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Species composition, habitat association and distribution of rodents and shrews in Chato Protected Area, Ethiopia.

By

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LIST OF ACRONYMS

ASL: Above Sea Level

BMNP: Bale Mauntains National Park

CCNP: Chebera Churchura National Park

CMR: Cupture Mark Recapure

CPA: Chato Protected Area

GPS: Geographical Positioning System

NFPA: National Forest Priority Areas

OFWE: Oromia Forest and Wildlife Enterprise

SMNP: Simien Mountains National Park

SPSS: Statistical Package for Social Sciences

ZNHM: Zoological Natural History Museum

ABSTRACT

Species composition, habitat association and altitudinal distribution of rodents and shrews were assessed in Chato Protected Area (CPA), Ethiopia between July 2015 and March, 2016. The area was stratified based upon vegetation types and altitudinal zonation. Based on vegetation and altitudinal composition, the study area was divided into five habitats. These were *Carissa spinarum* - *Justicia schimperiana, Maytenus gracilipes,* and *Podocarpus falcatus*- *Pyschotria orophila* dominated areas and riverine and plantation habitats. A total of 254 individuals comprising five rodent and one shrew species were live trapped from 1862 trap nights. These species of rodents were; *Stenocephalemys albipes* (40.95%), *Lophuromys flavopunctatus* (23.6%), *Arvicanthis* sp. (16.9%), *Mus mahomet* (13%), *Mastomys natalensis* (4.35%) and a shrew; shrew sp. (1.2%). Two of these rodent species (*S. albipes and L. flavopunctatus*) were the most abundant that comprised 64.56% of the total. They were distributed in the entire forest at variable elevations. The shrew sp. was the least abundant and was distributed along the center of the forest. *Matyenus gracilipes* dominated at 1,789 - 1,975 m was the most diverse and comprise 19.39% trap success. *Podocarpus falcatus*-*Pyschotria orophila* dominated from 1,975 to 2,230 m was another diverse habitat that comprised the highest or 22.7% trap success. Plantation supported the least number of rodents. Age and sex distribution of the rodents varied based upon seasons.

Keywords: Altitudinal variation, Chato Protected Area, distribution, habitat, rodents, shrews

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1. INTRODUCTION

1.1. General Background

In Ethiopia, the diverse macro and micro-climatic conditions have contributed to the formation of diverse ecosystems that inhabit diversity of life forms of both animals and plants (Fayera Senbeta, 2006). It is known that there occur 284 species of mammals of which 39.4% are small mammals (Taddesse Habtamu and Afework Bekele, 2008).

Rodents belong to mammalian order Rodentia, which consists of about 1750 species world-wide. They account 28% of the total mammalian fauna in Eastern Africa (Kingdon, 1989). In Africa, small rodents are the most ubiquitous and numerous among the mammals. The insectivore fauna, particularly shrews, were diverse having 140 species (Hutterer and Yalden, 1990).

Rodents are not uniformly distributed in all habitat types (Manyingerew Shenkute *et al.,* 2006). The distribution of rodents and shrews depends on various factors, largely on the seasonal availability of food and water. In addition, vegetation structure and cover affect the micro-climate and protection of small mammals against predators (Hansson, 1999). Their distribution and abundance is influenced by vegetation structure and composition, which reflect the habitat condition (Workneh Gebresilassie *et al.,* 2004). Afework Bekele (1996b) has revealed the distribution patterns of 10 species of rodents across different vegetation zones including human habitats in the Menagesha Forest.

Similarly, habitat complexity, association and disturbance are other important factors affecting species diversity and distribution in natural ecosystems (Demeke Datiko *et al*., 2007; Taddese Habtamu and Afework Bekele, 2008; Kilgore *et al.,* 2010). In addition to seasonal changes which occur in the habitats such as cover and food availability, altitude plays an important role in determining the distribution of rodents along gradients of temperature and vegetation types.

From the Tropics to the Polar region, rodent number experiences seasonal, inter-annual and multi-annual fluctuations (Leirs *et al.,* 1996). Such fluctuations are the results of the basic demographic processes such as reproduction, survival, mortality, emigration and immigration, which are also governed by the habitat structure and food supply (Boutin, 1990).

Small mammals consume invertebrates, vegetation, fruits and seeds, playing extremely important role as dispersal and pollination agents in different habitats. Thus changes in their abundance and distribution can affect the dynamics of other species as well (Solari *et al*., 2002). In addition to seed dispersal rodents and shrews are known to have ecological, economical, social and cultural values (Avenant, 2011). They play an important role in natural communities and they are the main food for many predators (Davies, 2002) including humans.

Rodents are the most diverse group of mammals in Ethiopia. According to Afework Bekele, (1996b), rodents comprise 25% of the Ethiopian mammal fauna, and around 50% of total endemic species (Demeke Datiko and Afework Bekele, 2014). This is due to the diversified topography of the country.

Even though, western lowlands of Ethiopia are under-explored for faunal diversity due to inaccessibility and remoteness of the area. Accelerated human interactions in search of arable land and resettlement have been adversely affecting the natural habitats of this area (Tilahun Chekol, *et al.,* 2012). As a result, the biodiversity resources along with their habitats were rapidly disappearing in the country (Fayera Senbeta and Denich, 2006). Therefore, there is a need for further assessment of various habitats in terms of both floral and faunal species composition including small mammals.

Ecological studies for small mammals in Africa focused mostly on the other regions, with minimal attention on the western part of the continent (Taddese Habtamu and Afework Bekele, 2008). In Ethiopia, the study of rodents in various areas can be ranked from low to very well studied. Some studies on protected areas like Simien Mountains National Park (SMNP) and a few studies of rodent biology have been conducted in the southeastern highlands of Bale Mountains National Park (BMNP) (Lavrenchenko *et al.,* 1997). But, remote areas of western Ethiopia like Chato protected area (CPA) were never studied. The current study is to investigate the habitat association and distribution of rodents and insectivores in Chato Protected Area (CPA), Ethiopia.

The current study area, Chato Protected Area (CPA), possesses moist evergreen montane forest similar climatic and physical features to the south western parts of the country. The dominant species of plants found in this forest vegetation were broad-leaved and evergreen (Fayera

Abdena, 2010). CPA forest topographically looks like a ladder divided by hilly areas which have altitudinal variations.

1.2. Review literature

The previous reports of high faunal biodiversity in Ethiopia highlight the existence of a large number of species of mammals and other higher vertebrates (Yalden and Largen, 1992). Among the 84 species of rodents of Ethiopia, 15 are endemic, which accounts 50% of mammals endemics (Afework Bekele and Corti, 1997; Afework Bekele 1996a).

Rodents and Shrews are important contributors to biodiversity of ecosystems in sub-Saharan Africa (Linzey and Kesner, 1997). Insectivore (shrews) fauna are also diverse, having 429 species worldwide, of which 312 are in Africa, 140 of which are found in East Africa (Kingdon, 1997).

Rodents are distributed from the high Arctic Tundra to equatorial rain forests, temperate bogs and swamps to hot, arid deserts and rocky mountain tops to sandy canyon bottoms. They occur in terrestrial, subterranean, arboreal, and semi-aquatic habitats (Feldhamer *et al*., 2007; Wolff and Sherman, 2007).

Rodents and shrews are highly mobile animals whose distribution is influenced by different factors. Habitat preferences of rodents and shrews in Africa are determined primarily by the type of cover and vegetation availability (Monadjem, 1997) and altitude (Mulungu *et al*, 2008).

Human disturbance (Liu *et al.*, 2008) and the presence of large mammals (Hoffmann and Zeller, 2005), that intensively graze degrades the land and makes it uninhabitable for rodents because of loss of cover and food (Baker *et al.*, 2003; Liu *et al.*, 2008). Therefore, species distributional patterns are not random and follow geographic patterns (Krytufek and Griffiths, 2002).

