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A comparison of rodent and insectivore communities between sugarcane plantation and natural habitat in Ethiopia

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Abstract: A study on the ecology of rodents and insectivores was carried out in Wonji Sugarcane Plantation between August 2005 and March 2006. As rodents are known to damage standing sugarcane, the present study was aimed to reveal the abundance of various rodent pests in the plantation and in the adjacent natural area. Three trapping grids were randomly selected in the sugarcane plantation based on the growth stage of the cane and an additional grid was selected in a natural bushland habitat adjoining the plantation. In 2940 trap nights of trapping, a total of 557 individual rodents were trapped. These represented eight species: *Mastomys natalensis, Arvicanthis dembeensis, Arvicanthis niloticus, Stenocephalemys albipes, Pelomys harringtoni, Mus mahomet, Mus musculus* and *Rattus rattus*. In addition, 72 individuals of two species of insectivores (*Crocidura flavescens* and *Crocidura fumosa*) were also trapped. The abundance of rodents and shrews was 62 (15.3 %), 137 (33.7 %), 86 (21.2 %) and 121 (29.8 %) in immature sugarcane plantation, young sugarcane plantation, old sugarcane plantation and bushland, respectively. Their abundance was high during the wet season than in the dry season.

Resumen: Se llevó a cabo un estudio sobre la ecología de roedores e insectívoros en la plantación de caña de azúcar Wonji entre agosto de 2005 y marzo de 2006. Como se sabe que los roedores dañan la caña de azúcar en pie, el objetivo del presente estudio fue revelar la abundancia de varias plagas de roedores en la plantación y en el área natural adyacente. Se seleccionaron al azar tres retículas de trampeo en la plantación de caña de azúcar de acuerdo con la etapa de crecimiento de la caña y se seleccionó una retícula adicional en un hábitat de matorral natural contiguo a la plantación. En 2940 noches-trampa de trampeo, fueron atrapados en total 557 individuos de roedores. Éstos representaron ocho especies: *Mastomys natalensis, Arvicanthis dembeensis, Arvicanthis niloticus, Stenocephalemys albipes, Pelomys harringtoni, Mus mahomet, Mus musculus* y *Rattus rattus*. Además, también fueron atrapados 72 individuos de dos especies insectívoras (*Crocidura flavescens* y *Crocidura fumosa*). La abundancia de roedores y musarañas fue de 62 (15.3 %), 137 (33.7 %), 86 (21.2 %) y 121 (29.8 %) en plantaciones de caña de azúcar inmadura, joven, vieja y en el matorral, respectivamente. Su abundancia fue más alta durante la temporada húmeda que durante la época seca.

Resumo: Realizou-se um estudo sobre a ecologia de roedores e insectívorosnuma plantação de cana de açúcar em Wonji entre Agosto de 2005 e Março de 2006. Como os roedores são conhecidos pelos estragos causados nas plantações de cana de açúcar, o presente estudo teve como objectivo revelar a abundância de várias pragas de roedores nas plantações e na área natural adjacente. Três quadriculas de armadilhas foram aleatoriamente instaladas na plantação de cana com base no estágio de crescimento da cana e uma quadrícula adicional foi seleccionado num habitat natural de mato adjacente à plantação. Em 2940 noites de armadilhagem, foram capturadosum total de 557 roedores. Nesta população estavam representadas oito espécies: *Mastomys natalensis, Arvicanthis dembeensis, Arvicanthis niloticus,*

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Stenocephalemys albipes, Pelomys harringtoni, Mus mahomet, Mus musculus e *Rattus rattus*. Além disso, foram também presos 72 indivíduos de duas espécies insectívoras (*Crocidura flavescens* e *Crocidura fumosa*). A abundância de roedores e musaranhos foi 62 (15,3%), 137 (33,7%), 86 (21,2%) e 121 (29,8%) em plantaçõesimaturas de cana de açúcar, plantação de cana jovens, velhas e mato nativo, respectivamente. A sua abundância foi mais elevada durante a estação chuvosa do que na estação seca.

Key words: Bushland, rodents, shrews, species abundance, species composition, sugarcane plantation.

