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SEASONAL POPULATION DYNAMICS OF RODENTS OF MOUNT CHILALO, ARSI, ETHIOPIA

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ABSTRACT: A study on seasonal population dynamics of rodents was carried out on Mount Chilalo from August, 2007 to April, 2008. Six habitats, namely grassland, bush land, montane forest, *Erica* forest, Afroalpine forest and moor land were identified to carry out live and snap trapping during wet and dry seasons in randomly selected grids. Seasonal species distribution, relative abundance and habitat association, weight, sex, age and reproductive status of rodents were studied. From 1,756 individuals captured, 985 (56.1%) and 771 (43.9%) were live trapped during wet and dry seasons, respectively. Species composition for live trapped individuals during wet and dry seasons was 9 and 10, respectively. These are: *Arvicanthis abyssinicus*, *A. blicki*, *Lophuromys flavopunctatus*, *L. melanonyx*, *Mastomys natalensis*, *Mus mahomet*, *Otomys typus*, *Stenocephalemys albipes*, *S. albocaudata* and *S. griseicauda*. *Mus mahomet* was trapped only during the dry season. There was no significant seasonal variation in the capture of young and sub-adult, while it is significant among adults with highest during wet season. Although more males than females were trapped during wet season, the sex ratio was not significantly different. The number of reproductively active males and females were higher during the wet than the dry season. The highest trap success (47.1%) was recorded during wet season. Biomass ranged from 9,231 g/ha (moor land habitat) to 55,507 g/ha (grassland habitat). From snap trapped rodents, pregnant females of *A. dembeensis*, *R. rattus* and *M. mahomet* were not obtained. Maximum number of embryo counted was 15 for *M. natalensis* and the least (2) was for *O. typus*.

Key words/phrases: Abundance, distribution, Ethiopia, Mount Chilalo, rodents

INTRODUCTION

The diversity of topographic features of Ethiopia coupled with the variation in weather components resulted in the possession of different habitats affecting the distribution of flora and fauna, human population and the type of agricultural practices that in turn is influenced by seasonal variations (Yalden and Largen, 1992). Seasonal variations affect the nature and densities of vegetation that determine the distribution and relative abundance of rodents with variable microclimates (Iyawe, 1988; Afework Bekele and Leirs, 1997). Vegetation besides being used as a source of food, provides protection against predators and determines the abundance and seasonal dynamics of rodents (Happold and Happold, 1991; Oguge, 1995; Hansson, 1999). Hence, vegetation cover plays an important role in population regulation whereas its removal results in depletion of rodent populations. Additionally, according to Taylor and Green (1976), the availability of nutritious food is a key factor in determining reproduction and population number of rodents because food quality and quantity is important in determining breeding due to gonadotropic factors available in plants at certain seasons that help in stimulating reproduction. Thus, for many rodents, breeding and rainfall are directly correlated (Taylor and Green, 1976; Linzey and Kesner, 1997).

Rodents exhibit variation in their standard body measurements from species to species. Although, most rodents are small and weigh less than 100 g, they are variable in size from 75 mm in head-to-tail length and weight of 5 g to the largest living rodent, the capybara of South America, reaching over 1.3 m in length and 50 kg in weight (Macdonald, 1984; Nowak, 1999; Vaughan, *et al.*, 2000). The African rodents also range in size from the smallest African Pygmy Mouse (*Mus minutoides*) which is 7 g to the African Crested Porcupine (*Hystrix cristata*) reaching 20 kg (Delany and Happold, 1979; Wilson and Reeder, 1993).

Diet is extremely significant to determine the ecological role of rodents (Krebs, 1998). Studies of diets and habitat preferences are important to understand community structure, species diversity, relative abundance, and resource partitioning among species and individuals (Zimmerman, 1965). Diets of rodents are usually evaluated by analyzing stomach contents or less frequently faecal materials (Putman, 1984; Workneh Gebresilassie *et al.*, 2004). Rodents exploit a broad spectrum of food items. Most of them consume diverse plant materials (seeds, stems, leaves, flowers, roots, tubers, fruits and berries) and small invertebrates such as insects (grasshoppers, ants, flies and termites), spiders and worms. Generally, most rodents are either herbivorous or omnivorous although a few species are strictly carnivorous like the Northern Grasshopper Mouse (*Onychomys leucagaster*) or specialized carnivorous, like the Australian Water Rat (*Hydromys chrysogaster*), which feeds on small fish, frogs and molluscs (Macdonald, 1984). Mole rats are the other specialized rodent species that feed on roots and tubers of different plants (Sidorowicz, 1974, Abebe Kokiso and Afework Bekele, 2008).

