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Habitat association of insectivores and rodents of Alatish National Park, northwestern Ethiopia

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Abstract: Species composition and habitat association of rodents and insectivores were studied from August 2004 to March 2005 in Alatish National Park, northwestern Ethiopia. The main purpose of the present study was to identify the species composition of small mammals, determine threats on this unique ecosystem, show the economic importance of insectivores and rodents in terms of food source and pest status, and increase awareness creation to help in the gazettment of the area. Wooded grassland, woodland, riverine woodland and mixed bamboo woodland habitats were identified. Nine representative live trapping grids were randomly selected to represent the four habitat types in addition to the three special trap sites. A total of 370 individuals comprising 23 rodent and six insectivore species were captured. Three rodent species and a shrew await further taxonomic analysis. The endemic rodent species of the Ethiopian highland forest, *S. albipes* and *D. harringtoni*, and the three shrew species (*C. flavescens, C. turba* and *C. fumosa*) were captured from areas outside their formerly recorded altitudinal limit and geographic ranges in the country. The study revealed the importance of remote areas in harbouring unique fauna although the harsh climate and limited accessibility are barriers for further exploration. The high diversity of small mammals and limited number of settlers make Alatish an important conservation centre.

Resumen: Se estudió la composición de especies y las asociaciones de hábitat de roedores e insectívoros en el Parque Nacional Alatish, noroeste de Etiopía, entre agosto de 2004 y marzo de 2005. El propósito principal del estudio fue identificar la composición de especies de mamíferos pequeños, reconocer las amenazas que se ciernen sobre este ecosistema único, mostrar la importancia económica de los insectívoros y los roedores en términos de las fuentes de alimento y el estatus de las plagas, e incrementar la generación de conciencia para ayudar a la difusión del área. Se identificaron los siguientes hábitats: pastizal arbolado, bosque abierto, bosque abierto ribereño y bosque abierto mixto de bambú. Se seleccionaron al azar nueve retículas para atrapar animales en vivo con el fin de representar los cuatro tipos de hábitat, además de los tres sitios de trampas especiales. En total fueron capturados 370 individuos que representaron 23 especies de roedores y seis especies de insectívoros. Tres especies de insectos y una musaraña quedaron en espera de un mayor análisis taxonómico. Las especies endémicas de roedores del bosque de las tierras altas de Etiopía, *S. albipes* and *D. harringtoni*, y las tres especies de musaraña (*C. flavescens, C. turba* y *C. fumosa*) fueron capturados en áreas que rebasaron el límite altitudinal y fuera de las áreas de distribución geográfica registradas con anterioridad en el país. El estudio reveló la importancia de las áreas remotas para albergar una fauna única, a pesar de que el clima adverso y el acceso limitado son barreras para una exploración más amplia. La alta diversidad de animales pequeños y el número limitado de pobladores hacen de Alatish un centro importante para la conservación.

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Resumo: A composição específica e o habitat da associação de roedores e insectívoros foram estudados de Agosto de 2004 a Março de 2005 no Parque Nacional de Alatish, no noroeste da Etiópia. O principal objectivo do presente estudo foi o de identificar a composição específica de pequenos mamíferos, determinar as ameaças neste ecossistema único, mostrar a importância económica dos insectívoros e roedores em termos de fonte alimentar e o status de pragas, e aumentar a criação de consciência para ajudar na divulgação da área. Habitats de pastagem arborizada, bosque, bosque ribeirinho e bosque misto com bambo, foram identificados. Nove quadriculas de ratoeiras vivas foram casualmente seleccionadas como representativas dos quatro tipos de habitats em adição às ratoeiras nas três estações especiais. Um total de 370 indivíduos, compreendendo 23 roedores e seis espécies insectívoras, foram capturadas. Três espécies de roedores e um musaranho aguardam futura análise taxonómica. As espécies roedoras endémicas da floresta de altitude na Etiópia, *S. albipes* e *D. harringtoni* e as três espécies de musaranhos (*C. flavescens, C. turba* and *C. fumosa*) foram capturadas em áreas fora dos limites de altitude e dos limites geográficos previamente registados no país. O estudo revelou a importância de áreas remotas em abrigar fauna única, embora o clima severo e a acessibilidade limitada constituam barreiras para exploração futura. A elevada diversidade de pequenos mamíferos e o pequeno número de fazendeiros fazem com que Alatish seja um importante centro de conservacionista.

Key words: Alatish, diversity, Ethiopia, habitat association, insectivores, rodents.