Introduction

Small mammals occur in every habitat, from the high Arctic Tundra, where they live and breed under the snow, to the hottest and driest of deserts (Kingdon 1997). Among the small mammals, rodents are more numerous all over the world. The distribution pattern and relative abundance of rodents depend on the seasonal availability of cover and food (Taylor & Green 1976), habitat structure, and predation risk (Kotler & Brown 1988). Rainfall is considered as the major climatic variable in determining population dynamics of rodents in East Africa (Delany & Monro 1985) as it affects both plant productivity and habitat structure. Some rodents occur in close association with man. This association is often not positive as rodents consume large quantities of stored food, spread fatal diseases (e.g. plague) and cause extensive damage to crops (Leirs *et al.* 1993; Macdonald 1984). Rodents are responsible for damage of over 30 % of the produced food globally (Fiedler 1988).

Being the prey of a wide variety of small carnivores, the habitat preference of rodents depends on a combination of several factors involved in eco-requirements of the concerned species. In addition to the seasonal fluctuation in the availability of food, predator risk forms a major factor governing the habitat association of rodents (Kotler & Brown 1988; Longland & Price 1991; Lagos *et al.* 1995; Lima *et al.* 2001). In general, rodents prefer habitats with higher vegetation cover as it helps to reduce predation risk by providing concealment. In areas with strong seasonality, microhabitat features are major factors, which govern the composition and abundance of rodents in a given habitat (Lin & Batzli 2001).

The rodent fauna of Ethiopia consists of 84 species, which accounts for nearly 25 per cent of the total mammals (Yalden & Largen 1992). Among these, 15 are endemic, contributing for about 50 per cent of the endemic mammalian fauna of the country (Hillman 1993). Despite their high diversity and endemism, studies on Ethiopian rodents are few (Afework 1996a; 1996b; Afework *et al.* 1993; Afework *et al.* 2003; Afework & Leirs 1997; Afework & Corti 1997; Lavrenchenko *et al.* 1998), in particular studies in agricultural habitats (Manyingerew *et al.* 2006; Workneh *et al.* 2004, 2005, 2006).

Even though some species of rodents are known to be pests in sugarcane fields in other parts of the world, the species composition of rodents in sugarcane plantations of Ethiopia is poorly known (Serekebirhan *et al.* 2008). Further, with the present expansion of agriculture (including sugarcane) in the arable regions of Ethiopia, a comparative study of rodents between wild and agricultural habitats would help to reveal how plantations affect local fauna. It is expected that monoculture plantations affect species richness in the area. It could also have a spill-over effect where commensal species might increase in abundance, thus affecting neighbouring habitats. The aim of this study was to determine the abundance, composition and habitat association of rodents and insectivores in a sugarcane plantation and its adjoining natural habitat in Ethiopia.

Materials and methods

Study area

The study was conducted at Wonji-Shoa sugarcane plantation and nearby areas, located at about 100 km southeast of Addis Ababa. It is situated between 8° 31' N and 39° 12' E at an average altitude of 1540 m asl (Fig. 1). The plantation, which covers a total area of 7022.24 ha, has a flat topography and is irrigated by furrow irrigation

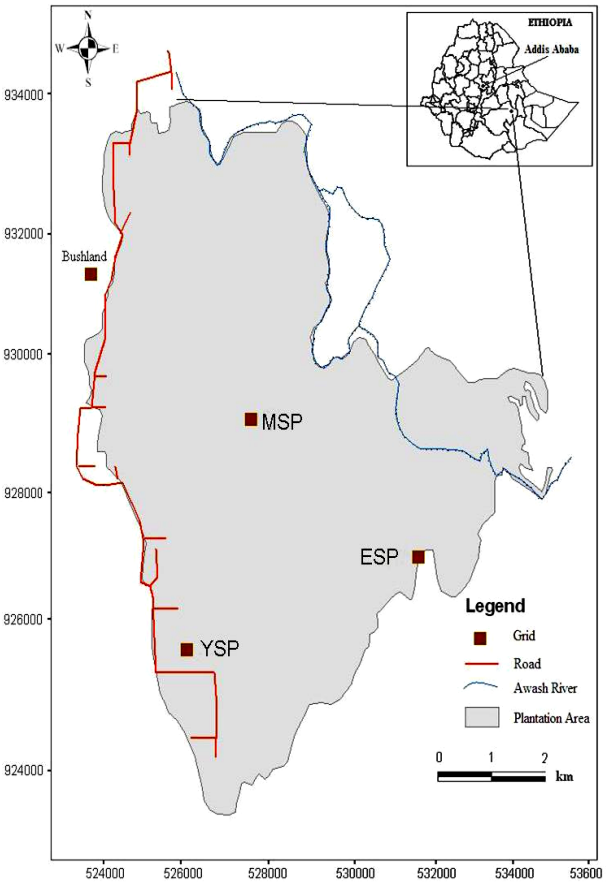

Fig. 1. Location map of Wonji Area in Ethiopia showing sampling sites (ESP = Early / Immature Sugarcane Plantation; YSP = Young Sugarcane Plantation; MSP = Mature Sugarcane Plantation).

