Species diversity, abundance and habitat association of small mammals in Wenchi montane forests, central Ethiopia

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May 27, 2023

Abstract

Studying small mammals has a paramount significance for ecological, cultural and economic reasons. A survey on the diversity, abundance and habitat association of small mammals in Wenchi highlands, central Ethiopia, was carried out from August 2019 to January 2021. Small mammals were trapped from six different habitats (Hagenia Woodland, Erica Scrub, Qibate, Lakeshore, Erica and Albesa Forests) using Sherman and snap traps in standard trapping grids. A total of 935 rodents belonging to 12 species (Arvicanthis abyssinicus, Desmomys yaldeni, Mastomys natalensis, M. awashensis, Stenocephaylemys albipes, Lophuromys flavopunctatus, L. brevicaudus, L. chrysopus, Dendromus lovati, Lophiomys imhausi, Graphirius murinus, and an unidentified murid rodent), and 24 insectivores belonging to 3 species (Crocidura bailey, C. fumosa and C. olivieri) were recorded. Hystrix cristata and Tachyoryctes splendens were also recorded through indirect evidences. About 52.9% of the identified small mammals were endemic to Ethiopia. A significant variation was observed in the captures of small mammals. The capture rate was higher in live traps (23.85%) than snap traps (8.26%). The diversity and distribution of small mammal species varied among habitats. The highest species diversity (H'=1.74) was recorded in Albesa Forest, while the least was in Qibate Forest (1.43). The highest number of individuals were recorded in Lakeshore Forest (27.73%), whereas the least was in Erica Forest (4.27%). M. natalensis (30.86%) and S. albipes (27.53%) were the two most abundant species, whereas L. imhausi (0.1%) was the least. Wenchi montane forests are one of the most important homes to unique small mammals that need urgent conservation actions.

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Running head/short title: small mammals of Wenchi highland

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Keywords: Abundance, Species diversity, Habitat association, Montane Forest, Small mammals, Wenchi highland

Introduction

Small mammals are the most diverse group of mammals, but yet little information is known about them compared to larger mammals (Kumaran et al. 2016). The study of these animals, however, has paramount implications for ecological, cultural and economic reasons (Torre 2004; Marques et al. 2015). Rodents are a group of small mammals with nearly worldwide distribution (Kingdon 1997). Rodents are important components of natural systems that aerate the soil and assist plant propagation, food base in food chain, and dietary components for many predators (Tobin and Fall 2004; Yihune and Bekele 2012). Some rodents are model organisms for ecological studies and serve as good indicators of environmental quality (Habtamu and Bekele 2012).

Rodents are also an important food source for humans (Habtamu and Bekele 2008; Meyer-Rochow et al. 2015). In contrast, rodents are major pests of agriculture, and involved in the distribution of many pathogens (Yihune and Bekele 2012; Garba et al. 2013). In this sense, their presence in crop fields, houses and/or around human dwellings is devastating rather than regulating nature (Tobin and Fall 2004). The economic and ecological benefits of rodents, however, outweigh these destructive effects (Habtamu and Bekele 2012).

Ethiopia harbors a much higher endemic mammalian species than any other African countries (Lavrenchenko and Bekele 2017). The order Rodentia alone contributes most of the total endemic mammalian fauna of the country (Kassa and Bekele 2008). It is still presumed that the species diversity and level of endemism could be far higher than this (Lavrenchenko and Bekele 2017). Most of the ecological studies on small mammals in Ethiopia are also largely restricted to the protected areas, like that of larger mammals (Habtamu and Bekele 2008; Workeneh et al. 2011; Yihune and Bekele 2012; Datiko and Bekele 2014; Dinaw et al. 2017), and farmlands (Datiko et al. 2007; Gadisa and Hundera 2015; Workineh and Reddy 2016). Only few studies were conducted outside such areas (Habtamu and Bekele 2012; Admas and Yihune 2016).However, comparative studies conducted in Tanzania suggested a higher diversity and abundance outside than in protected areas (Caro 2001, 2002). Thus, there are still many areas in Ethiopia yet to be explored for species composition and distribution of small mammals (Habtamu and Bekele 2008; Kassa and Bekele 2008).