In general, seasonal climate change influences vegetation growth, availability of food and water, and microclimatic conditions that in turn affect the abundance and distribution of species and population structures. Thus, this study aims at revealing the seasonal influence on distribution, abundance, reproductive status, age and sex ratio, biomass, trap success and diet preference of rodents.

MATERIALS AND METHODS

The study area

The present study area, Mount Chilalo, is located between 7°30′ and 7°59′N latitude and 39°10′ and 39°17′E longitude in the central part of the Arsi Administrative Zone, Oromia Regional State of Ethiopia. Mount Chilalo lies west of the northern end of the Galama Mountain Range and separated by a saddle-like terrain called Cheleleka (Mohammed Kasso *et al.*, 2010) (Fig. 1).

Mount Chilalo is part of the Arsi Mountains comprising the second highest Afroalpine habitat in Ethiopia (Gottelli and Sillero-Zubiri, 1992; Malcolm and Sillero-Zubiri, 1997). It has a great diversity of landscape with altitudes ranging from 2,000 to more than 4,000 masl. Many rivers and streams emanate from it in different directions forming different drainage basins (APEDO and ABRDP, 2004). These massifs also have Afroalpine lakes and swamps on the top of the plateau. The area possesses different types of soils at different altitudes such as Pellic Vertisols (lower altitude), Orthic Luvisols (medium altitude), Chromic Luvisols (higher altitude) and Eutric Nitosols (on the moor land). The soil colour along the western part of Mount Chilalo changes from darker to reddish brown between 2,500–3,000 masl and becomes dark above 3,000 masl. It has acidic pH value ranging from 5 to 6. The lower altitude area is frequently cultivated (Kebrom Tekle, 1984).

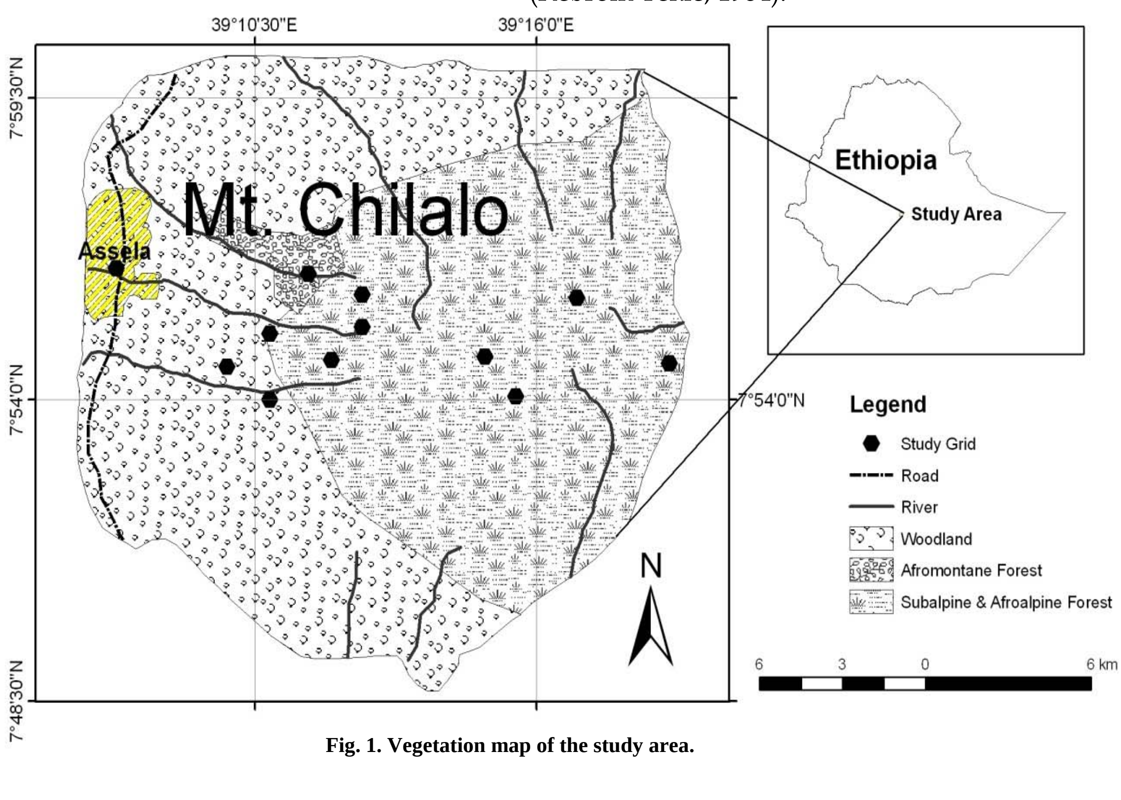

Fig. 1. Vegetation map of the study area.

