TEMPORAL AND SPATIAL ABUNDANCE OF AFROALPINE RODENTS OF THE BALE MOUNTAINS NATIONAL PARK

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By

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ABSTRACT

This study addresses the current relative and/or absolute abundance of the rodent guild in the Aforalpine belt (3400-4200 m asl) of the Bale Mountains National Park (BMNP). These rodents form the prey base for the critically endangered Ethiopia wolf. Hence, density assessment of these rodents is conceivably indispensable, as pertinent data are lacking since about a decade.

The data collecting technique had three components; namely, direct molerats observation, snap-trapping and live-trapping. All the three components of the technique were applied to each of the three representative study sites: Lower Web Valley, Upper Web Valley and the Sanetti Plateau, during the wet and dry seasons.

Accordingly, density of Tachyoryctes macrocephalus was 6-10/ha. The common species of murid rodents within all the three areas of the Afroalpine belt were: Lophuromys melanonyx 35.5% (18-48/ha), Stenocephalemys albocaudata 34.1% and Arvicanthis blicki 28.6% (12-48/ha) with percent trap success of 14.0, 13.4 and 11.3, respectively. The least abundant species were L. flavopunctatus and S. griseicauda constituting 0.6% and 1.2% of the total murids, respectivly. Percent trap success of L. flavopunctatus was 0.2, whereas S. griseicauda had 0.5.

The relative densities of the murid rodents were thus, firmly underpinned by percent trap success and absolute densities. Generally, the wet season and higher altitudes represented greater densities, in contrast to the dry season and the lower altitudes for both the rhizomyid and murid rodents in the BMNP.

INTRODUCTION

Rodents constitute the most diverse group of mammals comprising over 40% of the extant mammalian species (Nowak, 1991). On the basis of the nature of the masseter jaw muscles and associated skull features, the order to which they belong (Rodentia) is grouped into 3 suborders; namely, Sciuromorpha, **Myomorpha** and Hystricomorpha (Lawlor, 1979). Most of the 1814 total number of rodent species, belong to the suborder Myomorpha (Walker, 1975). For instance, family Muridae (that contains rats and mice alone makes one-sixth of all species of mammals (Lawlor, 1979).

In Ethiopia, there are about 280 mammalian species, of which 70 are rodents (Afework Bekele *et al.* 1997). Hence, rodents constitute 25% of the entire mammalian species, in this country. For example, the Bale Mountains National Park (BMNP) alone is inhabited by more than 14 different species of rodents (Yalden & Largen, 1992).

Hence, in the BMNP alone, more than 20% of the total rodent species of this country coexist. Ten of the 14 species are endemic to Ethiopia (Yalden & Largen, 1992). In fact, such species coexistence does not provide a test to Gause's competitive exclusion principle, because so long as two or more species are different species, they are almost inevitably going to occupy different niches (Chapman & Reiss, 1999).

Four of the 10 endemic species that are confined to areas above 3000 m asl are *Tachyoryctes macrocephalus, Lophuromys melanonyx, Stenocephalemys albocudata* and *Megadendromus nikolausi.* The remaining six endemic species extend further up into areas higher than 3000 m asl. These rodents are *Arvicanthis blicki, Dendromus lovati,* *Myomys albipes, Myomys ruppi, Mus mahomet and Stenocephalemys griseicauda* (Sillero-Zubri, 1994). All of these species belong to Family Muridae except *T. macrocephalus*

The four non-endemic species that are also found above above 3000 m asl are *T spendens, Otomys typus, L. flavopanctatus and A. abyssinicus* (Yalden *et al.*, 1992). In the BMNP, three of the above-mentioned rodents characterize the montane grassland. These rodents are: *L. flavopanctatus. S. griseicauda* and *O. typus.* Furthermore, among the above-mentioned rodents, the three species that characterize the Afroalpine belt of the BMNP are: *A. blicki, L. melanonyx* and *S. albocaudata.*

A dozen of the rodent species are notorious for their troublesome nature to man. For instance, they consume human food, dismantle infrastructures and spread diseases (Weber, 1982; Leirs, 1995), Paradoxically enough, the point of concern about rodents of BMNP is how to exercise conservation strategy for their welfare. This is because rodent communities in the Bale Mountains form the prey base for the critically endangered Ethiopian wolf (*Canis simensis*) (Sillero-Zubiri, 1994). Studies indicate that 95.8% of the wolf's diet is composed of four rodents, namely, *T. macrocephalus. A. blick, L. melanonyx* and *O. typus* (Gottelli & Sillero-Zubiri, 1990).

Hence, the ongoing increase in the density of livestock and the progressive encroachment into the Afroalpine habitats will in the long-term pose a detrimental effect on the rodents. This is evident as the ultimate effect of competition on individuals is a decreased contribution to the next generation compared with what would have happened had there been no competitors (Begon *et al*., 1996). As a result, decrease in the rodent guild density, couples inevitably lessening of the number of Ethiopian wolves.

Therefore, unless, the current trend in BMNP is reversed, as the number of Ethiopian wolves is already alarmingly small, progressive decrease in the density of the rodent guild will result in the extinction of *C. simensis.*

Assessing, therefore, the current abundance of the rodent communities in the BMNP aids the taking of pre-emptive measures in forestalling further deteriorations of the Afroalpine ecosystem. This attempt rescues the wolf and promotes the life of a host of raptors in the area. As a matter of fact information on the abundance of these rodents has been sketchy until Yalden (1988) and Sillero-Zubiri (1994). Since then, as well, ample information on the point in question has been lacking.

The present study is thus aimed to describe the abundance of rodents both temporally and spatially in the BMNP (Lower Web Valley, Sanetti Plateau and Upper Web Valley).

2. The Study Area

The study area is the Bale Mountains Notional Park (6° 30' – 7° 0' N and 39° 30' - 39° 55' E). The area is located in the southeastern highland of Ethiopia, along the eastern edge of the Rift Valley. EMNP has an area of 2,470 km^2 with elevations ranging from 2,900 m to 4,300 m asl (Hillman 1986). Its headquarters and research station is situated at Dinsho, a town north of the area, 400 km by road from the metropolis, Addis Ababa.

The study sites are within the Afroalpine belt of the BMNP. Afroalpine habitats are characterized by short sparse vegetation with heavy frosts and low rainfall. The Bale Mountains contain the largest Afroalpine belt in Africa and the park was established in 1969 mainly to protect the mountain nyala (*Tragelaphus buxtoni*) and the Ethiopian wolf (*C. simensis*) (Sillero-Zubiri, 1994). The actual representative study sites were Upper Web Valley (UW) (3645 m asl), Lower Web Valley (LW) (3,450 m asl) and Sanetti Plateau (SP) 3,800 m asl,) including Tullu Deemtu (4377 m asl) (Fig. 1 and 2)

The climate varies in different areas depending on altitude. However, normally the rainfall occurs during a single block of eight months (March through October) constituting the rainy season (Daniel Gamachu, 1977). This rainy season is followed by another single block of four months of dry season (November though February) (Daniel Gamachu, 1977).

