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Food Selection and Habitat Association of Starck's Hare (*Lepus starcki* Petter, 1963) in the Bale Mountains National Park, Ethiopia

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ABSTRACT

Starck's hare (*Lepus starcki* Petter, 1963) is one of the endemic mammals of Ethiopia and potentially a very important part of the ecosystem. In this study, the food and habitat selection of Starck's hare was investigated. To estimate the coverage of vegetation in the study area, the line intercept' method was used. Diet was identified by analyzing faecal pellets and direct observation. Vegetation coverage was high (65.21%) during the wet season and low (<30%) during the dry season. The vegetation consisted of 27 plant species of which 21 were herbs, four grasses and 2 were shrubs. Monocotyledons occurred in higher percentage frequency in the diet of Starck's hare during both seasons. Among the grasses, *Festuca* spp. was the most available and important food source for Starck's hare during both seasons. The highest number of starck's hares was recorded from rocky grass land during the wet season and from wetland during the dry season. *Lepus starcki* is an important component in the diet of the Ethiopian wolf and as a result proper management measures should be taken to conserve the endangered species.

Key words: Starck's hare, food selection, forage availability, ecology, vegetation cover

INTRODUCTION

The geographical location and physical features of Ethiopia have resulted in the diversification of wildlife (Tedla, 1995; Refera and Bekele, 2004). Thus, Ethiopia possesses a unique and characteristic fauna with a high level of endemism (Hillman, 1993).

Hares are important economically and aesthetically for humans (Nowak, 1999; Malcolm, 1997; Burgos and Burgos, 2007). They provide sport hunting, food and fur. Hares also form an important link in ecological food chains. Many predators rely on the abundance of hares for their diet. One example of this phenomenon is the linkage of Ethiopian wolf and Starck's hares in the Bale Mountains (Sillero-Zubiri and Macdonald, 1997; Marino, 2003).

Starck's hare (*Lepus starcki*) is one of the endemic mammals of Ethiopia (Yalden and Largen, 1992; Kingdon, 1997) and potentially a very important part of the ecosystem of the Bale Mountains National Park (BMNP). It is an important part of the diet of the endangered and endemic Ethiopian wolf. They are mainly found in afroalpine parts of the BMNP including Tullu

Deemtu but also seen at low density in heather moorland and forest as well in the northern woodlands of the Park (Hillman, 1993). Yalden and Largen (1992) stated that Starck's hares are quite abundant on the moorlands of the Bale Mountains. At the same time, they also occurred on both sides of the Rift Valley at altitude between 2140-4000 meter above sea level (m.a.s.l) in both grassland and afroalpine moorland. Sillero-Zubiri (1994) stated that Starck's hares were particularly abundant on Sanetti Plateau and less in ericaceous heather and montane grassland.

Hares are herbivores and eat wide varieties of plants including grass, herbs and barks of plants. However, they often show preference to certain species of Vegetation. These preferences vary greatly between regions and are dependent on the local plant communities (Strevens and Rochford, 2004).

Currently, because of habitat loss and agriculture expansion wildlife population is decreasing in the world (Idris *et al.*, 2001; Maan and Chaudhry, 2001; Gabol *et al.*, 2005; Gundogdu, 2011). IUCN (2006) grouped Starck's hares as least concern. And for effective research and management of wildlife species, the study of feeding ecology of mammals is in the center of population biology and ecology (Matrai *et al.*, 1998). Therefore, the objective of this study was to identify the preferred diets and habitats of Starck's hare.

MATERIALS AND METHOD

The Bale Mountains National Park (BMNP) is located Southeast of the Rift Valley about 400 km by road from Addis Ababa, between 6° 29' and 7° 10' N and 39° 28' and 39° 58' E. It covers an area of 2200 km², with an altitudinal range from 1500-4377 masl. The typical afroalpine habitats in BMNP, Sanetti Plateau (3800-4050 m), Web Valley (3450-3550 m) and Tullu Deemtu (4000-4377 m.a.s.l.) formed the main study area.