Rainfall also plays a significant role in the occurrence of high population of rodents during the wet season (Tadesse Habtamu and Afework Bekele, 2008). Breeding decreases during the dry months and rainfall is the ultimate source of variation in rodent density (Caro, 2002). Moreover, many environmental factors have similar effect on the time of reproduction in rodents. Among these temperature, humidity (Windberg, 1998) and nutrition are the most important factors in rodent activity (Vaughan *et al*., 2000). Diurnal small mammals prefer dense vegetation than

nocturnal ones (Lobue and Darnell, 1959). Habitats with high diversity of plant species can support many diverse groups of mammal species. A decrease of vegetation cover leads to exposure of rodents to predators and, therefore, increases the predation risk (Goheen *et al.,* 2004; Hagenah *et al.,* 2009). Hence, landscape mosaic and characteristics, as well as habitat type availability, are potentially influential in determining species presence and persistence (Kupfer *et al*., 2006).

The species richness of rodents and shrews is related to habitat structure and complexity, area productivity, predation, trampling and grazing, surrounding landscape and the distance between similar habitats (Avenant and Cavallini, 2007). Characteristics of soil, like soil structure, fertility and texture can directly or indirectly influence the distribution and abundance of small mammals (Massawe *et al.,* 2008).

Several new species of rodents have been discovered from different parts of the world. Even though, the results of many studies have revealed the need for further exploration on small mammal distribution and diversity. Most of the time mountainous and afro alpine areas harbor endemic species of plants and animals, although the species diversity is less than many lowlands (Yalden and Largen, 1992). Similarly, in Ethiopia, many of the endemic mammals are associated with high altitude moorland and grassland habitats (Afework Bekele, 1996a).

Small mammals are categorized based on criteria such as body size and home range size. Those included in the small mammal category are species such as rodents (mice, rats and ground squirrels). Many of these species are difficult to observe in the wild because of their size, habit of moving only at night or because they live underground or in other hidden places (NLFC, 2005). Thus changes in rodent abundance and distribution can affect the dynamics of other species as well (Solari *et al*., 2002).

Among all the families of Rodentia, Muridae have a worldwide distribution and represents the most diverse group of rodents. They constitute almost 66% of the extant species of rodents (Vaughan *et al*., 2000), containing 1,326 species and 17 subfamilies (Feldhamer *et al*., 2007). Also they comprise the highest percentage (84%) in comparison to the nine families of rodents, which occur in Ethiopia (Afework Bekele and Corti, 1997).

Rodents form vital components of the ecosystems (Hansson, 1999). They interact extensively with their environments and their activities have beneficial effects on other organisms in different ecosystems. Most rodent species play great role in maintaining the ecosystem like in seed dispersal, pollination, predator - prey relationship and in maintaining ecological balance and habitat modification (Habtamu Taddesse and Afework Bekele, 2008; Mohammed Kasso *et al*., 2010). They are important food source for predators including the endangered and endemic Ethiopian Wolf (*Canis Simensis*) (Mohammed Kasso *et al*., 2010).

1.3. OBJECTIVES

1.3.1. General objective

- To assess the population status, species composition, distribution and habitat associations of rodents and shrews in Chato Protected Area using species richness and abundance indices.

1.3.2. Specific objectives

- To study the distribution of rodents and shrews in relation to altitudinal variation in CPA.
- To compare the seasonal species composition of rodents in different vegetation zones.
- To compare the seasonal age and sex structure of rodents and shrews in CPA.
- To estimate the biomass of rodents and shrews in various vegetation and altitudinal zones.
- To describe the reproductive status of rodents and shrews in CPA.
- To describe the habitat preference of rodents and shrews in the study area.

2. MATERIALS AND METHODS

2.1. Study Area

2.1.1 Geographical Location

Chato Protected Area (CPA) is located in the Horo Guduru Wollega Zone of Oromia Region, Ethiopia. It was part of National Forest Priority Areas (NFPAs) and has been known by the name Chato-Sangi-Dangab Forest. The forest lies approximately between 9˚ 38'- 9˚ 48' N latitude and 36˚ 58'-37˚ 20'E longitude in Horo District, 30 km north-west of Shambu which is located at about 314 km west of Addis Ababa. Chato Protected Area was located along altitudinal ranges between 1532 and 2537 m asl and covers total area of 42,000 hectares. Out of this 42.8% or around 18, 000 ha was plantation (Head of Oromia Forest and Wildlife Enterprise (OFWE)).

CPA was generally characterized by rough topography which looks like a ladder with undulating plain, hills, slopes, deep valley, gorges, escarpments and dissected plateaus. Several perennial rivers such as Yamalagi, Badessa, Chiracho, Jaba and Gabar flow into Garchi River by crossing the forest. All of these originate from the highlands. The area was bounded in the north by Jaba River (Jardega-Jarte District) in the west by Garchi River (Abe Dongoro District), in the southeast by Bafo-Gabar River and in the east direction by plantation (Horo District) (Figs. 1to3).

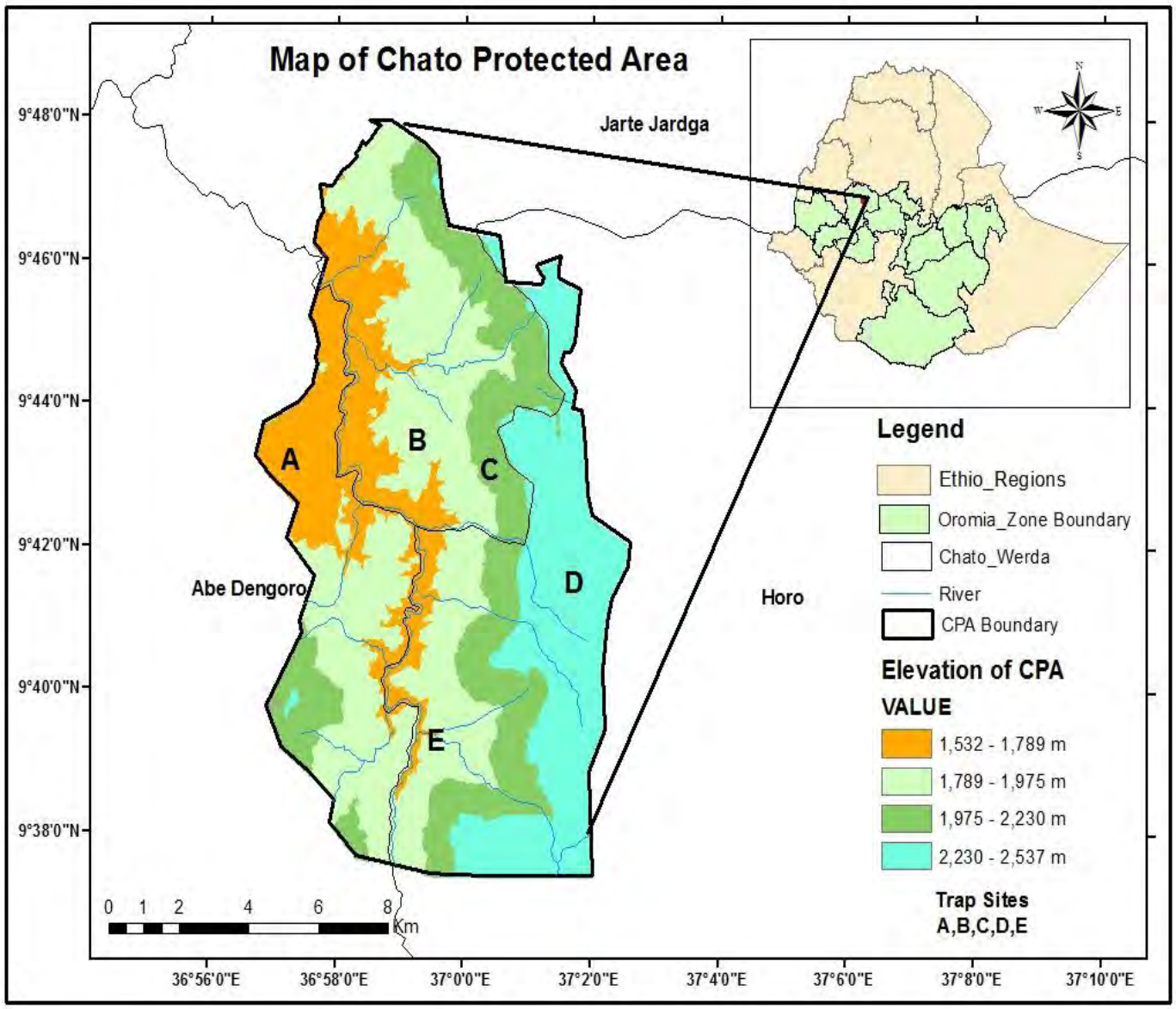

Figure 1. Location of the study Area/Chato Protected Area, Ethiopia (Source the altitudinal and topographic map of the Caato Forest Protected Area, Head of Oromia Forest and Wildlife Enterprise, Finfinne).