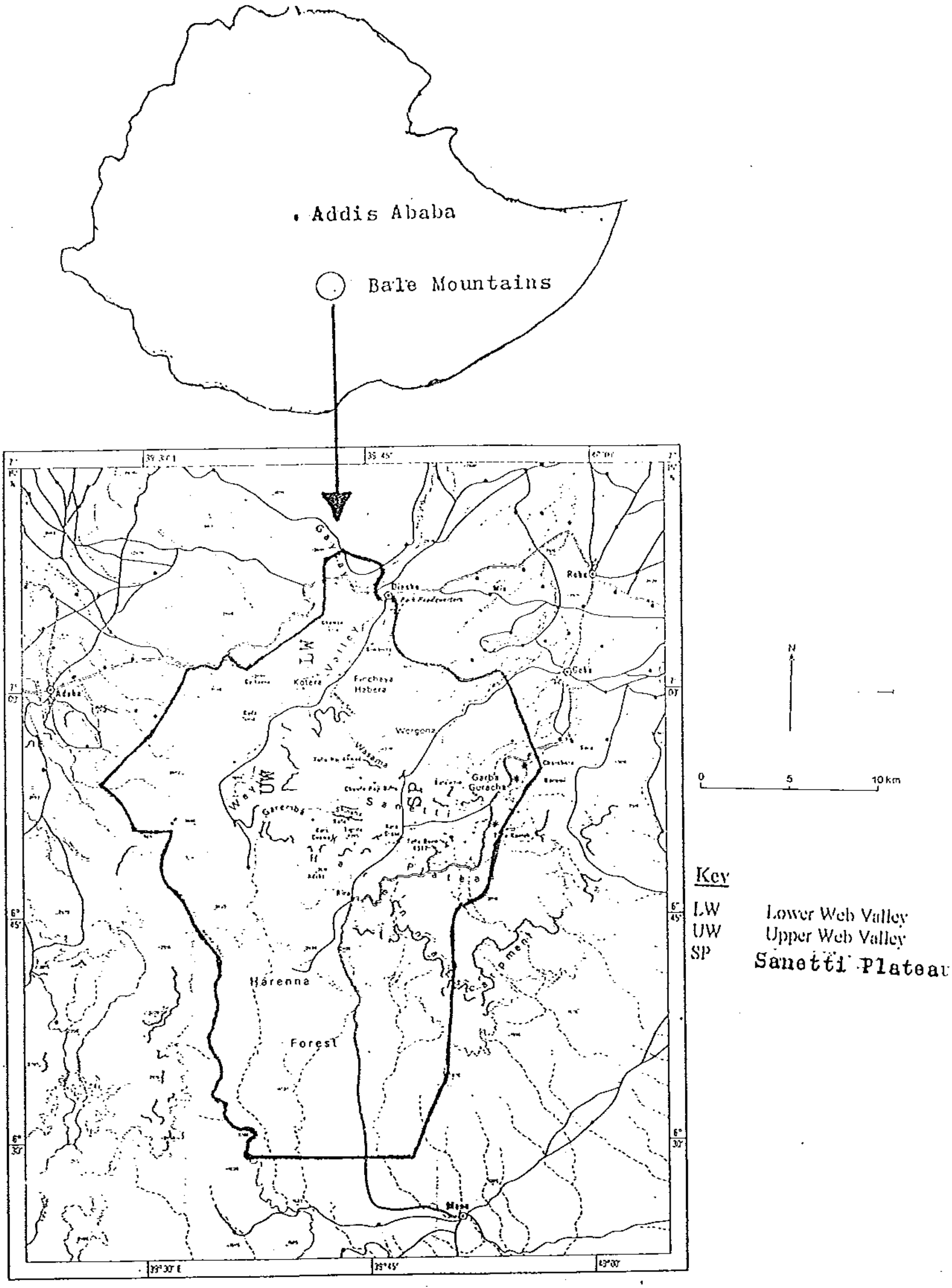
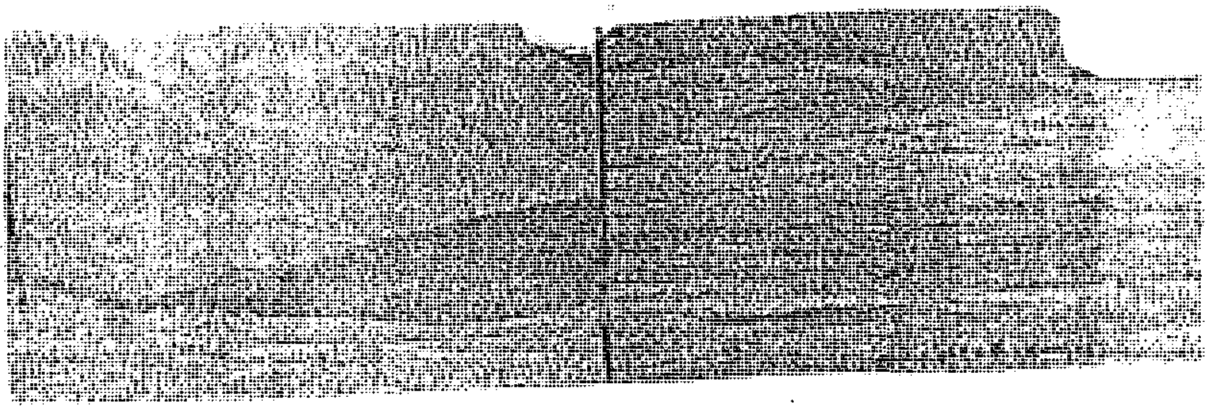
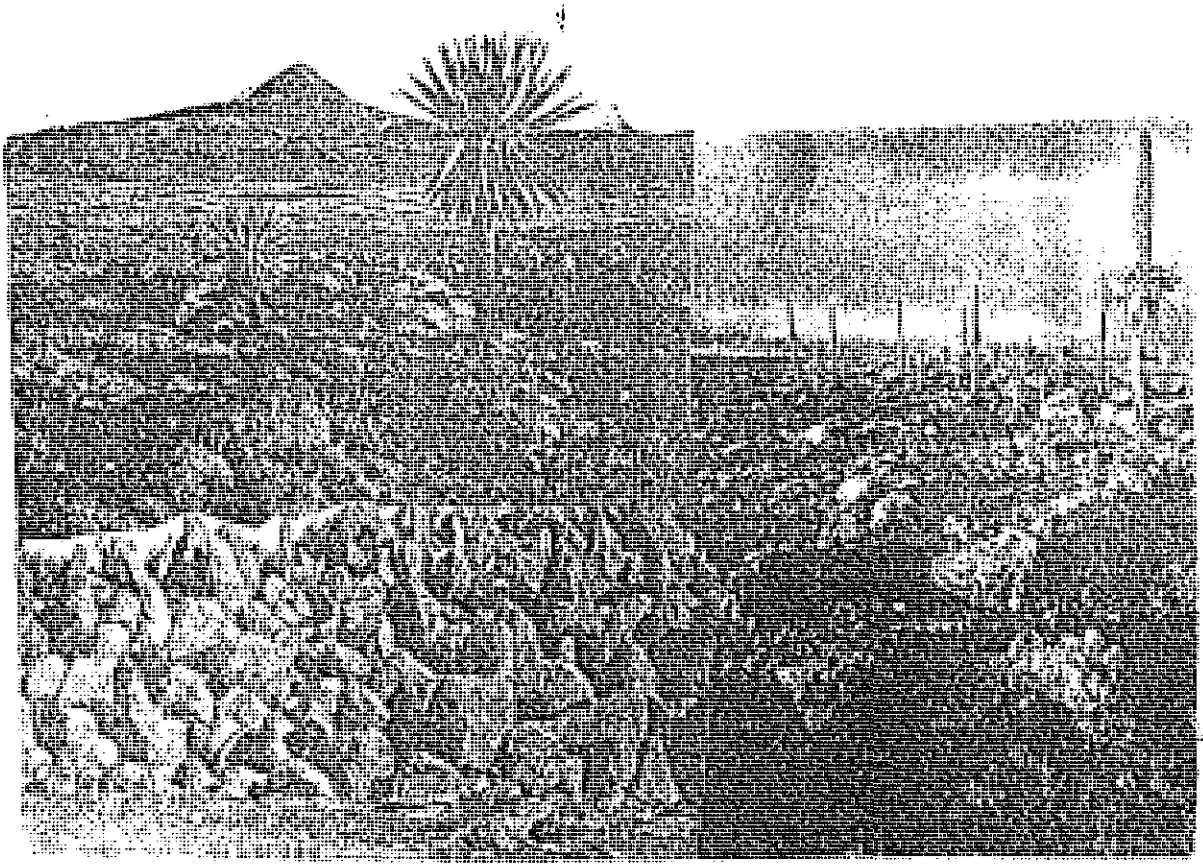


Figure 1. Location Map of the Bale Mountains National Park and the study sites



Lower Web Valley

Upper Web Valley



Sanetti Plateau

Figure 2. Representative sites of the study area

3. Materials and Methods

The study was undertaken during five months' period, starting from October 2002 until February 2003, covering both the wet and dry seasons. October and November, 2002 as period of the wet season, whereas, December 2002, January and February 2003 was a duration of the dry season.

Within each of the representative study sites, the study comprised three techniques: namely, Molerat live observation, Snap trapping and Capture Mark Recapture (CMR). Data collection was carried out in the habitats of all of the study sites during both the rainy and dry seasons. In all cases, survey on the vegetation has been carried out.

3.1 Molerat Live Observation: A total of nineteen 50 m x 50 m plots were used. A given plot was bounded by a string of 200 m length tied up to a metal peg at each of the four corners. Location of the plot was determined through randomization bearing or compass direction, being 100 m or more away from both the live-trapping grid and the snap transects. The point of reference for the randomized bearing was the northwest corner of the live-trapping grid.

The number of observed plots during the wet season is three in LW, three in SP and two in UW study sites. However, during the dry season the number of observed plots is four in LW, three in SP and four in UW.

Each plot was scanned for two days with binoculars. The direct scanning ran for six hours per day starting at 10:00 in the morning and ending at 16:00 in the afternoon. The intermittent scanning was just for a while, being at the intervals of 10 minutes. The preference of timing is intended to coincide with the noticeable activities of the molerats (*T. macrocephalus*) (Sillero-Zubiri, 1994).

Data on rainfall, extent of cloud and degrees of wind were collected along with the scanning, for two days per plot. The observation sessions were designed to be simultaneous with the pre-baiting days of the trappings. The giant molerat population abundances of the three representative study sites, namely LW, UW and SP would be compared using the non-parametric test of Kruskal-Wallis, whose parametric test equivalent is the One-Way ANOVA. The dry and wet inter-seasonal population abundances of all the study sites were compared using the non-parametric test of Mann-Whitney U-test for which the equivalent parametric test is Variance Ratio (F- test).

3.2 Snap-trapping transects: A total of nineteen snap-trapping transects were executed. There were three transects in the habitats of LW per season. In SP four transects were employed during each the wet and dry seasons, respectively. However, for the habitats of the UW there were two and four transects for the rainy and dry seasons respectively.