Most rodents of Ethiopia are also geographically restricted to the highlands (Yalden and Largen 1992). Many of these are potentially threatened because of their extremely limited distributional ranges and habitat destruction (Fekdu et al. 2015; Lavrenchenko and Bekele 2017). This may also hold true for Wenchi highland, and open the door for faunal diversity, abundance and distribution studies. In this highland, natural forests are fragmented into numerous patches, and most of the medium to large-bodied mammals are pushed out from the remaining forest fragments. Even primates that have probably high level of tolerance to human

disturbances (Bobo et al. 2014) are restricted except *Colobus guereza* .

Small mammals and birds may relatively persist in this modified habitat (Shale et al. 2014), but the ecology of these animal groups in the area is still poorly known. Thus, the purpose of the current study was to explore the faunal diversity, abundance and distribution of rodents and insectivores in Wenchi montane forests. Assessing this area for its faunal diversity may, therefore, contribute to their conservation, and enrichment of the faunal list of the country. Such studies could also help in predicting the trends of faunal potential of the area and document them before their extinction (Lavrenchenko and Bekele 2017).

Materials and Methods

Description of the study area

The study was conducted in the central highlands of Ethiopia, Wenchi district of southwest Shewa Zone, Oromia. It is located between Ambo and Waliso towns, 155 km away from the capital, Addis Ababa (Fig 1). The altitude of the area ranges between 2,810 and 3,386 m asl (Tefera et al. 2002). The area is characterized by highland sub-humid climate with the average annual rainfall of 1400 to 1420 mm (Shale et al. 2014; Angessa et al. 2020). It receives unimodal rainfall with longer rainy periods stretching from May to September. The peak rainfall occurs in July and August, while the cold-dry season occurs between October and January (Angessa et al. 2020). The temperature varies between 14 to 26°C during the day and falls below 10°C at night (Degefu and Schargel 2015).
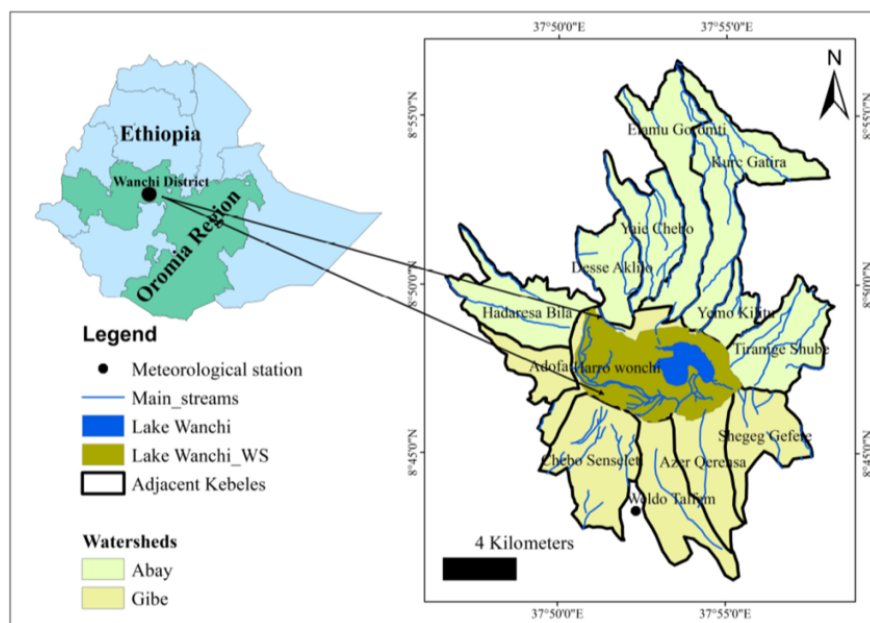