system. An efficient irrigation system has been developed through the years with irrigation canals of 300 km, drainage canals of 200 km, and numerous artificial ponds. The source of water is Awash River. As many as 10 varieties of sugarcane are planted in this area, of these, the B52-298 is the most widely grown. The sugarcane is cultivated as a perennial monocrop and it flourishes in a wide variety of soils. The densities of sugarcane stalks (number per 100 m^2) at early, mid and mature phase of plantation were 1317, 1440, and 960, respectively. The mean height of the sugarcane plants were 0.4 m (early stage), 1.6 m (young plantation) and 2.0 m (mature plantation) during the first trapping session, and 1.6 m, 2.0 m and 2.8 m, respectively, during the last trapping session. The bushland or secondary scrub adjacent to plantations was characterized by *Acacia* spp. interspersed with grasses and scattered eucalypts trees.

The climate of Wonji area is tropical with seasonal wet and dry seasons. Short rains (March to May) merge into the main rainy season from mid-June to mid-September. The mean annual rainfall is 825 mm. The annual relative humidity ranges between 34.5 - 63.0 %. The mean monthly minimum temperature ranged between 6.9 °C and 14.7 °C, and that of maximum between 23.1 °C and 30.0 °C. The minimum temperature was 6.9 °C in November and the maximum 30.0 °C in May.

Methods

Data on the species composition, abundance and habitat association of rodents and insectivores were collected for wet and dry seasons during August 2005–March 2006, using Sherman live traps of size 23.5 x 7.5 x 7.5 cm^3. Trapping was conducted twice during the wet season (August and September) and thrice during the dry season (November, January and March). Based on a topographic map of the study area (1:75000), four grids (three each of 70 x 70 m, i.e. 4900 m^2 and one of 120 x 40 m, i.e. 4800 m^2) were selected randomly. Among these, three were in the plantation, and one was a bushland area (BLA) near a rocky outcrop, 200 m away from the plantation. The first grid was set up in early sugarcane plantation (ESP), the second in mature sugarcane plantation (MSP) and the third in young sugarcane plantation (YSP). Each grid, in the three stages of plantation, had a 7 x 7 setup, with a distance of 10 m between stations. In the BLA, the grid had a 12 x 4 setup, with traps spaced at 10 m apart. Trapping stations were marked with a white scotch tape for identity, approximately 1 m above the traps. During each trapping session, the traps were set for three consecutive days. Each trap was baited with peanut butter and checked twice a day (7:00–8:00 a.m. and 5:00–6:00 p.m.). The trapped animals were then identified, body mass and sexual conditions were recorded and trapping location was noted. They were then toe-clipped for individual identification, and released back at the site from were trapped. 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 (Afework 1996a).

For data analysis, SPSS software version 14.0 was used. Chi-square test was used to analyse the difference of abundance of rodents between grids.

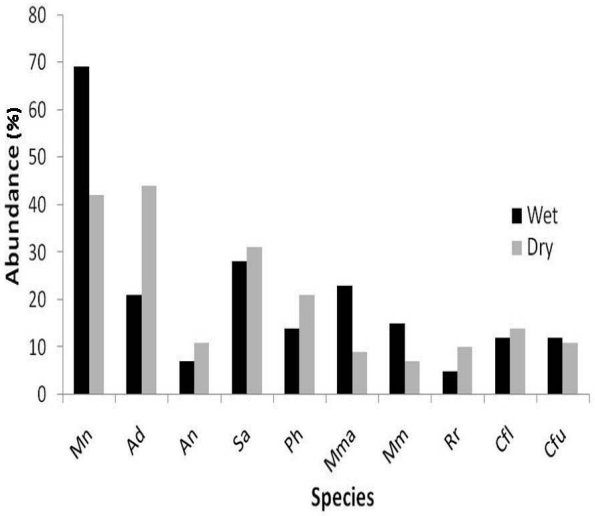

Fig. 2. Abundance of different species of rodents and insectivores in Wonji Sugarcane Plantations during wet and dry seasons (Mn = *M. natalensis,* Ad = *A. dembeensis,* An = *A. niloticus,* Sa = *S. albipes,* Ph = *P. harringtoni,* Mma = *M. mahomet,* Mm = *M. musculus,* Rr = *R. rattus,* Cfl = *C. flavescens,* Cfu = *C. fumosa.*