Introduction

In Eastern Africa, rodents account for 28% of the total mammalian fauna (Kingdon 1989). The insectivore fauna, particularly of shrews, is also most diverse having 140 species (Hutterer & Yalden 1990). However, ecological studies for small mammals in Africa were focused mostly on the western region with minimal attention on the eastern part of the continent (Delany 1986). Frequent discovery of new species of small mammals from Africa shows the need for faunal survey, particularly in remote areas. Faunal exploration is an important component of the study before considering a given area as a protected centre. Information on the diversity of small mammals besides reinforcing scientific knowledge will boost the importance of the region to establish refugia.

Ethiopia's past geological history, unique topography and wide ranging climate have made home for diverse biological resources with 284 species of mammals of which 39.4% are small mammals (Hillman 1993; Lavrenchenko *et al.* 1997; Yalden & Largen 1992). Ethiopia is also notable for containing 50% the Afrotropical region's land above 2000 m asl (Yalden 1983). Extensive surveys for small mammals of the country were confined in relatively accessible parts of these highground areas that account for little more than 17% of the total area (Yalden & Largen 1992). The southwestern forest, south and southeastern highlands, the Rift Valley, the Simien massifs and few isolated forest blocks of central Ethiopia are the only surveyed areas (Afework Bekele 1996a, 1996b; Muller 1977; Rupp 1980; Sillero-Zubiri *et al.* 1995; Yalden 1988a, 1988b). Many regions in Ethiopia are underexplored as a result of inaccessibility, remoteness and inhospitability of these areas. Besides lack of scientific information about the fauna of such areas, opportunities to collect such data are rapidly diminishing due to the ever accelerating human demand for arable land. The present study site, Alatish National Park (ANP) is part of the northwestern extensive lowland area of the Amhara National Regional State (ANRS), Ethiopia. The ANRS has recently established the Alatish lowland area as a key biological resource conservation area based on the diversity of large mammal fauna and the unique ecosystem of the area (BOARD-LUPT 1997; Crabtree 1997; Kefyalew Sime *et al.* 1996). To fulfill the gap on information on the small mammal fauna of the

area, the present paper attempts to collate data on the diversity, distribution, relative abundance and habitat association of rodents and insectivores of the ANP.

Materials and methods

The study area, ANP is located in the Quara district of north Gonder Zone, northwestern Ethiopia (between 11°47' & 12°21'N latitude and 35°16' & 35°47'E longitude). It is about 1123 km northwest of Addis Ababa and 324 km southwest of Gonder and covers an area of 2600 km². This is a lowland area with an elevation ranging between 528 and 654 m asl. The climate of the area is classified as a tropical semi-arid zone, characterized by five rainy months (May to September) with highest concentration in July and August (Daniel Gemechu 1977). The mean annual rainfall ranges between 600 and 1000 mm. The mean minimum temperature ranges between 13.6°C and 19.2°C, and maximum between 34.0°C and 41.1°C. As a result of the sandy nature of the soil, high temperature and low rainfall, there is a low diversity of vegetation dominated by few species of deciduous trees such as *Pterocarpus lucens*, *Terminalia laxiflora*, *Combretum* sp. and few tall annual grasses dominated by *Hyparrhenia cynescence* and *Rottboelia cochinchinensis*. Due to the harsh environmental conditions and high prevalence of malaria, there is limited year round development activity in the area. However, few Gumuz indigenous people reside along the three sides except west of Alatish following the basins of the two seasonal rivers (Gelegu and Dinder) depending on subsistence farming, hunting and gathering.

Due to the presence of invariably uniform climate, altitude, soil type, temperature and rainfall; the vegetation of the study area is not clearly differentiated and demarcated into well defined habitat types. However, based on the classification of vegetation regions of Ethiopia (Yalden & Largen 1992); habitat classification scheme of Western & Grimsdell (1979); White (1983); GIS vegetation data scanned from satellite (2004) and the vegetation classification data of the adjacent Dinder National Park (Dasmann 1972), the habitat of Alatish area was classified into four broad categories: Wooded grassland (WGL), Woodland (WL), Riverine woodland (RWL) and Mixed bamboo woodland (BWL) (Fig. 1).