Methods: Data for the availability of vegetation were obtained from 44 sample sites using line intercept method (Sutherland, 1996; Cummings and Smith, 2001).

To find the mean percentage coverage of each species (MPCSp), the following formula was used:

$$\text{MPCSp} = \frac{\text{TCSp}}{L} \times 100$$

where, TCSp is total cover of the species, L is length of line.

To find the mean percentage vegetation coverage of the site (MPCS):

$$\text{MPCS} = \frac{\text{TCS}}{L} \times 100$$

where, TCS is total cover of the site, L is length of line.

Diet analysis was carried out following the methods of Dingerkus and Montgomery (2001), Katona and Altbacker (2002) and Reichlin *et al.* (2005).

To identify the types and proportion of plant species used by *L. starcki*, the combination of faecal analysis and direct observation were used. Fresh pellets of Starck's hare were collected from sites of different vegetation types during both seasons. In each season, two pellets were collected from 25 independent droppings at the minimum of 200 m interval. The samples were preserved in 70% ethanol and taken to the Department of Biology, Addis Ababa University, for further analysis. They were washed independently with distilled water to remove fine particles for proper

identification and air dried. Two slides were prepared for each sample (mixing thoroughly) and observed under microscope to identify the diet. All fragments found on the slides were identified as monocotyledon, dicotyledon, or unidentified. Relative occurrence was determined by dividing the number of microscopic views in which a given species occurred by the total number of views multiplying by 100 (Katona and Altbacker, 2002).

In addition to faecal analysis, direct observation was used to identify different species of grasses consumed by Starck's hare. Different types of habitats, where hares usually fed were selected carefully for hide observation. Using 8×42 binocular, species of plant eaten were examined for 120 h. The plant species on the habitat was directly observed, before and after, to see the plant eaten by looking at the bite.

To identify habitat selection, a total of 10 transects were systematically located on 40 km² on each of the study area at the interval of 1 km. The length of each transect was 4 km. Transects were conducted on foot stopping and carefully observing at approximately 50 m interval. Each time, a hare was seen, habitat type, activity at a time and weather condition were recorded. The survey time was at dusk and dawn.

Data analysis: Data analysis was done using SPSS Vession 16. Significance difference between wet and dry season diet composition and plant coverage were analyzed using chi-square.

RESULTS

Forage availability: During the wet season, Starck's hare had most access to different species of herbs and grasses (Table 1). However, the proportion of plant species changed dramatically during the dry season. The major components of plant species in the study area were *Festuca* spp., *Alchemilla abyssinica*, *Helichrysum* spp. and *Trifolium* species. Usually, Starck's hares use *Helichrysum* spp. as a shelter. During the dry season, wetland plants were available for feeding. These include *Carex monostachya*, *Ranunculus oreophytus*, *Haplocarpha rueppelli* and *Trifolium acaule*. Although, *Festuca* spp. and *Alchemilla* spp. decreased in coverage during the dry season, their relative abundance was high. There is significant difference ($p < 0.05$) between plant cover during the wet season (65.21%) and during the dry season (<30%).

In this study, the most abundant plant species during both seasons were *Festuca* spp., *Alchemilla byssinica*, *Helichrysum gofanse*, *H. citrispinum*, *H. splendidum* and *Trifolium acaule*. Other studies have also noted all these species, as a dominant group in the area (Gashaw and Fetene, 1996; Puccetti *et al.*, 1996).

Food use: Of the 27 plant species identified from the study area, Starck's hares entirely fed on monocotyledons (grasses) during the wet season. These were *Festuca* spp., *Koeleria capensis*, *Agrostis gracilifolia* and *Carex monostachya*. During the dry season, dicotyledon plants were observed in the diet of Starck's hares, however, the proportion of monocotyledons was still high (Table 2).

Starck's hares were highly selective for monocot plants with limited use of dicots during the dry season (Table 3).