Each transect stretched over a distance of 200 m having 20 kill rattraps. At every trap point, one such trap was assigned with 10 m of inter-trap spacing along the transect. Each trap was tied up to a wooden peg with a piece of string. It was pre-emptive measure to decrease, predictably the chance of trap disappearance along with its catch by carnivores including wolves and raptors as the pegs were hammered into the ground.

Pre-baiting for two days preceded the actual trapping session, which went on for three consecutive days per transect. It was performed for both day and night times. Baiting and its refreshment were preferred to be in the early morning, 6:30 to 7:00 a.m for the day time trapping and 6:30 to 7:00 p.m for the night-time trappings.

For the day time session, traps were monitored for clearance twice a day, around noon and late in the afternoon. However, for the night time trapping, there was a single clearance, just after dawn (6:00 to 7:00 a.m).

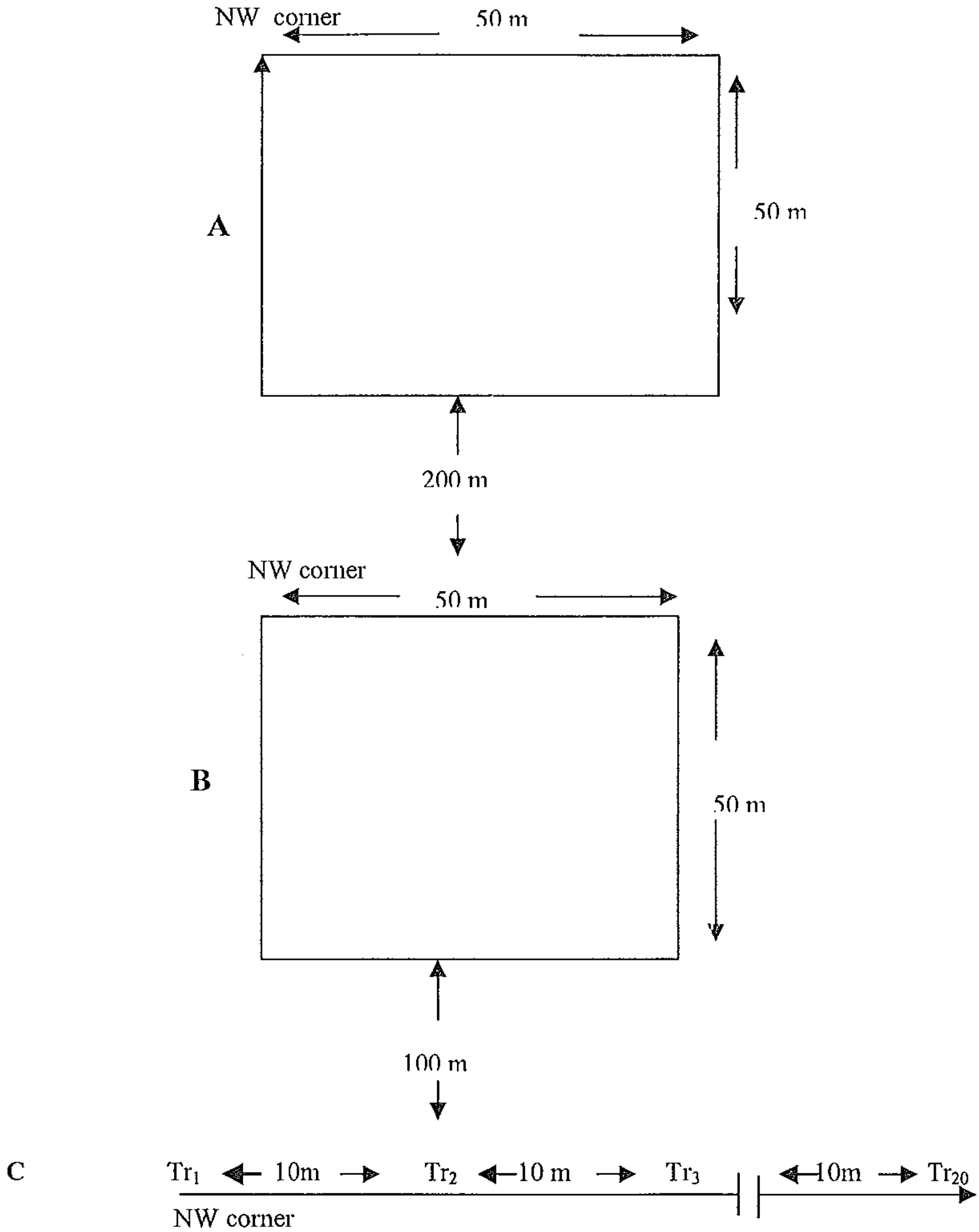


Figure 3. Generalized layout within a habitat of a given study site: A. Live-trapping grid with trap effective area B. Molerat observation plot and C. Snap-trapping transect with 'Tr' representing traps in the series. NW corners indicate the starting point in all cases.

The checking of sprung traps, the baiting and its renewal were kept running for the three solid days per transect and per habitat. Each time, just after clearance, the snap-trapped rodents were identified to the species level, weighed using Pesola spring balance, and sexed. The male to female sex ratios of each species are tested for checking the probable departure of the observed values from the hypothetical 0.50 (50%) value using the sample proportion for one population. Thus, the required information is included in the text.

The relative age of the catches was also determined as adult, subadult or juvenile. The age determination was a mere approximation and arbitrary. In addition, in males testes were noted as abdominal or distended. In females vagina, was noted as perforate or closed.

3.3 Live-trapping grids: Live-trappings were undertaken concurrently with snap-trappings throughout the study session. During the wet season, the number of executed grids was three, three and two in the habitats of LW, SP and UW, respectively. In the same manner, for the dry season, the number of performed grids was two, two and three in the habitats of LW, SP and UW, respectively. Thus, there were 15 live-trapping grids done in total, in all the study sites.

50 Sherman live-traps were employed per grid. The traps were placed at 10 m interval, with two such traps at a point. Hence, the grids exhibited 5 x 5 points occupying 40 m x 40 m areas. However, for the sake of population size estimation, the effective trap area is taken as 50 m x 50 m by adding up half the inter-trap distance to all the peripheral traps. This is to assign equal distance to all the traps involved in the grid. The starting position for the grids was designated as "north west corner" with "A_1" labeled traps (Fig. 4). The north east corner had "A_5" labeled traps. The labeling of the traps was to

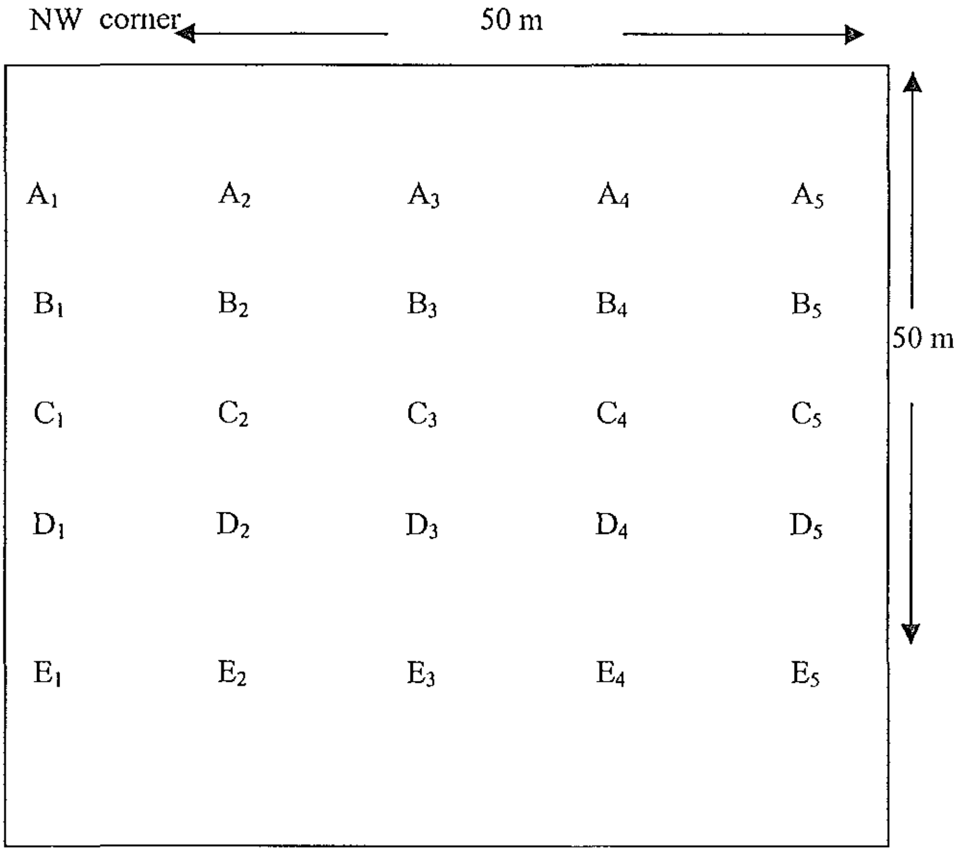


Figure 4. Labeling and placement of Sherman traps within the live-trapping grid. Each inter-trap distance is 10 m.

pinpoint which trap caught what, and at a given point the two traps were placed about 10 cm with their open-ends in an opposite direction.