Figure 2. Top view of the natural forest of Chato Protected Area (from east to west).

Figure 3. The top view (left) and ground view (right) of Plantation of Chato Protected Area

2.1.2. Wildlife

The forest supports larger mammals and birds as well. The abundant larger mammals in the area were Anubis baboon (*Papio Anubis*), Bushbuck (*Tragelaphus scriptus*), Bush duiker (*Sylvicapra grimmia*), Warthog (*Phacochoerus aethiopicus*) and spotted hyena (*Crocuta crocuta*). The Lions, Buffalo and Wild beast were recently extinct from the forest (Source from local peoples).

2.1.3. Vegetation and study site description

The forest was categorized in to three plant communities. These were *Carissa spinarum* - *Justicia schimperiana* dominated areas, between 1,532 - 1,789 m altitudinal range, *Maytenus gracilipes* dominated areas, between 1,789 -1,975 m altitudinal range, some part is under intense human impacts such as logging trees for timber and construction purpose and *Podocarpus falcatus* - *Pyschotria orophila* dominated areas between 1,975 -2,230 m altitudinal ranges and it is the center of the forest (Fayera Abdena, 2010). The peak of the mountain or above 2,230 m is characterized by rocky, hilly and covered by plantation. The plantation and riverside areas of the forest were studied as different sites of the study area. They were also coded as Pl. and Rv., respectively (Table 1).

Table 1. Trapping sites at variable vegetational composition and altitudinal ranges in Chato Protected Area (CJ = *Carissa spinarum* - *Justicia schimperiana* dominated, M.G. = *Matyenus gracilipes* dominated, PP = *Pyschotria orophila* - *Podocarpus falcatus* dominated, Rv. = riverine and Pl. = plantation)

Habitat / altitude	**Dominant vegetation**	**Hydrology**	**Topography**	**Human activity**
C.J. (1,532 up to 1,789 m)	Tree:- *Carissa spinarum, Justicia schimperiana* Shrubs:- *Clausena anistata, Ekebergia capensis, Diospyros abyssinica, Croton macrostachyus, Nuxia congesta, Premna schimperi, Embelia schimperi,* and *Maesa lanceolata;* Herbs:- *Hyposetes forskaoli, Setaria megaphylla, Kalancheo petitiana, Cyathula cylinderica* and *Achyranthes aspera.*	Dry	Sloppy	Low human activity
M.G. (1,789 up to 1,975 m)	Trees:- *Maytenus gracilipes* Shrubs:- *Prunus africana, Ficus thonnigii, Ochna holstii, Olea welwitschii, Clutia abyssinica, Rothmannia urcelliformis, Myrsine africana, Dracaena afromontana;* Herbs: *Cyperus fischerianus, Commelina foliacea, and Oplismenus hirtellus*.	Dry	Sloppy	Logging trees No other activities
P.P. (1,975 up to 2,230 m)	Trees:- *Pyschotria orophila, Podocarpus falcatus, Landolphia buchananii*, *Teclea nobilis*, and *Olea capensis*; Shrubs: *Calpurnia aurea, Ocimum lamiifolium, Rubus steudneri, solanum giganteum,* and *Lepidotrichilia volkensii,* and few herbaceus plants	Dry	Slanty and few Steepy places	Logging trees Frequently grazing cows, goats and others
Pl. (Above 2,230 m)	Plantation: Conifers (*Juniperus procera*), *Cupressus lucitanica* and *Eucalyptus* tree; Natural vegetation, and shrubs and grasses	Dry	Slightly sloppy	Logging and plantig trees Grazing animals
Rv. (1,714 up to 2,200 m)	Natural vegetation:- trees like *Podocarpus falcutus,* Shrubs:- *Ochna holstii, Olea welwitschii, Allophylus abyssinicus, Clutia abyssinica* and *some herbaceous plants*, Plantation:- *Eucalyptus* and Conifers	River	Steepy	Logging trees Grazing cows, goats and others

2.1.4. Social values

CPA has dense natural forest where people use it as sacred place for a long time. This sacredness of the forest calls for undying protection for the environment. Oromo communities living around the forest sacrifice tame animals to the forest every two years. The sacred area of the forest constitutes 11,904 hectares (ha) or 24.5% of the total forest coverage (Lemessa Mergo, 2014).

2.2. Materials

Sherman live traps, snap traps, camera, GPS, spring balance, marker, data sheets, scissors, dissecting kit, meters, peanut butter and preserving chemicals like alcohol (70%) and formalin were used during the study. For identification of specimens of rodent and shrews, identified samples in the display room of Zoological Natural History Museum of Addis Ababa University was use

2.3. Methods

2.3.1. Sampling and grid design

Based on vegetation and altitudinal variation, the study area was separated into five different habitats. Each zone was based on the altitude, the climatic situation and the extent of human influence (Mulungu *et al.,* 2008).

These habitats were: *Carissa spinarum* - *Justicia schimperiana* (C.J.), *Matyenus gracilipes* (M.G.) and *Podocarpus falcatus* - *Pyschotria orophila* (P.P.) dominated areas, the riverine areas (R.V.) and the plantation (Pl.) areas. The representative grids were established randomly among the vegetation type based upon possible representation of different habitats as well as easy accessibility. For both wet and dry seasons, the same sampling grids were used.

Snap trapping grids were established at 200 m away from live trapping grids in each area. Both live trapping grids and snap trapping grids were separated and placed at 10 m intervals. Each sampling site of live trap constituted an area of 4900 m^2 (70 x 70 m). For body measurements (head and body length, tail length, hind foot and ear length) and further studies, 15 snap-traps were used during both wet and dry seasons.

2.3.2. Data Collection

Rodents and shrews were trapped during two periods of trapping session (wet and dry season) from August, 2015 up to March, 2016. Data were collected from each habitats, wet season during the end of August and beginning of September, 2015, and dry season in March, 2016. Both live and snap traps were used to collect the specimen during each trapping session. Additional data were gathered by direct observations in the study sites. Trapping and handling of captured rodents and shrews followed the procedures of Gurnell and Flowerdew (1990). A number was assigned to each toe and no two animals on the same grid were given the same mark even if they belong to the same species. Following the toe clipping method a toe per foot was clipped to mark the individuals captured.

2.3.3. Trapping protocol

A total of 49 Sherman live traps were used in randomly selected grids of each habitat during both seasons. The traps were baited by peanut butter and checked twice a day, early in the morning hours (6:00 - 8:00h) and late in the afternoon hours (17:00-18:00h). Traps were covered by hay and plant leaves during the dry season. Traps were rebaited as necessary for three consecutive nights. Known captured animals were identified to their genus level, while others coded for identification in the Zoological Natural History Museum (ZNHM) of Addis Ababa University.

State of maturity or reproductive status was identified by the same method described and illustrated in Gurnell and Flowerdew, (1990). The position of the testes and condition of the vagina and nipples were noted as indicators of current breeding, previous breeding or juvenile status. Males were recorded as breeding if the testes were scrotal or abdominal and if the epididymal gubernacula is externally visible or not. Females were recorded as sexually active when the vagina was perforated or when they were visibly pregnant and whether nipples are swollen due to lactation. Pregnancies were identified by palpation. Animals were later released at the station of capture.

Similar to the live-trapping, all snap-traps were baited with peanut butter and checked twice a day for three consecutive days. After removing the trapped rodents from the traps, the following data were taken: weight, sex, relative age, reproductive condition, standard body measurements

(head-body length, tail length, hind foot and ear length) and ecto-parasites if present. Specimens collected from the study area were currently deposited at ZNHM of Addis Ababa University.

