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Habitat association and distribution of rodents and insectivores in Chebera Churchura National Park, Ethiopia

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Abstract: The main objective of the study was to characterize the habitat composition and distribution of rodents and insectivores in a recently established Chebera Churchura National Park, Ethiopia. The study was carried out between 2010 and 2011. Study grids were marked in seven randomly selected habitats. Swampy forest, riverine forest, grassland, wooded grassland, bushland, lake shore, and agricultural field were identified. Forty nine Sherman live traps were used to capture the small mammals. A total of 704 individuals of rodents and insectivores were captured in 5488 trap-nights. These comprised 16 species of rodents, and 2 species of insectivores. The distribution of species varied among habitats. *Mastomys natalensis* was the most widely distributed species, whereas *Crocidura flavescens* was the least. The distribution pattern also varied along altitudinal gradients. The study revealed that habitat composition is a very important factor for species richness and distribution of rodents and insectivores in the park.

Resumen: El objetivo principal delestudio fuecaracterizarla composición del hábitat y ladistribuciónde roedores einsectívoros en el recién establecido Parque Nacional Chebera Churchura, Etiopía. Elestudio se realizóen 2010 y 2011. Se marcaron retículas de estudio en siete hábitats seleccionados al azar: bosque de pantano, bosque ribereño, pastizal, pastizal arbolado, matorral, orilla de lago ycampo agrícola. Se usaron 49 trampas Sherman para la capturaren vivo de losmamíferos pequeños. Se capturaron en total 704 individuos de roedoreseinsectívorosen 5488 noches-trampa, las cuales abarcaron16 especies de roedoresydosde insectívoros. Ladistribuciónde lasespecies varióentre hábitats. *Mastomys natalensis* fue la especie con distribución más amplia, mientras que *Crocidura flavescens* fue la más restringida. El patrón dedistribución también varióa lo largo de los gradientes altitudinales.El estudio mostróque la composición del hábitat es un factor muy importante para la riqueza de especies y la distribución de roedores e insectívoros en el parque.

Resumo: O principal objetivo do estudo foi caracterizar a composição do habitat ea distribuição de roedores e insectívoros no Parque Nacional Churchura Cheberarecém-criada, na Etiópia. O estudo foi realizado entre 2010 e 2011. Foram marcadas aleatoriamente quadrículas de estudo em sete habitats selecionados. Identificaram-se a floresta pantanosa, a mata ribeirinha, a pastagem, a pastagemarborizado, o matagal, apraia lacustre, e o campo agrícola. Foram utilizadas quarenta e nove armadilhas Sherman para capturar os pequenos mamíferos. Um total de 704 roedores e insectívoros foram capturados em 5488 noites de armadilhagem. Estes compreendiam 16 espécies de roedores e 2 espécies de insectívoros. A distribuição das espécies variou entre habitats. A *Mastomys natalensis* foi a espécie mais amplamente distribuída, enquanto a *Crocidura flavescens* foi a menos representada. O padrão de distribuição também variou ao longo dos gradientes de altitude. O estudo revelou que a composição do habitat é um fator muito importante para a riqueza específica e a distribuição de roedores e insectívoros no parque.

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Key words: Altitudinal zonation, Chebera Churchura, Ethiopia, distribution, insectivores, live traps.

Introduction

Rodents and insectivores are able to exploit a wide range of habitats and environments throughout the world (Lange *et al.* 2004; Vaughan *et al.* 2000). They show tremendous variation in their ecology, morphology, physiology, behaviour and life history strategies (Nedbal *et al.* 1996). At a local scale, their distribution and abundance is influenced by vegetation structure and composition, which reflect the habitat condition (Gebresilassie *et al.* 2004; Kannan & James 2009; Nowak 1999). Habitat selection is considered an important factor in community dynamics (Shanker 2001; Shurchfiesd 1997). Habitat complexity, association and disturbance are other important factors affecting species diversity and distribution in natural ecosystems (Datiko *et al.* 2007b; Habtamu & Bekele 2008; Kilgore *et al.* 2010; Obsom & Parker 2003). Habitat complexity is scale dependent and it increases with reduction in body size of the species. The distribution and pattern of the relative abundance of animals depend largely on the seasonal availability of food and water. In addition, vegetation structure and cover affect the micro-climate and necessary cover for small mammals against predators (Hansson 1999). Accordingly, habitats of small mammals can be much more variable (Girma *et al.* 2012). Ecological studies addressing the relationships between habitat types versus species abundance and distribution are rather scanty. Except for a short study by Linzey & Kesner (1997), there is hardly any study on population ecology of small mammals in sub-Saharan Africa.

