academicJournals

Vol. 6(5), pp. 415-421, May 2014
DOI: 10.5897/IJBC2014.0685
Article Number: 5ED18D044260
ISSN 2141-243X

http://www.academicjournals.org/IJBC

International Journal of Biodiversity and Conservation

Full Length Research Paper

Distribution and diversity of small mammals In Borena-Sayint National Park, South Wollo, Ethiopia: Implications of habitat specialization

Meseret Chane[1]* and Solomon Yirga[2]

[1]Department of Biology, College of Natural and Computational Sciences, Dilla University, Dilla, P.O Box 419, Ethiopia.
[2]Department of Biology, Faculty of Science, Addis Ababa University, Addis Ababa, P.O Box 1176, Ethiopia.

Receive 21 January 2014; Accepted 28 February 2014

The study on distribution and diversity of small mammals in Borena-Sayint National Park (BSNP), South Wollo Zone, Ethiopia was conducted from December, 2009 to April, 2010. Representative sample sites were taken from each habitat type and surveyed using random line transect method. Five species of rodents and two species of shrews were identified and recorded from BSNP. Small and large sized Sherman and snaps traps were used to trap small mammals and morphometric measurement was taken for the species. From a total of 88 small mammals trapped and caught, *Lophuromys flavopunctatus* had the highest relative abundance (37.7%), followed by *Pelomys harringtoni* and *Otomys typus* with 17% each. *Stenocephalemys albipes*, *Arvicanthis dembeensis* and *Crocidura flavessens* had 12.5, 8 and 5.7% of abundance, respectively. *Crocidura fumosa* had the lowest relative abundance (2.3%).

Key words: Small mammals, diversity, distribution, relative abundance.

INTRODUCTION

Small mammals are categorized based on criteria such as body size and home range size. Those included in the small mammal category are species such as rodents (mice, rats and ground squirrels). Many of these species are difficult to observe in the wild because of their size, their habit of moving only at night or because they live under ground or in other hidden places (NLFC, 2005).

Small mammals are important components of biological diversity (Hashim and Mahgoub, 2007). They are known to have economical, ecological, social and cultural values (Afework Bekele and Leirs, 1997; Martin, 2003). They also play an important role in natural communities and provide the main supply of live-food for many of the predatory mammals, birds and reptiles (Decher and Bahian, 1999; Granjon et al., 2002). They make up a significant percentage of the diet of a variety of carnivores (Ray, 1998; Jorge, 2008).

Small mammals consume invertebrates, vegetation, fruits and seeds, playing extremely important role as dispersal and pollination agents in different habitats. Thus, changes in their abundance and distribution can affect the dynamics of other species as well (Ray, 1998; Solari et al., 2002).

Small mammals are considered to be good

*Corresponding author. E-mail: meseret.chane2009@gmail.com.