Based on the topographic map of the area (1:250,000), Alatish area was divided into 37 grids. From these, a total of 11 grids, that represented the four vegetation types (WGL, WL, RWL & BWL) were randomly selected. These were coded and latitudinal and longitudinal boundary

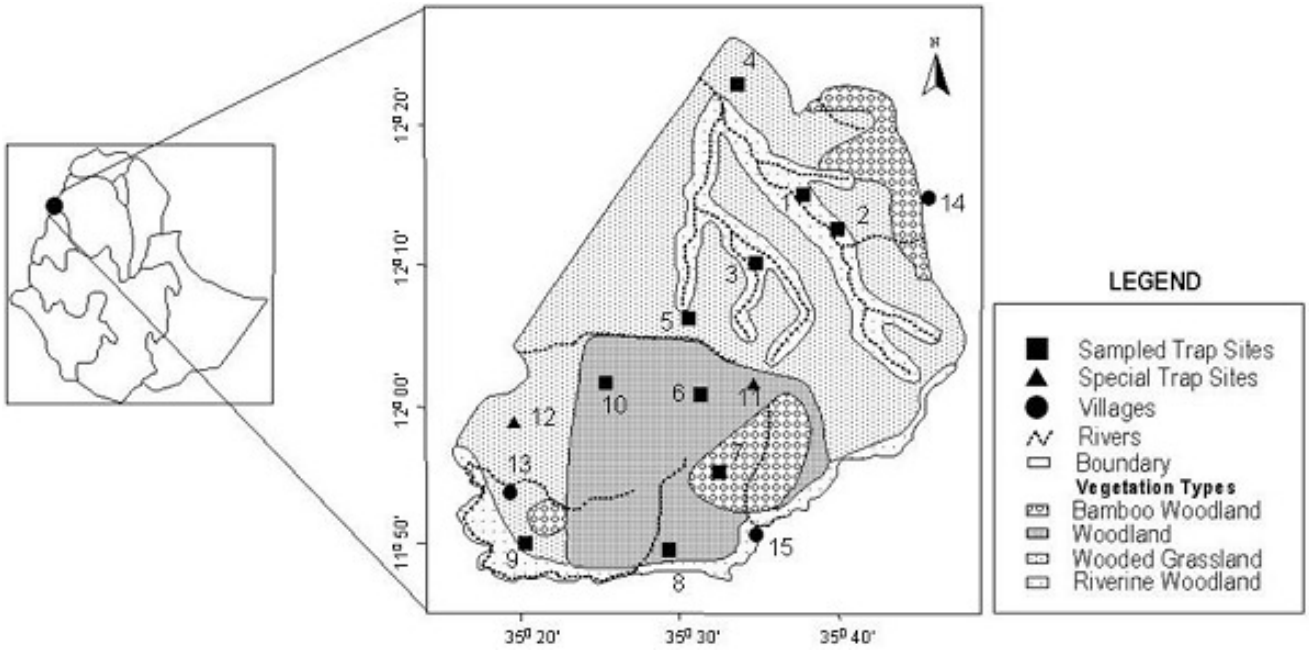

Fig. 1. Map of Ethiopia showing the vegetation categories and trap sites of Alatish National Park.

coordinates of each were worked out from the topographic map. Nine of them were surveyed during the wet (Oct.-Nov. 2004) and dry (Feb.-Mar. 2005) data collection seasons, in addition to August-September 2004 survey. Each sampled grid site on the ground was traced and located using GPS and the topographic map of the area.

Data to study the diversity, distribution, and relative abundance and habitat association of rodent and insectivore species for both seasons were collected using the standard trapping techniques. Live trapping was carried out by small (16x6.5x5.5 cm), medium (23.5x8x8.9cm) and large sized (35x8x9.5cm) Sherman live traps. On randomly sampled study grids, 50 Sherman traps, spaced at 10 m interval, were placed. Additional traps were set when a unique habitat was observed as STS-1 & STS-2. Traps were also set in few Gumuz villages to sample the commensal fauna of the area (Fig. 1). All villagers were interviewed and shown the different species of insectivores and rodents to identify the pests and food preference. In addition, guides from the local community helped to identify the valuable species as important food source and were collecting some of the species for consumption. Peanut butter mixed with corn flour was used as bait for each species. Traps were checked between 0600 and 0800 and 1700 and 1800. Local rodent snares were used for larger rodents and extreme trap shy rodents were excavated. The necessary information surrounding the trap sites, and all standard measurements of the captured animals including their weight, sex, and reproductive conditions (for males: position of the testes, scrotal or abdominal; for females: vaginal conditions, perforate or imperforate, pregnant or lactating) were recorded. Dissection was carried out on pregnant females to count the number of embryos on each horn of the uterus. Resorbed embryos were excluded. All snap trapped animals were collected. Skin and skull of the representative specimens were mounted and deposited in the Zoological Natural History Museum, Addis Ababa University. Shannon-Weaver Index was used to compute the insectivore and rodent species diversity. The relative abundance of trapped small mammals was assessed as the percentage of trap success, and Chi-square test was used to show the differences. Simpson's Similarly Index was used to assess the similarity of small mammals among the habitats.