Fig 1 Map of the study area (Adopted from Angessa et al. 2022)

Wenchi highland is characterized by sub-afro alpine vegetation type. The uplands which make the Lake Wenchi watershed are dominated by *Erica* shrublands, whereas the lower altitude, Qibate and Lakeshore forests, are occupied by several ever-green highland trees, shrubs and herbs. About 104 woody plants are identified in the lake escarpment (Angessa et al. 2020). According to this study, 74.5% are indigenous and 16.7% are endemic plant species to Ethiopia. *Hagenia abyssinica, Juniperus procera, Olea europaea subsp., cuspidata, Ilex mitis* and *Myrsine melanophloeos* are some of indigenous tree species in the area. Bracken fern*, Pteridium aquilinum* is a widespread invasive fern in the area.

Land-cover types, disturbances and elevation significantly modify the structured vegetation composition of the area (Angessa et al. 2021). Forest land, bushland and lakeshore comprise the natural vegetation of the

area. Next to farmland, forest land is the most common land type in the district. This is located in the southwestern block of the lake, and is locally known as Qibate Forest. Albesa Forest is another natural forest patch located outside Wenchi Lake escarpment in the southwestern direction of Qibate Forest and Haro town.

Lakeshore forests are natural forests that surround the lake, and are separated from the main Qibate Forest by the road that takes to the monastery and hot springs. Angessa et al. (2021) considered this habitat as wetland habitat category. *Erica* Forest is a habitat that is dominated by *Erica* trees interspersed with some woody plants. Some of these habitats are heavily exploited and grazed by cattle. However, the northern and western portions of this habitat are inaccessible for humans because of their sloppy landscape structures. *Erica* scrub is another natural vegetation area dominated by *Erica* shrubs in the uplands.

The main livelihood of the community in the area is mixed agriculture (crop cultivation and livestock rearing), small and micro enterprises, and income generating activities from ecotourism (Angessa et al. 2022). The average land holding size for a single household is 0.5 ha and the major crops grown in the area are enset (*Ensete ventricosum*), barley, wheat, and potato (Shale et al. 2014). Like other highland farmers of the country, farming and harvesting is performed by traditional technologies.

Sampling design and sampled environments

A preliminary survey was conducted in Wenchi highland before the actual study was commenced to locate suitable sampling site and select sampling units. Four forest remnants in the highland were identified based on the topography, altitude, human disturbances and vegetation types, and further classified into dominant and representative habitats (Terefe and Samuel 2015). Qibate, Albesa and Lakeshore Forests have a uniform vegetation structure and were treated as independent sampling sites. *Hagenia* woodland and *Erica* Forests also formed the remaining sampling units because they showed unique vegetational structure. *Erica* scrub is natural vegetation isolated from the main forests, and in the uplands of the lake watershed made the last habitat category.

We have also tried to increase the sampling efforts by incorporating an independent sampling site from either human settlement or/and farmland to have information on synanthropic rodents, and a full package of small mammal diversity from the mosaic landscapes. However, this remained unattainable because of the unwillingness of the local communities. The sampling design was based on a spatial grid design approach (Kassa and Bekele 2008; Tadesse and Bekele 2012). The sampling protocol was implemented in 49 sampling unities encompassing all the native vegetation patches of the study area.

Trapping procedures

The study was conducted for two dry and wet seasons in between August 2019 and January 2021. Sherman live traps and snap traps were used to capture small mammals (Kassa and Bekele 2008; Terefe and Samuel 2015). Live-trapping grids representing the available habitat types were established for capture-mark-recapture study. A single grid was set up in each of the representative sites of the habitat during the study periods. Each of the grids consisted of 7x7 lines at 10 m intervals. Then, a total of 49 Sherman live traps (5.5 x 6.5 x size) at 10 m intervals were placed for three consecutive days for each habitat type.