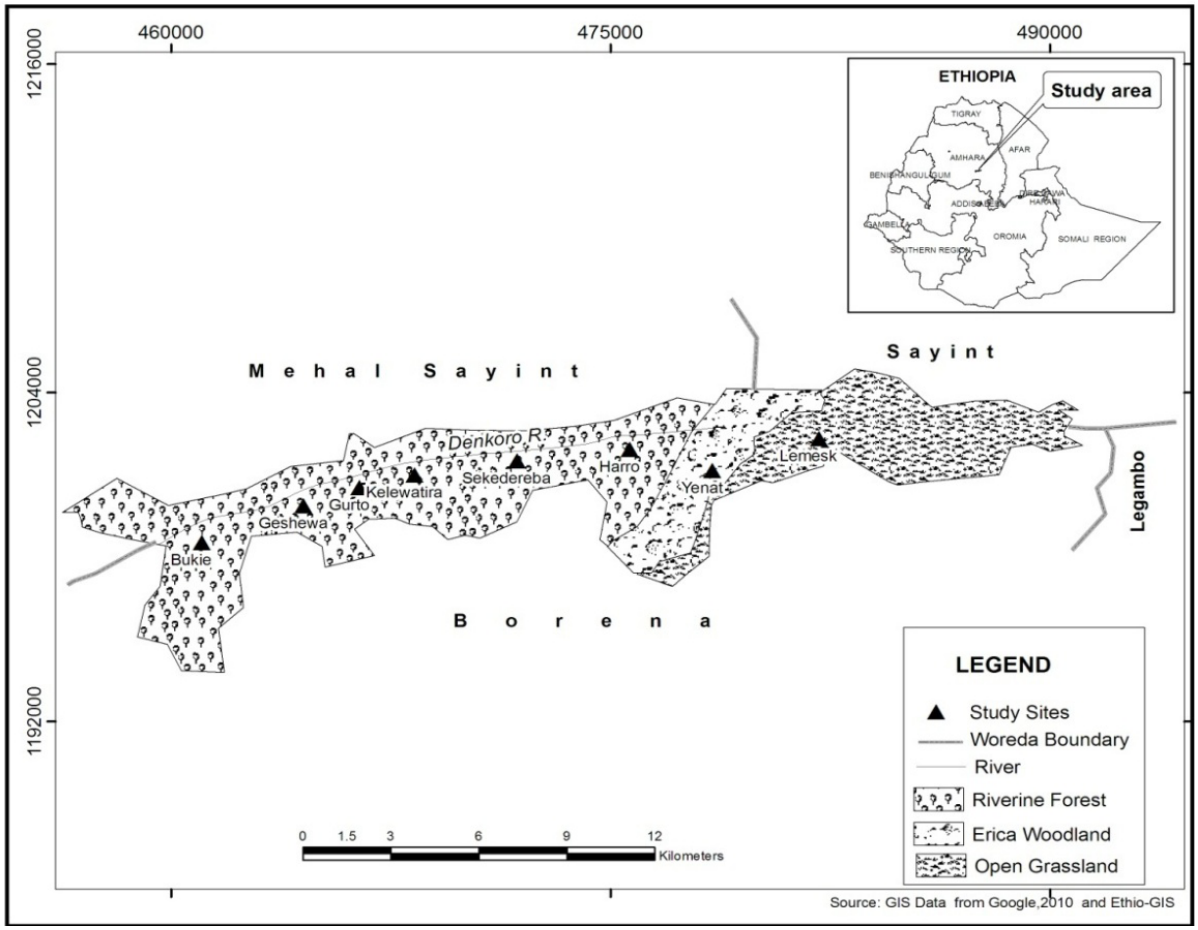

Figure 1. Location map of the study area, Borena-Sayint National Park, South Wollo, Ethiopia, 2009.

bio-indicators of habitats because of their short lifespan, rapid population dynamics and low level of pressure on their populations as a result of hunting in comparison with large mammals (shrews are never hunted because of the strong, unpleasant smell of their flank glands). They are also good bio-indicators because of the diversity, in tropical Africa, in terms of species and habitat preference (Barriere et al., 2006). Therefore, this study aims at describing the distribution and diversity of small mammals in BSNP.

MATERIALS AND METHODS

Geographic location

Borena-Sayint National Park is found in South Wollo Zone (Amhara Regional State) and lies between 10°50'45.4"-10°53'58.3" latitude and 38°40'28.4" 38°54'49" longitu-de (Figure 1). The park is located in the north eastern part of Ethiopia about 600 km by road from Addis Ababa, 205 km from Dessie and 16 km from Mekane Selam, the capital of Borena Woreda. The park is situated among three Woredas namely Borena to the south, Sayint to the north and Mehal Sayint (a newly established Woreda) to the east. Borena Woreda on south (with its seven Kebeles) and southwest (with its two Kebeles), Sayint on the north (with one Kebele) and Mehal Sayint on the north (with its two Kebeles) and on the west with one Kebele. Legambo Woreda is located bordering the two Woreda Borena and Sayint. The largest portion of the park is found in Borena Woreda.

Duration of the study

Small mammals' trapping was conducted from December 2009 to April 2010 in BSNP. During this period, random transect lines were established randomly and the locations were marked using Global Positioning System (GPS.) Study area was classified in to three major vegetation zones based on vegetation types and altitude. A total of 40 days of fieldwork was done. Random study sites were taken to trap small mammals and both snap traps and live traps were used. Specimens were collected and identified.