Habitat: Starck's hares were mostly restricted to rocky grassland with low wind areas. However, during the dry season when grasslands dried out, most were observed feeding in wetland habitats (Table 4).

Table 1: Coverage of plant species identified from the study area using line intercept method from sanetti plateau

Species	Family	Coverage (%)	
		Wet	Dry
<i>Agrostis gracilifolia</i> C.E. Hubbard	Poaceae	0.20	0.80
<i>Alchemilla abyssinica</i> Fress.	Rosaceae	11.80	4.20
<i>A. haumanii</i> Rothm.	Rosaceae	1.20	1.60
<i>A. rothii</i> Oliv.	Rosaceae	5.30	1.12
<i>Anthemis tigreensis</i> A. Rich	Asteraceae	0.72	0.53
<i>Arabis alpina</i> L.	Brassicaceae	0.21	0.11
<i>Artemisia spoerri</i> Engl.	Asteraceae	0.61	0.52
<i>Carex monostachya</i> A. Rich	Poaceae	0.30	0.43
<i>Cynoglossum lanceolatum</i> Forsk.	Boraginaceae	0.21	0.10
<i>Dianthoseris schimperi</i> A. Rich	Asteraceae	0.20	0.14
<i>Erica philippia</i> Complex	Ericaceae	0.42	0.41
<i>Euryops prostratus</i> Nordenstam	Asteraceae	0.37	0.00
<i>Festuca</i> spp.	Poaceae	15.00	6.33
<i>Haplocarpha rueppelli</i> P. Beauv.	Asteraceae	2.60	0.12
<i>Hebenstretia dentata</i> L.	Scrophulariaceae	0.20	0.17
<i>Helichrysum citrispinum</i> Del.	Asteraceae	2.60	0.00
<i>H. gofense</i> cuf	Asteraceae	8.80	5.25
<i>H. splendidum</i> Lees.	Asteraceae	5.90	1.22
<i>Koeleria capensis</i> Nees	Poaceae	0.51	0.31
<i>Lobelia rhyngopetalum</i> Hemsl.	Campanulaceae	0.20	0.23
<i>Ranunculus oreophytus</i> Del.	Ranunculaceae	0.23	0.81
<i>Rumex abyssinicus</i> Jacq.	Polygonaceae	0.30	0.63
<i>Salvia nilotica</i> Juss. Ex. Jacq	Lamiaceae	0.34	0.00
<i>Satureja simensis</i> (Benth.) Brif.	Lamiaceae	0.11	0.00
<i>Senecio schultzi</i> Hochst	Asteraceae	0.90	0.32
<i>Thymus schimperi</i> Ronniger	Lamiaceae	0.72	0.31
<i>Trifolium acaule</i> A. Rich	Papilionaceae	5.60	2.18

DISCUSSION

In this study, the most abundant plant species during both seasons were *Festuca* spp., *Alchemilla abyssinica*, *Helichrysum gofense*, *H. citrispinum*, *H. splendidum* and *Trifolium acaule*. Other studies have also noted all these species, as a dominant group in the area (Gashaw and Fetene, 1996; Puccetti *et al.*, 1996).

Most literature implies that hares are generalized herbivores, with a diet consisting primarily of grasses and shrubs but also barks, fruits, seeds, leaves and buds based on the habitat types (Rao *et al.*, 2002). However, in the present study, Starck's hares have a preferences to grasses as these occurred at high frequencies in all independent droppings. Supporting this, Hewson and Hinge (1990) concluded that hares spent a large part of their time grazing on wild grassland, indicating a preference for grasses. During the dry season, they fed on more diverse plant species than during the wet season, even though there was relatively high plant species diversity during the wet season. This might be due to the low availability of preferred food (grasses). Plants consumed during the dry season were based on the availability in the area (wetland plants). However, certain species such as *Alchemilla* spp. were never eaten although abundant.