The mean annual temperature and rainfall of Mount Chilalo vary depending on altitude. Areas > 3,300 masl have annual mean temperature less than 10°C while areas <3,300 masl show ranges from 10 to 15°C. During the dry season, diurnal temperature is high and at night, it is low (Alemayehu Mengistu, 1975). Mount Chilalo experiences eight months of rainfall commencing from March and extending until November with the highest rainfall concentration during June - August. The annual rainfall ranges from 800 to 2,000 mm (APEDO and ABRDP, 2004).

Mount Chilalo is characterized by three vegetation zones at different altitudes although it is dominated by ericaceous and Afroalpine vegetation (Hedberg, 1951). These are the mixed montane forest (2,300–3,100 masl), ericaceous forest zone (3,100–3,900 masl) and the Afroalpine vegetation (3,300–4,200 masl) (Alemayehu Mengistu, 1975; APEDO and ABRDP, 2004). The mountain is one of the Afrotropical biodiversity hotspots areas. Most people who reside on the slopes of Mount Chilalo are engaged in mixed farming, although farmers who live near ericaceous zone are more inclined to animal rearing than crop production. At present, local people are causing a great negative impact on the habitat (Gottelli and Sillero-Zubiri, 1992; Malcolm and Sillero-Zubiri, 1997). Thus, the area needs urgent conservation action to maintain it.

Methods

During the preliminary survey, all the available and relevant information such as climatic condition, topography, size of the area, vegetation and habitat types were gathered. Based on the different vegetation types and altitudinal ranges, six representative habitat types were identified. In these habitats, eight grids were randomly selected representing different habitats. The grid number in each habitat depended on the size of the habitat. The six selected representative habitats are: Afroalpine grassland with short *Erica* scrub, bush land, *Erica* forest, grassland, montane forest and moor land. The same grid was used for both dry and wet seasons.

Data collection was undertaken from August 2007 to April 2008, covering both wet and dry seasons. Data were collected twice for each season. Each data collection session was named by Roman numbers I, II, III and IV. I and II data collection sessions were during the wet season (August to October), whereas III and IV sessions were during the dry season (November to March). Collapsible Aluminum Sherman live traps and snap traps were used for trapping rodents. A total of 49 Sherman live-traps were set per square grid (70 m x 70 m) at 10 m interval. In addition, 20 snap traps at least 200 m away from each of the live-trapping grids were set at 20 m intervals. Snap trapping was also carried whenever unique habitats were encountered. Traps were baited with peanut butter mixed with roasted barley flour and replenished daily. Trapping was conducted for three consecutive days. Traps were usually checked twice a day early in the morning (7:00 to 9:00 h.) and late in the afternoon (16:30 to 18:30 h.).

Live-trapped rodents were removed and placed in a polythene bag to gather information on weight, sex, approximate age (juvenile, sub-adult, adult) and reproductive conditions. Approximate age was determined by their weight and pelage colour and the reproductive condition for females (closed or perforated vagina) and for males, the position and size of testes (scrotal or abdominal) were used (Taylor and Green, 1976; Afework Bekele, 1996; Tilaye Wube, 1999). Live trapped animals were toe clipped before release. In the same way, the snap trapped rodents were removed as soon as possible for collection of data on species (weight, sex, approximate age, reproductive condition, and standard body measurements). All snap-trapped pregnant females were dissected for embryo count. Skin and skull voucher specimens were prepared for species identification and deposited at the Zoological Natural History Museum, Addis Ababa University. All the trapped animals were identified to species level by using the taxonomic characters listed in Kingdon (1974; 2004), Yalden *et al.* (1976), Afework Bekele (1996) and Nowak (1999) and by comparing with specimens in the Zoological Natural History Museum, Addis Ababa University and Bale Mountains National Park Museum.