Ethiopia is one of the most physically and biologically diverse countries of Africa. Its interesting palaeo-history, diverse climate and topography have resulted in diverse habitats and species diversity (Abunie 2000; Tedla 1995). For instance, of about 1150 species of mammals recorded from entire Africa (Kingdon 1997), 284 have been recorded from Ethiopia (Bekele *et al.* 1993; Bekele & Leris 1997; Datiko *et al.* 2007b; Yalden & Largen 1992). Rodents and shrews account for 39.4 % of the mammal species (Laverenchenko *et al.* 1997). Among these, 31 species (11 %) are endemic (Yalden & Largen 1992). Rodents comprise 25 % of the Ethiopian mammal fauna and contribute about 50 % of the total endemic species (Bekele 1996b). According to Laverenchenko *et al.* (1997), this figure has been elevated to 84 as a result of additional collections (Datiko *et al.* 2007b). However, a few ecological studies have been carried out on small mammals (Bekele 1996a b; Datiko *et al.* 2007b; Habtamu & Bekele 2008). Therefore, there is a need for further assessment of various habitats in terms of small mammalian species composition. The present study aimed to investigate the habitat association and distribution of rodents and insectivores in Chebera Churchura National park (CCNP), Ethiopia, which is one of a recently established wildlife protected areas in the country.

Materials and methods

The study area, CCNP, is located along the southwestern part of Ethiopia. It is partly located within Dawro zone and in Konta special district, about 300 and 580 km southwest of Awassa and Addis Ababa, respectively. It covers an area of 1250 km^2 and lies between 36^o 27' 00"- 36^o 57' 14" E longitudes and 6^o 56' 05" - 7^o 08' 02" N latitudes (Fig. 1). The park is bordered by Konta special district to the north, Omo River to the south, Dawro zone to the east and southeast and Agare high mountains and Omo River to the west (Weldeyohanes 2006). There are four small crater lakes distributed in different parts of the Park. The altitude of the park ranges from 550 - 1700 m asl, highest peak being Mecha hill on the western boundary (Timer 2005; Weldeyohanes 2006). The climate of the study area is relatively hot. The mean annual rainfall in the study area varies from 1000 to 3500 mm, and is unimodal between April and August.

The natural vegetation of the study area is broadly divisible into four categories. These are: (i) Montane Forests in the eastern and northwestern highlands, dominated by *Podocarpus falcatus*, *Juniperus procera* and broad-leaved tree species, (ii) The Riverine Forests, along the river courses, characterized by species such as *Albizia grandibracteata, Chionantus mildobradii, Grewia ferrugunea, Aspilia mosambicensis, Arundo donax* and *Ehretia cymosa,* (iii) The Woodland vegetation, in the southern part of the Park, with notable