Traps were set in the afternoon and baited with peanut butter and barley flour. They were checked the following morning and evening, and old baits were replaced with new ones. Traps were covered with grass to reduce mortality from cold and to avoid damage by other animals (Caceres et al. 2011; Workineh and Reddy 2016) . Each newly captured animal was marked by toe clipping and released at capture point (Tuyisingize et al. 2013; Bantihun and Bekele 2015; Workineh and Reddy 2016).

Snap traps (20) were placed at 10 m intervals in each habitat, 200 m away from the live trapping grids for stomach contents analysis and embryo count (Datiko and Bekele 2013). Trapped animals were weighed using Pesola spring balances and species was identified using standard keys, and field guides (Kingdon 1997, 2015; Bekele and Yalden 2013 and Happold 2013), sex was determined, and morphometric measurements were taken using a ruler graded in mm from snap trapped animals (Bantihun and Bekele 2015). Voucher

specimens were prepared for species that were difficult to identify in the field and compared to the specimens at Zoological Natural History Museum, Addis Ababa University. Personal observations and some indirect evidence such as quills, burrows and soil mounds were also employed to record some non-trapped rodents.

Data analyses

Data analyses were based on captures per unit effort to account for variation in effort among study sites. Shannon-Wiener Diversity Index (H') was used to estimate species diversity (Shannon and Weiner, 1949). Species distribution patterns in the community was assessed using Evenness index (E) (Tuyisingize et al. 2013). Simpson's Similarity Index (SI) was used to compare the small mammal composition among habitats (Dakito and Bekele, 2014). The similarity of small mammal communities among the habitats was estimated by Sørensen's coefficient (Venance 2009). The dissimilarity of small mammal communities among the habitats were estimated using dissimilarity index.

Abundance of rodent species in each habitat was calculated as the ratio between the number of species found in each habitat and the total number of species recorded in the study area (Venance, 2009). This result was compared with a relative abundance index for each species that was estimated with the Trap Success Index (Gómez-Villafañe et al. 2012; Li et al. 2015). The total number of trapped individuals and the overall trap night was used to compute trap success for each trap line (Kumaran et al. 2016). Chi-square test using SPSS statistical program was used to interpret variations of rodent species in different trapping seasons and habitat association of rodents. A significance level of P<0.05 was set for all appropriate tests.

Results

A total of 935 individual rodents and 24 insectivores were captured in 4,968 trapping efforts from six different habitats. The captured rodents belonged to 12 species and six families. Of these, nine species were from the family Muridae (*A. abyssinicus* , *D. yaldeni* ,*M. natalensis* , *M. awanshensis* , *S. albipes* , *L. flavopunctatus* , *L. brevicaudus* , *L. chryopus* and an unidentified murid rodent (*Murid* spp. *A*)). The others were only represented by a single species, and from the family Gliridae (*G. murinus*), Nesomyidae (*D. lovati*), and Cricetidae (*L. imhausi*). *C. bailey* , *C. fumosa* and *C. olivieri* were the three shrew species trapped in the present study area.

Of the total captured rodents, 841 were live-trapped and the remaining 118 were snap trapped. The capture rate was higher in live traps (23.85%) than snap traps (8.26%). A total of 555 small mammals were new capture (including the snap trapped) and 404 were recaptures. A significant variation was observed in the captures of small mammals (χ^2=511.698, df=1, P<0.05). Crested porcupines (*H. cristata*) and African mole rats (*T. splendens*) were neither live-trapped nor snap trapped. Instead, they were confirmed through indirect evidence.

More than half of these small mammals (52.9%) were endemic to Ethiopia. These include *L. flavopunctatus, L. brevicaudus, L. chryopus, D. yaldeni, D. lovati, A. abyssinicus, M. awashensis* and *S. albipes* . *C. bailey* is an endemic insectivore. *M. natalensis* was the dominant rodent species with 294(30.86%) individuals followed by *S. albipes* with 266 (27.82%) individuals, while *L. imhausi* was the least, represented only by a single (0.10%) individual (Table 1). There was a significant difference in the total capture of individuals among small mammal species (χ^2= 2304.27, df=16, P<0.05).