The starting point (A_1) was maintained constant in all grids as the northwest corner. The northwest corner was used as a "reference point", in arranging the whole layout for molerat observation plot and the snap-trapping transect on the basis of randomized compass direction. There was a distance of 300 m between the grid and the snap-trapping transect.

In order to reduce trap shyness of rodents, pre-baiting was carried out for the first two days with a paste of peanut butter concocted with wheat or barely flour. During pre-baiting session, the traps were kept open being upside down to avoid catching of rodents. After the pre-baiting session, the traps were baited and set just in early morning, 6.40 to 7:10 a.m. The traps were kept closed over night to avoid the unnecessary death of catches,

Twice a day, the traps were monitored for clearance. The convenient time for clearing was both around noon and dusk. In all cases, trapping went on for three consecutive days, like in snap-trapping, the caught rats were identified to species level, weighed, sexed and were given relative age as adult, subadult or juvenile. Furthermore, for males, testes were checked and noted as abdominal or distended, In females, vaginas were noted as perforate or closed. In recaptures, only the clip markings were noted. Then the rodents were let go exactly at the point of catch. This is to minimize the degree of disturbance to them. On the sixth day, after starting the engagement, vegetation of the grid was surveyed.

In this case also abundances of the Afroalpine rodents of the three representative study sites are compared using the Kruskal-Wallis test for each species.

4. RESULTS

The work comprises three main components that stem from direct scanning of giant molerats, snap-trapping and live-trapping. Thus, the three complements of the results are sequentially presented to cover abundance of the giant molerats, relative abundance, sex and age distribution in each of the habitats and absolute abundance of the Afroalpine rodents. Incidentally, a hyphen (-) in tables indicates nil result.

4.1 Abundance of the giant molerats

Giant molerats were most abundant within the habitats of Sanetti Plateau (SP), with an observed mean of 2.5 $\pm$ 2.2 per plot and 10 individuals per hectare (Table 1). They are also plentiful within the habitats of Upper Web Valley (UW) only next to SP, with a mean density of 2.0 $\pm$ 1.1 and 8 individuals per hectare during the wet and dry seasons (Table 1).

Molerats were least abundant within the habitats of Lower Web Valley (L.W) with a mean density of 1.7 $\pm$ 1.5 per plot, having 6 individuals per hectare during the two seasons,

The population densities of giant molerats of all the three study sites do not show significant variation ($H= 0.7$, d.f. $= 2$, $p = 0.4$) from each other. However, they are not evenly distributed even within the habitats of a given study site (Table 2). Some of the habitats within each study site had nil population densities.

The highest population density was estimated during the wet season within the habitats of SP with observed mean of 3.0 $\pm$ 2.7 per plot and 12 individual per hectare (Table 3). The second highest density was also observed during the wet season with mean of 2.5 $\pm$ 0.7 per plot within the habitats of UW. The number of individuals is 10/ha for the second highest density.

The least molerats population density was also observed during the wet season with a mean of 1.0 $\pm$ 1.0 within the habitats of LW having 4 individuals per hectare (Table 3). Hence, in the estimated molerats population densities, there is no significant difference between the wet dry seasons ($n_1 = 8$, $n_2 = 11$, $p = 0.4$).

Table 1. Abundance of giant molerats in the habitats of Lower Web Valley (LW), Upper Web Valley (UW) and Sanetti Plateau (SP)

Study sites	Altitude (m)	Number of Samples (n)	Estimated population size	
			Mean ± SD/ plot	Individuals/ha
LW	3502 – 3695	7	1.7 ± 1.5	6
UW	3630 – 3862	6	2.0 ± 1.1	8
SP	4025 - 4151	6	2.5 ± 2.2	10

Table 2 Abundance of the giant molerats within each of the habitats of LW, UW and SP for wet and dry seasons, (MT = Mesa top, ME = Mesa edge, AG = *Artemesia* grassland, VF = Valley floor, HS = *Helichrysum* scrub, RG = Rocky grassland, HG = *Helichrysum* grassland, BRG = Bare rocky grassland and Av. max = Average maximum number)

Seasons	LW	Av. max.	UW	Av. max.	SP	Av. max.
Wet	Habitats	Molerats	Habitats	Molerats	Habitats	Molerats
	MT_1	2	HS_1	2	BRG	5
	MT_2	-	RG	3	RG	4
	ME	1			HS_5	-
Dry	MT_3	3	HS_2	-	HS_6	4
	AG	2	MT_5	2	HS_7	-
	VF	4	HS_3	2	MT_6	2
	MT_4	-	HS_4	3		

Table 3. Density of the giant molerats in the habitats of LW, UW and SP for the wet and dry seasons.

Study sites	Seasons	Numbers of sampled habitats (n)	Estimated population size	
			Mean ± SD/ plot	Individuals/ha
LW	Wet	3	1.0 ± 1.0	4
	Dry	4	2.3 ± 1.7	9
UW	Wet	2	2.5 ± 0.7	10
	Dry	4	1.8 ± 1.3	7
SP	Wet	3	3.0 ± 2.7	12
	Dry	3	2.0 ± 2.0	8

4.2 Relative abundance, sex and age distribution

A total of 504 rodents were snap-trapped within the habitats of all the study sites during both the wet and dry seasons. These comprised 179 (35.5%) *L. melanonyx,* 172 (34.1 %) *S. albocaudata*, 144 (28.6%) *A. blicki*, 6 (1.2%) *S. griseicauda* and 3 (0.6% *L. flavopunctatus.* Study site wise 207 (41.1%), 170 (33.7%) and 127 (25.2%) were snap-trapped in SP, UW and LW, respectively (Table 4).

Out of the 144 captured *A. blicki,* 67 (46.5 %) were males and 77 (53.5%) were females. For *A. blicki*, the possible departure of the observed sex ratio from the hypothetical 50% is tested for male ($n = 144$, $p = 0.5$) and is not significant. Out of the 179 *L. melanonyx,* males comprised 94 (52.5%) and females 85 (47.5%). There is no significant departure in sex ratio ($n = 179$, $p = 0.4$). Out of the 172 *S. albocaudata,* males comprised (44.8%) while females 95 (55.2%). Of the 6 *S. griseicauda,* 5 were male. Nevertheless, for the female, the observed sex ratio did not significantly depart from the hypothetical one ($n = 6$, $p= 0.1$). All of the 3 *L. flavopunctatus* were male.

Table 4. Number of the snap-trapped rodents for the representative study sites in each season, (Ab = *A. blicki*, Lm = *L. melanonyx*, Lf = *L. flavopunctatus*, Sa = *S. albocaudata* and Sg = *S. griseicauda*).

Study sites	Season	Ab	Lm	Lf	Sa	Sg	Total	Grand total
LW	Wet	29	17	-	38	-	84	127
	Dry	16	6	-	21	-	43	
	Total	45	23	-	59	-	127	
UW	Wet	33	18	-	26	-	77	170
	Dry	36	33	-	20	4	93	
	Total	69	51	-	46	4	170	
SP	Wet	13	61	3	36	2	115	207
	Dry	17	44	-	31	-	92	
	Total	30	105	3	67	2	207	504
	Grand total	144	179	3	172	6		
	%	28.6	35.5	0.6	34.1	1.2		

4.2.1. Lower Web Valley

Out of the 127 catches within the habitats of this study site 45 (35.4%) were *A. blicki*, 23 (18.1%) were *L. melanonyx* and 59 (46.5%) were *S. albocaudata* (Table 4). For the wet and dry seasons, the percentage trap success of and *S. albocaudata*, *A. blicki* and *L. melanonyx* was 14.1, 10.7, and 5.5, respectively (Table 5).

Within the habitats of this study site, of the subtotal 127 rodents 84 (66.1 %) were snap-trapped during the wet season. Of these, 38 (45.2%) were *S. albocaudata*, 29 (34.5%) wrere *A. blicki and* 17 (20.2%) were *L. melanonyx*. For the wet season, percentage trap success for *S. albocaudata*, *A. blicki* and *L. melanonyx* were 15.8, 12.1 and 6.7, respectively (Tables 6). For the wet season catches, sex distribution of each species is given in Table 8. The age grouping for the wet season is provided in Table 9.

Of the 127 snap-trapped rodents within the habitats of LW, 43 (33.9%) were during the dry season. These comprised 21 (48.8%) *S. albocaudata*, 16 (37.2%) *A. blicki* and 6 (13.9%) *L. melanonyx* (Table 4). For the dry season percentage trap success for the above-mentioned rodents were 12.2, 8.9 and 3.8, respectively (Tables 6). As it was the case in all study sites, percentage trap successes exhibited discrepancy among habitats irrespective of the season (Table 7). For the dry season, catches in the habitats of LW, sex distribution for each species is listed in Table 8. The age categorization of the dry season catches is given in Table 9.