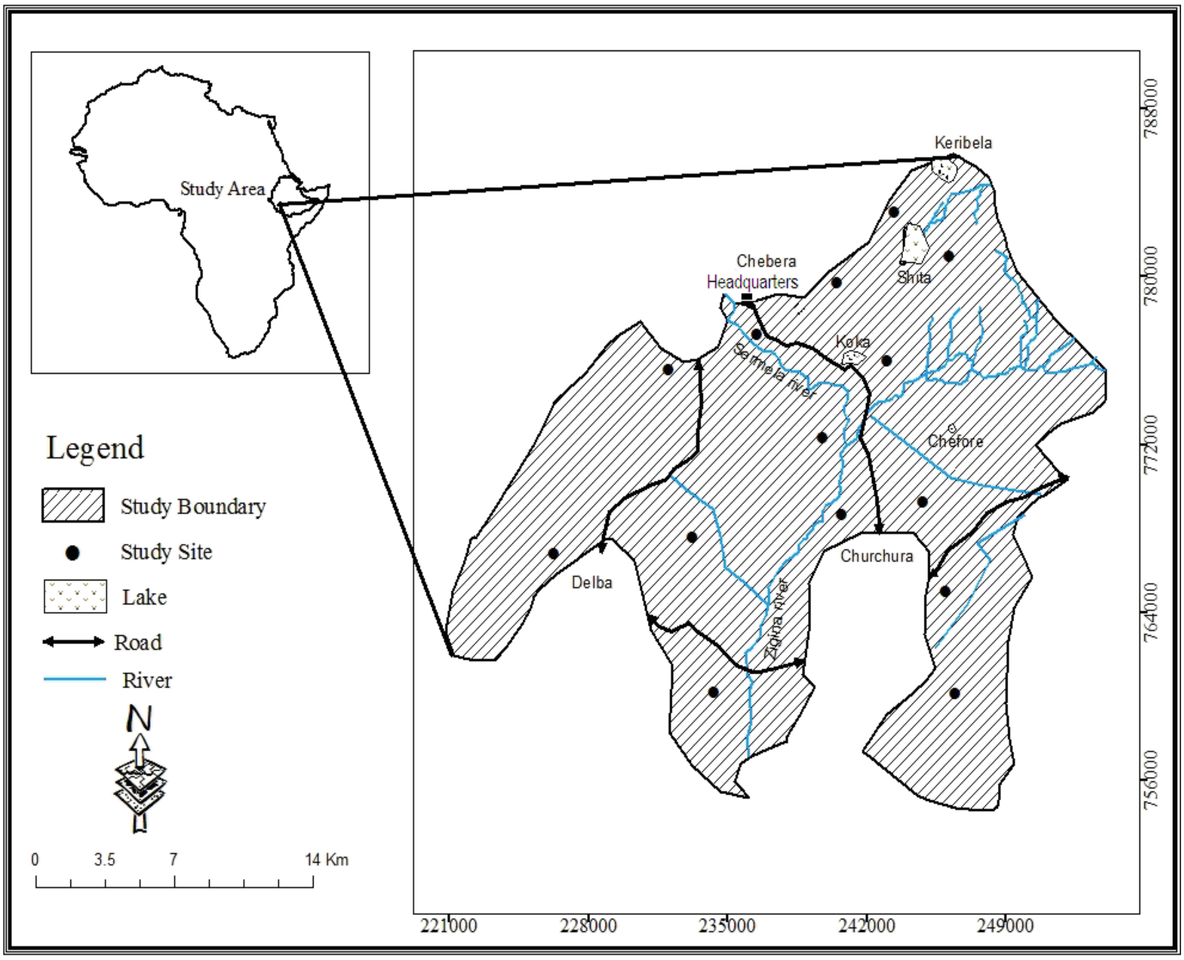

Fig. 1. Map of the study area with location of the study sites/grids.

species such as *Acacia brevispica, Maytenus arbutifolia, Vitex doniana, Terminalia brownii, Combretum colinum* and *Combretum molle,* and (iv) The Grassland, covering largest portion of the park, dominated by *Pennisetum purpureum* grass species (Weldeyohanes 2006). There are also four smaller Crater Lakes in the Park. The people practice traditional agricultural system and cultivate cereals, coffee and root crops around the Park (Timer 2005).

Based on the topography and land use, seven habitat types were identified for sampling: Swampy forest (SF), Riverine forest (RF), Grassland (GL), Wooded grassland (WGL) Bushland (BL), Lake shore (LS) and Agricultural field (AF). A total of 14 grids (two different girds designed in a similar habitat type during the same season) were used in a randomly selected site. All of the girds were surveyed twice during the dry and wet seasons. A permanent 4900 m^2 (70 m x 70 m) live trapping grid was established at different habitat types. Within each grid, 7 rows by 7 columns of live trapping lines were established during both seasons. A total of 49 Sherman live traps were set per grid at 10 m intervals between points during both seasons. The traps were baited with peanut butter and crushed maize. This trapping design formed a standard grid following Bekele (1996a, b) and Linzey & Kesner (1997). Traps were covered by hay, leaf litter/leafy shoots during the dry season. This provides protection to trapped animals against the strong heat. The traps were checked twice a day, early morning (between 07:00 and 08:00 a.m.) and late afternoon (between 05:00 and 06.00 p.m.) for five (in 7 sites) or three (in 7 sites) consecutive days depending on the accessibility of the site. Each trapped animal was captured alive and identified for species. Sexual conditions of trapped males were detected by the colour and position of testicles (scrotal or abdominal) following Ghobrial & Hodieb (1982). Pregnant females were identified from their enlarged nipples, large swollen abdomen and body weight. Age structure (adult, sub-adult and young) was recorded based on their weight and pelage colour (Bekele 1996a). These were marked by toe-clipping (Clausnitzer 2003; Linzey & Kesner 1997) and released for future identification. The representative snap trapped animals were also collected. Skin and skull of the representative specimens were mounted and deposited in the Zoological Natural History Museum, Addis Ababa University. The specimens were compared and identified at species level by referring to additional reference materials deposited in the Museum.