Stomach content analysis was performed following the method used by Demeke Datiko *et al*. (2007). Stomach samples from the dissected animals were removed and preserved in 70% alcohol. All stomach contents were brought to Vertebrate Research Laboratory section of ZNHM of Addis Ababa University for microscopic examination. The contents were putted on petridishes and water added to wash digested particles and to differentiate the materials eaten by the rodent. By using light microscope and forceps the contents separated into plant (leaves, stems, roots, and seed), animal (invertebrates) and unidentified matter. Stomach content analysis was made through calculating the mean percentage proportion of food fragments per slides.

2.3.4. Data analysis

Population number of rodents in each trapping sessions and grids was estimated by capture mark recapture (CMR) method. Shannon-Weiner Diversity Index was used for calculating the rodent species diversity in the different habitat types. It used to assess both abundance and evenness as; $H = -\sum_{i=1}^{s}(pi \ln pi)$,

When: Pi is the relative proportion of species *i* in habitat and ln is the natural logarithm. Abundance of small mammals in each habitat was assessed by the percentage of trap success between the seasons and habitat types. The percentage of trapped individuals was expressed according to Afework Bekele (1996a),

$$\text{Trap success} = \frac{N}{Nt \times Nn} \times 100$$

when N is the number of individuals captured, Nt is the number of traps and Nn is trap nights. Comparison of species richness, distribution and habitat association of species in the study area were made by using Chi-square test and SPSS Version 21.0 statistical program.

3. RESULTS

3.1. Live Trapped Rodents

3.1.1. Species composition and abundance of rodents and shrews

From a total of 1862 trap nights', 254 individuals representing 5 rodent species and one shrew species were captured during both dry and wet seasons. The total traps success was 13.64%. All of the species (5 rodent species and one shrew species) were recorded from *Maytenus gracilipes* dominated habitat between 1,789 -1,975 m, asl. Those rodent species were: *Stenocephalemys albipes* (*S.a.*), *Lophuromys flavopunctatus (L.p.), Arvicanthis* sp. *(A.*sp.*), Mus mahomet (M.m.),* Multimammate mouse *(Mastomys natalensis)* and a shrew species (*S.* sp.).

Stenocephalemys albipes and *L. flavopunctatus* were trapped from all habitat types and *Arvicanthis* sp. was absent from plantation habitat. Also *S. albipes* was the most abundant of all trapped animals which accounted the highest percentage (40.95%). Shrew sp. was the least abundant species of the study area while *L. flavopunctatus*, *Arvicanthis* sp. And *M. mahomet,* accounted 23.6%, 16.9% and 13% respectively. *Mastomys natalensis* was one of the least abundant (4.35%) rodents of the area. Shrew species was trapped only from two habitats during the wet season accounting 1.2 %. The total catch and percentage abundance of rodents and shrews were presented in Table 2.

Table 2. Species composition, total catch and abundance of rodents and shrews from Chato Protected Area

Species	Total catch	Abundance(%)
Stenocephalemys albipes	104	40.95
Lophuromys flavopunctatus	60	23.6
Arvicanthis species	43	16.9
Mus mahomet	33	13
Mastomys natalensis	11	4.35
Shrew species	3	1.2
Total	254	100

3.1.2. Species richness and Distribution

Species richness of the study area varied between vegetation communities of different elevations. *Matyenus gracilipes* dominated habitat at 1,789 -1,975 m elevation harbored all the recorded species of rodents and shrews (6 species). While the plantation accounted the lowest number of species (3 species). *Pyschotria orophila* - *Podocarpus falcatus* and *Carissa spinarum* - *Justicia schimperiana* dominated habitats have equal number of species (5). Four species were recorded from riverine habitat.

All species were recorded in both habitats except *M. natalensis* from *P. orophila* - *P. falcatus* dominated and Shrew sp. from *C. spinarum* - *J. schimperiana* dominated habitats. *M. mahomet* and Shrew sp. were absent from Riverine habitat. *S. albipes*, *L. flavopuctatus* and *M. mahomet* were recorded frequently from plantation habitat. The variation of species richness between study sites was statistically not significant ($x^2 = 0.667$, df=3 and $p > 0.05$) (Table 3).

Table 3. Species richness and composition of rodents across each habitats

Species	Habitat and altitude (m)				
	C.J. (1,532-1,789)	M.G. (1,789-1,975)	P.P. (1,975-2,230)	Rv. (1,714-2,200)	Pl. (above 2,230)
S.a.	x	x	x	x	x
L.f.	x	x	x	x	x
A. sp.	x	x	x	x	-
M.m.	x	x	x	-	x
M.n.	x	x	-	x	-
S.sp,	-	x	x	-	-
Total	5	6	5	4	3

*S.a. = S. albipes, L.f. =L. flavopunctatus, A.*sp *=Arvicanthis* sp.*, M.m= M. mahomet, M.n. =M. natalensis* and S.sp.= Shrew sp. X, = presence of species, and - = absence of species. C.J. = *C. spinarum* - *J. schimperiana* dominated, M.G. = *M. gracilipes* dominated, P.P. = *P. orophila* - *P. falcatus* dominated, Rv. = Riverine and Pl. =Plantation.

3.1.3. Seasonal species composition, distribution and abundance

All species were relatively more abundant during the wet season than the dry season. They show an increment in number in all habitats except *L. flavopunctatus* in *M. gracileps* dominated habitat and *S. albipes* in plantation habitat. Some species were trapped during one season and disappeared during the other season from the same habitat. Shrew sp. was trapped only during the wet season from *M. gracilipes* and *P. orophila* - *P. falcatus* dominated habitats. *Lophuromys flavopunctatus* and *M.mahomet* was trapped only during the wet season from plantation and riverine habitats, respectively. *Arvicanthis* sp. was never trapped from the riverine habitat. The species richness of *M. gracilipes*, *C. spinarum* - *J.schimperiana* dominated habitats and that of *P. orophila* - *P. falcatus* dominated habitats were statistically not significant ($x^2 = 0.667, df = 4\ and\ p > 0.05$). It was also not significant in the riverine habitat during the dry (x^2=0.667, df=3 and $p > 0.05$) and the wet season (x^2=1.00,df=2 and $p > 0.05$). In *P. orophila* - *P. falcatus* dominated habitat during the wet season (x^2=0.00, df=5 and $p > 0.05$) and plantation during the dry (x^2=3, df=2 and $p > 0.05$) and wet (x^2= 2, df= 3 and $p > 0.05$) also statistically not significant (Table 4).

Table 4. Seasonal species composition, distribution and abundance of live- trapped small mammals from different habitats during both wet and dry seasons (-; not recorded)

Species	**Seasonal distribution of rodents**										**Total**
	C.J.		M.G.		P.P.		Rv.		Pl.		
	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	
S.a.	9	12	7	15	18	22	2	8	7	4	104
L.f.	-	1	10	9	9	14	4	8	2	3	60
A. sp.	4	9	10	11	4	4	1	-	-	-	43
M.m.	3	3	3	7	6	10	-	-	-	1	33
M.n.	2	3	2	1	-	-	1	2	-	-	11
S.sp.	-	-	-	1	-	2	-	-	-	-	3
total	18	28	32	44	37	52	8	18	9	8	254

S.a.= S. albipes, L.f.=L. flavopunctatus, A.sp =Arvicanthis sp., *M.m= M. mahomet, M.n. =M. natalensis* and S.sp.= Shrew sp. C.J. = *C. spinarum* and *J. schimperiana* dominated, M.G. = *M. gracilipes* dominated, P.P. = *P. orophila* and *P. falcatus* dominated, Rv. = riverine and Pl. =plantation.

In general, the abundance of rodents and shrews during the dry season was lower than the wet season. *Stenocephalemys albipes* was the most trapped rodent during both seasons. All species were more abundant during the wet season. Shrew sp. was trapped and abundant only during the wet season (Table 5).