Table 5. Percentage trap success of rodents within habitats of the LW, UW and SP during the wet and dry seasons, (Ab = *A. blicki* Lm = *L. melanonyx*, Lf = *L. flavopunctatus*, Sa = *S. albocaudata* and Sg = *S. griseicauda*).

Study sites	Altitude (m)	Number of samples (n)	Trap night	Trap success (%)				
				Ab	Lm	Lf	Sa	Sg
LW	3510 - 3586	6	420	10.7	5.5	-	14.1	-
UW	3617 -3677	6	360	19.2	14.2	-	12.8	1.1
SP	4024 - 4149	7	500	6.0	21.0	0.6	13.4	0.4

Table 6. Percentage trap success of rodents within habitats of the LW, UW and SP during the wet and dry seasons, (Ab = A. *blicki*, Lm = *L. melanonyx*, Lf = *L. flavopunctatus*, Sa = *S. albocaudata* and Sg = *S. griseicauda)*.

Study sites	Season	Sample number	Trap night	Trap success (%)				
				Ab	Lm	Lf	Sa	Sg
LW	Wet	3	240	12.1	6.7	-	15.8	-
	Dry	3	180	8.9	3.8	-	12.2	-
UW	Wet	2	120	27.5	15.0	-	21.7	-
	Dry	4	240	15.0	13.8	-	8.3	0.8
SP	Wet	4	320	4.1	19.1	0.9	11.6	0.6
	Dry	3	180	9.4	25.0	-	9.8	-

Table 7 Percentage trap success of rodents within each of the habitats of LW, UW and SP (VB = Valley bottom, SG = Swampy grassland, BG = Bare grassland GL = Grassland, MT = Mesa top, ME = Mesa edge, VF = Valley floor, HS = *Helichrysum* scrub, HG = *Helichrysum* grassland and RG = Rocky grassland)

Study sites with their subhabitats		Trap night	Trap success (%)					Seasons
			Ab	Lm	Lf	Sa	Sg	
LW	MT_1	80	12.5	5.00	-	20.0	-	Wet
	ME	80	-	-	-	-	-	
	MT_2	80	23.8	15.0	-	27.5	-	
	VF	60	3.3	1.7	-	15.0	-	Dry
	VB_1	60	23.3	8.3	-	16.7	-	
	SG	60	-	1.7	-	5.0	-	
UW	HS_1	60	40.4	18.3	-	28.3	-	Wet
	VB_2	60	15.0	11.7	-	15.0	-	
	VB_3	60	10.0	8.3	-	3.3	1.7	Dry
	HS_2	60	5.0	28.3	-	13.3	-	
	HG	60	6.7	10.0	-	3.3	-	
	AG	60	38.3	8.3	-	13.3	1.7	
SP	BG	80	1.3	25.0	-	17.5	-	Wet
	HS_3	80	6.3	17.5	-	10.0	2.5	
	GL_1	80	3.8	17.5	3.8	8.8	-	
	RG	80	5.0	16.3	-	10.0	-	
	HS_4	60	10.0	38.3	-	23.3	-	Dry
	GL_2	60	3.3	23.3	-	23.3	-	
	MT_3	60	15.0	13.3	-	5.0	-	

Table 8. Summary of sex distribution in rodents of the representative study sites of BMNP during both the wet and dry seasons, (Ab = *A. blicki*, Lm = *L. melanonyx* Lf = *L. flavopunctatus*, Sa = *S. albocaudata*, Sg = *S. griseicauda*, M = male and F = female).

Study sites	Seasons	Ab		Lm		Lf		Sa		Sg		Total	
		M	F	M	F	M	F	M	F	M	F	M	F
LW	Wet	11	18	10	7	-	-	17	21	-	-	38	46
	Dry	7	9	3	3	-	-	10	11	-	-	20	23
	Total	18	27	13	10	-	-	27	32	-	-	58	69
UW	Wet	18	15	10	8	-	-	10	16	-	-	38	39
	Dry	20	16	18	15	-	-	8	12	3	1	49	44
	Total	38	31	28	23	-	-	18	28	3	1	87	83
SP	Wet	1	12	34	27	-	3	15	21	2	-	52	63
	Dry	10	7	19	25	-	-	17	14	-	-	46	46
	Total	11	19	53	52	-	3	32	35	2	-	98	109
Grand total		67	77	94	85	-	3	77	95	5	1	243	261

Table 9. Age distribution of rodents in the habitats of LW during the wet and dry seasons.

Species	Season	Adult	Subadult	Juvenile	Total
A. blicki	Wet	26	1	2	29
	Dry	15	1	0	16
	Total	41	2	2	45
L. melanonyx	Wet	14	3	-	17
	Dry	5	1	-	6
	Total	19	4	-	33
S. albocaudata	Wet	35	3	-	38
	Dry	18	1	2	21
	Total	53	4	2	59
Grand total		113	10	4	127

4.2.2 Upper Web Valley

Of the 170 rodents snap-trapped within the habitats of UW, 69 (40.6%) were *A. blicki*, 51 (30.0%) were *L. melanonyx*, 46 (27.6%) were *S. albocaudata* and 4 (2.3%) were *S. griseicauda* (Table 4). During the wet and dry seasons, the percentage trap successe for the above-mentioned rodents were 19.2, 14.2, 12.8 and 1.1, respectively (Table 5). Out of the 77 (45.3%) rodents captured during the wet season, 33 (42.8%) were *A. blicki*, 26 (33.8%) were *S. albocaudata* and 18 (23.4%) were *L. melanonyx* (Table 4). For the wet season percentage trap success for the above-mentioned rodents was 27.5, 21.7 and 15.0, respectively (Tables 6). For the wet season catches, sex distribution for each species is given in Table 8, whereas the age grouping is given in Table 10

Out of the 170 rodents 93 (54.7%) were snap-trapped during the dry season within the habitats of UW. Of these 36 (38.7%) were *A. blicki*, 33 (35.5%) were *L.melanonyx*, 20 (21.5%) were *S. albocaudata* and 4 (4.3%) were *S. griseicauda* (Table 4). For the dry season catches, the percentage trap-success of the above-mentioned rodents was 15.00, 13.75, 8.33 and 0.84 respectively (Tables 6). Sex distribution for dry season catches of each species of rodents is provided in Table 8, whereas age distribution is given in Table 10

Table 10 Age distribution of rodents in the habitats of UW during the wet and dry seasons.

Species	Season	Adult	Subadult	Juvenile	Total
A. blicki	Wet	28	4	1	33
	Dry	27	6	3	36
	Total	55	10	4	69
L. melanonyx	Wet	13	5	-	18
	Dry	23	7	3	33
	Total	36	12	3	51
S. albocaudata	Wet	22	1	3	26
	Dry	17	2	1	20
	Total	39	3	4	46
S. griseicarda	Wet	-	-	-	-
	Dry	4	-	-	-
	Total	4	-	-	4
Grand Total		134	25	11	170

4.2.3 Sanetti Plateau

Within the habitats of this study site, out of the 207 snap-trapped rodents, , 105 (50.7%) were *L. melanonyx*, 67 (32.4%) were *S. albocandat*, 30 (14.5%) were *A. blicki*, 3 (1.4%) were *L .flavopuntantus* and 2 (1.0%) were *S. griseicauda* (Table 4). During the wet and dry seasons, the percentage trap success for *L. melanonyx*, *S. albocaudata*, *A. blicki*, *L . flavopunctatus* and *S. griseicauda* were 21.0, 13.4, 6.0, 0.6 and 0.4, respectively (Table 5).

Out of the 207 rodents, 115 (55.6%) were captured during the wet season. These comprised 61 (53.0%) *L. melanonyx*, 36 (31.3%) *S. albocaudata* 13 (11.3%) *A. blicki*, 3 (2.6%) *L. flavopunctatus* and 2 (1.7%) *S. griseicauda* (Table 4). The percentage trap success was 19.1, 11.6, 4.1, 0.9, and 0.6, respectively (Table 6). The sex distribution for each of the snap-trapped species is shown in Table 8, whereas the approximated age categorization is given in Table 11.

Of the 207 rodents, 92 (44.4%) were captured during the dry season. These comprised 44 (47.8%) *L. melanonyx*, 31 (33.7%) *S. albocoudata* and 17 (18.5%) *A. blicki*, (Table 4) The percentage trap success was 25.0, 9.8 and 9.4, respectively (Table 6). For the dry season catches, the sex distribution for each species is given in Table 8. The age grouping for each species is given in Table 11.

Table 11 Age distribution of rodents in the habitats of SP during the wet and dry seasons, (Ab = *A blicki*, Lm = *L. melanonyx*, Lf = *L. flavopunctatus* Sa = *S. albocaudata* and Sg = *S. griseicauda*).

