in the abundance of rodents between habitats ($F = 4.258$, df = 1, $P = 0.006$).

There was a high association of rodent species with habitat types. *Mastomys natalensis*, *Mastomys awashensis*, and *Rattus rattus* were highly associated with modified habitat, while *Stenocephalemys albipes* and *Mastomys erythroleucus* show a higher association with natural habitat (Fig. 2).

Seasonal abundance of rodents between habitats

The abundance of rodents was higher during the wet season 119 (64.3%) than dry season 66 (34.7%). However, it was not statistically significant ($F = 0.001$, df = 1, $P > 0.05$). Seasonal abundance variation was observed between habitats. During the wet season, higher abundance was recorded from natural habitat (65.6%) than modified habitat (63.2%), while during dry season modified habitat had a higher abundance (36.8%) (Table 2). Natural habitat had higher species richness during the dry season ($n = 6$ species) than the wet season ($n = 5$ species), while in modified habitat number of species between wet and dry seasons was equal ($n = 6$ species for each). In both habitats, *Mastomys erythroleucus* and *Arvicanthis dembeensis* were captured only during the dry and wet season, respectively. In natural habitat, *Acomys cahirinus* were captured only during the dry season.

Trap success

Higher trap success of rodents was recorded in the modified habitat (8.1%) than the natural habitat (7.7%) (Fig. 3). The average trap success in both natural and modified habitats was 7.9%.

Species diversity

In both the habitats, equal number of species was recorded ($n = 7$ species for each). Diversity indices showed variations of rodent community between habitats. Higher species diversity index was recorded in modified habitat (H' = 1.337) than the natural habitat (H' = 1.306). Similarly, a higher number of evenness was also obtained

Table 1 Captures and abundance (%) of rodents between modified and natural habitats of Kafta-Sheraro National Park and its adjacent villages

Species	Modified habitat	Natural habitat	Total captures	Abundance
Stenocephalemys albipes	9	46	55	29.7
Mastomys natalensis	49	23	72	38.9
Mastomys awashensis	12	5	17	9.2
Rattus rattus	21	12	33	17.8
Mastomys erythroleucus	1	2	3	1.6
Acomys cahirinus	2	1	3	1.6
Arvicanthis dembeensis	1	1	2	1.1
Total	95	90	185	100

for the modified habitat. *Mastomys natalensis* was the most dominant species in modified habitat reflected in the highest dominance estimate on Berger-Parker index (Table 3).

Discussion

During this study, *Mastomys natalensis* and *Stenocephalemys albipes* were recorded as the most abundant and dominant rodent species in the study area. *Mastomys natalensis* and *Stenocephalemys albipes* have been regarded as the most adaptable and widespread rodent species in Ethiopia (Bantihun & Bekele, 2015; Getachew, Balakrishnan, & Bekele, 2016; Habtamu & Bekele, 2008). *Mastomys natalensis* is a multimammate mouse known for its high reproductive and feeding potential. It can produce up to 20 young per litter and feed on varied food items. *Acomys cahirinus*, *Mastomys erythroleucus*, and *Arvicanthis dembeensis* were recorded as the least abundant species. This could be associated with the specific ecological requirements of the species, the topography of the area, vegetation cover and food supply, habitat suitability, and predation status.

Higher captures and abundances of *Mastomys natalensis*, *Rattus rattus*, *Mastomys awashensis*, and *Arvicanthis cahirinus* were obtained in the modified habitat than in the natural habitat. High association of these species in barley and wheat farms Yonas et al. (2014), in sugarcane plantation Takele, Bekele, Belay, and Balakrishnan (2011), in maize farms Chekol, Bekele, and Balakrishnan (2012), and in cultivated cereals, Datiko and Bekele (2014) have been reported by earlier workers. This might be related to the commensal habits and ecological requirements of these species that are better met within a modified habitat. The modified habitats also provide high and alternative sources of food and shelter. Several authors revealed that *Mastomys* species, *Rattus rattus*, and *Acomys cahirinus* are agricultural pests mostly on germinated, matured, and stored cereal crops (like maize, wheat, barley, and rice), invertebrates, organic debris, and household materials (Bekele, Leirs, & Verhagen, 2003; Kasso, 2013; Yonas et al., 2010).