SPSS Version 13.0 statistical program, PAST version 1.62 Statistical Package (Software) and appropriate statistical methods such as Chi-square test were used to compare seasonal variation in species composition, relative abundance and habitat association, age and sex ratio and reproductive condition. The number of caught individuals and total number of trap nights were used to work out the trap success. The mean trap success is used for habitats that have more than two grids (grassland and montane forest) to ease the comparison with other habits. For biomass computation, the population size of each rodent species and the mean of adult weight were used. The population size in each habitat was estimated from the data on the capture-recapture following Jolly-Seber capture-recapture techniques. Then mean weight of each adult species was multiplied with the total estimated population in the habitat and season.

RESULTS

A total of 1,756 individuals were captured, of which 985 (56.1%) were trapped during the wet season and 771 (43.9%) during the dry season (Table 1). The difference in abundance of rodents between seasons was statistically significant (χ^2 =26.08, df=1, P<0.05). The species composition for the wet and dry seasons was 9 and 10, respectively. This was not statistically significant (χ^2 =0.05, df=1, P>0.05). *Mus mahomet* was trapped only during the dry season. *Lophuromys flavopunctatus* was the most abundant species (25.7%) followed by *Stenocephalemys albipes* (21.6%). Additionally, two species namely, *Arvicanthis dembeensis* and *Rattus rattus* were trapped by snap traps during both seasons.

Lophuromys flavopunctatus had the highest number of adult animal and all other age groups (sub-adult and young) were represented in the trapped populations. The total number of adult, sub-adult and young among the captured individuals was: 1,459 (83.1%), 220 (12.5%) and 77 (4.4%), respectively (Table 2). The proportion in age distribution was significantly different (χ^2 =1,973.52, df =2, P<0.05).

The proportion of age group varied from species to species and from season to season. Out of the 1,459 adult individuals, *L. flavopunctatus* had the highest number of adult animals (186) whereas *M. mahomet* had only one adult. A total of 34 and 43 young, 96 and 124 sub- adult, and 855 and 604 adult individuals were captured during the wet and dry seasons, respectively (Table 2). However, the seasonal variation in the total capture of sub-adult and young was not statistically significant (χ^2 = 3.56, df = 1, P>0.05, and χ^2 =1.05, df = 1, P>0.05, respectively). On the other hand, seasonal variation between adults was statistically significant (χ^2 = 43.18, df = 1, P<0.05).

Table 1. Species composition and abundance of live-trapped rodents at different seasons.

Species	Seasons				Total (%)
	Wet		Dry		
	I	II	III	IV	
L. flavopunctatus	137	121	106	88	452(25.7)
S. albipes	113	99	87	81	380(21.6)
A. blicki	55	60	57	61	233(13.3)
L. melanonyx	50	55	53	49	207(11.8)
S. albocaudata	42	40	38	39	159(9.1)
S. griseicauda	54	51	35	7	147(8.4)
O. typus	30	32	18	14	94(5.4)
M. natalensis	22	8	21	9	60(3.4)
A. abyssinicus	5	11	3	4	23(1.3)
M. mahomet	-	-	1	-	1(0.06)
Total/Session	508	477	419	352	1,756
Mean/Season	493		386		
Percent	56.09		43.91		100
No. of species	9		10		

(I, II, III, IV – shows trapping sessions) (*A. dembeensis* and *R. rattus* were only snap trapped.)

Table 2. Sex and age distribution of live-trapped rodents during wet and dry seasons.

Species	Season												Total Sex	
	Wet						Dry							
	M			F			M			F				
	A	Sa	Y	A	Sa	Y	A	Sa	Y	A	Sa	Y	M	F
Lf	85	24	12	101	30	6	71	24	11	58	26	4	227	225
Stal	95	11	5	84	8	9	58	17	8	56	20	9	194	186
Ab	60	4	-	50	1	-	58	4	-	54	2	-	126	107
Lm	47	3	-	52	3	-	48	1	-	42	9	2	99	108
Sta	43	-	-	38	1	-	30	2	2	35	8	-	77	82
Stg	49	1	-	52	3	-	17	5	2	15	2	1	74	73
Ot	25	3	-	34	-	-	11	1	1	18	0	1	41	53
Mn	13	-	1	13	3	-	9	2	2	16	1	-	27	33
Aa	4	-	-	10	1	1	5	-	-	2	0	-	9	14
Mm	-	-	-	-	-	-		-	-	1	0	-	-	1
Total	421	46	18	434	50	16	307	56	26	297	68	17	874	882
(%)	24.0	2.6	1.0	24.7	2.8	0.9	17.5	3.2	1.5	16.9	3.9	1.0	49.8	50.2