Species	Season	Adult	Subadult	Juvenile	Total
Ab	Wet	12	1	-	13
	Dry	14	3	-	17
	Total	26	4	-	30
Lm	Wet	47	11	3	61
	Dry	28	12	4	44
	Total	75	23	7	105
Lf	Wet	2	-	1	3
	Dry	-	-	-	-
	Total	2	-	1	3
Sa	Wet	23	7	6	36
	Dry	24	2	5	31
	Total	47	9	11	67
Sg	Wet	1	-	1	2
	Dry	-	-	-	-
	Total	1	-	1	2
Grand Total		151	36	20	207

4.3 Abundance of the Afroalpine rodents

A. blicki: The highest density for this rodent was within the LW with 48 individuals per hectare for both the wet and dry seasons (Table 12). The second highest density was within the habitats of UW with 20 individual per hectare. Its least density estimate was within SP habitats with 12 individuals per hectare (H = 1.34, d.f. = 2, p = 0.20).

The highest absolute density was obtained during the wet season with 74 individuals per hectare in the habitats of LW (Table 13). The second highest density for the rodent was also during the wet season with 44/ha individuals within the habitats of UW. The least seasonal absolute density estimate was during the dry season with nil number of individual per hectare within the habitats of SP (Table 13).

L. melanonyx:- The highest density was also 48 individuals per hectare within the habitats of SP (Table 12). The least density estimate in UW was 18 individuals per hectare (H=1.82, d.f. = 2 , p = 0.18). Regarding the seasonal abundance, the highest density was also during the wet season in SP with 68 individuals per hectare. The least density was during the dry season with 1 individual per hectare (Table 13). Like in *A. blicki*, some of the habitats within all the representative study sites had nil density for the rodent in both seasons (Table 14)

Table 12 Estimates of rodents using live trapping within habitats of the LW, UP and SP ,(Ab = *A blicki* and Lm = *L melanonyx*)

Study sites	Altitudes (m)	Number of Samples (n)	Species	Estimated population size	
				Mean ± SD/grid	Individuals/ha
LW	3519-3885	5	Ab	12.0 ± 20.0	48
			Lm	9.0 ± 10.0	36
UW	3620-3762	5	Ab	5.0 ± 7.0	20
			Lm	4.6 ±5.9	18
SP	4036-4152	5	Ab	3.0 ± 7.0	12
			Lm	12.0 ± 10.0	48

Table 13. Estimates of rodents using live trapping within habitats of LW, UW, and SP during the wet and dry seasons, (Ab = *A. blicki* and Lm = *L. melanonyx).*

Study site	Season	Sample number	Species	Estimated population size	
				Mean ± SD/grid	induviduals/ha
LW	Wet	3	Ab	18.7 ± 25.4	74
			Lm	7.3 ± 12.7	29
	Dry	2	Ab	1.0 ± 1.4	4
			Lm	12.0 ± 7.1	48
UW	Wet	2	Ab	11.0 ± 8.5	44
			Lm	11.0 ± 1.4	44
	Dry	3	Ab	1.0 ± 1.7	4
			Lm	0.3 ± 0.6	1
SP	Wet	3	Ab	5.7 ± 8.1	22
			Lm	17.0 ± 11.4	68
	Dry	2	Ab	-	-
			Lm	5.5 ± 2.1	22

Table 14. Estimates of rodents per grid and per habitat within the study site, LW, UW and SP for the wet and dry seasons using live traps, (Ab = *A. blicki* Lm = *L melanonyx*, TDF = Tullu Deemtu Floor and the remaining abbreviated habitat names are given in Appendix 3)

Seasons	LW			UW			SP		
	Habitats	Ab	Lm	Habitats	Ab	Lm	Habitats	Ab	Lm
Wet	MT_4	48	22	HS_5	5	10	BRG	15	22
	MT_5	4	-	HS_6	17	12	RG	-	4
	ME_2	4	-	MT	-	-	TDF	2	25
Dry	VF_2	-	7	HG	3	1	HS_7	-	7
	AG	2	17	MT_6	-	-	MT_8	-	4

5. DISCUSSION

Giant molerats: In this study, the densities of the molerats were estimated using a direct scanning of 50 m x 50 m plot. Although limited to a relative estimate of abundance as Shimelis Beyene (1986) and Sillero – Zubiri *et al.* (1995a) noted, direct observation technique is necessary for the molerats since either snap-trapping or live-trapping proved impossible. In addition, Yalden (1975), Shimelis Bayene (1986) and Sillero-Zubiri (1994) observed that generally, only one individual molerat occupies a burrow system. This work has also confirmed further the same behavior of the rodent. Consequently, the risk of recounting the same individual during the direct observation has been practically minimal.

Giant moterals were most abundant within the habitats of Sanetti Plateau. The second highest density was in Upper Web Valley with the least abundance observed in Lower Web Valley. Yalden (1975), Shimelis Beyene (1986), Hillman (1986) and Gottelli *et al.* (1990) have reported the density estimates of the giant molerats in the BMNP, to be from 5.7/ha to 90 individuals per hectare. The density estimates in the present study also fall within the stated range (Table 1). As has been observed, the density estimates of the rodent increased with altitude in the Afroalpine belt. This is not surprising, as *T. macrocephalus* is an endemic rodent to Ethiopia, being confined to the high altitude of 3,000 – 4150 m a s l, as noted by Yalden (1975, 1985), Yalden and Largen (1992).

At the high attitudes of Sanctti Plaleau, the giant molerats are most likely favored for they exhibit both behavioral and physiological adaptations for their body thermoregulation. Behavioral adaptation exhibited by them includes plugging of the barrow entrance at night in most cases, the fact also stressed by Sillero-Zubiriet *et al.* (1995). Basking in the warm temperature (Shimelis Beyene, 1986) coupled with restrictions of emergence from the hole to durations of relatively warm temperatures are also parts of behavioral adaptation during the day time (Shimelis Beyene, 1986). Nevertheless, Yalden (1795) and Shimelis, (1986) also observed that the rodents perform burrow entrance plugging once they have depleted vegetation from around the holes, regardless of the nature of the diurnal temperature.

Physiological adaptations that the giant molerats exercise at high altitude include nighttime torpors and possession of large subcutaneous fat deposits (Turk & Arnold, 1988). It might be such an adaptation and the inability to cope with increased temperatures at lower altitudes, that has resulted in their decreased density at Lower Web Valley.

In addition to the altitudinal effect, attributes such as type and density of vegetation as well as impacts posed by local people and their livestock are also influential. As it is harsher for human settlement Sanetti Plateau is less densely inhabited by local people. However, more settlement in Lower Web Valley implies greater habitats destruction by local people and their livestock. Nevo (1979) noted that molerats are xenophobic like most other fossorial mammals. Thus, being unflavored they shrink away with increased human interference. Giant molerats are also hunted by feral and domestic dogs (Shimelis Beyene, 1896). So, survival strategy of the rhizmyid rodent is likely practiced in maintaining itself at higher elevations with minimal habitat disturbance.

All habitats within each of the three study sites were not equally inhabited by molerats (Table 2). They are more abundant in vegetated habitats near swamp shores or water-areas than on mesa tops as also observed by Sillero Zubiri (1994).

Generally, giant molerats were greater in number per hectare of an area during the wet season (Table 3). This seasonal variation in densities of the rodent is likely attributed to the more easily available vegetation for them during wet season as the fast-growing creeping hemicryptophytes such as *Alchemilla abyssinica* and other rosette plants become available as reported by Miehe & Miehe (1994a). This observation has also confirmed further the fact that wet season is more ideal for the molerats, nonetheless its cold temperature than the dry season.

Trappable rodents: In this study, the trappable rodents recorded in the Afroalpine belt of BMNP were five, namely *A. blicki, L. melanonyx, L. flavopunctatus, S. albocaudata* and *S. griseicauda*. However in similar studies lialden (1988) and Sillero-Zubri (1994) encounter seven species in more or less the same area. On top of the present species composition, O*tomys typus* and *Dendromus lovati* were also involved. Besides, the five rodent species a small number of shrews were also uninvited guest for both the snap and live traps within the habitats of all the three study sites, LW, UW and SP. Such phenomena are not uncommon. For instance Afework Bekele (1996) recorded one shrew along with 12 species of trappable rodents in Central Ethiopia, Menagesha State Forest.

Relative and absolute densities for the above mentioned rodents were performed after having employed snap-trapping and live-trapping, in parallel for the data collection. The rodents were also classified on the basis of sex and age. Relative density estimates including the percentage trap successes stemmed from the snap trap catches. The same rodents were also spared for morphometric measurements and computation of the male/ female sex ratios. However, live-trapping were employed for the estimates of absolute densities. In the live-trapping technique, two traps per point with 10 m spacing between successive points, comprising 50 Sherman traps per grid were used. In a given habitat the actual grid area was 0.16 ha. Nonetheless, the effective area for the grid was taken to be 0.25 ha. Bondrup Nielsen (1983) an performing small mammals density estimations using live-trapping grid had underlined the importance of considering effective grid area due to edge-effecti and grid sixe. Gurnell & Gipps (1989) working on the predictability of the effects of trap spacing on small mammals density estimation, came to highlight validity of animal's density by trap- estimate when the total number of captured individuals are divided by the effective grid area. In this study therefore, the total number of captured individuals as estimated by Bailey's Triple Catch was taken as density estimate of the rodent in the effective trap area.