Table 2: Relative frequency of occurrence of plants identified from independent droppings

Independent droppings	Wet			Dry		
	MN	DC	UN	MN	DC	UN
1	83.33	-	16.67	66.66	33.33	-
2	100.00	-	-	100.00	-	-
3	100.00	-	-	71.43	14.29	14.29
4	77.78	-	22.22	90.00	-	10.00
5	91.67	-	8.33	87.50	12.50	-
6	100.00	-	-	42.85	28.57	28.57
7	100.00	-	-	83.33	16.67	-
8	100.00	-	-	84.62	7.69	7.69
9	100.00	-	-	75.00	25.00	-
10	90.00	-	10.00	83.33	10.00	6.67
11	100.00	-	-	100.00	-	-
12	100.00	-	-	71.43	14.29	14.29
13	100.00	-	-	77.78	11.11	11.11
14	83.33	-	16.67	60.00	20.00	20.00
15	100.00	-	-	100.00	-	-
16	100.00	-	-	72.72	9.09	18.18
17	100.00	-	-	90.00	10.00	-
18	100.00	-	-	100.00	-	-
19	100.00	-	-	80.00	-	20.00
20	87.50	-	12.50	70.66	12.67	16.67
21	100.00	-	-	80.00	10.00	10.00
22	87.50	-	12.50	83.33	10.00	6.67
23	100.00	-	-	75.00	12.50	12.50
24	100.00	-	-	100.00	-	-
25	100.00	-	-	100.00	-	-

MN: Monocotyledon, DC: Dicotyledon, UN: Unidentified

Table 3: Plant coverage and percentage dietary composition of starck's hare from faecal analysis

Season	Monocot (%)		Dicot (%)	
	Plant coverage	Diet	Plant coverage	Diet
Wet	16.01	95.88	49.20	0.00
Dry	7.87	81.82	19.33	11.32

Table 4: Number and percentage of starck's hares recorded from different types of habitats at different level of wind

Seasons	Habitat type			Wind level		
	Rocky grassland	Wetland	Others	Strong	Medium	Low
Wet						
No. of individuals	278.00	42.00	69.00	45.00	125.00	219.00
%	71.47	10.08	17.74	11.66	32.13	56.30
Dry						
No. of individuals	95.00	112.00	60.00	54.00	71.00	142.00
%	35.58	41.95	22.47	20.22	26.59	53.18

The pattern of Starck's hares habitat use observed was associated with seasons. Though rocky grassland is the most preferred areas for starck's hare to protect themselves from predator and get grasses, during dry season mostly they are observed in wetland areas to get food.

From all the grass species identified from the study area, Starck's hares fed frequently on *Festuca* species. Soft and green parts of the plants were the most preferred compared to other parts during the study period in both seasons.