Data were analysed using SPSS version 16 computer software programme. To assess the similarity of the different habitats with respect to the presence of rodents and insectivores species and to compute species diversity at different habitats, we used the Shannon's diversity index (H') = $H' = -\sum P_i \ln P_i$ and the Simpson's index (D) = $(1-\sum P_i^2)$, where, pi is the relative abundance of each species (n/N) and ln is the natural log of the number. Richness Index (R) = S-1/ lnI, where, S is the number of species, I is a total number of individuals, and Simpson's Similarity Index (SI) = 2**C**/A+B+…+G, where, C is common species for the seven habitat types and A+B+C+…+G are the sum number of species from each habitat surveyed.

Results

A total of 15 species were trapped and additional 3 species were observed in the study area (Table 1). The highest number of rodents and insectivores were trapped from agricultural field 226 (32 %) followed by bushland 127 (18 %) and the least from riverine forest and swampy forest, 14 (2 %) and 24 (3 %), respectively. The total catch was statistically significant between different habitat types ($\chi^2 = 3.72$, d.f.= 6, $P < 0.05$). However, among the three major habitats, viz., grassland, wooded grassland and bushland, the differences were not significant. *Mastomys natalensis, Lemniscomys striatus* and *Acomys cahirinus* were distributed in all habitat types even though their abundance was statistically significant ($\chi^2 = 106.3$, d.f.= 2, $P < 0.5$). *M. natalensis* was highly associated with agricultural field followed by *Arvicanthis dembeensis.* The highest number of *Mastomys erythroleucus* was also trapped in this habitat. *Arvicanthis niloticus, A. dembeensis, M. erythroleucus, Rattus rattus, Lophuromys flavopunctatus*, *Mus tentellus, Crocidura fumosa* and *Crocidura flavescens* were not trapped from the forested habitat. *Stenocephalemys albipes* was associated with wooded grassland. *Lemniscomys striatus* was the second abundant species with the highest trapping from bushland. *L. flavopuctatus* and *Pelomys harringtoni* had a preference to the non-agricultural habitats. *L. flavopuctatus* was captured only from three habitat types (grassland, wooded grassland, bushland). *Mus musculus* was also mainly trapped from agricultural land. Among the observed rodents, *Hystrix cristata* was observed in all habitats. It is commonly observed rodent in the area at night and when they are looking for food during evening. But *Tachyorctes splendens* and *Xerus rutilus* (diurnal) were not recorded from the forests.

Trap success was highest for agricultural land (29 %) and lowest for the riverine forest (2 %). The difference in the trap success was also statistically significant ($\chi^2 = 3.37$, d.f.= 6, $P < 0.05$) between different habitat types. Species richness varied across habitats i.e., maximum of 18 species in the grassland and wooded grassland habitats and minimum of four species in riverine forest. Species composition among various habitats did not vary significantly. Simpson's Similarity Index (SI) showed < 50 % (SI = 0.23) similarity among major habitats. The small mammal diversity index was highest in wooded grassland (H' = 2.17) and lowest in riverine forest H'=1.24 (RF) (Table 2). Simpson's Index (D) was highest in wooded grassland (0.87) and the lowest in riverine forest (0.68). Highest value of Richness Index (R) was obtained for wooded grassland (3.52) followed by bushland (3.30) and the least for riverine forest (1.14).