Like in the case of giant molerats relative abundances of the trappable rodents exhibited an increase with altitude as it can be reflected by comparing the number of catches (Table 4). The percentage trap success is also in favor of the density increment of the rodent with altitude. As has been mentioned earlier in BMNP the extent of human influence tends to increase with a decrease in altitude thereby adversely affecting the rodent guild. The most plentiful species in the Afroalpine belt of Bale Mountains was

L. melanonyx, constituting 35.5% of the total catch. The other common species were *S. albocaudata* and *A. blick.* The present result on the abundance of the three common species of the Afroalpine belt, is compatible with that of Yalden (1988) and Sillero-Zubiri (1994). As studies reveal, *L. melanonyx* coexists with *A. blicki* through more or less resource partitioning. Although both species are predominantly herbivores, *L. melanonyx* consumes less of monocotyledonous plants with additional feed consisting of small invertebrates (Yalden & Largen, 1992; Sillero-Zubiri *et al.*, 1995). Gottelli *et al.* (1990) and Yalden (1988) noted that *A. blicki* and *L. melanonyx* are diurnal rodents whereas *S. albocaudata* is a nocturnal forager. So, the problem of interspecific competition can be temporally alleviated between the latter and the former two rodents. The least abundant species was *L. flavopunctatus*. Yet, Yalden & Largen (1992) stressed that the species was the most abundant and widespread of all rodents in Ethiopia. Nevertheless, its abundance in Menagesha State Forest was observed by Afework Bekele (1996) to be limited. Moreover, in the present study, *L. flavopunctatus* constituted the least portion of all catches (0.6%). The other less abundant species was *S. griseicauda*. As both *L. flovopunctatus* and *S. griseicauda* are characteristic rodents of a montane grassland (Sillero-Zubiri, 1994), their decreased abundance in the Afroalpine habitats may not be surprising. They are likely constrained at the higher altitude of the Afroalpine area coupled with the scanty vegetation favored by them.

Sex distribution of all the common species is in line with what was reported by Yalden (1988) and Sillero-Zubiri (1994) on the same study areas. However, probably due to stochastic factors, the male to female sex ratio of the two less abundant species was found to be departed from the hypothetical value of 50% (Table 8). The total absence of male in *L. flavopunctatus*, is a bit surprising as it is incompatible with the result of other studies on the same area.

Morphometric measurements for age determination were not an easy task in the field. As probably, it is the case, in other similar studies age, judgment has been more or less an arbitrary. Tilaye Wube (1999) estimated age of rodents based on their weight and reproductive organ conditions. The catches were categorized into different age groups as juvenile, subadult and adult based on their weight and the nature of their reproductive organs. In order to at least maintain consistency among the catches from time to time, ample care has been exercised.

For the sake of classifying the rodents to species level, just in the field, the museum specimen of the rodents in the research center of the BMNP were used for comparison. Results from the live-trapping confirm those of the snap-trapping regarding seasonal variation in population densities of *A. blicki* and *L. melanonyx* (Table 13). The trend in population density increase with an altitude is also well maintained except in *A. blicki* among the three study sites (Table 12).

Habitat selection for sampling was entirely randomized. Hence similar, subhabitat types could be encountered (Table 14). As it has been the case in snap-trapping and the molerat observation plots, certain habitats had nil density estimates in the live-trapping (Table 14). In most cases, the habitats with minimal densities of rodents were the mesa tops, mesa edge and water-areas (Appendices 1, 2 and 3). The mesa tops and mesa edges are either covered with bare rocks or are highly degraded and already exploited. The trappable rodents are more densely distributed in the habitats of the valley bottom with enough vegetation cover in both LW and UW. In SP also, the plain areas harbor more rodents than the mesa tops. Yalden (1988) and Sillero-Zubiri (1994) observed that the ericaceous belt and the mesa tops were sparsely populated with rodents.

In SP based on the relative abundance and trap success the most abundant trappable rodent was *L. melanonyx*. However the least abundant species was *S. griseicauda*. Int fact, *L. flavopuctatus* was the second least abundant, despite its outspoken abundance else where in Ethiopia (Yalden & Largen, 1992). The second most abundant in SP was *S. albocaudata* This study site exhibited greater rodent densities during the wet seasons except in *Arvicanthis* (Table 6). The *Helchrysum* serub (HS) habitat types were notable in harboring greater number of rodents (Table 7). Conceivably, notorious in sustaining generally they least number of rodents were the mesa top habitat types. It is noteworthy, that in SP *L. flavopunctatus* was only encountered in a grassland habitat types along with other rodents, whereas *S. griseicauda* was captured only in *Helichrysum* scrub habitat (Table 7).

Regarding the two diurnal rodents that are characteristic to Afroalpine areas, on the whole the results from live-trapping consolidate those of the snap-trapping, except that of *A. blicki* in some cases. However, the rocky grassland (RG) displayed nil density for *Arvicanthis* during the wet season. This is predictably attributed to the scanty vegetation of the stated habitat (Appendix 3). Not only mesa top (MT) but also *Helichrysum* scrub (HS) habitat types in the SP had also nil density for the same rodent during the dry season (Table 14). Although it seems bizarre point to record nil density for *Arvicanthis* in HS habitat, the fact is that monocot vegetation was almost none in the area. As it has been mentioned earlier monocots are highly favored by the rodent.

In the SP the age grouping indicate that many juvenil *S. albocaudata*, were captured (Table 11). *Arvicanthis* were not captured in either season. Yalden (1988) excluded all juveniles of all species snap-trapped, while taking various body dimensions, in the same area. The highest number of subadults was that of *L. melanonyx* of all study sites, whereas the two least abundant species had nil subadults (Table 11). The sex ratios of most species were not significantly departed form the hypothetical values of 50% for the wet and the dry seasons. However, during the wet season in *A. blicki* the male to female sex ratio was very significantly departed from the hypothetical one ($n = 13$, $p = 0.0002$) in the favor of the females. During the same wet season, despite the absence of male, the sex ratio departure form the 50% was not significant in *L. flvopunctatus* ($n = 3$, $p = 0.08$) in favor of the female as the number of totally captured individuals was very small (Table 8). In the same manner, the sex ratio departure was not also significant in *S. grisecauda* ($n = 2$, $p = 0.16$) in the SP.

In UW the most abundant trappable rodent was *A. blicki*. Unlike in SP, *L. melanonyx* density was relegated to the second place in UW (Table 4). The least abundant species was *S. griseicauda*, as *L. flavopunctatus* was not entirely recorded in this study site. The relative abundance of the rodents was also underpinned by percentage trap success (Table 5). Live-trapping also confirmed that *A. bliki* was greater in density than *L. melanonyx* in UW. Abundance of all the trappable rodents was, anomaly greater during the dry season except *S. albocaudata* in UW. (Table 6). However, regarding the abundance of *A. blicki* and *L. melanonyx* from live-trapping, the wet season exhibited greater densities. *Helichrysum* scrub habitat types had more rodent guild, whereas the *Helichrysum* grassland harbored less rodent community during snap-trapping (Table 7). The *Helichrysum* scrub also outnumbered the other habitat types in rodent densities pertaining to live-trapping catches in this study site. Presumably, mesa top habitats had nil rodent densities due to scanty vegetation presence (Table 14). Unlike in SP, in this study site, *L. flavopunctatus* was not recorded and *S. griseicauda* was also represented only by the adult-age group (Table 10). The sex ratios of the rodent guild in UW are not significantly departed from the hypothetical one, in all the recorded species. In fact, the sex ratio deserving a mention is that of *S. albocaudata*, which is not still significantly departed ($n = 26$, $p = 0.23$).

In the LW, the most abundant trappable species of rodents was *S. albocaudata*. However, both *L. flavopunctatus* and *S. griseicauda* were not entirely recorded. Out of the three captured species, the least abundant was *L. melanonyx*, relegating further to the third place when compared vis-à-vis its densities both in SP and UW (Table 5). Nevertheless, results from the live-trapping show that density of the rodent in UW is less than that of LW. The relative abundance and the percentage trap success show that greater densities were recorded during the wet season in all of the captured species (Table 6). However, in the live-trapping, *L. melanonyx* exhibited high density during the dry season than during the wet. Generally, in LW, mesa tops and valley bottom, sustained more rodent guild, whereas the mesa edges and the swampy grassland had the least rodent number (Table 7).

Juveniles were recorded during the wet season only in *A. blicki*, and during the dry season only in *S. albocaudata* (Table 9) in LW. Regarding the sex ratios of the rodents, there is no significant departure from the 50%, and the ones notable are exactly

50% (1:1) male to female sex ratio in *L. melanonyx* during the dry season and that of the *A. blicki* during the wet season (n = 29 , p = 0.18) as indicated in Table 8.

Generally, according to the present study, the common trappable species in the Afroalpine belt of BMNP were three, namely *L. melanonyx*, *S. albocaudata* and *A. blicki* constituting a relative abundance of 35.5%, 34.1% and 28.6%, respectively (Table 4). Both *L. flavopunctatus* and *S. griseicauda* were scanty. Relative abundance of the collective rodent guild displayed increase with an altitude in the BMNP. Hence, SP, UW and LW showed a relative abundance of 41.1%, 33.7% and 25.2%, respectively. Yalden (1988) and Sillero-Zubiri (1994) reported also that SP had the highest rodent density; nonetheless they lumped UW and LW together as the Web Valley and further stretched the study areas into montane grassland and ericaceous belt. In fact, in this study Tullu Deemtu was viewed as a part of the SP.