Species richness and diversity

The highest number of species (9) was registered from *Erica* scrub habitat followed by Albesa Forest and *Hagenia* woodland (8). The least number of species was registered from Lakeshore Forest (6). Albesa Forest has showed the highest species diversity (H'=1.74) followed by*Hagenia* woodland (H'=1.57). The lowest species diversity index (1.43) was recorded from Qibate Forest habitat. Simpson's diversity index was higher in the Albesa Forest (D=0.77) followed by *Erica*Forest (D=0.76). The lowest Simpson's diversity index was recorded from Lakeshore Forest (D=0.63). The highest evenness was recorded in*Erica* Forest (E=0.94) habitat followed by *Hagenia* woodland (E=0.75) habitat. Small mammals were unevenly distributed in*Erica* scrub habitat type (Table 2).

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Sørensen similarity coefficient (Ss) showed a varying degree of similarities among the rodent community between the paired habitats. The highest similarity index (0.85) was recorded between Qibate and Lakeshore Forests, while the lowest score (0.35) was between *Erica* Forest and scrub. The second highest similarity index (0.71) was observed between *Erica* Forest and both Lakeshore and Qibate Forests. In contrast, the highest dissimilarity index (Ds) was scored between *Erica* Forest and scrub (0.65), while the lowest score was between Qibate and Lakeshore Forests (0.15).

Habitat association

M. natalensis and *L. flavopunctatus* were recorded in all habitats. *S. albipes* and *L. chryopus* were recorded in all four forest habitats, but absent from the scrubland. *D. yaldeni* and *A. abysinicus* were the two rodent species captured from two different habitat types. *D. yaldeni* was first trapped from a cleared forest in Qibate Forest and an open-spaced upland ericaceous scrub, whereas *A. abysinicus* was trapped from the outskirt of *Hagenia* woodland and in ericaceous scrub, the same area where *D. yaldeni* was captured. *D. lovati, G. murinus, L. imhausi* and *Murid* spp. *A* . were limited to a single habitat type. They were captured from *Hagenia* woodland, Lakeshore Forest, Albessa and ericaceous scrub, respectively.

Crested porcupine was evident in Albesa Forest and scrubland habitat types. The indirect evidence also encountered at the entry point to the *Hagenia* woodland and on the main road during the dry season. This rodent was a pest to the common crops (potatoes and enset) in the area (Mengasha, 2020; *Pers. comm* .). African mole rat was recorded only from Qibate Forest and Albesa Forest habitats. Locals claimed its distribution and pest nature in farming areas primarily after the rainy season. No squirrel species was observed in the study area during the study periods. Insectivores, shrew species were recorded from all the habitat types, except in the *Hagenia* woodland (Table 3).

Small mammal abundance

From the total population of small mammals, the highest number of individuals, 266 (27.73%) were recorded in Lakeshore Forest followed by Qibate Forest, which was represented by 194 (20.23%) individuals. The least small mammal individuals, 41 (4.27%) were recorded in *Erica* Forest. The highest number of insectivores, 7 (27.16%) were recorded in the scrubland, while the least was in Qibate and Lakeshore Forests, each represented by a single encounter. There was a significant difference in the total abundance of small mammals among habitat types (χ^2=169.644, df=5, P<0.05).

The abundance of species also varied within the habitat types. From the total population of *M. natalensis* , 92 (31.1%) individuals were recorded in Lakeshore Forest, while the lowest population, 15 (36.58%) was from *Erica* Forest. Out of the total population, the highest population of *S. albipes,* 83 (31.20%), *M. awashensis* , 31 (57.41%) and *L. chryopus* , 32 (35.55%) were recorded in Lakeshore Forest. The lowest population record for these species was also from the same habitat, in *Erica* Forest. The highest population of *L. flavopanctatus* , 36 (42.35%) was registered in Albesa Forest, while its lowest, 3 (17.07%) was in *Erica* Forest. The highest population of *L. brevicaudus* 14 (9.65%) was recorded in *Erica* scrub. The population of this species was also fairly represented in *Hagenia* woodland and Albesa Forest. *C. fumosa* , and *C. olivieri* 8 (33.33%) were the two most abundant shrew species with joint number of occurrences, while *C. bailey* was the least (Table 3).