Table 5. Seasonal abundance of rodents in the study area (Figures in the bracket represent percentage composition)

Species	Total catch	Abundance (%)		
		Dry	Wet	Total
S. albipes	104	43(41.34)	61(58.66)	40.94
L. flavopunctatus.	60	25(41.67)	35(58.33)	23.62
Arvicanthis Sp.	43	19(44.20)	24(55.80)	16.93
M. mahomet	33	12(36.36)	21(63.64)	12.99
M. natalensis	11	5(45.45)	6(54.54)	4.33
Shrew sp.	3	0	3(100)	1.18
Total	254	104	150	100

The abundance of rodents varied between habitats. It was highest in *P. orophila* - *P. falcatus* dominated area, 89 individual rodents (35.04%), followed by *M. gracilipes* dominated habitat (76 captured individuals, 30%). All of the recorded species of rodents and shrews preferred *M. gracilipes* dominated habitat. Even though rich in abundance of rodents, *P. orophila* - *P. falcatus* dominated habitat was the second diverse habitat to *M. gracilipes* dominated area. In this habitat,

S. albipes accounts 44.94 % of trapped individuals while the least abundant species of the area was shrew sp., 2.24%.

Similarly, *S. albipes* was the most abundant rodent in all other habitat types except in riverine habitat, where *L. flavopunctatus* was more abundant. In *C. spinarum* - *J. schimperiana* dominated and riverine habitats the abundance of *S. albipes* was 45.65% and 38.46%, respectively. Even if there is variation in abundance of the species across *P. orophila* - *P. falcatus*, *M. gracilipes* dominated and plantation habitats were statistically not significant ($x^2 = 0.00, df = 5,\ p > 0.05$). The plantation habitat showed the least abundance (Table 6). Variation in abundance of species in *C. spinarum* - *J. schimperiana* dominated and plantation habitats were also statistically not significant, ($x^2 = 0.667, df = 4, p > 0.05\ and\ x^2 = 2.00, df = 3, p > 0.05$, respectively).

Table 6. Rodent species diversity, proportional composition and abundance in different habitats (Figures in bracket shows percentage composition)

Species	Habitat wise abundance (%)				
	C.J.	M.G.	P.P.	Rv.	Pl.
S. albipes	20.19	21.15	38.46	9.61	10.57
L. flavopunctatus.	1.67	31.67	38.33	20	8.33
Arvicanthis Sp.	30.23	48.83	18.60	2.32	0
M. mahomet	18.18	30.30	48.48	0	3.03
M. natalensis	45.45	27.27	0	27.27	0
Shrew sp.	0	33.33	66.67	0	0
Abundance	18.10	30	35.04	10.20	6.7

C.J. = *C. spinarum* -*J. schimperiana* dominated, M.G. = *M. gracilipes* dominated, P.P. = *P. orophila* - *P. falcatus* dominated, Rv. = riverine and Pl. = plantation.

3.1.4. Population Estimate

The population estimate of live-trapped rodents across different habitats was given in Figure 4. Relatively, the highest population estimate was obtained from *P. orophila* - *P. falcatus* dominated habitat, whereas, the lowest estimate was obtained from plantation habitat. There was no significance difference in the population estimate between the habitats ($\chi 2$= 0.00, df= 4, P > 0.05).

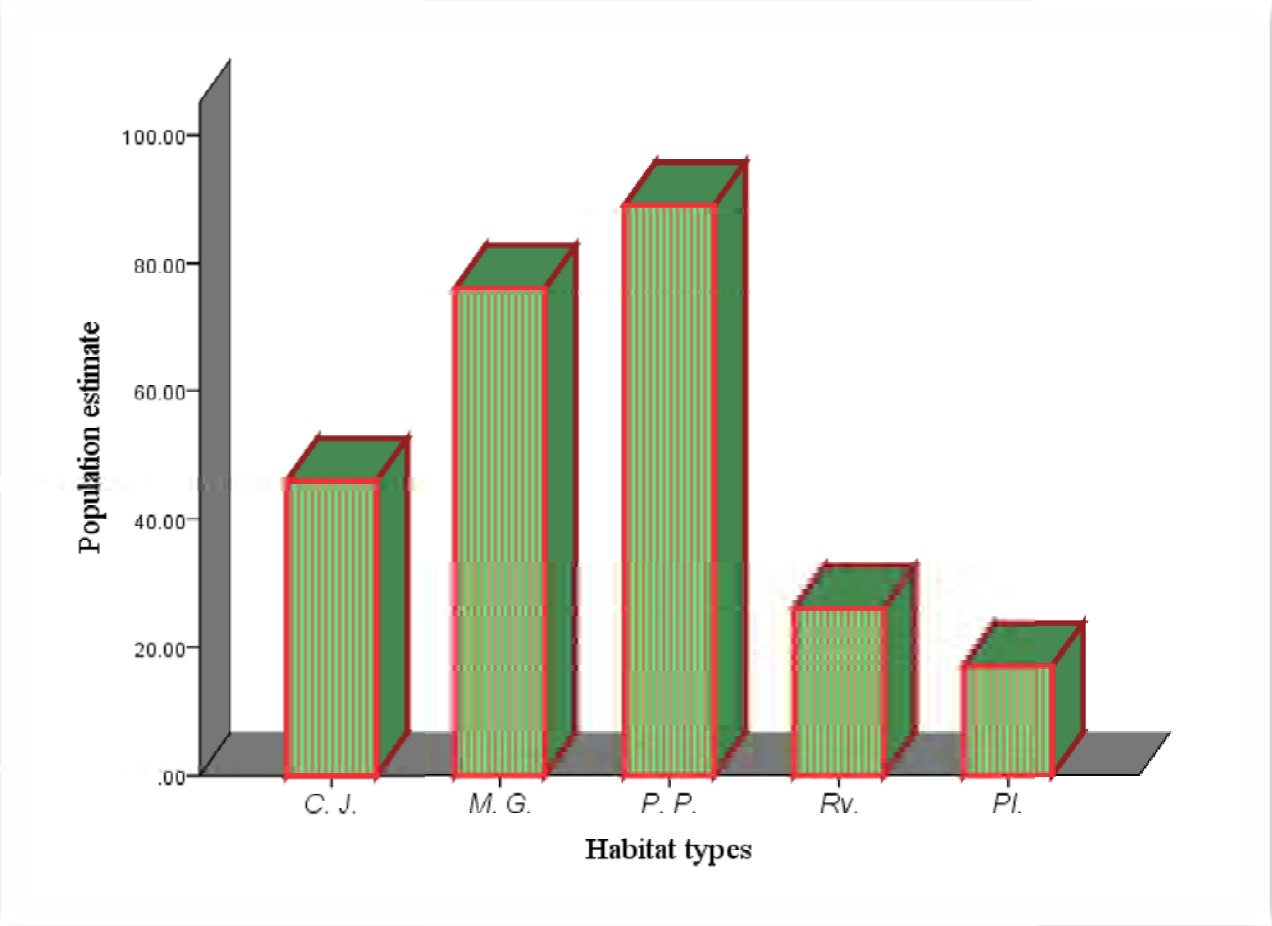

Figure 4. Population estimate of rodents and shrews per each habitats (C. J. = *C. spinarum* - *J. schimperiana* dominated, M.G. = *M. gracilipes* dominated, P.P. = *P. orophila* - *P. falcatus* dominated).

3.1.5. Habitat preference of rodents

Abundance and habitat preference of each species within five vegetation types and altitudes of C.P.A. were given in figure 5. Both *S. albipes* and *L. flavopunctatus* species were widespread and mostly preferred *P. orophila* - *P. falcatus* dominated habitat. They also preferred *M. gracilipes* dominated habitat. *L. flavopunctatus* was never trapped from *C. spinarum* - *J. schimperiana* dominated habitat. *Arvicanthis* species was abundant in *M. gracilipes* dominated habitat and not recorded from plantation. Like *S. albipes* and *L. flavopunctatus* species the *M. mahomet* preferred *P. orophila* - *P. falcatus* and *M. gracilipes* dominated habitats. *M. natalensis* restricted to elevation below 1,975 m asl. Shrew sp. was trapped from *P. orophila* - *P. falcatus* and *M. gracilipes*.