Results

The present work revealed the presence of 29 species of insectivores and rodents in the study area. Out of these, 23 were rodents (including four squirrels and a porcupine), six were insectivores (five shrew species and the African hedgehog). 959 trap nights yielded a total of 370 individuals. Of these, 343 (92.4%) represented 19 species of rodents of 11 genera and three families and the remaining 27 individuals (7.6%) represented six species of insectivores grouped in three genera and two families. These rodent species were classified as relatively more abundant and rare based on the number of individuals of each species trapped (Table 1). Larger rodents such as porcupine,

Table 1. Diversity and relative abundance (%) of rodent and insectivore species (*observed species).

Family	Species	Relative abundance
Muridae	*Arvicanthis dembeensis*	27.80
	A. niloticus	24.50
	Desmomys harringtoni	7.80
	Mastomys natalensis	7.00
	Stenocephalemys albipes	5.40
	Acomys cahirinus	4.10
	Murid sp. B	3.24
	Acomys wilsoni	2.90
Crecitidae	*Tatera valida*	2.40
Muridae	*Mastomys erythroleucus*	1.35
	Acomys cineracues	1.35
	Acomys sp. A	1.08
Crecitidae	*Tatera phillipsi*	0.80
Muridae	*Mus musculus*	0.80
Crecitidae	*Tatera robusta*	0.50
Muridae	*Lemniscomys barbarus*	0.50
	Mus tenellus	0.27
	Murid sp. A	0.27
Sciuridae	*Euxerus erythropus*	0.27
Soricidae	*Crocidura flavescens*	2.70
	Crocidura turba	2.70
	Crocidura smithi	0.50
	Crocidura fumosa	0.50
	Soricid sp. A	0.27
Erinaceidae	*Atelex albiventris* (African hedgehog)	0.50
Sciuridae	*Paraxerus ochraceus* (*Bush squirrel)	
	Heliosciurus gambianus (*Gambian sunsquirrel)	
	Xerus rutilus (*Unstriped ground squirrel)	
Hystricidae	*Hystrix cristata* (*Porcupine)	

unstriped ground squirrel, bush squirrel and the Gambian sun squirrel were observed throughout the study area, but were not trapped.

Three rodent species (*Murid* sp. A, *Murid* sp. B and *Acomys* sp. A) and a shrew (*Soricid* sp. A) were newly described from ANP. A general morphological description of these new small mammals is given as follows:

Murid sp. A

Single specimen of this species was trapped from the northern grid (Megenagna trap site), 12° 11' N latitude & 35° 40' E longitude. It is a medium sized scrotal male rodent, testes with creamy dark black colour (shiny), light dark ventral part with large eyes and ears. The dorsal side of the feet was whitish and soles were dark. It possessed non-grooved incisors and exceptionally big testes. The bicolor tail was scaly. The skull was rounded and the anterior palatal foramina extended down to half of the first molar. M^{1-3} = 5.1 mm, and has unique frontally oriented cusps of the upper last (3rd) molars. The head and body length measures 98 mm, tail 84 mm, hind foot 23 mm, ear 15 mm and weight 30 g.

Murid sp. B

Twelve individuals of these medium sized rats were trapped during the dry season from three habitats (RWL, WGL & from a patch of pocket grassland habitat near the Ethio-Sudan border). This species showed superficial resemblance to *D. harringtoni*. It had harsh gray fur on the back and light paler hair on the ventral side. The special feature of this species is the presence of reddish coloured hair from the base of the tail along the mid-dorsal surface forming a 'V' shaped structure. The upper incisors were slightly grooved; tail was paler, scaly and slightly shorter than head and body. It was observed foraging during late afternoon. The head and body length was 139.5 ± 22 mm, tail 136 ± 7 mm, hind foot 30± 28 mm, ear 13.5±1.08 mm and weighed 125.0±16.4 g.

Acomys sp. A

One specimen of this species was trapped from Megenagna trap grid during the wet season and three were from different habitats including the human habitation during the dry season. It was a tri-colored spiny-skinned and tail-less. The body surface was covered with spine. The dorsal colour was pale with narrow golden line on the sides separating the pure white ventral part from the dorsal one. Rough spines extended to the face region unlike those of *A. cahirinus*, *A. wilsoni* and *A. cineraceus*. The ventral part was fully covered with white semi-spinous fur. Ears were large and forwardly oriented. The face surface was darker than the dorsal colour. The specimens lacked tail, even traces. Average head body length was 98.7 mm, hind foot 14.7 mm, ear 10 mm and weighed 36.7 g.