Relative abundance of species varied within the habitat types. *M. natalensis* was the most abundant species in Qibate Forest (43.81%), *Hagenia* woodland (38.82%) and Lakeshore Forest (34.58%). In scrubland, *Murid* spp. *A.* (55.17%) was the most abundant species. *S. albipes* (37.27%) was the dominant rodent species in Albesa Forest. *L. imhausi* was the least abundant species, only represented by 0.37% of Lakeshore Forest captures (Table 4).

Discussion

The present study recorded a high number of small mammal species for a disturbed and unprotected area. This result supports the high species diversity of small mammals in unprotected areas (Caro 2001, 2002) and the highlands of Ethiopia (Yalden and Largen 1992; Bekele and Yalden 2013; Lavrenchenko and Bekele 2017). However, it is against the notion that protected areas are fairly helpful and unprotected areas are

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rather detrimental to their inhabitants (Caro 2002). This could be associated with a complex interaction of various biotic and abiotic factors in the area.

The species diversity of small mammals in the area is high compared to several reports from other unprotected areas in Ethiopia (Girma et al. 2012; Simeneh 2016; Kostin et al. 2018, 2020; Takele et al. 2022) and elsewhere (Vazquez et al. 2000; Richard et al. 2020). It is even more than double compared to reports from some protected areas (Yihunie and Bekele 2012; Yimer and Yirga 2013; Fekdu et al. 2015; Assefa and Srinivasulu 2019), and comparable to a report of Dakito and Bekele (2014) from Chebera Churchura National Park. The topographic, climatic nature and vegetation structure of this area are some of the most probable explanations to a relatively high species diversity. A low predator density and adequate food availability may also contribute to the small mammal diversity in the area (Caro 2001). The number of identified small mammals in the current study is still a way behind of reports from Alatish National Park (Habtamu and Bekele 2012) and Nechisar National Park (Workeneh et al. 2011). This variation might be due to the difference in the habitat structure, resource distribution, climatic conditions, and species adaptability between these areas (Habtamu and Bekele 2008; Kasso and Bekele 2017; Assefa and Srinivasulu 2019).

The present study registered high number of endemic small mammal species. This is congruent to the fact that Ethiopian highlands are hot spots and center of small mammal endemism (Yalden and Largen, 1992; Bryja et al. 2017; Lavrenchenko and Bekele 2017). The level of endemism in the present study is far higher than the reports from both protected and unprotected areas in the northern parts of Ethiopia (Moges et al. 2016; Simeneh 2016; Kostin et al. 2020; Craig et al. 2020; Takele et al. 2021), but it is a way behind to the Chilalo–Galama Mountain range (Kasso et al. 2010) and Arsi Mountains (Kostin et al. 2018). Such geographic discrepancy in species endemism might be associated to the difference in the habitat quality and productivity of the two parts of the country (Bryja et al. 2017). The southern parts have numerous isolated and heterogeneous high grounds that may allow geographic speciation to happen and hosts more endemic small mammals than its northern counterparts.

The highest species diversity of small mammals is registered from Albesa Forest. This is attributed to the spatial factors (Camacho-Sanchez et al. 2019), the habitat structure and complexity (Yihune and Bekele 2012; Terefe and Samuel 2015), quality of food and vegetation cover, diverse microhabitats, and the surrounding landscape (Torre 2004; Horncastle et al. 2019) that this habitat provides. The lowest species diversity is from Qibate Forest. The result contravenes with the reports of Bekele (1996) and Girma et al. (2012), where *Erica* scrub is more specious. This may be because of the diminishing in the size and structure of forest, less diverse micro-habitats, and intensive grazing by livestock of this habitat (Horncastle et al. 2019).