Results

A total of 629 captures were made in 2940 trap nights. Among these, 557 individuals (88.6 %) represented eight species of rodents and 72 individuals (11.4 %) represented two species of insectivores. There were 357 rodents and 49 shrews as new captures. The trapped rodents were of the following species: *Mastomys natalensis* (111), *Arvicanthis dembeensis* (65), *Stenocephalemys albipes* (59), *Pelomys harringtoni* (35), *Mus mahomet* (32), *Mus musculus* (22), *Arvicanthis niloticus* (18), and *Rattus rattus* (15). The insectivores were *Crocidura flavescens* (26) and *Crocidura fumosa* (23). Table 1 gives the data on species-wise capture from each of the habitats and their abundance.

M. natalensis was the most abundant rodent constituting 27.33 % of the total catch (Table 1). In ESP, YSP and MSP, it constituted 24.2 %, 32.8 %, and 31.4 % of the total catch, respectively. *A. niloticus* was the second highest in abundance, constituting 20.4 % of the total catch. The third largest number of individuals trapped was of *S. albipes* (14.53 %). They were most abundant in YSP (37.3 %). *M. mahomet* and *M. musculus* together comprised 13.3 % of the total catch. They were relatively more in MSP. *P. harringtoni* and *R. rattus* comprised 8.62 % and 3.70 % of the total catch, respectively. They were relatively more in YSP. Among the shrews trapped, 32.7 % was from YSP. Overall, there was a significant difference in species abundance between ESP, YSP and MSP ($\chi^2 = 30.9$, df = 2, $P < 0.001$).

In BLA, *Arvicanthis* (*A. dembeensis* and *A. niloticus*) contributed the highest number of individuals constituting 30.6 % of the trapping from the area (Table 1). *M. natalensis* and *P. harringtoni* were recorded at 19.8 % and 18.2 % of the

Table 1. Habitat-wise species composition and abundance of rodents and insectivores in Wonji Sugarcane Plantation.

Species	Species-wise abundance in different habitats					
	ESP	YSP	MSP	BLA	Individuals captured (*)	Abundance %
Rodents						
Mastomys natalensis A. Smith 1834	15	45	27	24	111 (181)	27.33
Arvicanthis dembeensis Rüppell 1842	8	23	5	29	65 (96)	16.00
Arvicanthis niloticus Desmarest 1822	2	6	2	8	18 (32)	4.40
Stenocephalemys albipes Rüppell 1842	9	22	18	10	59 (94)	14.53
Pelomys harringtoni Thomas 1903	3	6	4	22	35 (63)	8.62
Mus mahomet Rhoads 1896	7	8	13	4	32 (40)	7.90
Mus musculus Linnaeus 1758	5	5	6	6	22 (26)	5.42
Rattus rattus Linnaeus 1758	2	6	1	6	15 (25)	3.70
Insectivores						
Crocidura flavescens I. Geoffroy 1827	6	8	5	7	26 (39)	6.40
Crocidura fumosa Thomas 1904	5	8	5	5	23 (33)	5.70
Total	62	137	86	121	406 (629)	100.00

ESP = Early Sugarcane Plantation, YSP = Young Sugarcane Plantation, MSP = Mature Sugarcane Plantation, BLA = Bushland Area, *(Figures in brackets are inclusive of recaptures).

Table 2. Species composition and the number of individuals of each species captured in different habitats during wet and dry seasons ("–" indicates no capture).

	Number of individuals trapped during the wet and dry seasons in different habitats							
	ESP		YSP		MSP		BLA	
Species	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
Mastomys natalensis	4	11	30	15	18	9	17	7
Arvicanthis dembeensis	–	8	9	14	1	4	11	18
Arvicanthis niloticus	–	2	4	2	–	2	3	5
Stenocephalemys albipes	3	6	13	9	6	12	6	4
Pelomys harringtoni	3	–	3	3	4	–	4	18
Mus mahomet	3	4	8	–	8	5	4	–
Mus musculus	2	3	4	1	4	2	5	1
Rattus rattus	–	2	2	4	–	1	3	3
Crocidura flavescens	2	4	3	5	3	2	4	3
Crocidura fumosa	3	2	3	5	2	3	4	1
Total species	7	9	10	9	8	9	10	9

ESP = Early Sugarcane Plantation, YSP = Young Sugarcane Plantation, MSP = Mature Sugarcane Plantation, BLA = Bushland.

total catch, respectively. Moreover, *M. musculus* and *M. mahomet* together contributed 8.3 %, *S. albipes* 8.3 % and *R. rattus* 4.9 % of the total catch. Shrews constituted 9.9 % of the total catch in this area.