Soricid sp. A

The only shrew specimen of this type was trapped from a settlement area, northeastern Alatish (12°12'N & 35°53'E). It had soft pale hair throughout its body. The elongated skull, the protruded snout and body size resembled *C. flavescens*. The upper lip was tapered with long sparse whiskers. The presence of white teeth may lead to mistaken identification with other species of the genus *Crocidura*. It had short ears and minute eyes. The dorsal surface of feet was black and the black soles were bare. It was an adult female with six mammae. The short thick tail was covered by short hairs and interspersed by black long vibrissae all along. The head and body length was 140 mm, tail 70 mm, hind foot 20 mm, ear 10 mm and weighed 50 g. The skull structure and dentition were unique. Unlike those of *Crocidura*, its brain case is not flattened. I^1 - M^3 = 15 mm. It lacked three unicuspid teeth behind the front incisors on the upper jaw as in the case of genus *Crocidura* (in which case the dental formula becomes 3113/2013 = 28), or four unicuspid teeth as those of the genus *Suncus* and *Sylvisorex* (in which cases the dental formula become 3123/2013 =30). This shrew has only two unicuspid teeth behind the upper front incisors with the dental formula 3013/2013 = 26. In addition, the third molar is not reduced as those of *Crocidura*.

Most of the insectivore and rodent species were trapped from the wooded grassland habitat (WGL). Only zebra mice, *L. barbarus,* and *Soricid* sp. A were absent in this habitat type. The only trapped ground squirrel (*E. erythropus*) and the excavated *Tatera* (*T. robusta* & *T. phillipsi*) were also from this habitat. The riverine woodland (RWL) had the second highest number of species during the dry season with ten rodent and one insectivore species.

However, during the wet season, none of the 100 traps set in the two representative grids caught small mammals. Mixed bamboo woodland (BWL) habitat has the highest overall trap success. However, it is next to the riverine woodland in terms of the number of species caught. The Shannon-Weaver Index (H′) showed 2.195, 1.766 and 1.399 for WGL, RWL and BWL, respectively (Table 2). When the overall capture is considered, WGL had the highest capture rate (47%), followed by RWL and BWL with 17.3 and 11.6%, respectively whereas, WL contributed for only 1.6%.

Table 2. Distribution of species in the four habitats, special trap sites (STS 1, 2) and villages (HH) in ANP (*observed species).

Species	Habitat types						
	WGL	WL	BWL	RWL	HH	STS-1	STS-2
A. dembeensis	49	4	28	14	-	8	-
A. niloticus	43	-	17	10	4	14	3
D. harringtoni	12	-	8	2	1	6	-
M. natalensis	10	-	3	3	7	3	-
M. erythroleucus	5	-	-	-	-	-	-
S. albipes	6	-	1	-	5	-	8
A. cahirinus	10	2	2	1	-	-	-
A. wilsoni	5	-	4	-	1	1	-
A. cineraceus	5	-	-	-	-	-	-
Acomys sp. A	1	-	-	2	1	-	-
T. robusta	2	-	-	-	-	-	-
T. valida	2	-	-	2	-	-	5
T. phillipsi	3	-	-	1	-	-	-
Murid sp. A	1	-	-	-	-	-	-
Murid sp. B	2	-	-	5	-	2	3
M. musculus	1	-	-	-	-	1	-
M. tenellus	1	-	-	-	-	-	-
L. barbarus	-	-	-	2	-	-	-
C. flavescens	7	-	-	-	3	-	-
C. turba	4	-	1	1	4	-	-
C. fumosa	2	-	-	-	-	-	-
C. smithi	2	-	-	-	-	-	-
Soricid sp. A	-	-	-	-	1	-	-
A. albiventris	2	-	-	-	-	-	-
E. erythropus	1	*	*	*	*	*	*
P. ochraceus	*	*	*	*	-	*	*
H. gambianus	*	*	*	*	-	*	*
X. rutilus	*	*	*	*	*	*	*
H. cristata	*	*	*	*	*	*	*
H′	2.195	-	1.399	1.766	-	-	-

The overall difference in the recorded species diversity between the two seasons was not significant (p>0.05). However, *M. erythroleucus, T. robusta, Murid* sp. A, *C. fumosa* and *Soricid* sp. A were absent during the dry season capture while *Murid* sp. B*, L. barbarus, A. albiventris* and *E. erythropus* were absent during the wet season trapping. Variation in species diversity between habitats was significant (x_3^2 = 19.5, P<0.001). The number of species captured from different grids of each habitat also varied considerably (Table 3). Maximum number of species was from grid 20 (WGL habitat) during the wet season, which comprised eight rodent and four shrew species.

Trap success was significantly high χ_1^2 = 7.6, p<0.01 during the dry season. There was also variation in the trap success between the different sampled study grids during the two seasons (χ_8^2 = 62.6, P<0.001). The overall trap success for the two seasons was 38.6%. However, among the major habitat types, capture rate varied from 12 to 64%

Table 3. Number of species of small mammals trapped from different study grids during both seasons.