Study area sub division

Preliminary study was conducted in the first field work. This showed that the study area was heterogeneous in vegetation type and topography and classified into three Vegetation Zones. These include Vegetation Zone 1/Riverine forest (RF), Vegetation Zone 2/Erica woodland (EWL) and Vegetation Zone 3/Open grassland (OGL). Classification of the study area was based on the map of Denkoro Chaka sketched by Park Development and Protection Authority in December, 2006. Each vegetation zone has distinguish-

ing features in vegetation type and topography. Censes zones were established in all three vegetations.

Small mammals trapping

Recent studies define small mammals as those of less than 200 g body mass, but the threshold is still debatable (Juokaitis and Baranauskas, 2001; Hashim and Mahgoub, 2007). Therefore, in this study, mammal with body weight less than 200 g was taken as small.

Both live and snap trapping were used in randomly selected transects at different habitats of the study area to represent all the vegetation types. The length of line transect varied from 400 to 500 m. A total of twenty small and large sized (13 x 13 x 38 and 7.5 x 9 x 22 cm) Sherman and five snap traps were placed 20 m apart along the transect. Traps were set for three consecutive days along transect of each habitat types so as to cover different habitat types.

Trapping was conducted from December 15, 2009 to January 5, 2010 during the first data collection period and from March 19, 2010 to April 9, 2010 during the second data collection period. The total trap nights during the survey period were 720.

Each trap was baited with peanut butter and covered with foliage and hays to camouflage and avoid excess heat during day time. This also protected the local people from being attracted by these shiny and glittering objects from far. The traps were checked twice a day, early in the morning hours (07:00-08:00) and late in the afternoon hours (17:00-18:00). The trapped specimens were removed from the trap and kept in polyethylene bags. Live trapped animals were weighted, sex identified, and released at the place of capture after being marked.

Snap trapped specimens were used for standard morphological measurement such as head to body length (HB), tail length (TL), hind leg length (HL), front leg length (FL) and bodyweight (W). Some specimens were skinned and dried and identified at species level in Zoological Natural History Museum (ZNHM) of Addis Ababa University, Ethiopia.

Data analysis

Species diversity of small mammals were calculated using the Shannon-Weaver index of diversity, $H'=- \sum PilnPi$ where Pi is the proportion of the i^{th} species in the habitat (Shannon and Weaver, 1949). H' is influenced both by number of species as well as by the evenness with which mammals are distributed with those species.

Equal H values may thus be obtained if one habitat contains fewer and evenly distributed species of mammals. The evenness of mammalian species was calculated as J = H'/H'max; where, H'max = ln(s) and s is the number of species.

This measure varies between 1 (complete evenness) and 0 (complete unevenness). Chi-square (χ^2) was used to compare differences in abundance of mammal species between habitats and the overall significant difference in abundance of mammal species in the study area. SPSS computer Programme was used for Chi-square analysis to test the association of medium and large mammal species and their habitats (Flower and Cohen, 1990).

Simpson similarity index (SI) was also computed to assess the similarity among and between three habitats with reference to the composition of species.

SI= 3C/I+II+III

Where: SI= Simpson's similarity index, C = the number of common species to all three habitats, I= the number of species in habitat one, II = the number of species in habitat two, III = the number of species in habitat three.

RESULTS

Distribution of small mammals and their relative abundance in different habitats

Seven species of small mammals, *Arvicanthis dembeensis* (Grass rat), *Lophuromys flavopunctatus* (Harsh furred rat), *Pelomys harringtoni*, *Stenocephalemys albipes* (White footed Stenocephalemys), *Otomys typus* (Typical veli rat), *Crocidura fumosa* (Smoky white toothed shrew) and *Crocidura flavessens* (Great red musk shrew) were trapped (Table 1). From a total of seven species recorded in the study area, open grassland contained six species, while erica woodland and riverine forest contained five and four species, respectively. A total of 88 individuals belonging to family Muridae (five species) and Soricidea (two species) were encountered. Of the seven species, *L. flavopunctatus* was with 33 individuals (a total of 37.7%). This was followed by *P. harringtoni* and *O. typus* with 17% each. *S. albipes*, *A. dembeensis* and *C. flavescens* had 12.5, 8 and 5.7%, respectively. *C. fumosa* had the lowest frequency (2.3%) as shown in Figure 2.