Some of the rodent species showed differences in their abundance during the wet and dry seasons. *M. natalensis* ($\chi^2 = 16.7$, df = 1, $P < 0.001$), *M. mahomet* ($\chi^2 = 15.1$, df = 1, $P < 0.001$), and *M. musculus* ($\chi^2 = 8.9$, df = 1, $P < 0.01$) were more abundant during the wet season. *A. niloticus*, *P. harringtoni*, *R. rattus*, *C. flavescens* and *C. fumosa* did not show significant difference in their abundance between seasons (Fig. 2). However, the overall abundance of rodents and insectivores was higher during the wet season (Table 2).

Most of the small mammals were captured during wet as well as dry seasons in all the four habitats. However, the relative abundance of species between seasons in each of the growth stages of the sugarcane varied. During wet season, YSP had the highest species richness while ESP had the lowest species richness (Table 2), but during the dry season, all three stages had similar species richness. Some species, which were trapped during the wet season, were not captured during the dry season and *vice-versa*. In ESP, *A. dembeensis*, *A. niloticus* and *R. rattus* were captured only during the dry season. In YSP, *M. mahomet* was not captured during the dry season. In MSP, *A. niloticus* and *R. rattus* were not captured during the wet season, while in ESP and MSP, *P. harringtoni* was trapped only during the wet season (Table 2). High species richness in BLA was revealed during the wet season. All species other than *M. mahomet* were also captured from BLA during the dry season.

Thus, eight species of rodents and two species of insectivores constituted the small mammals of the present study area; *M. natalensis* being the most abundant in all the grids studied. The abundance of small mammals varied from habitat to habitat and from season to season. The BLA had higher abundance and richness of small mammals.

Discussion

The abundance of rodents in Wonji sugarcane plantations varied with the different growth stages of the cane. Among the grids in the plantation, the grid of YSP contained the highest number of rodents and insectivores. According to Blackburn (1984), mature sugarcane plants provide heavy cover, safety and enough food for a relatively high population of rodents. However, the present observation in Wonji might have several reasons. Firstly, the YSP sample was of ratoon cane. The number of cane stalks and density were higher in

ratoon fields. The ratoon fields are reported to have relatively high ground cover which are preferred by rodents and insectivores (Fauconnier 1993). Higher ground cover provides safety to the small mammals, which explains higher abundance. Secondly, presence of a parallel mature sugarcane plantation 10 m away from this site could have influenced migration of rodents into YSP leading to higher abundance. Such migration has been observed by Haque *et al.* (1985). Thirdly, B52 cane variety being relatively sweet and soft, might also have been the preferred by the rodents for food. Such preference was also suggested earlier by Fauconnier (1993).

In ESP (5-7 month old plantation), abundance of rodents and insectivores was the least compared to others. During the first two trapping sessions in 294 trap nights, only 20 individuals were trapped. The cane at this age provides very little cover and food (Whisson 1996). However, in the later three trapping sessions in 441 trap nights, a total of 42 individuals were trapped. Thus, an average of only 10 individuals were trapped per session during the early growth stage of the cane, whereas it was 14 individuals per session during the later growth stage of ESP. The cane during these sessions increased in age, which contributed to a good ground cover for the rodents.

The BLA was located very near to a rocky hill. This was an advantage for rodents as a good hiding place reducing the risk of predation. As a result, there were more individuals trapped from this habitat (121 in 441 trap nights), with an average of 24 individuals per session. Emmons (1984) also recorded high density of rodents in BLAs, near or adjacent to rocky hills. The availability of natural cover and different food items in the bushland might have also contributed to the high number of rodents in this habitat.