Grid	Habitat type	Season	Number of species
4	WGL	Wet	5
		Dry	-
7	RWL	Wet	-
		Dry	10
13	RWL	Wet	-
		Dry	7
13	WGL	Wet	5
		Dry	6
20	WGL	Wet	12
		Dry	7
26	WL	Wet	2
		Dry	-
29	WGL	Wet	9
		Dry	4
33	BWL	Wet	4
		Dry	6
37	WGL	Wet	7
		Dry	3
HH	Commensal	Wet	3
		Dry	9
STS-1	WGL	Dry	7
STS-2	GL	Dry	4

and the variation was highly significant (χ^2_3 = 46.9 p<0.001) (Table 4).

Individuals of all age groups (juvenile, young, sub-adult & adult) were represented during the wet season trapping. Young animals during the wet season accounted for 34.4% of the total capture. Young individuals of only few species were represented during the dry season trapping. Among the adult females 69% of *A. dembeensis*, 60% of *M. natalensis*, and 50% of *D. harringtoni* were pregnant or lactating during the wet season (Table 5). Such reproductive animals were only few during the dry season.

Twelve rodent and three insectivore species were chronic pests in villages surrounding the Park. Locals use small mammals as an important food source. Out of the 23 rodent species, 16 rodent and one insectivore species were important components of the diets of Gumuz indigenous people. The Gumuz ethnic group use Alatish area as a hunting and trapping ground. Their mode of life (hunter-gatherer), the abundance and accessibility of rodents, easy trappability and easy cooking methods might have contributed for their high demand. Preference for rodents by the two tribes of Gumuz (Datse and Gumuz) varied. However, porcupines, squirrels, *Arvicanthis* and *Desmomys* species were the most preferred by both tribes. All *Acomys* and shrew species were rejected by both tribes. Table 6 shows rodent species used as a source of food. Among the insectivores, only the African hedgehog is used as a food source.

Table 4. Trap success rate and relative success of various habitats in ANP.

Habitat	No. of grids	Trap nights	Percent	Success rate	Relative sucess
WGL	5	450	47.40	39.1%	18.35
WL	1	50	5.26	12.0%	0.60
RWL	2	200	20.50	21.5%	4.48
BWL	1	110	11.50	64.0%	6.67
Village	2	40	4.17	67.5%	2.80
STS-1	1	59	6.16	59.3%	3.60
STS-2	1	50	5.26	38.0%	1.90
Total	13	959	100.00	-	38.60

Table 5. Representative pregnant and lactating female rodents from the wet season capture.

Species	Number			
	Adult	Pregnant	No. of embryos	Lactating
A. dembeensis	16	11	4-6	4
M. natalensis	5	3	22	2
M. erythroleucus	3	1	13	2
D. harringtoni	6	3	6-10	3
A. cahirinus	8	7	4-6	1
C. turba	2	1	5	1
M. musculus	1	-	-	1
A. wilsoni	3	2	4	1

Table 6. Rodent species consumed by Gumuz people as an important food source.

Family	Species	Degree of preference
Hytricidae	*H. cristata*	High, by both tribes
Scuiridae	*E. erythropus*	"
	P. ochraceus	"
	X. rutilus	"
	H. gambianus	"
Erinaceidae	*A. Albiventris*	"
Muridae	*A. dembeensis*	"
	A. niloticus	"
	Murid sp. B	"
	D. harringtoni	"
	M. natalensis	Children of both tribes
	L. barbarous	"
	S. albipes	"
Cricetidae	*T. valida*	Only Datse & children of both tribes
	T. robusta	"
	T. phillipsi	"

Nine rodent species were observed in human habitats, acting as pests**.** *M. natalensis, S. albipes, A. wilsoni, Acomys* sp. A. *D. harringtoni* and *A. niloticus* were the most common commensal pests, while porcupine was the most important crop field pest of the area. Both species of ground squirrels (*E. erythropus* and *X. rutilus*) were known pests of stored grains. *C. flavescens*, *C. turba*, and *Soricid* sp. A, besides consuming household materials, are notorious chicken raiders of the area.