In the present study, the overall abundance of small mammals is high in Lakeshore Forest. This is possibly associated with the forest structure (Pardini et al. 2005), high vegetative diversity and herbage production (Horncastle et al. 2019), a relatively low level of disturbance, diverse microhabitats, proximity to water sources and presence of adequate vegetation cover of this habitat (Girma et al. 2012; Richard et al. 2020). The presence of diverse vegetation with adequate cover provides plenty of habitat choices and feeding items as well as hiding options from predators (Girma et al. 2012). Several studies from various parts of Ethiopia, however, documented a high abundance of small mammals in scrubland (Bekele 1996; Kasso et al. 2010; Girma et al. 2012). This discrepancy might be because of the varying degree of human interferences (Bekele, 1996), the size of forest fragments (Pardini et al. 2005), vegetation diversity and herbage production, and underground cover (Horncastle et al. 2019) of the habitats.

In the current study, the *Erica* scrub has supported a higher species richness. This is in agreement to the several reports in Ethiopia (Bekele 1996; Kasso et al. 2010; Girma et al. 2012). However, it also contradicts with other findings (Datiko and Bekele 2014; Getachew et al. 2016; Dinaw et al. 2017; Takele et al. 2022), where high number of small mammals are trapped outside scrubland habitats. Such variation may be associated to spatial factors, environmental variables, species requirements and biological interactions (Gómez-Villafañe et al. 2012; Lavrenchenko and Bekele 2017).

A comparable and low small mammal species richness is recorded in *Erica* , Qibate and Lakeshore forests. This is due to agrees to the intrinsic behavior of small mammal habitat selection based on the resources it offers (Torre, 2004). Such a low species richness, and abundance in *Erica* Forest habitat may be ascribed to the sloppy landscape, *Erica* trees dominated vegetation, and bare ground cover (Datiko and Bekele 2014). A low species richness of Qibate Forest maybe well explained by the modification of habitats by continuous livestock grazing, fuel wood exploitation and other human disturbances (Bekele 1996; Girma et al. 2012; Horncastle et al. 2019).

M. natalensis is the most abundant and widely distributed species in the study area. This is in agreement with the wide spread distribution of this species across the Ethiopian highlands (Datiko et al. 2007; Bantihun and Bekele 2015; Assefa and Srinivasulu 2019; Martynov et al. 2020). However, the finding also contravenes with other reports (Bekele 1996; Kasso et al. 2010; Girma et al. 2012; Takele et al. 2022). This discrepancy might be associated to the difference in the geography, habitats and environmental variables. The highest population of *M. natalensis, S. albipes* , *M. awashensis* , and *L. chryopus* is documented in Lakeshore Forest. This is due to the habitat preferences of these rodent species (Lavrenchenko and Bekele 2017). This is against several reports in Ethiopia (Datiko et al. 2007; Workeneh et al. 2011; Datiko and Bekele 2014; Assefa and Srinivasulu 2019), where these species are abundant in the farmlands and crop fields. This variation may be attributed to the variation in the availability of natural food items and shelters.