L. flavopunctatus and *O. typus* were the most widely dispersed species, occurring in all three habitat types but *L. flavopunctatus* had relatively high numbers as compared to other species in all habitat types. *A. dembeensis*, *P. harringtoni*, *S. albipes* and *C. flavescens* were present in two of the three habitats. *C. fumosa* was found only in riverine forest habitat.

Morphometric measurements of small mammals in the study area were taken (Table 2).The difference in abundance of small mammals is given in Table 3.

Diversity indices for small mammals

Diversity index (H') and evenness (J) of small mammals varied among different habitats (Table 4). The highest diversity index was recorded in open grassland habitat, but the highest evenness was recorded in *Erica* woodland habitat. Riverine forest had the lowest diversity index and evenness.

The Simpson similarity index (SI) for small mammals showed that the similarity of species composition of small mammals among three habitats of the study area was 0.4 (Table 5). This means that 40% of the species were common for all three habitats.

The overall difference in abundance of small mammals among the three habitats of the study area was significant at (X^2=6.72, df= 2, $p<0.05$).

DISCUSSION

This study has recorded seven small mammal species. Five of them were rodents and two of them were insecti-

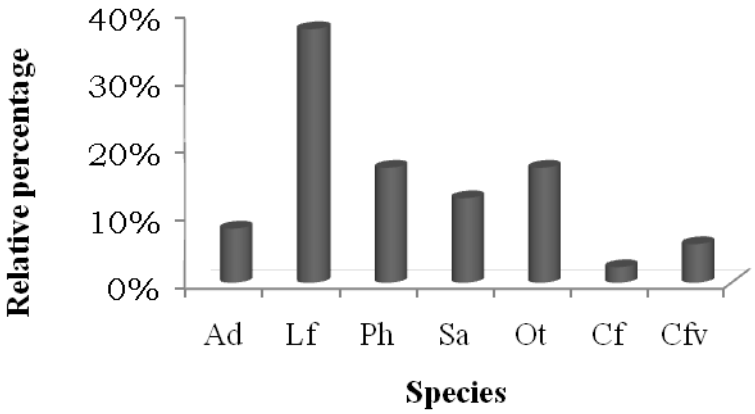

Figure 2. Relative abundance of small mammal species of the study area. Ad = *A.dembeensis*, Lf = *L. flavopunctatus*, Ph = *P. harringtoni*, Sa = *S. albipes*, Ot =*O. typus,* Cf = *C. fumosa*, Cfv = *C. flavescens*.

Table 1. Small mammals caught and their relative abundance (in brackets) at three habitats of the study area.

Species	Number of caught at each habitat type				
	RF	EWL	OPG	Total	Occurrence (%)
Arvicanthis dembeensis	3 (3.4)	-	4 (4.6)	7	8
Lophuromys flavopunctatus	9 (10.2)	12 (13.6)	12 (13.6)	33	37.5
Pelomys harringtoni	-	8 (9)	7 (8)	15	17
Stenocephalemys albipes	-	8 (9)	3 (3.4)	11	12.5
Otomys typus	4 (4.6)	5 (5.7)	6 (6.8)	15	17
Crocidura fumosa	2 (2.3)	-	-	2	2.3
Crocidura flavescens	-	3 (3.4)	2 (2.3)	5	5.7
Total	18 (20.4)	36 (41)	34 (38.6)	88	100

RF= Riverine forest, EWL = *Erica* woodland, OPG = open grassland; N.B. Blank (-) indicates the absence of species in the habitat.

Table 2. Morphometric measurements of small mammals in the study area.

Species	HBL (cm)	TL (cm)	HLL (cm)	FLL (cm)	BW (g)	Habit
A. dembeensis	8	10	3.8	2.9	78	Diurnal
L. flavopunctatus	9.5	5.5	4.5	3	48	Nocturnal/Diurnal
P. harringtoni	12	11.5	4.6	3	74	Nocturnal/Diurnal
S. albipes	12	11.5	4.9	3.2	85	Nocturnal
O. typus	8	17	4.6	2.5	64	Diurnal
C. fumosa	7	5	2.5	2.1	15	Nocturnal
C. flavescens	6	4.5	1.6	1.4	11	Nocturnal

HBL = Head body length, TL = tail length, HLL = hind leg length; FLL = front leg length, BW = body weight.

vores. This may not represent all the species present in the study area, but it gives update accounts of some of the small mammal species present in the study sites. The species composition and abundance in natural habitats (ground water forest and riverine forest) were very poor. This might be due to the homogeneous vegetation that is dominated by few species of trees. In addition, the under-ground habitat is open or has less cover resulting

Table 3. Comparison abundance of small mammal between habitats of the study area.