(A = adult, Sa = sub-adult, Y = young; Lf = *L. flavopunctatus*, Stal = *S. albipes*, Ab = *A. blicki*, Lm = *L. melanonyx*, Sta = *S. Albocaudata,* Stg = *S. griseicauda*, Ot = *O. typus*, Mn = *M. natalensis*, Aa = *A. abyssinicus*, Mm = *M. mahomet*; (-) = shows absence of trapped individuals)

Among the live-trapped rodents, males comprised 49.8% (874) and females 50.2% (882) (Table 2). The overall variation in the sex ratio was not statistically significant (χ^2 = 0.04, df = 1, P>0.05). The number of males captured during the wet and dry seasons was 485 and 389 while the females trapped were 500 and 382, respectively (Table 2). The difference between captured males and females with respect to wet and dry seasons was statistically significant (χ^2 = 10.54, df = 1, P<0.05) for males and (χ^2 = 15.78, df = 1, P<0.05) for females. The sex distribution of each species is shown in Figure 2.

Out of the 882 trapped females, 734 (83.2%) were perforate and 148 (16.8%) were non-perforate. Out of the perforate females, 368 were pregnant or lactating and 366 were impregnated. Among the males, 732 and 142 had scrotal and inguinal testes, respectively. During the wet and dry seasons, 425 and 307 males had scrotal and 60 and 80 inguinal, respectively (Table 3). The seasonal variation of scrotal males and pregnant females was statistically significant (χ^2=19.02, df=1, P<0.05 and χ^2=100.17, df=1, P<0.05) respectively.

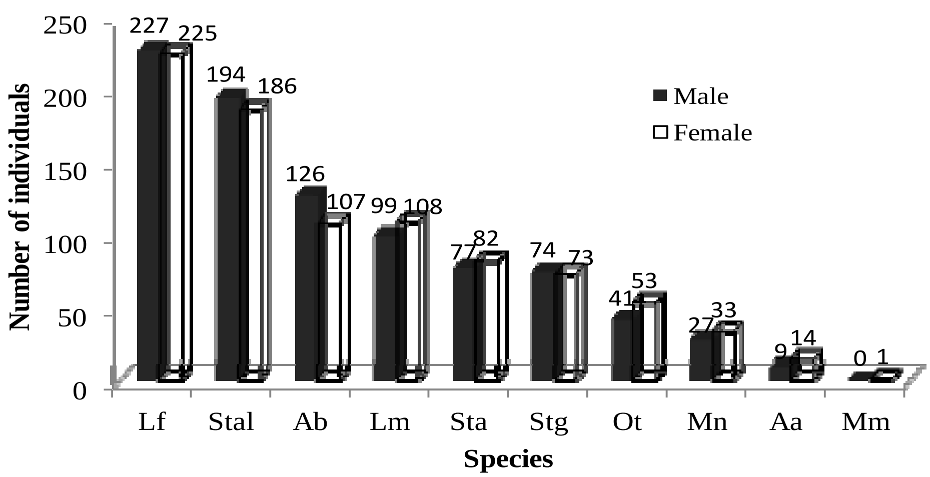

Fig. 2. Sex **distribution of different rodent species captured (Lf =** ***L. flavopunctatus*****, Stal =** ***S. albipes*****, Ab =** ***A. blicki*****, Lm =** ***L. melanonyx*****, Sta =** ***S. Albocaudata*****, Stg =** ***S. griseicauda*****, Ot =** ***O. typus*****, Mn =** ***M. natalensis*****, Aa =** ***A. abyssinicus*****, and Mm =** ***M. mahomet*****).**

The highest mean biomass was recorded from the grassland habitat (55,567g/ha). It accounted for 47.3% of the total biomass. The second habitat with highest mean biomass was montane forest (18,177g/ha), followed by *Erica* forest (12,828g/ha), bush land (12,206g/ha), Afroalpine grassland with short *Erica* scrub (9,277g/ha) and moor land (9,231g/ha) (Table 4).

Arvicanthis blicki accounted for the highest share of biomass with 26,036g/ha and 26,700g/ha for wet and dry seasons, respectively. Although, *L. flavopunctatus* was more abundant than *A. blicki*, it had a lower biomass (24,343g/ha wet season and 18,280g/ha dry season). The least biomass was obtained for *M. mahomet*. It had 20g/ha in the montane forest habitat during the dry season (Table 4).