The present study recorded three species of brush-furred rats (*L. chrysopus, L. brevicaudus* and *L. flavo-punctatus*). This finding is in line with the wide distribution of the genus *Lophuromys* in moist and forest highlands of central Ethiopia (Bekele 1996; Lavrenchenko et al. 2001; Lavrenchenko and Bekele 2017; Bryja et al. 2019). The golden footed (*L. chrysopus*) brush-furred rat inhabited forested areas, but short tailed (*L. brevicaudus*) brush-furred rat is confined to ericaceous belt. This agrees with the finding of Lavrenchenko et al. (2001) and Ivlev and Lavrenchenko(2016). *L. flavopunctatus* was well documented throughout the study habitats. This is in agreement to the finding of Bekele (1996), and perhaps due to its ability to colonize less favorable habitat, and feeding habit (Girma et al. 2012). The population of *L. brevicaudus* was also fairly represented in *Hagenia* woodland and Albesa Forest. This is in disagreement to the findings of Lavrenchenko et al. (2001) and Lavrenchenko and Bekele (2017), where *L. flavopunctatus and L. brevicaudus* are confined to the forested and scrubland habitats, respectively. This disparity implies that these species was widespread in the continuous forest of this highland, and probably separated from their sister populations through time due to the fragmentation of these habitats into forest and scrubland habitats.

G. murinus, D. lovati, A. abyssinicus , *Murid* spp. *A* and *D. yaldeni* are recorded in few numbers and from limited habitats. *G. murinus, L. imhausi* and *D. lovati* are only trapped from a single habitat, Albesa Forest, Lakeshore Forest and *Hagenia* woodland, respectively. African dormice (*G. murinus*) are trapped only twice, while crested or maned rat (*L. imhausi*) is trapped only once throughout the study periods. This is perhaps due to the imbalance between the habitat preferences of these species and the available habitat in the area. The low abundance of these and the other rare species in the area might be associated with the decline in their populations along with the ongoing habitat fragmentation, losses and destructions.

Dendromus lovati is an endemic rodent trapped from open spaced and grassy areas of *Hagenia* woodland. This is in agreement with the species distributional range, in the upland grassland and across the Ethiopian highlands (Bekele and Yalden, 2013). The low abundance of this species is also reported by Girma et al. (2012). However, no species encounter was made from the scrubland habitat (Bekele and Yalden 2013). This is mainly because the habitat requirement of the species is relatively dense afro-montane vegetation with high cover of understory vegetation.

The present study recorded *A. abyssinicus* in very low abundance with limited distribution. This report is the fourth to document *A. abyssinicus* from west of the great Rift Valley, and against the species distributional range, largely limited to the eastern Rift Valley and northern Ethiopia (Yihunie and Bekele 2012; Bekele and Yalden 2013; Kostin et al. 2020; Takele et al. 2022). A limited distribution of this species is also documented (Bekele and Yalden 2013; Takele et al. 2022). The trapping of this rodent species from *Erica* scrub, and areas close to farmlands supports the pest nature of this rodent (Happold 2013). The species also avoids heavily

grazed areas and long grass–short grass mosaics (Happold 2013; Bryja et al. 2017).

H. cristata and *T. splendens* are the two rodent species that were observed based on indirect evidences. Porcupine was a common rodent species in the uplands and scrubby habitats as it was encountered only once at the edges of forested areas. The distribution of this species is probably impacted by the availability of food sources and concealing places. African mole rat is widely distributed in farming areas mainly after rainy seasons. It is a major rodent pest in high ground and farming areas (Mengesha 2020 *Pers. comm* .). Mole hills were observed only twice in forested areas.

The current study recorded shrews in a very low population and patchy distribution with one seemingly endemic to Ethiopia. Such in encounter is in line within their habitat requirements, and general distributional pattern (Stanley et al. 1998; Li et al. 2015). Such a patchy distribution and low population abundance might be because of the limited availability of shelters, food items, and their own short comes (Stanley et al. 1998; Timbuka and Kabigumila 2006) . More individual shrews were recorded from the *Erica* dominated areas, and this agrees with the finding of Girma et al. (2012). The confinement of these mammals to the ericaceous habitats could be due to the sparse herb and shrub vegetation provide ideal habitat as cover, breeding ground and food source.

Wenchi montane forests are home to several small mammals including numerous endemic species, but yet highly threatened by mounting agriculture, human settlement, intensive livestock grazing, replacement of native plants by exotics, and seasonal burning of ericaceous belts. Hence, conservation of these habitats should be a priority for the continued survival of these diverse and endemic small mammals.

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