Sugarcane plantations may not exhibit strong seasonality in abundance of small mammals due to regular growth of the cane and uniform phenology. However, there were remarkable differences in the abundance of some of the rodent species in the sample plots in different seasons (see Table 2). The multimammate rat (*M. natalensis*) was more abundant during the wet season. It is already known that rainfall has a positive impact on breeding of this species (Hubert & Adam 1985; Stenseth *et al.* 2001; Taylor & Green 1976). Rainfall also favours growth of weeds in sugarcane plantations. Ground cover was an additional advantage for *M. natalensis* during this season. The African multimammate rat shows a strict breeding seasonality, linked to rainfall, probably through the stimulating effect of germinating weeds (Leirs *et al.* 1994). Two species of *Mus* (*M. mahomet* and *M. musculus*) were the second most abundant rodents during the wet season. In contrast to the report that they occur exclusively in urban and village areas (Bates 1988), this study reveals that they are also present in the sugarcane plantations. *S. albipes* was also more abundant during the wet season. The un-stripped grass rat (*A. dembeensis*) and the Nile-rat (*A. niloticus*) were more abundant during the dry season. This observation is well in line with the findings of Delany (1986) and Afework *et al.* (1993). They attain maximum numbers during the mid-dry season.

In general, the rodents and insectivores inhabited all the growth stages of the sugarcane. However, their abundance varied considerably. ESP, YSP and MSP contributed for 15.3 %, 33.7 % and 21.2 % of the total catch, respectively. The initial growth stage of the sugarcane plant was not a suitable habitat for rodents compared to the other growth stages. In the later growth stages, more rodent and insectivore species were attracted due to a relatively better cover. Tobin *et al.* (1990) also observed that during the long growing phase the sugarcane stalks were tall and big, and rows were shaded or hidden by foliage, which provided a suitable resting and breeding place for rodents.

M. natalensis was the dominant species in all ages of the sugarcane plantation. It is well documented as a major agricultural pest in East Africa (Fiedler 1994) having a wider distribution over most of Ethiopia, in altitudes ranging between 500–2900 m asl (Yalden *et al.* 1976). The Genus *Arvicanthis* (*A. dembeensis* and *A. niloticus*) were the second most dominant species trapped from all ages of sugarcane. These species are also reported as agricultural pests in Ethiopia (Afework *et al.* 1993; Lavrenchenko *et al.* 1998). Compared to *A. dembeensis*, *A. niloticus* was relatively less in number in sugarcane fields. *Mus* species were also dominant in ESP and MSP. They were also trapped from YSP and BLA but in less numbers. Occurrence of the house mouse, *M. musculus* in sugarcane plantations was unusual. This species usually occurs in urban and village areas. *M. mahomet* occurs in agricultural fields, including sugarcane fields of Southeast Asian countries (Engeman *et al.* 1998). In maize fields of central Ethiopia, *M. mahomet* comprised 35 % of the total live-trapped small mammals (Afework *et al.* 2003). The Ethiopian endemic rodent species, *S. albipes* was trapped in a significant number next to *Mus*

species in ESP and MSP. Bushland also contained this species. According to Afework & Corti (1997), its habitat varied from forest to scrubs in altitudes between 1500–3300 m asl. However, there was no previous record of this species in agricultural fields such as sugarcane plantation in Ethiopia. The other Ethiopian endemic rodent species, *P. harringtoni* was the least trapped rodent next to *R. rattus* in all growth stages of the cane. More number of this species was found in bushland. It inhabits scrub or bushland areas. Moreover, it was not recorded as an agricultural pest in Ethiopia so far. The black rat, *R. rattus,* although trapped from all growth stages of the sugarcane and bushland habitats, was the least trapped rodent during the present investigation. *C. flavescens* and *C. fumosa* were trapped in all growth stages of the sugarcane plants and in bushland habitat as well. But, their occurrence in sugarcane plantation was unusual. These species have not been recorded in agricultural areas of Ethiopia so far. *C. flavescens* is a typical forest species (Delany 1986), whereas *C. fumosa* as a moorland species common in areas of altitudinal ranges from 3800 to 4000 m asl (Yalden 1998). During the present study, they were found in a new altitudinal range.

The higher density and abundance of small mammals in BLA than in plantations suggest that their ecological requirements are better met within natural habitats than in plantations. Serekebirhan *et al*. (2008) have already revealed that small mammals are pests in the present study area in Wonji, damaging up to 4.7 % of the stalks during the wet season in YSP. Even though the level of damage is not high, it is expected to control such damages if buffer area is maintained around the plantation, so that natural populations of rodents and insectivores from BLA might not reach the plantation.

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