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REFERENCES

- Burgos, S. and S.A. Burgos, 2007. Influence of exotic bird and wildlife trade on avian influenza transmission dynamics: Animal-human interface. *Int. J. Poult. Sci.*, 6: 535-538.
- Cummings, J. and D. Smith, 2001. The Line Intercepts Method: A Tool for Introductory Plant Ecology Laboratories. Clemson University, Clemson, pp: 246.
- Dingerkus, S.K. and W.I. Montgomery, 2001. The diet and land class affinities of the Irish hare (*Lepus timidus hibernicus*). *J. Zool.*, 253: 233-240.
- Gabol, K., S. Mehmood, N. Yasmin, R.M. Tariq and R. Tabassum, 2005. Distribution, status of migratory and resident waterfowls of Drigh lake (Sindh) wildlife sanctuary. *Int. J. Zool. Res.*, 1: 37-40.
- Gashaw, M. and M. Fetene, 1996. Plant communities of afroalpine vegetation of sanetti plateau, Bale Mountains, Ethiopia. *SINET Eth. J. Sci.*, 19: 65-86.
- Gundogdu, E., 2011. Population size, structure and behaviours of wild goat in cehennemdere wildlife improvement area. *Asian J. Anim. Vet. Adv.*, 6: 555-563.
- Hewson, R. and M.D.C. Hinge, 1990. Characteristics of the home range of mountain hares *Lepus timidus*. *J. Applied Ecol.*, 27: 651-666.
- Hillman, J.C., 1993. Ethiopia: Compendium of Wildlife Conservation Information (CWCI). Vol. I, Ethiopia Wildlife Conservation Organization, Addis Ababa, pp: 27.
- IUCN., 2006. IUCN red list of threatened species. <http://www.iucnredlist.org>.
- Idris, A.B., A.D. Gonzaga, N.N. Zaneedarwaty, B.T. Hasnah and B.Y. Natasha, 2001. Does habitat disturbance has dverse effect on the diversity of parasitoid community? *J. Biol. Sci.*, 1: 1040-1042.
- Katona, K. and V. Altbacker, 2002. Diet estimation by faeces analysis: Sampling optimization for the European hare. *Folia Zool.*, 51: 11-15.
- Kingdon, J., 1997. The Kingdon Field Guide to African Mammals. Academic Press, London, UK., pp: 476.
- Maan, M.A. and A.A. Chaudhry, 2001. Wildlife Diversity in the Punjab (Pakistan). *J. Biological Sci.*, 1: 417-420.
- Malcolm, J., 1997. The diet of Ethiopian wolf (*Canis simensis*) from agrassland area of Bale Mountains, Ethiopia. *Afri. J. Ecol.*, 35: 162-164.
- Marino, J., 2003. Spatial ecology of Ethiopian wolf, *Canis Simensis*. Ph.D. Thesis, University of Oxford, London.
- Matrai, K., V. Altbacker and I. Hahn, 1998. Seasonal diet of rabbits and their browsing effect on Juniper in Bugae Juniper Forest. *Acta. Theriol.*, 43: 107-112.

- Nowak, R.M., 1999. Walker's Mammals of the World. 6th Edn., The John Hopkins University Press, London, pp: 837-1921.
- Puccetti, M.L.A., M. Corti, A. Scanzani, M.V. Civitelli and E. Capanna, 1996. Karyotypes of two endemic species of hares from Ethiopia. *Lepus habessinicus* and *L. starki* (Lagomorpha, Leporidae). A comparison with *L. europaeus*. *Mammalia-Int. J. Syst. Biol. Ecol. Mammals*, 60: 223-230.
- Rao, J.S., G.R. Iason, I.A.R. Hulbert and P.A. Racey, 2002. The effect of establishing native woodland on habitat selection and ranging of moorland mountain hares (*Lepus timidus*), a flexible forager. *J. Zool.*, 260: 1-9.
- Refera, B. and A. Bekele, 2004. Population status and structure of Mountain Nyala in the Bale Mountains National Park, Ethiopia. *Afri. J. Ecol.*, 42: 1-7.
- Reichlin, T., E. Klansek and H. Klaus, 2005. Diet selection by hares (*Lepus europaeus*) in arable land and its implications for habitat management. *Eur. J. Wildlife Res.*, 52: 109-118.
- Sillero-Zubiri, C., 1994. Behavioral ecology of the Ethiopian wolf (*Canis simensis*). Ph.D. Thesis, University of Oxford, Oxford
- Sillero-Zubiri, C. and D.W. Macdonald, 1997. The Ethiopian Wolf: Status Survey and Conservation Action Plan. IUCN/SSC Canid Specialist Group, Cambridge, pp: 123.
- Stevens, T.C. and J.M. Rochford, 2004. The diet and impact of the Irish hare (*Lepus timidus hibernicus*, Bell 1837) in a young plantation. *Biol. Environ. Proc. Royal Irish Acad.*, 104: 89-94.
- Sutherland, W.J., 1996. *Ecological Census Techniques: A Handbook*. 2nd Edn., Cambridge University Press, Cambridge.
- Tedla, S., 1995. Protected areas management crisis in Ethiopia. *Walia*, 16: 17-30.
- Yalden, D.W. and M.J. Lagen, 1992. The endemic mammals of Ethiopia. *Mammal Rev.*, 22: 115-150.