Discussion

The present study has recorded 29 species of insectivores and rodents. Two rodent species (*S. albipes* and *D. harringtoni*) and three shrews (*C. flavescens*, *C. turba* and *C. fumosa*) were captured from altitudinal limits and geographic ranges new to these species. *S. albipes*, which was thought to

be an endemic species to the Ethiopian highland plateaux (Yalden & Largen 1992) is also a common species in all habitats of ANP including the human habitats. Formerly, in Ethiopia, it was trapped between 820 and 4000 m asl (Afework Bekele 1996a; Dorst 1972; Ingersol 1968; Yalden *et al*. 1976; Yalden & Largen 1992). The current capture is a new altitudinal and habitat range for the species. This species was also trapped from the Ethio-Sudan border trap site, which shows the possibility of range expansion to the neighbouring country. *D. harringtoni* is an Ethiopian endemic species, whose range was thought to be restricted in the Ethiopian highlands. It is also the third abundant species in ANP. The previous records were between 1800 and 2800 m asl (Afework Bekele 1996b; Yalden *et al*. 1976). Its occurrence in ANP is a new record for its range. *C. flavescens,* the common shrew of ANP was thought to be typically a forest species (Yalden *et al*. 1976). Former records of this species in the country were never below 1500 m asl. The present finding of the species in ANP is a new range extention. *C. fumosa* was considered as a moorland species (Yalden 1988b) sighting between 1750-4000 m asl. During the present study, few specimens were captured from the wooded grassland habitat. Genus *Acomys*, occurring between sea level and 1500 m asl (Bates 1994; Sokolov *et al*. 1993; Yalden *et al*. 1976) has high diversity in ANP. Ellerman *et al*. (1953) stated Ethiopia as an evolutionary centre for this genus. The high sympatric diversity of the species in ANP also supports this view. The lowland species, *A. dembeensis* is common between sea level and 2200 m asl (Afework Bekele 1996b). Capula *et al*. (1997) reported that this species is the third endemic species of the genus in Ethiopia. However, the current trapping of this species from the Ethio-Sudan border makes its endemicity under doubt. The trap shy species of *Tatera* (*T. robusta*), was excavated from its burrows during the present study and the trap prone species of the genus (*T. valida*) was well within the described geographic range of the species (between 200 & 1700 m asl) (Afework Bekele & Leirs 1997). However, the capture of *T. phillipsi* in Alatish contradicts the description of Bates (1988) limiting the distribution within the Ethiopian and Kenyan Rift Valley. The two species of *Mus* (*Mus musculus* and *Mus tenellus*) of ANP are also unique as they are known for their occurrence in open habitats between 1500 - 3000 m asl (Yalden 1988a). Bates (1988) also stated their occurrence exclusively in urban areas and villages. ANP is the second site record for *Lemniscomys barbarus* in Ethiopia, the former being near to the shore of Lake Abaya. In the current taxonomic revision of the genus, this species is re-named as *L. zebra*, and is recognized as a distinct species of Ethiopia. During the present study, it is considered as a rare species. The record of the unstriped ground squirrel, *Xerus rutilus* in ANP is in line with the description of Fiedler (1994), who stated its occurrence in the more arid areas of up to 2000 m asl in Ethiopia, Kenya, East and Southern Sudan, Tanzania and Uganda. However, this contradicts with the records of Yalden *et al*. (1976) and Kingdon (1997) that restrict its distribution only to the eastern lowlands of Ethiopia.

Differences in small mammal abundance from various areas can be compared using average trap success rates. The highest record in Ethiopia was reported by Rupp (1980), 35% success rate from south Goba. An average trap success varying between 24 and 27% was also recorded from various sites in Harenna Forest (Ethiopia) (Yalden 1988b). Afework Bekele (1996a) reported 9.1% success rate from Menagesha State Forest, central Ethiopia. When compared with these, the average trap success rate during the present study (36.8%) is relatively high, indicating the high abundance of small mammals in the area. Climatic factors, availability of food, adequate cover and minimum human interference might have contributed to the diversity of small mammals in the area.

Regardless of the prevailing climatic and anthropogenic effects, abundance of small mammals was very high during the dry season (47.8%) when compared to the wet season (25.3%). This might be associated with the wet season breeding behaviour of most of the small mammals of the area that can reach trappable age where they move away from the nest site by gaining weight through time reaching sub-adult and adult stages during the dry season.

From the distribution data, the small mammal species of ANP tend to prefer open habitats. This may be the reason why the relatively open habitat of the area, (WGL), harboured the highest number of species. Davis & Schmidly (1994) stated that most granivores typically occupy open habitats.

Over 77% of the trapped small mammals in ANP were granivores and omnivores.

Small mammals in Alatish area show seasonal movement between habitats following seasonal changes. The absence of animals from the riverine woodland during the wet season and their high abundance during the dry season strengthens this possibility. They migrate into the WGL during the wet season, and back to the RWL, BWL and possibly to WL during the dry season. Relative openness and dryness of the wooded grassland habitat may be suitable for free movement and burrow construction during the wet season compared to the other habitats. However, further study is essential to substantiate this argument. The relatively openness and dryness of the WGL habitat during the wet season allows more inflow of small mammals from neighbouring habitats. The overflooded, moist, humid and damp microhabitats of RWL, WL and BWL during the wet season are inhospitable to small mammals. On the other hand, dry season forest fire and excessive grazing remove most of the cover and food of small animals from larger areas of the WGL habitat. However, these are abundantly present in other habitats during this season. Similarly, Hansson (1977) reported the movements of animals between refugia and affected habitats following seasonal changes in food supply and habitat conditions.