Species	Habitats		
	RF vs. EWL	RF vs. OGL	EWL vs. OGL
A.dembeensis	3	0.14	4*
L.flavopunctatus	0.43	0.43	0
P.harringtoni	8***	7**	0.067
S.albipes	8***	3	2.27
O. types	0.11	0.4	0.09
C.fumosa	2	2	2
C.flavescens	3	2	0.2

Figures in the table represent χ^2 values. RF= Riverine forest, EWL = Erica woodland, OGL = open grassland. *significance at p<0.05; **= p<0.01; ***= p<0.005; df=1.

Table 4. Diversity indices (H') and evenness (J) for small mammal species in different habitat types of the study area.

Habitat	Number of Species	Abundance	H'	J
Riverine forest	4	18	1.224	0.883
Erica woodland	5	36	1.515	0.942
Open grassland	6	34	1.633	0.911

Table 5. Simpsons' similarity index (SI) for small mammals caught among the three habitats. Formula for SI for three habitats, SI = 3C/I+II+II.

Species in habitat I	Species in habitat II	Species in habitat III	Species common to habitat I, II and III	Similarity index SI=3C/I+II+III
Ad	Lf	Ad	Lf	
Lf	Ph	Lf	Ot	
Ot	Sa	Ph		
Cf	Ot	Sa		
	Cfv	Ot		
		Cfv		
∑S=4	∑S=5	∑S=6	∑S=2	SI= 0.4

Habitat I = Riverine forest, Habitat II = Erica woodland, Habitat III = Open grassland. Ad = *Arvicanthis dembeensis*, Lf = *Lophuromys flavopunctatus,* Ph = *Pelomys harringtoni*, Ot = *Otomys typus*, Sa = *Stenocephalemys albipes,* Cf = *Crocidura fumosa*, Cfv = *Crocidura flavessens*.

in shortage of cover, food and diversity of microhabitats (Demeke et al., 2007). Likewise, in this study, the lowest composition and abundance of small mammals was recorded in riverine forest. On the other hand, high small mammal diversity was recorded in *Erica* woodland and open grassland. This might be due to the difference in vegetation cover, foliage and availability of food in these habitat types (Mgatha, 2002).

According to Morris (1987), distribution of small mammals over an area is not uniform and species are more abundant in some habitats than others. This is due to the abundance and distribution of small mammals depending mainly on the nature and density of vegetation for food and shelter (Happold, 1974). In the present study area, the distribution of rodents and insectivores were not uniform. Some species were widely distributed and others were restricted only to two or one habitat. For instance, *L. flavopunctatus* and *O. typus* were recorded in all three habitats. *A. dembeensis* was recorded from riverine forest and open grassland, whereas *P.*

harringtoni, *S. albipes* and *C. flavessens* were recorded from *Erica* woodland and open grassland. On the other hand, *C. fumosa* was recorded only from riverine forest.

L. flavopunctatus is one of the most widespread and numerous rodents in the moister areas of East Africa, inhabiting a range of different habitats with a preference for montane habitats (Clausnitzer et al., 2003). Misonne (1969) stated that this species occurred from lowland forests at about 500 m asl to afro-alpine, reaching well above 4200 m and extending into ericaceous habitats and montane moorlands. Yalden (1988) reported that this species was also the most abundant, ranging from near the lower tree line at 1550 m, right up through the forested zones and on to the Afro-alpine moorland at 3900 m in the Bale Mountains. Likewise, this species was the most abundant and widely distributed in all three habitats of the present study area. It occurred in riverine forest, Erica woodland and open grassland habitats and accounted for 37.5% of the total catches.