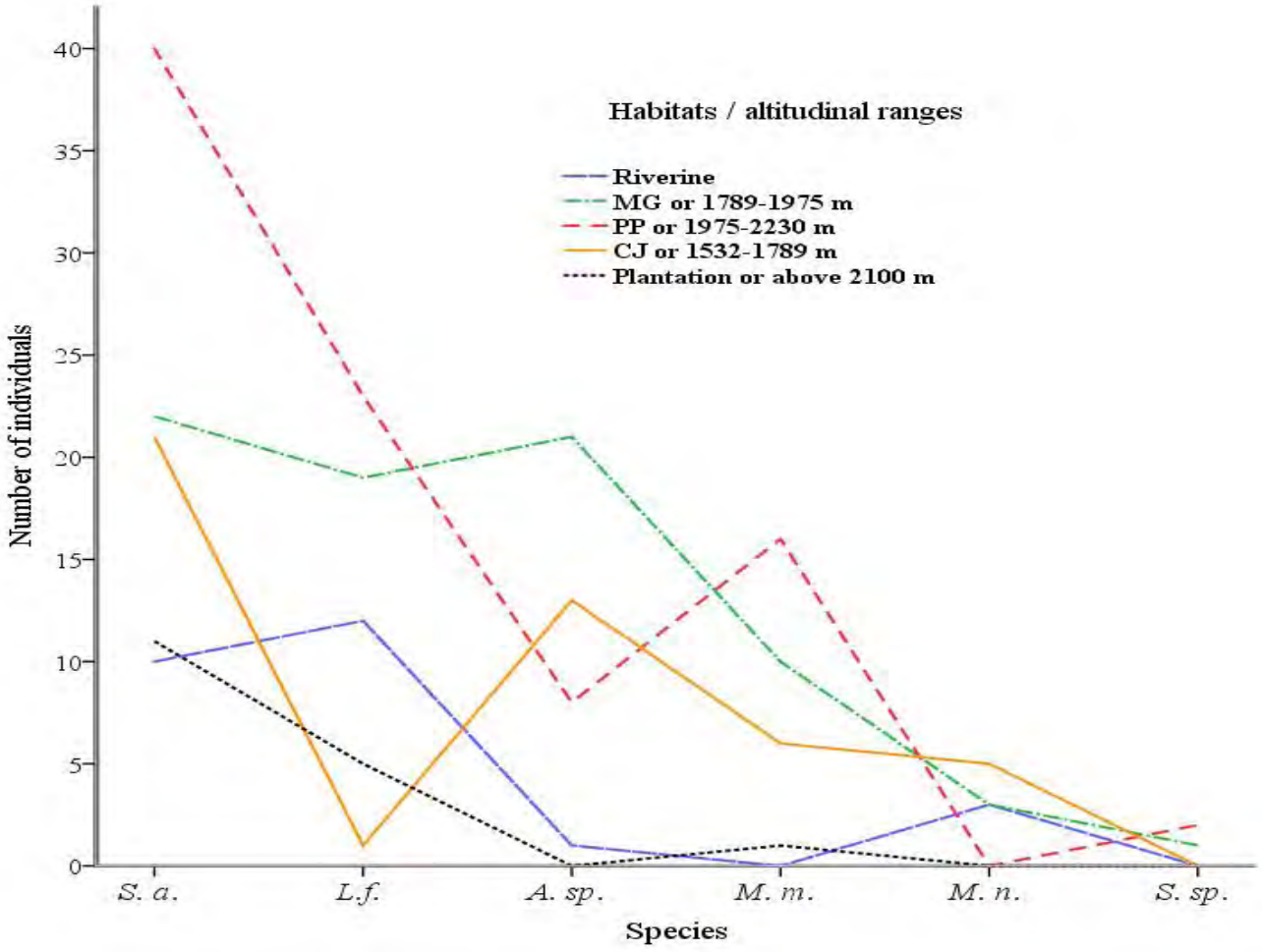

Figure 5. Abundance and habitat preference of each species within five vegetation types at variable elevation ranges, (*S. a.=S. albipes, L.f.=L. flavopunctatus, A.* sp. *=Arvicanthis* species,

M. m. = M. mahomet, M. n. =M. natalensis and S.sp.= Shrew sp. C. J. = *C. spinarum* - *J. schimperiana* dominated, M.G. = *M. gracilipes* dominated, P.P. = *P. orophila* - *P. falcatus* dominated).

The trap success and diversity index of five habitats with their altitudinal variation was given in Table 7. *M. gracilipes* dominated habitat, between 1,789 -1,975 m altitudinal variation had more diverse than others with H' = 1.51 and trap success of 19.39%. The highest trap success was observed in *P. orophila* - *P. falcatus* dominated habitat (22.7%). This was the second most diverse habitat with diversity index of 1.32.

Table 7. Trap success and diversity indices of rodents and shrews in different habitats at various altitudes

Altitude(m)	Habitats	No of species	Trap night	Total catch	(H') Shannon's diversity index	Trap success(%)
1,532 – 1,789	C.J.	5	294	46	1.30	15.65
1,789-1,975	M.G.	6	392	76	1.51	19.39
1,975-2,230	P.P.	5	392	89	1.32	22.7
1714-2200	Rv.	4	392	26	1.1	6.6
Above 2,230	Pl.	3	392	17	0.8	4.3

C.J. = *C. spinarum* - *J. schimperiana* dominated, M.G. = *M. gracilipes* dominated, P.P. = *P. orophila* - *P. falcatus* dominated, Rv. = riverine and Pl. =plantation)

3.1.6. Seasonal variation and sex ratio

The sex distribution of trapped rodents and shrews from different habitats was given in Table 8. From a total of trapped animals, females comprised 54.3% and males 45.7%. Seasonally, the sex ratio was variable in each different species. Sex ratio from male to female for the dry season was1:1.1 and wet season, 1:1.2 while the overall sex ratio from male to female of the study area was 1:1.19. Even though there were variations in the sex ratio of species between dry and wet seasons, it was statistically not significant (x^2=0.00, df =1 and P > 0.05).

Table 8. Seasonal variation in sex distribution of live-trapped rodents and shrews (M=male, F= female)

Time	*S. a.*		*L. f.*		*A.* sp.		*M. m.*		*M.n.*		S. sp.	
	M	F	M	F	M	F	M	F	M	F	M	F
Dry (March)	22	21	10	15	10	9	5	7	2	3	0	0
Wet (August)	28	33	14	21	10	14	10	11	4	2	1	2
Total	50	54	24	36	20	23	15	18	6	5	1	2

S.a. = S. albipes, L.f. = L. flavopunctatus, A.sp. = Arvicanthis sp.*, M.m. = M. mahomet, M.n. =M. natalensis* and S.sp.= Shrew sp. M= male, F= female.

3.1.7. Population structure

Population structure of rodents and shrews of Chato Protected Area based on age and sex varied between species. From the total of captured rodents and shrews, 142 individuals (55.9 %) were adults, 95 individuals (37.4%) were sub-adults and 17 individuals (6.70%) were juveniles. In species like *S. albipes, L. flavopunctatus* and *Arvicanthis* sp. the number of adult individuals were higher than the number of sub-adults and juveniles. In *M. natalensis,* the number of sub-adult individuals was higher than adults. Juvenile individuals for *M. mahomet, M. natalensis* and Shrew species were not recorded. Thus the age structure of rodents in the study area was statistically not significant (x^2=0.00, df =2 and p > 0.05) (Table 9).

Table 9. Age, sex and abundance of live-trapped rodents from the study area (M= male, F= female)

Species	Adults		Sub-adults		young	
	M	F	M	F	M	F
S. albipes	24	28	21	19	5	7
L. flavopunctatus.	13	23	9	12	2	1
Arvicanthis Sp.	14	13	6	8	-	2
M. mahomet	9	11	6	7	-	-
M. natalensis	2	3	4	2	-	-
Shrew sp.	-	2	1	-	-	-
Total	62	80	47	48	7	10
Relative abundance (%)	24.40	31.50	18.50	18.9	2.75	3.95

3.1.8. Biomass

A total of 14,358.9 g/ha biomass was obtained for rodents and shrews during each seasons. In all species the biomass recorded during the wet season was higher than dry season. The highest biomass was recorded from *P. orophila* and *P. falcatus* dominated (4711.4 g/ha) and *M. gracilipes* dominated (4276.1 g/ha) habitats. The lowest biomass obtained was from plantation habitat (1023.3 g/ha). The maximum biomass among the species was observed in S. albipes (6943 g/ha) and the lowest in Shrew sp. (30 g/ha) (Table 10).