Composition of different age groups, trap success and relative abundance of small mammals between seasons are given in Table 3. Out of the 704 individual rodents and insectivores captured, adults comprised 532 (76 %), sub-adults 99 (14 %) and juveniles 73 (10 %). Dry season yielded more captures (414) compared to wet season (290) , with the relative abundance of 59 % and 41 %, respectively. The relative abundance of capture was statistically significant ($\chi^2 = 3.10$, d.f. = 1, $P < 0.05$) between seasons. Trap success was also high during the dry season (15.1) and low during the wet season (10.6).

Species composition and abundance of rodents and insectivores trapped from different altitudinal zones are shown in Table 4. Generally, number of species increased with increasing altitude. The increase in the number of species was statistically not significant ($\chi^2 = 0.57$, d.f.= 3, $P > 0.05$), but significant variation was observed on the abundance

Table 1. The distribution of small mammal species from seven habitat types (*: observed species, -: absence).

Species	Total Catch							
	SF	RF	GL	WGL	BL	LS	AF	Total
Mastomys natalensis	8	6	29	25	23	26	87	204
Lemniscomys striatus	5	4	25	30	37	25	16	142
Arvicanthis niloticus	-	-	11	13	10	4	22	60
Arvicanthis dembeensis	-	-	4	6	8	3	31	52
Mastomys erythroleucus	-	-	6	7	9	5	17	44
Acomys cahirinus	4	3	6	3	6	4	14	40
Rattus rattus	-	-	7	7	5	-	18	37
Mus musculus	2	-	4	5	8	2	14	35
Stenocephalemys albipes	1	-	4	6	3	4	2	20
Tatera robusta	2	1	2	5	6	-	3	19
Lophuromys flavopunctatus	-	-	7	8	3	-	-	18
Pelomys harringtoni	1	-	3	3	4	2	-	13
Mus tentellus	-	-	2	2	3	-	1	8
Crocidura fumosa	-	-	1	3	2	1	1	8
Crocidura flavescens	-	-	1	2	-	1	-	4
*Tachyorctes splendens**	-	-	*	*	*	*	*	*
*Xerus rutilus**	-	-	*	*	*	*	*	*
*Hystrix cristata**	*	*	*	*	*	*	*	*
Total Catch	23	14	112	125	127	77	226	704

SF: Swampy forest; RF: Riverine forest; GL: Grassland; WGL: Wooded grassland; BL: Bushland; LS: Lake shore; AF: Agricultural field.

Table 2. Diversity indices of small mammals in different habitats.

Parameters	Habitat Type						
	SF	RF	GL	WGL	BL	LS	AF
Number of species	7	4	18	18	17	14	15
Total catch	23	14	112	125	127	77	226
Shannon's Diversity Index (H')	1.69	1.24	2.12	2.17	2.14	1.80	1.94
Simpson's Index (D)	0.78	0.68	0.84	0.87	0.85	0.76	0.80
Richness Index (R)	1.91	1.13	3.60	3.52	3.30	2.99	2.58
Trap nights	784	784	784	784	784	784	784
Trap success	2.93	1.79	14.29	15.94	16.20	9.82	28.83

SF: Swampy forest; RF: Riverine forest; GL: Grassland; WGL: Wooded grassland; BL: Bushland; LS: Lake shore; AF: Agricultural field.

of most species such as *M. natalensis, L. striatus* and *A. dembeensis* along altitudinal zones. The altitudinal zone 1401-1600 m asl had the highest number of species (15) followed by next zone i.e., 1200 - 1400 (14). Number of catches above 1400 m asl was higher (427 i.e., 60.65 %) compared to lower zone (below 1400 m asl) that yielded 277 individuals (39.35 %). *M. natalensis* was the most abundant and widely distributed species, recorded along all altitudinal zones. Similarly, *L. striatus, A. niloticus, A. dembeensis, M. erythroleucus, A. cahirinus* and *P. harringtoni* were also widely distributed but their abundance varied considerably. However, the relative abundance of a particular species differed between altitudinal zones. *R. rattus* and *S. albipes* occurred only above 1200 m asl. *L. flavopunctatus* was also confined above 1000 m asl. *L. striatus, R. rattus, S. albipes* and *P. harringtoni* showed increase in abundance along altitudinal ranges from 800 to 1600 m asl while *A. dembeensis* and *M. musculus* decreased in the number of catch. Richness index (R) was high for altitude between 1401 and 1600 (R = 2.80). This was least between altitudes of 1001 and 1200

Table 3. Composition of different age groups, trap success and relative abundance of small mammals between seasons.