The overall captures made during the 4,700 trap nights in the extensive study grids were 2,074 individuals. Although trapping success varied between habitats and seasons, the overall trapping success was 44.1%. The total captures during the wet and dry seasons were 1,107 and 967, respectively. The trap success was 47.1% during the wet and 41.1% the dry season (Table 5). The overall trap success between wet and dry seasons was significantly different (χ^2= 9.45, df = 1, P<0.05).

Grassland habitat had the highest mean trapping success (56.1%) whereas moor land had the lowest (21.4%). Mean trap success for montane forest was 55.4%. Trap success for bush land, *Erica* forest and Afroalpine grassland was 47.1%, 36.4% and 24.7%, respectively.

Table 3. Reproductive conditions of live-trapped rodents at different seasons.

Season	Male		Female			Total
			Perforate			
	Scrotal	Inguinal	Pregnant/lactating	Impregnated	Non-perforate	
Wet	425	60	280	156	64	985
Dry	307	82	88	210	84	771
Total	732	142	368	366	148	1,756
(%)	41.7	8.1	21	20.8	8.4	100

Table 4. Biomass (g/ha) of each live-trapped species of rodents from different habitats during wet and dry seasons. Figures in bracket represent individuals per hectare.

Weight of species (g)	Seasons	Habitats						Total
		GL	MF	EF	BL	AG	ML	
Lf	Wet	1805 (39)	12264(265)	3286(71)	4350(94)	1527(33)	1111(24)	24343
(46.28)	Dry	2545(55)	9904(214)	1897(41)	2823(61)	278(6)	833(18)	18280
Stal	Wet	-	1449(29)	-	7446(149)	-	-	8895
(49.97)	Dry	-	1349(27)	-	6346(127)	-	-	7695
Ab	Wet	26036(235)	-	-	-	-	-	26036
(110.79)	Dry	26700(241)	-	-	-	-	-	26700
Lm	Wet	13022(173)	-	-	-	-	3086(41)	16108
(75.27)	Dry	12570(167)	-	-	-	-	3086(41)	15656
Sta	Wet	11504(92)	-	-	-	4626(37)	4877(39)	21007
(125.04)	Dry	13504(108)	-	-	-	2751(22)	3376(27)	19631
Stg	Wet	-	1288(16)	11829(147)	-	2816(35)	1288(16)	17221
(80.47)	Dry	-	644(8)	4104(51)	-	1288(16)	805(10)	6841
Ot	Wet	-	4712(55)	3855(45)	-	2313(27)	-	10880
(85.67)	Dry	-	1885(22)	685(8)	-	2998(35)	-	5568
Mn	Wet	-	1470(29)	-	1673(33)	-	-	3143
(50.70)	Dry	-	1369(27)	-	1774(35)	-	-	3143
Aa	Wet	2337(33)	-	-	-	-	-	2337
(70.81)	Dry	991(14)	-	-	-	-	-	991
Mm	Wet	-	-	-	-	-	-	-
(10)	Dry	-	20(2)	-	-	-	-	20
Mean for wet and dry season		55507	18177	12828	12206	9299	9231	**117248**

(GL = grassland, MF = montane forest, BL = bush land, EF = *Erica* forest, ML = moor land, AG = Afroalpine grassland;
Lf = *L. flavopunctatus*, Stal = *S. albipes*, Ab = *A. blicki*, Lm = *L. melanonyx*, Sta = *S. Albocaudata*, Stg = *S. griseicauda*,
Ot = *O. typus*, Mn = *Mastomys natalensis*, Aa = *A. abyssinicus*, and Mm = *M. mahomet* and (-) = absence of weighed biomass.

Table 5. Trap success from different habitats and seasons.

Habitat	Grid	Trap night	Wet season			Dry season			Total	% Trap success
			Ro	Sh	Rec	Ro	Sh	Rec		
GL	ChE_7	588	140	0	21	144	0	24	329	56.0
	ChE_8	588	140	0	22	143	0	26	331	56.3
MF	ChE_2	588	147	0	10	131	0	34	322	54.8
	ChE_3	588	171	6	13	109	6	25	330	56.1
BL	ChE_1	588	135	3	13	109	1	16	277	47.1
EF	ChE_4	588	129	6	7	49	14	9	214	36.4
AG	ChE_5	588	64	9	7	39	16	10	145	24.7
ML	ChE_6	588	59	1	4	47	3	12	126	21.4
Total/Average		4,704	985	25	97	771	40	156	2,074	44.1

(GL = grassland, MF = montane forest, BL = bush land, EF= *Erica* forest, ML= moor land, AG = Afroalpine grassland, Ro = newly captured rodents, Sh = shrews, Rec = recaptures)