Table 2 Captures of rodents in modified and natural habitats during wet and dry seasons

Species	Modified habitat		Natural habitat	
	Wet	Dry	Wet	Dry
S. albipes	7	2	31	15
M. natalensis	30	19	15	8
M. awashensis	7	5	4	1
R. rattus	14	7	8	4
M. erythroleucus	–	1	–	2
A. cahirinus	1	1	–	1
A. dembeensis	1	–	1	–
Total (%)	60(63.2)	35(36.8)	59(65.6)	31(34.4)
No. of species	6	6	5	6

Stenocephalemys albipes is among the endemic species of Ethiopia and now its subpopulations are also found along the border to Eritrea. The natural habitats of this species are mostly the moist montane forests and scrubland and sometimes in agricultural fields. During this study, *Stenocephalemys albipes* was highly associated with natural habitat than modified habitat. High association of *Stenocephalemys albipes* with the bushland and forest habitats has been reported by Wube (2005) and Kassa and Bekele (2008). This shows that these natural habitats hold suitable conditions that determine the distribution of this species.

In both the habitats, the abundance of rodents was higher during the wet season than the dry season. This might be related to the presence of rainfall during the wet season, which may contribute to high quantity and quality of food sources and vegetation cover as shelter. Reproduction of most African rodents is seasonal and directly associated with rainfall, and their abundance was generally higher during the wet season (Bantihun & Bekele, 2015; Makundi, Massawe, & Mulungu, 2006). The study area receives rainfall only during the wet season and at this time become more suitable by producing

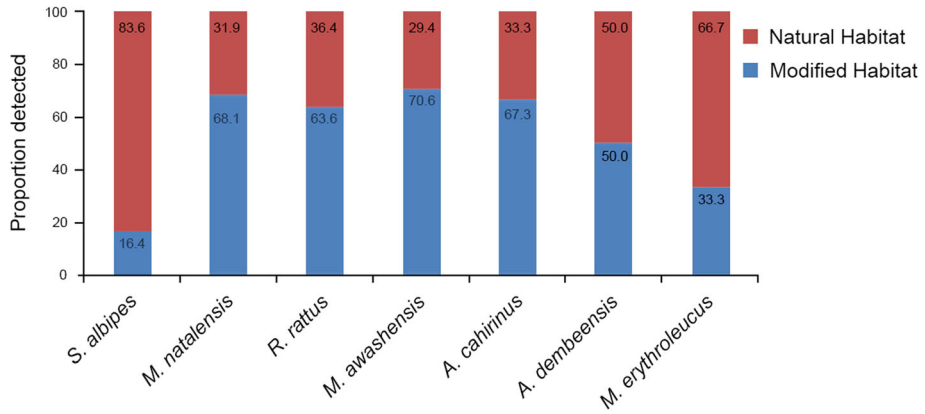

Fig. 2 Habitat association of rodent species

enough food and shelter that facilitate reproduction than during dry season. As a result of this, a high abundance of rodents can be recorded during the wet season. However, few authors observed that the abundance of rodents is higher during the dry season, due to the habitats become drier and open. Dry season also forces rodents to wander far off in search of food, making them more prone to enter baited traps resulting in high capture rates compared to the wet season (Datiko & Bekele, 2014; Yihune & Bekele, 2012). During the dry season, higher abundance of rodents was recorded in modified habitat than natural habitats. The reason is probably during the dry season most of the species tend to move and confined themselves to the nearby human settlement because at this time in natural habitat food items like flowers, leaves, grasses, and others can be dry and sparse due to lack of rainfall. Rodents can migrate long distances from temporarily unfavorable habitats to nearby favorable and resourceful areas. This supports the high abundance of rodents in adjoining villages of the park during the dry season when the park is less favorable and lacks food.