Seasons	Age groups			Total catch	Relative abundance	Trap nights	Trap success
	Adult	Sub-adult	Young (juveniles)				
Dry (Oct-Dec 2010)	326	69	19	414	59%	2744	15.1
Wet (Jun-Aug 2011)	206	30	54	290	41%	2744	10.6
Total/average	532	99	73	704	100	5488	12.8

Table 4. Catch per trap-night and abundance of small mammals trapped from different altitudinal zonations (- : represents no record).

Species	Altitudinal zonation (m asl)				Total
	800-1000	1001-1200	1201-1400	1401-1600	
Mastomys natalensis	42	52	63	47	204
Lemniscomys striatus	19	23	48	52	142
Arvicanthis niloticus	15	13	14	18	60
Arvicanthis dembeensis	19	13	12	8	52
Mastomys erythroleucus	6	14	10	14	44
Acomys cahirinus	7	9	14	10	40
Rattus rattus	-	-	16	21	37
Mus musculus	12	11	7	5	35
Stenocephalemys albipes	-	-	8	12	20
Tatera robusta	5	4	4	6	19
Lophuromys flavopunctatus	-	2	9	7	18
Pelomys harringtoni	1	2	4	6	13
Mus tentellus	3	-	2	3	8
Crocidura fumosa	1	2	3	2	8
Crocidura flavescens	2	-	-	2	4
No. of species	12	11	14	15	15
Richness Index (R)	2.25	2.01	2.42	2.80	
Total	132	145	214	213	704

(R = 2.01). Generally, richness index increased from low to high altitudes but the differences were not significant.

Discussion

The highest numbers of rodents and insectivores were trapped from agricultural field (226) followed by bushland (127), wooded grassland (125), grassland 112 and the least from ground water forest and riverine forest, 14 and 24, respectively. The three major habitats such as bushland, grassland and wooded grassland also support many species in the study area. Habitat complexity in relation to food availability and cover is a key factor to influence the overall distribution of rodents in the study area. Makundi *et al.* (2005) also noted the association of small mammals composition with the resources found in an environment. As a result, the relative habitat association of rodents and insectivores showed variation across habitat types in both total catch and number of species.

The study of Chekol *et al.* (2012) and Makundi *et al.* (2005) also confirmed that population size of small mammals fluctuates greatly as a result of change in quality and quantity of resources in an environment. The three species, *Mastomys natalensis, Lemniscomys striatus* and *Acomys cahirinus* were widely distributed across all habitat types indicating their ecological adaptability. Habtamu & Bekele (2008) also reported similar trends for these species in the northwestern Ethiopia. As expected, there were differences in the overall small mammal composition and distribution between habitats. This conforms to the earlier study by Avenant & Cavallini (2008) who noted that the structure and species richness of small mammal community were related to variables such as habitat structure and complexity, rainfall, productivity, predation, trampling and nature of surrounding geographical extent of the habitat. During the present study most species were collected from wooded grassland and bushland. This might be due to the habitat composition of the area such as cover for breeding sites and food habits of rodents. Davis & Schmidly (1994) also observed that most granivores typically occupy open habitats. The previous study of Datiko *et al*. (2007b) from Arbaminch forest and of Habtamu & Bekele (2008) from Alatish National Park also recorded similar observations in different parts of the country. However, the effect of habitat change varied between species (Pahl *et al*. 1988).

M. natalensis was the most widely distributed and abundant small mammal in the study area. This species is also known to have wide distribution in East Africa and different parts of Ethiopia as reported by Datiko *et al*. (2007b), Habtamu & Bekele (2008), Lavrenchenko *et al*. (1998), and Takele *et al*. (2010). The major reason for its success appears to be its opportunistic food habit (Meehan 1984). *L. striatus* was also recorded from all habitats and it is the second abundant species of the area. This supports the findings of Habtamu & Bekele (2008) who identified this species possessing wide ecological tolerance, and occurring in savanna, forest and farmlands. In contrast to this, the species was restricted to a fewer habitats in a study conducted in Arbaminch forest by Datiko *et al*. (2007b). This shows that specific habitat occupancy by a species in different area could be due to the range of conditions within which a species actually does occur (Gebresilassie *et al*. 2004; Shanker 2001).