Out of the 120 adult females trapped, 51 (27%) were pregnant while others were lactating or did not show any sign of pregnancy. From the 12 species captured by snap traps, pregnant females of *A. dembeensis*, *R. rattus* and *M. mahomet* were not represented. The number of embryos of pregnant females varied from species to species. Even within the same species, there was also seasonal variation. The number of embryos implanted in left and right horns showed variations within the same species. The left horn embryo implantation was higher than that of the right horn in many species. However, the variation in embryo implantation between the horns was not statistically significant ($\chi^2 = 0.116$, df = 1, P>0.05). A maximum number of 15 embryos were counted for *M. natalensis,* whereas the least (1) was for *O. typus*. The seasonal variation in the number of embryos was statistically significant ($\chi^2 = 1.181$, df = 1, P<0.05). Most of the pregnant females were trapped during the wet season. The number of embryos in pregnant females is given in Table 6.

Table 6. Number of embryos of pregnant females (Mean ± SD)

Species	*No. of pregnant females*	*No. of embryos per season*		*Mean ± SD*
		Wet	Dry	
S. albipes	13	2–6	2–6	5.2 ± 1.4
L. flavopunctatus	10	2–4	2–4	3.3 ± 1.0
S. griseicauda	9	2–4	2–4	3.2 ± 1.2
A. blicki	6	1– 4	1–6	4.0 ± 1.3
S. albocaudata	5	1–4	2–3	2.0 ± 1.0
L. melanonyx	4	1–4	1–3	2.5 ± 1.2
M. natalensis	2	12	15	13.5 ± 2.1
A. abyssinicus	1	-	3	3
O. typus	1	-	2	2

DISCUSSION

In the present study, there was a significant seasonal variation in abundance of rodents. This variation might be due to changes in food availability, cover and reproductive conditions. The effect of habitat change varied among species (Emmons, 1984; Pahl *et al*., 1988). Some animals might be specialists on a particular vegetation type. The number of individuals trapped decreased from wet to dry seasons. Some of the reasons for this fluctuation might be vegetation cover, food and water sources, reproductive condition, migration and death due to burning of the *Erica*.

Although the higher altitude part of Mount Chilalo is reserved as a state forest, there is frequent *Erica* burning for different purposes such as: for the use of burnt heather stick for domestic or commercial fuel wood, to facilitate the growth of new grass shoots for livestock and for fear of predators to make the grazing area open. In addition to burning of the *Erica,* there is a high deforestation of remnant forests for settlement, agriculture and construction. Thus, absence or reduction of capture of rodents in many habitats during the dry season, just after burning of the *Erica,* revealed the effect of burning. In addition to this, the capture rate was very low in the previously burnt *Erica* habitats. This shows that the effect of *Erica* burning lasts for many months. The decline of individuals trapped might be due to the drying of herbaceous vegetation that serves as food and cover. Previous studies noted that abundance and habitat preference of rodents are positively correlated with vegetation cover and heterogeneity, availability of food and water resources, and reproductive conditions of the species (Afework Bekele *et al*., 2003; Agerie Addisu, 2007; Demeke Datiko *et al*, 2008).

Except for *M. mahomet*, all age groups were represented in all trapping sessions. There was also a significant seasonal variation among the age groups. This might be due to species showing seasonality in reproduction. The record of all age groups in the population implies that they reproduce throughout the year. If reproduction is seasonal, it is expected that all age groups appear only during the specific season (Tadesse Habtamu and Afework Bekele, 2008). For most species, there was a positive correlation between rainfall and seasonality in reproduction. As the study area experiences a prolonged period of rainfall, all age groups were captured during both seasons. In this respect, the present result agrees with the findings of Taylor and Green (1976), Happold and Happold (1991), Afework Bekele and Leirs (1997), Tsegaye Gadisa and Afework Bekele (2006).

Similar to the previous studies by Demeke Datiko *et al.* (2008), adults dominated among the age groups. The higher proportion of adults during the wet season than the dry season might be due to the addition of juveniles and sub-adults born during the wet season. As described by Happold and Happold (1991), as young population increases, the proportion of adults increases, during the most next dry season. The present study showed that the proportion of pregnant or lactating females and scrotal males was higher during the wet season. This indicates that the reproductive period of most rodents was during the wet season. Rainfall affects reproductive activity indirectly by influencing the vegetation growth to be used for food and shelter. The present result is in agreement with previous studies on the breeding patterns of rodents (Delany and Happold, 1979; Happold and Happold, 1991; Afework Bekele, 1996).