P. harringtoni was recorded in *Erica* woodland and open grassland habitats at an altitude of more than 3200 m asl in the present study and this second most abundant species accounted for 17% of the total catches. Yalden et al. (1976a) indicated that this species was widespread on Ethiopian plateau, on both sides of the Rift Valley, at altitudes of 1800-2800 m asl. Serekebirhan (2006) also recorded this species from Wonji sugarcane plantation area and indicated that it was one of the Ethiopian endemic rodent species. This shift in habitat by the species in the present study area might be due to the scarcity of food and cover at lower altitude habitat in the present study area.

According to Delany and Happold (1979), *O. typus* had been recorded from different mountains in Kenya, Uganda, Zambia and Tanzania in addition to Ethiopia.

This species somewhat resembles *Dasymys incomtus* but differ in its shorter tail and agouti-brown fur. The species has a distribution of altitudinal range 1800-4000 m asl (Yalden et al., 1976a). In the present study, this species was recorded from riverine forest, *Erica* woodland and open grassland. It was the second most abundant species comprising 17% of the total catches.

A. dembeensis is common between sea level and 2200 m asl and considered to be a lowland species (Afework, 1996). Capula et al. (1997) reported that this species is the third endemic species of the genus in Ethiopia. Yalden et al. (1976a) also indicated that the species is widely distributed in Ethiopia including Awash National Park, Holeta, Akordat, Arbaminch, Koffole, Koka, Shore of Lake Zeway, Shore of Lake Tana and Awash River basin and feeds mainly on leaves, seeds and shoot of grass. This species is reported as agricultural pest in Ethiopia (Afework et al., 1993). Dawud (2008) also recorded this species from Mazie National Park. The present study showed that this species was recorded in riverine forest and open grassland and accounted for 8% of the total catches. The presence of this species in these two habitats might be due to closeness to agricultural fields.

S. albipes is an endemic rodent of Ethiopia species inhabiting varied habitats from forest to scrubs in altitudes between 1500 - 3300 m asl (Afework and Corti, 1997). According to Yaleden et al. (1976a), this species has been recorded from various parts of Ethiopia including Bahir-Dar, Lake Zeway, Alemaya, Debre Markos, Dembecha, Mendi, Nijabara, Goba, Kebre Mengist and Bako. However, in the present study, this species was recorded in *Erica* woodland and open grassland at an altitude of 3100 m asl and never in riverine forest. This might be due to the feeding behavior of the species as it feeds mainly on grass, leaves and animal matters. The species was the third most abundant and comprised 12.5% of the total number of rodent species in the present study area. *C. flavescens* is a very large shrew with flat brain case and likely to be confused with *Suncus murinus*. It is, however, a very variable species in both size and color, and there are some suggestions that both characters are influenced by altitude. This shrew is one of the most common and widespread in Ethiopia, where it ranges from approximately 1000-3000 m asl. It was recorded in different parts of Ethiopia including Addis Ababa, Chilalo Mountains, Debre Markos and west shore of Lake Tana. It was thought to be a typical forest species (Yalden et al., 1976a). Yalden (1988) also observed the species in Bale Mountains National Park, below the tree line, and in association with clearings and within the forest. However, in the present study, it was not trapped in the riverine forest. Instead, it was trapped in *Erica* woodland and open grassland habitats. This species was not abundant in the present study area. It was accounted for only 5.7% from the total catches.

C. fumosa is essentially a montane shrew with thick fur usually showing little contrast between the grey brown dorsum and silivery-grey venter. It has been recorded in Ethiopia at an altitude of 1750-3900 m and is also known from mountains in Kenya, Uganda and Malawi (Yalden et al., 1976a). This species was trapped only in the riverine habitats of the study area. The species was poorly distributed and the least abundant of small mammals species that comprised 2.3% of the total number.

Conclusion

The present study identifies and documented seven small mammalian species of BSNP and gave base line information about their presence. The distribution and abundance of small mammals' species in the park varied because of vegetation types and altitudinal differences.

Conflict of Interests

The author(s) have not declared any conflict of interests.

ACKNOWLEDGEMENTS

Department of Biology, Addis Ababa University is highly acknowledged for financial assistance, fieldwork equipments and opportunity to carry out the research.

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