The two *Arvicanthis* species (*A. niloticus* and *A. dembeensis*) are widely distributed in all habitat types except for the forests. However, their abundance varied across habitats. For both species, high capture was recorded from agricultural fields. This might be related to their feeding habits as they are known to be major pests on cereal crops (Datiko *et al*. 2007a; Habtamu & Bekele 2008). Similarly, M. *natalensis, M. erythroleucus, A. cahirinus, R. rattus* and *M. musculus* were found in high abundance in the agricultural fields during this study. *M. tentellus, C. fumosa* and *C. flavescens* had restricted distribution and trapped only in a few habitats. The highest adaptability to the natural habitats as well as competition in the modified habitats (farmlands and plantations) might have influenced their distribution.

Habitat selection has an adaptive basis (Martin 1998). The abundance of rodents was significantly different among the habitats in the present study area, with the highest abundance in the agricultural field, followed by bushland, wooded grassland and grassland. The diversity indices of small mammals also varied in different habitats. For instance, the Shannon-Wiener Index (H') was highest in the wooded grassland (2.17) and lowest in the riverine forest (1.24). This might be attributed to the presence of several microhabitats such as habitat cover and their diverse resources in the wooded grassland. However, the lower Shannon-Wiener index (H') in the riverine forest might be a result of a permanently moist environment and occasional flooding of the entire area, thereby restricting immigration and burrowing activities of the animals. In addition, sparse ground vegetation under the forest may expose the animals to predation. The present result on their habitat preference of *M. natalensis, L. striatus, A. dembeensis, A. cahirinus* and *T. robusta* agrees with the previous work of Datiko *et al*. (2007b) and Habtamu & Bekele (2008).

A high abundance of rodents in agricultural field (32 %) was recorded during the present study. Delany (1986) also noted the temporary farmland derived as a result of forest modification supported more species and abundance than the forest itself. The cropping system of the area possibly might have contributed to the continuous and alternative supply of food and shelter for the species. Rodents were also abundant in the bushland habitat next to agricultural field. This might be also related to the diverse and densely grown plants that provided shelter, food and escape cover from predators. The low species richness and abundance in the forest might be a result of a permanently moist environment and occasional flooding of the entire area, thereby restricting immigration by burrowing or avoiding the area. In addition, sparse ground vegetation under the forest may expose the animals to predation. The study carried out by Datiko *et al*. (2007a) also revealed this situation in Arbaminch forest, southern Ethiopia.

The study also revealed a significant variation in the total catch and trap success of small mammals between seasons. Four hundred fourteen and two hundred ninety individuals were captured during dry season and wet season, respectively.

Seasonality might cause the dynamic changes which occur in the habitats such as cover and food availability.

Altitude plays an important role in determining gradients of temperature and vegetation types in hilly areas. However, the expression of vegetation and productivity of each zone depends on various other factors such as climatic conditions, rockiness, soil characteristics, soil depth and the extent of human influence. Interestingly, this study contradicts the report from a study conducted by Clausnitzer (2003) in western Rwenzori which showed that number and abundance of rodent species decreased with increasing altitude. According to Bekele (1996b), *A. dembeensis* is common in the lowland between sea level and 2200 m asl. The present study also showed their existence in this altitudinal range. Yalden (1988) noted that *M. musculus* and *M. tenellus* are known for their occurrence in open habitats between 1500 - 3000 m asl. However, during this study they were captured only below 1500 m. This observation also corroborates the study by Datiko *et al.* (2007b) and Habtamu & Bekele (2008) in Arbainch forest and Alatish National Park, respectively. A study conducted by Clausnitzer & Kityo (2001) on Mount Elgon showed that species richness depended upon habitat complexity, rather than altitude alone. Although, this study revealed the increment of species richness along increasing altitude, the differences were statistically not very significant. Moreover, as noted by Kasso *et al.* (2010), the present study has revealed different factors such as the variety of resources and regulators, including precipitation and temperature contributing to the distribution of species along with altitude. Shanker (2001) noted that the altitudinal distribution of small mammals was determined by the habitat complexity. As a result, in addition to altitudinal variation, the availability and quality of food, shelter and rainfall might be the main factors that determined the distribution of the small mammals in the study area.

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