The number of sampled habitats within a study site or from one area to another area, varied due to time and material constraints, which were beyond control. Although the rainy season in the BMNP ceases at the end of October (Daniel Gamachu 1977), the effective wet season for the observation went on deep into November / 2002. Taylor and Green (1976) working at Kitale, reported that *Arvicanthis* begins breeding 2 to 3 months after the start of the rain and ceases approximately a month after its termination. Thus, the intention in this study was also the persistence of the effect of the rain for a month after its termination.

In this study, the major point of concern has been with assessment of the diurnal rodent guild abundance. Predictably, the diurnal rodents serve as a prey base for the critically endangered Ethiopian wolf. *C. simensis* has also diurnal foraging behavior.

6. CONCLUSION

Densities of the Afroalpine rodents of the BMNP are currently on the decline. For instance, in the present study, the population density of *L. melanonyx* at SP was 48 individuals per hectare (Table 12). However. Sillero-Zubiri (1994) reported the density of the same rodent at the same study site to be 60 individuals per hectare. In both cases, the method used for population size estimation was Bailey's Triple Catch. In other studies, Delany & Roberts (1978) noted a rodent density of up to 200 individuals per hectare on scrub land in Kenya. Even, before a decade, the density of a specific rodent in the most notable areas of BMNP was not appreciable, let alone heading downhill thence. Thus, the current trend needs to be reversed, or at least be alleviated. To this end, *in situ* conservation strategy should be promoted for the rehabilitation of the habitats. As the result:-

- Resettlement of the local people outside the Park boundary is indispensable.
- Grazing livestock in the park territory has to be forbidden.
- Castration program of the stray dogs currently underway, within the park including vicinal areas by EWCP should be enhanced.
- Feral dogs that hunt the rodents need be eliminated
- Primarily, the Park has to be gazetted to give legal background for all that need protection.

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Appendix 1. Habitats description in each study site for the wet and dry seasons along with exact location of the initial points of the plots of the molerats direct observation.

Study sites	Seasons	Coordinates of NW corner of Plots (UTM)	Habitats description		
			Habitat types	Altitude (m)	Prominent vegetation
Lower Web Valley	Wet	x: 576691 y: 772594	Mesa top (MT)	3553	*Alchemilla*, moss, lichen and grass
		x:574376 y: 771370	Mesa top (MT)	3559	*Kniphofia*, gras and *Alchemilla*
		x: 576601 y: 771710	Mrsa edge (ME)	3565	Grass and *Alchemilla*
	Dry	x: 575139 y: 775357	Mesa top (MT)	3502	*Artemesia* and grass
		x: 574898 y: 771862	*Artemesia* Grassland (AG)	3586	Grass, and *Alchemilla*
		x: 599604 y: 777693	Valley floor (VF)	3524	*Alchemilla* pasture
		x: 580808 y: 772074	Mesa top (MT)	3695	*Helichrysum* and grass
Upper Web Valley	Wet	x: 570545 y: 775885	*Helichysum* scrub (HS)	3676	*Helichrysum and grass*
		x: 599629 y: 769854	Rocky Grassland (RG)	3630	Grass, moss & lichen
	Dry	x: 569441 y: 764181	*Helichrysum* scrub (HS)	3656	*Helichrysum*, *Alchemilla* and *kniphofia*
		x: 570877 y: 765656	Mesa top (MT)	3630	*Helichrysum* and grass
		x: 574387 y: 762646	*Helichrysum* scrub (HS)	3862	*Alchemilla* and grass
		x: 568763 y: 763155	*Helichrysum* scrub (HS)	3679	*Helichrysum*, and grass
Sanetti Plateau	Wet	x: 596514 y: 758416	Bare rocky, grassland (BRG)	4130	Sparse *Helichrysum*, moss and sichen
		x: 599042 y: 760704	Rocky grassland (RG)	4025	Sparse *Alchemilla* and *Helichrysum*
		x: 597622 y: 755059	*Helichrysum* scrub (HS)	4101	*Helichrysum* and Alchemilla
	Dry	x: 597668 756737	*Helichrysum* scrub (HS)	4121	*Helichrysum*, and *Alchemilla*
		x: 594462 y: 762387	*Helichrysum* scrub (HS)	4092	*Helichrysum*, *Erica*
		x: 593501 y: 760845	Mesa top (MT)	4151	*Alchemilla* and *Helichrysum*

Appendix 2. Habitats description in each study site for the wet and dry seasons along with exact location of the initial points snap-trapping transects.

Study sites	Seasons	Coordinates of NW corner of Plots (UTM)	Habitats description		
			Habitat types	Altitude (m)	Prominent vegetation
Lower Web Valley	Wet	x: 576114 y: 772772	Mesa top (MT)	3549	Grass and *Alchemilla*
		x: 576775 y: 771192	Mesa edge (MT)	3580	*Erica* and *Aremesia*
		x: 574540 y: 771188	Mesa top (MT)	3573	Grass and *Kniphofia*
	Dry	x: 579814 y: 777662	Valley floor (VF)	3516	*Alchemilla*
		x: 575078 y: 775153	Valley botton (VB)	3510	Grass, and sedge
		x: 574189 y: 777753	*Helichrysum* grassland (HG)	3586	*Helichrysum* and *Alchemilla*
Upper Web Valley	Wet	x: 572582 y: 763864	*Helichrysum* scrub (HS)	3677	*Helichrysum* and *Alchemilla*
		x: 569209 y: 765640	Valley botton (VB)	3617	Grass and *Helichrysum*
	Dry	x: 569715 y: 769768	Valley botton (VB)	3620	Grass, Erica and *Alchemilla*
		x: 569419 y: 764272	*Helichrysum* scrub (HS)	3636	*Helichrysum*, and lobelia
		x: 569543 y: 764751	*Helichrysum* grassland (HG)	3628	*Helichrysum* and grass
		x: 568733 y: 763252	*Artemesia* grassland (AG)	3667	*Artemesia*, grass and *Erica*
Sanetti Plateau	Wet	x: 586411 y: 758444	Bare grassland (BG)	4125	Grass and *Alchemilia*
		x: 597694 y:755139	*Helichrysum* scrub (HS)	4082	*Helichrysum* grass and *Alchemilla*
		x: 595546 y: 760226	Grassland (GL)	4049	grass and *Helichrysum*
		x: 599042 y: 760226	Rocky grassland (RG)	4136	Grass, moss and lichen
	Dry	x: 599042 y:760704	*Helichrysum* scrub (HS)	4136	*Helichrysum*, *Erica* and grass
		x: 597733 y: 756808	Grassland (GL)	4024	Grass, Kniphofia and *Alchemilla*
		x: 593573 y: 767358	Mesa top (MT)	4149	*Helichrysum*, *Alchemilla* and grass

Appendix 3. Habitats description in each study site for the wet and dry seasons along with exact location of the initial points of the live-trapping grids.

Study sites	Seasons	Coordinates of NW corner of grids (UTM)	Habitats description		
			Habitat types	Altitude (m)	Prominent vegetation
Lower Web Valley	Wet	x: 576243 y: 772629	Mesa top (MT)	3551	Grass and *Alchemilla*
		x: 574883 y: 771709	Mesa top (MT)	3561	Sparse grass and *Kniphofia*
		x: 576747 y: 771934	Mesa edge (ME)	3565	*Erica* shrubs
	Dry	x: 579483 y: 777709	Valley floor (VF)	3502	Grass, and *Alchemilla*
		x: 574000 y: 777520	*Artemesia* grassland (AG)	3519	*Artemesia* and grass
Upper Web Valley	Wet	x: 572730 y: 764463	*Helichrysum* scrub (HS)	3666	*Helichrysum* and grass
		x: 568714 y: 765879	*Helichrysum* Scrub (HS)	6662	*Helichrysum* and grass
	Dry	x: 570801 y: 765722	*Helichrysum* grassland (HG)	3620	*Helichrysum* and grass
		x: 568800 y: 762060	Mesa top (MT)	3696	*Helichrysum* and grass
		x: 574080 y: 764440	Mesa top (MT)	3762	*Alchemilla* and *Kniphofia*
Sanetti Plateau	Wet	x: 596698 y: 758339	Bare rocky grassland (RG)	4136	Moss, lichens and sparse grass
		x: 598740 y: 760738	Rocky grassland (BRG)	4040	Grass, mosses and lichens
		x: 597446 y: 756139	Tullu Deemtu Floor (TDF)	4123	*Helichrysum* heaths
	Dry	x: 593980 y: 760220	*Helichryusum* Scrub (HS)	4036	*Helichrysum* and *Alchemilla*
		x: 593420 y: 760960	Mesa top (MT)	4152	*Alchemilla*, *Helichrysum* and grass