In this study, higher trap success occurred in modified habitat and this could due to the suitability of this habitat in terms of adequate food and shelter, less risk of predation (snakes and raptors mostly prefer natural habitats), and less harsh conditions that help for distribution of rodents. Dubale and Ejigu (2015) reported that modified habitats such as farmlands are more preferable for high trapping success of rodents than natural habitats such as the forest habitat.

Species diversity of rodents in the study area was low compared to other localities of the country as reported by several authors. This might be due to the harsh climatic conditions of the area, altitudinal variation (low land area), intensive human activities inside the park such as gold mining, habitat destruction for agricultural expansion and charcoal production, forest fire, rodent management practice of local community (using rodenticides), and high status of predator birds in the area. With respect to study habitats, higher species diversity

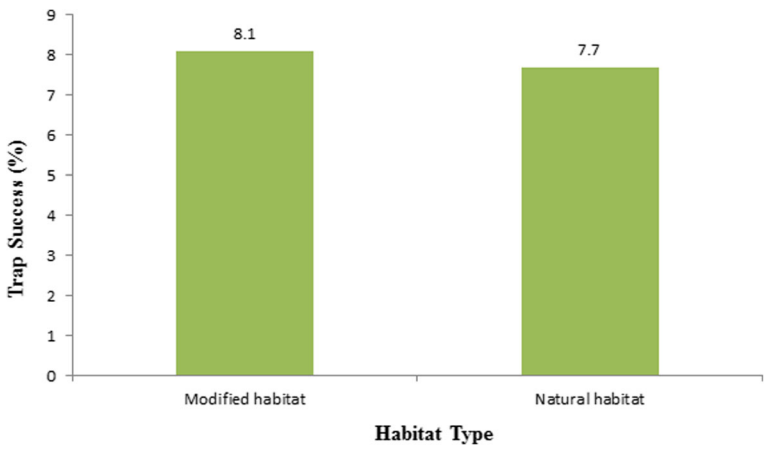

Fig. 3 Trap success of rodents between modified and natural habitats

Table 3 Diversity indices of rodents between natural and modified habitats in Kafta-Sheraro National Park

Habitat	*S*	*N*	*H′*	*E*	Dominance
Natural	7	90	1.306	0.5271	0.5111
Modified	7	95	1.337	0.5439	0.5158

S number of species, *N* number of individuals, *H′* Shannon-Wiener Diversity Index, *E* evenness and dominance—Berger-Parker Index

and evenness was recorded in modified habitat. This is in agreement with the finding of Datiko, Bekele, and Belay (2007), who reported high rodent species diversity from farmland and low in forest and bushland habitats. However, Takele et al. (2011) reported higher species diversity of rodents from bushland than plantations. This variation might be due to the availability of food, shelter and cover, and other requirements of species. Rodent species vary in their dependence on habitat types as either habitat specialists or generalists. Habtamu and Bekele (2008) and Fekdu, Bekele, and Datiko (2015) revealed that diversity of small mammals can be influenced by many factors such as cover, grazing patterns, and vegetation structure and thickness.

Conclusions

Rodents have wide distribution with various habitat preferences. Natural ecosystems are mostly stable with natural cover and different food items that support a high diversity of rodent species. The distribution and abundance of rodents can be affected by habitat modification or disturbance via anthropogenic factors such as deforestation, burning, mining, and livestock grazing. Modified habitats are mostly interfered by human activities that influence the distribution of rodents. However, this study indicates that modified habitats contribute to the distribution of important commensal and other species, which have the ability to adapt and live in human habitations and nearby agricultural fields. Therefore, ecologically based rodent management is crucial for conservation.

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Authors' contributions

AA conducted the fieldwork. Both authors designed, read, and approved the final manuscript.

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Availability of data and materials

It is possible to request authors for the data used and analyzed during the current study.

Ethics approval and consent to participate

Authors have government permission to collect animals and permission was collected from Ethiopian Wildlife Conservation Authority (Reference No.: DA 31/129/09, 2017). Moreover, the study was conducted in accordance with institutional and national guidelines for handling the experimental animals.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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