During the present study, it was also observed that 11 species of the small mammals in ANP have a highly restricted distribution since they were trapped from a single habitat, while the other six species from two habitats, four from three and three from all habitats. The effect of habitat change varies between species (Emmons 1984; Pahl *et al*. 1988). Species to disappear first due to habitat change are those that are conspicuous and specialists on limited vegetation types (Emmons 1984). Although the exact causes are not known, during the present study, some species are categorized as rare (that are represented fewer than 5 individuals) and some are trapped only in one season but not in the other.

The age distribution in a population of small mammals in various seasons is directly related to the seasonality in reproduction of the species. The small mammal communities in the ANP showed this general principle. Young members accounted for 34.3% of the total population during the wet season. The correlation between rainfall and the seasonality of reproduction for the majority of the small mammals in Africa has gained acceptance by many workers (Afework Bekele & Leirs 1997; Delany 1986; Happold 1974; Perrin *et al*. 1992; Taylor & Green 1976). The presence of pregnant or lactating females, juveniles and young individuals during the wet season trapping goes in line with the statement. But, only *Mastomys*, S*tenocephalemys* and *Acomys* species had pregnant, lactating or young members during the dry season. This is in agreement with the findings of continuous breeding throughout the year for these species (Afework Bekele & Leirs 1997; Perrin *et al*. 1992). The occurrence of two pregnant females each with six embryos of *T. valida* during the dry season, however, contradicts the report of Fiedler (1994) describing the rainy season breeding property of the genus. *Acomys* has pregnant females in both seasons but showed considerable variation in the number of embryos between the seasons. During the wet season, *Acomys* had 4 to 6 embryos each sampled from nine pregnant females. However, during the dry season, pregnant females invariably contained only two embryos. Pianka (1970) reported the occurrence of smaller litter size when *Arvicanthis* reproduce aseasonally. This may also hold true for *Acomys* in ANP.

70% of the rodent species of ANP are important components of the diet of Gumuz indigenous people residing near the Park. They use Alatish area as hunting or trapping ground. Their mode of life (hunter-gatherer), and the abundance, accessibility, easily trappability and easily cookability of rodents might have contributed for their high demand. Rodent species preference by the two tribes of Gumuz (Datse and Gumuz) varied. However, porcupines, squirrels, *Arvicanthis* and *Desmomys* species are the most preferred whereas all *Acomys* and shrew species are rejected by both tribes. Among the insectivores, only the African hedgehog is used as a very important food source.

Nine rodent species (50%) have representatives in the human habitation, becoming chronic pests. The mechanism of co-existence of small mammals in villages need further study. However, the absence of the world wide commensal rats *(Rattus rattus* and *R. norvegicus*) from the present collection sites as a result of isolation might have contributed to the

diversity of small mammals in human habitation. Minimal anthropogenic effect with limited transport system as well as competition might have played a role in limiting the distribution of *Rattus*. Both species of ground squirrels (*E. erythropus* and *X. rutilus*) are known pests of stored grains.

Information on the effects of fire on small mammals is immense. Its effects have been shown in lowering the species diversity, in the destruction of vast areas of their habitat and food, changing their behaviour and leading to population fluctuation (Clausnitzer 2003; Delany 1986; Haim & Izhaki 1994). Similar effects might have contributed to the small mammal fauna of ANP due to the dry season fire. The extensive fire, excessive grazing effects by the "Fellata" herds and the complete absence of surface water during the dry season seem the most important threats for the survival of small mammals in Alatish area. Many authors also demonstrated effects of habitat change on small mammal diversity, distribution and abundance due to heavy utilization by wild ungulates and livestock (Joubert & Ryan 1999; Keesing 1998; Keske & Campbell 1991). This might have affected the small mammal fauna of ANP due to the uncontrolled grazing by the tens of thousands of the “Fellata” herds from the Sudan during the dry season. Unraveling the secrets of the small mammal fauna of Alatish demand further detailed studies focusing on individual species and community ecology. The unique lowland ecosystem of Alatish revealed that the inaccessible, remote areas of the country harboured probably unique, rare, endemic or endangered fauna of special ecological, biological and conservation interest. Therefore, in order to have a comprehensive understanding about the Ethiopian faunal diversity, assessing every corner within the geographic boundary of the country should be a priority.

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