Table 10. Biomass (g/ha) of each rodent species in each habitat types and seasons (-; indicate absence of trapped individuals)

Species	Season	Biomass(g) of each species					
		C. J.	M.G.	P. P.	Rv.	Pl.	Total
S. a.	Wet	816	1020	1496	544	272	4148
	Dry	585	455	1170	130	455	2795
L. f.	Wet	59	531	826	472	177	2065
	Dry	-	540	486	216	108	1350
***A.* sp.**	Wet	666	814	296	-	-	1776
	Dry	248	620	248	62	-	1178
M. m	Wet	33.9	79.1	113	-	11.3	237.3
	Dry	28.2	28.2	56.4	-	-	112.8
M. n.	Wet	188.4	62.8	-	125.6	-	376.8
	Dry	116	116	-	58	-	290
S. sp.	Wet	-	10	20	-	-	30
	Dry	-	-	-	-	-	0
Total	-	2740.5	4276.1	4711.4	1607.6	1023.3	14,358.9

S.a.= S. albipes, L.f.=L. flavopunctatus, A.sp =Arvicanthis sp.*, M.m= M. mahomet, M.n. =M. natalensis* and S.sp.= Shrew sp. C.J. = *C. spinarum* and *J. schimperiana* dominated, M.G. = *M. gracilipes* dominated, P.P. = *P. orophila* and *P. falcatus* dominated, Rv. = riverine and Pl. =plantation.

3.2. Snap Trapped Rodents

3.2.1. Species composition and abundance

A total of 57 rodents were snap trapped during the wet and dry seasons from 450 trap nights. Five rodent species: *S. albipes* (33.35%), *L. flavopunctatus* (19.3%), *Arvicanthis* sp. (17.55%), *M. mahomet* (19.3%), and *M. natalensis* (10.5%) were recorded.

3.2.2. Body measurements

Weight and standard body measurements of analyzed rodent individuals were presented in table 11. The largest mean body weight recorded was that of *Arvicanthis* sp. (74 g) during the wet season. The lowest mean body weight recorded was *M. mahomet* (9.4 g) during the dry season. The shrew specimen for measurement was killed and taken from the Sherman live trap during the last session of trapping. Variation in the mean body weight among species and between seasons was statistically not significant ($x^2 = 0.00$, df =10 P >0.05).

Table 11. Body weight and measurements of rodents snap trapped during the dry and wet seasons (Mean ± standard deviation, -; indicates absence)

Species	Season	Number	Mean body Weight (g)	Body measurements (cm)			
				HB	TL	HF	ER
S. a.	Wet	4	68 ± 7.8	12.1± 1.3	16.3 ± 1.7	2.8 ± 0.5	2.3 ± 0.7
	Dry	3	65 ± 11.2	11 ± 0.5	15 ± 2.3	2.8 ± 0.4	2.2 ± 0.6
L. f.	Wet	3	59 ± 6.1	13.3 ± 1.0	6.9 ± 0.6	2.2 ± 0.5	2.1 ± 0.4
	Dry	2	54 ± 9.3	12.9 ± 1.4	6.7 ± 0.7	2.3 ± 0.6	1.9 ± 0.6
A. sp.	Wet	3	74 ± 12.2	13.6 ± 2.1	9.9 ± 1.3	2.9 ± 0.2	1.3 ± 0.3
	Dry	2	62 ± 8	12.3 ± 1.0	9.2 ± 2.1	2.6 ±0.2	1.3 ± 0.4
M. m.	Wet	4	11.3 ± 2.8	7.1 ± 0.4	6.4 ± 0.4	1.4 ± 0.3	0.8 ± 0.2
	Dry	3	9.4 ± 1.5	6.2 ± 0.9	5.9 ± 0.6	1.5 ± 0.4	0.9 ± 0.2
M. n.	Wet	2	62.8 ± 4.4	14.8 ± 2.2	15.9 ± 1.2	3 ± 0.6	1.7 ± 0.3
	Dry	2	58 ± 3.9	14.2 ±1.56	13.9 ± 0.9	3.1 ± 0.3	1.5 ±0.2
S. sp.	Wet	1	10 ± 0.00	10.8 ± 0.00	6.1± 0.00	1.2 ± 0.00	1.0 ± 0.00
	Dry	-	-	-	-	-	-

S. a. = S. albipes, L. f. = L. flavopunctatus, A. sp. =Arvicanthis sp.*, M. m. = M. mahomet, M. n. = M. natalensis* and S. sp.= Shrew sp. HB = head body length, TL= tail length, HF = hind foot length, ER = ear length.

3.2.3. Stomach contents

The mean percentage of stomach contents of snap trapped rodents during the wet and dry seasons was given in Table 12. A total of 28, two to four stomach per each rodent species were analyzed from snap trapped animals. The percentage frequency of plant matters in the stomach was higher than animal matters in all species except in the stomach of *L. flavopunctatus* where the percentage of arthropods was high.

Relative proportion of the food items varied among the seasons and the species. The stomach of *Arvicanthis* sp., *M. mahomet* and *M. natalensis* constituted higher percentage of leaves. The percentage of stem and root was higher in stomach during the dry season. Consumption of arthropods and worms generally increased more during the wet season than the dry season. The stomach contents of *L. flavopunctatus* contained relatively higher frequency of animal matter. Hair was observed in the stomach of three rodent species (*S. albipes, L. flavopunctatus, and M. natalensis*). Baits and unknown substances were grouped under unknown matters.

Table 12. The mean percentage frequency of food items in five rodent species (* = presence, - = absence)

Species	Season	No of stomach examined	Plant matter			Animal matter			UN
			SD	LF	SR	W	A	H	
S.a.	Wet	4	41.5	6.9	14.7	6.2	16.6	*	14.1
	Dry	3	39.2	13.5	14.0	5.8	14.2	-	13.3
L.f.	Wet	3	16.1	4.5	6.0	4.4	62.2	*	6.8
	Dry	2	11.6	6.1	7.7	3.9	59.3	-	11.4
A. sp.	Wet	3	21.8	52.3	15	0.5	1.5	-	8.9
	Dry	2	18.7	41.6	21.3	0	2.6	-	15.8
M.m.	Wet	4	23.6	36.4	19.6	1.4	4.5	-	14.5
	Dry	2	27.6	29.7	25.3	0	2.1	-	15.3
M.n.	Wet	2	24	30.5	14.2	12.8	8.4	*	10.1
	Dry	1	20.3	28.8	15.4	7	20.1	-	8.4

SD = seed, LF = leaves, SR = stems and roots, W = worms, A = arthropods, H= hair, UN = unrecognized matters, *S.a. = S. albipes, L.f. = L. flavopunctatus, A. sp. = Arvicanthis* sp.*, M.m. = M. mahomet,* and *M.n. = M. natalensis*.

3.2.4. Embryo counts

From 17 trapped pregnant female rodents, the number of embryos varied between seasons and species. Most of pregnant females (73.7%) were snap trapped during the wet season. In all species, the number of embryos during the wet season was slightly higher than the dry season. Most of the number of embryos varied between 3 to 6. Among the number of embryos observed, the highest numbers of embryo was recorded from *M. natalensis* (8) and the least from *L. flavopunctatus* (3) (Table 13).

Table 13. The number of pregnant females and embryo count for the snap-trapped species during the wet and the dry seasons (-; indicates absence)

Species	Season	No of pregnant females dissected	No of embryos recorded
S. albipes	Wet	5	4-7
	Dry	2	5
L. flavopunctatus	Wet	2	4
	Dry	1	3
Arvicanthis sp.	Wet	3	4-6
	Dry	0	-
M. mahomet	Wet	2	6-7
	Dry	1	6
M. natalenses	Wet	1	8
	Dry	0	-

4. DISCUSSION

Five species of rodents and one species of shrews were trapped from different vegetation types along altitudes of 1,532m - 2,537 m asl. This may not represent the whole species of the habitat due to heterogeneity and inaccessibility of some areas, but it gives update accounts of rodents and shrews recently present in the forest.