In the present study, the total biomass obtained during the study period was 233,475g/ha. The total biomass was dissimilar for different habitats; it ranged from 110,294 in the grassland to 18,462g/ha in the moor land habitat. The seasonal variation in biomass was associated with the availability of food, cover and abundance of rodents and the burning of *Erica*. Biomass recorded from *Erica* forest habitat showed highest seasonal variation as a result of burning. From this habitat, the capture rate was nil just after burn. In the study area, the biomass for *A. blicki* was highest although it was relatively less abundant than *L. flavopunctatus*. This highest biomass with low abundance is attributed to the large body size of *A. blicki* compared to *L. flavopunctatus*. The total biomass obtained in the present study is greater than the total biomass obtained in different parts of Ethiopia. For instance, Agerie Addisu (2007) obtained a total biomass of 43,326.2g/ha from Alage, Ziway, south Ethiopia.

Trap success varied between habitats and seasons. The variation in trap success could be due to factors such as rainfall, food availability, and activities of animals, cover, trap shyness and habitat type (Smith and Blessing, 1969; Sidorowicz, 1974; George, 1984; Kotler, 1984; Sillero-Zubiri *et al*., 1995). The record of highest trap success from grassland habitat was due to high abundance of rodents, capture of two individuals by single trap, and the gregarious life style of rodents in the habitat. The highest seasonal variation in the trap success was recorded from *Erica* forest due to the *Erica* burning. The overall trap success obtained in the present study area was high when compared with pervious studies carried out in different parts of Ethiopia. For example, Rupp (1980) recorded 35% trap success from the Bale Mountains; Yalden (1988a) recorded 24–27% trap success from Harrena Forest; Afework Bekele (1996) recorded 3.5–16% trap success from Menagesha State Forest; Tadesse Habtamu and Afework Bekele (2008) recorded 38.6% trap success from Alatish Proposed National Park; Demeke Datiko *et al*. (2008) recorded 17.6% trap success from Arba Minch Forest and Farmlands and Agerie Addisu (2007) recorded 29.1% trap success from Alage, Ziway, southern Ethiopia.

Among the snap-trapped rodents, there was seasonal weight variation. The highest mean body weight was recorded for *S. albocaudata*. The least was measured for *M. mahomet*. The second species that had the highest mean body weight was *A. blicki*. In general, their mean body measurement agrees with the characters described by Kingdon (1974; 2004), Yalden *et al.* (1976), Yalden (1988b) and Nowak (1999).

The number of embryos among pregnant females varied between species and seasons as well. Taylor and Green (1976) also revealed similar results. There was also positional difference in embryo implantation as obtained by Afework Bekele (1996). The maximum number of embryo counted for *M. natalensis* was 15 during the wet season from bush land habitats. The high number of records of embryo during the wet season compared to the dry season might be associated with the availability of food and cover. The most common feature of most rodent breeding patterns is that they prefer a season in which rich food is available. As rainfall is seasonal, the availability of food varies. Thus, the present result is consistent with the study that relates breeding patterns to rainfall (Sicard and Fuminier, 1996). Ghobrial and Hodieb (1982) noted that females exposed to high temperature had prolonged pregnancies and produce fewer embryos. Most of the pregnant females trapped during the wet season had a mean number of embryos in line with similar studies undertaken by different researchers (Ghobrial and Hodieb, 1982; Afework Bekele, 1996; Afework Bekele and Leirs, 1997).

CONCLUSION

In conclusion, the seasonal population dynamics of rodents in different habitats and seasons indicated that there were no significant seasonal variations in species composition, sex ratio and the age distribution between young and subadults (except adults). However, a significant seasonal variation was observed in trap success of rodents, as it is mostly affected by *Erica* burning. The trapped rodent species show that 60% are endemic to the country indicating that the area possesses high stock of endemicity. In addition, Mount Chilalo is one of the Arsi highland massifs that is the second suitable area for the endangered Ethiopian wolf and it is a part of the Eastern Afromontane biodiversity hotspot. Furthermore, the agricultural field extension to higher altitudes and the presence of good quality of grass for livestock grazing in Chalalaka and on the top of Mount Chilalo were the main reasons for disturbance of the ecosystem. Therefore, to maintain the habitat and the rodent species, urgent conservation action and further detailed studies on fauna and flora should be carried out.

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