In the current study area, species composition and abundance varied with altitudes and vegetation composition. The highest composition of species was in the *M. gracilipes* dominated habitat which have variable vegetation types (trees, shrubs and herbs), but the abundance was high in *P. orophila* - *P. falcatus* dominated habitat. Happold (1974) reported the abundance and distribution of small mammals mainly depending on density and nature of vegetation for food and shelter.

In terms of diversity, *P. orophila* - *P. falcatus* dominated habitat was the next more diverse (H'=1.32) habitat than others. The lowest species composition and abundance were recorded in the plantation habitat. Because the habitat has barrier ground cover. Similar result was obtained from the study of Afework Bekele (1996a) where young *J. procera* and *C. lusitanica* plantations supported fewer species and individuals because of bare ground, no cover and no berries.

The interference of human and other domestic animals was also another disturbance for rodents and shrews. Similar report by Daniel Bayessa (2010) indicated that modified habitats including plantation forest and cultivation influenced rodent distribution due to availability and quality of food, shelter and rainfall.

Few species of rodents were widely distributed, almost at all elevation levels and different vegetation types. *S. albipes* and *L. flavopunctatus* were the two most distributed rodent species of the area. Their highest record was from *P. orophila*-*P. falcatus* dominated habitat followed by *M. gracilipes* dominated habitat. In the report of Afework Bekele (1996a) in the Menagesha State Forest *S. albipes* was found to be ubiquitous in the forest and distributed up to 3300 m asl.

L. flavopunctatus is one of the most common rodents in the moist areas of East Africa (Clausnitzer and Kityo, 2001), with very wide range of altitude from 500 to 4200 m highland (Mulungu *et al*., 2008). This might be attributed to the diverse feeding habit of the species

(Hanney, 1964). Since invertebrates made the dominant diet of *L. flavopunctatus*, it may prefer habitats that are hospitable to worms and arthropods such as damp, rotten woody and leafy debris.

Arvicanthis sp. was the third dominant and widely distributed rodent of the study area. Demeke Datiko *et al*., (2007) also confirmed its wide occurrence in Ethiopia. The highest record of *Arvicanthis* species was from *Matyenus gracilipes* and *Carissa spinarum* - *Justicia schimperiana* dominated habitats. It was frequently trapped from lower areas of riverine habitat and totally absent from plantation habitat. The altitudinal distribution of this rodent was similar with that of Afework Bekele (1996a).

M. natalensis is distributed throughout sub-Saharan Africa (Kingdon, 1974). It is also widely distributed over most places in Ethiopia (Yalden *et al*., 1976). In Chebera Churchura National Park (CCNP), *M. natalensis* was the most abundant species constituting 29.0% of the total number of captures (Demeke Datiko and Afework Bekele, 2013). Even though, in CPA *M.natalensis* was the least abundant but trapped from *Carissa spinarum* - *Justicia schimperiana, Matyenus gracilipes* dominated habitats and riverine habitats only. The shrew sp. was restricted to *Matyenus gracilipes* and *Pyschotria orophila* - *Podocarpus falcatus* (1,789-2,230 m).

Mean trap success of the current study area was 13.73%, which is high compared to Afework Bekele (1996a) on Menagesha Forest (9.1%), Dawit Kassa and Afework Bekele (2008) on Wando Genet (12.7%). There are also other places that have higher trap success in Ethiopia, Bekele Tsegaye (1999) on Entoto Natural Park, (62.8%).

Total number of captures varied between seasons, the highest number of individuals was trapped during wet season. The abundance of rodents was based on their reproduction time which can be affected by availability of food, shelter and moisture. The time of reproduction also varied from species to species. Similarly, Demeke Datiko *et al*. (2007) and Mossisa Geleta (2010) stressed quality of food resource and shelter within habitats play crucial role on the onset of breeding in many small mammal species.

In the present study out of the total number of captured individuals, adults comprised the largest number (55.9 %). This result goes in line with the study of Shanker (2001) who reported that

adults and sub-adults have relatively larger home ranges than young individuals of the same species. As a result, the total number of capture for each age group varied.

In most places of CPA the abundance of female rodents was more than that of males. Similar findings were reported by Afework Bekele (1996a), Demeke Datiko *et al*. (2007), Demeke Datiko and Afework Bekele 2013 and Taddese Habtamu and Afework Bekele (2008) in different parts of the country. The activity of rodents, pregnant and lactating females may need more food than others.

During the dry season there might be scarcity of food and exposure to predators. The number of pregnant females and juveniles was high during the wet season due to the availability of food. This was also observed in the study of Demeke Datiko *et al*. (2007).

The highest rodents and shrews biomass was recorded in the *P. orophila* and *P. falcatus* dominated habitat. This might be due to the availability of adequate food and shelter. The maximum biomass was observed in *S. albipes* species, similar findings by Mosissa Geleta (2010). Afework Bekele (1996a) stated that comparisons of biomasses of rodents was difficult due to the variation of habitats and weights in different species of small mammals and underestimation of the available numbers.

The results of body measurement show a significant variation in the mean body weight of rodents between species and seasons It might be related to shortage of food and water, both in quality and quantity. Similar result was observed by Taylor and Green (1976).

The stomach content analysis revealed a variety of food items consumed by 5 rodents. Campos *et al*. (2001) described that the feeding ecology of small mammals throughout the world is highly diverse. Similarly Workneh Gebresilassie *et al*. (2004) and Mohammed kasso *et al*. (2010) described that rodents are opportunistic feeders capable of changing their feeding habits based on the availability of food from season to season.

There was also seasonal variation in the proportion of plant and animal matter obtained from the stomach contents of each species. Hairs were observed in *S. albipes, L. flavopunctatus,* and *M. natalensis* stomach content analysis. Similar findings by Mosissa Geleta (2010) obtained a comparable result from the stomach content analysis three rodent species.

In present study, embryo count was varied between seasons. The highest embryo count among the rodents was recorded during the wet season. According to Boutin (1990), the presence of good quality and quantity of food in a given habitat may have significant effect on the time of reproduction, litter size and body growth rate of rodents.

5. CONCLUSION AND RECOMMENDATION

5.1. Conclusion

Chato Protected Area has variable topography with different vegetation communities. Most of the area was covered with dense forest, shrubs and herbs dominating some places. The distribution, species composition and abundance of rodents and shrews varied with altitudes and vegetation composition. Dense and heterogeneous habitat comprises the highest number of rodents and shrews.

Variation in abundance among the rodents was observed in all habitats. The abundance of rodents was high in *P. orophila* - *P. falcatus* (1,975-2,230 m) where as the least in plantation. *S. albipes* was the most abundant species in all habitat types.

The distribution of rodents and shrews was varied among the species. The *S. albipes* and *L. flavopunctatus* species were adapted to variable vegetation types and distributed throughout the forest during both seasons. But the shrew sp. was distributed in *Maytenus gracilipes* and *Pyschotria orophila* - *Podocarpus falcatus* (1,789 -2,230 m) habitats.

The stomach content analysis showed that most of the rodent species consumed plant matters than animal matters. The consumption of plant matters increased more during the dry season but animal matters decreased. The number of pregnant females was high during the wet season and most of the rodent species were reproduce during the wet season.

5.2. Recommendations

Based on the status of the study area the following points were recommended:

- Even though the area was protected there is intense human activity in and around the forest. Peoples use the forest as grazing area, firewood collection, logging and hunting wild animals. This can displace many wild animals and can eliminate endangered animals including small mammals.
- The topography, vegetation type along hilly areas including waterfalls, and sacrificing activities will attract tourists The society and government should initiate adequate condition for tourism.
- The focus of attention is mainly given to the plantation. Wild animals should also be given protection.
- The area should be properly demarcated not to allow settlers to damage the forest.

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LIST OF PLATES

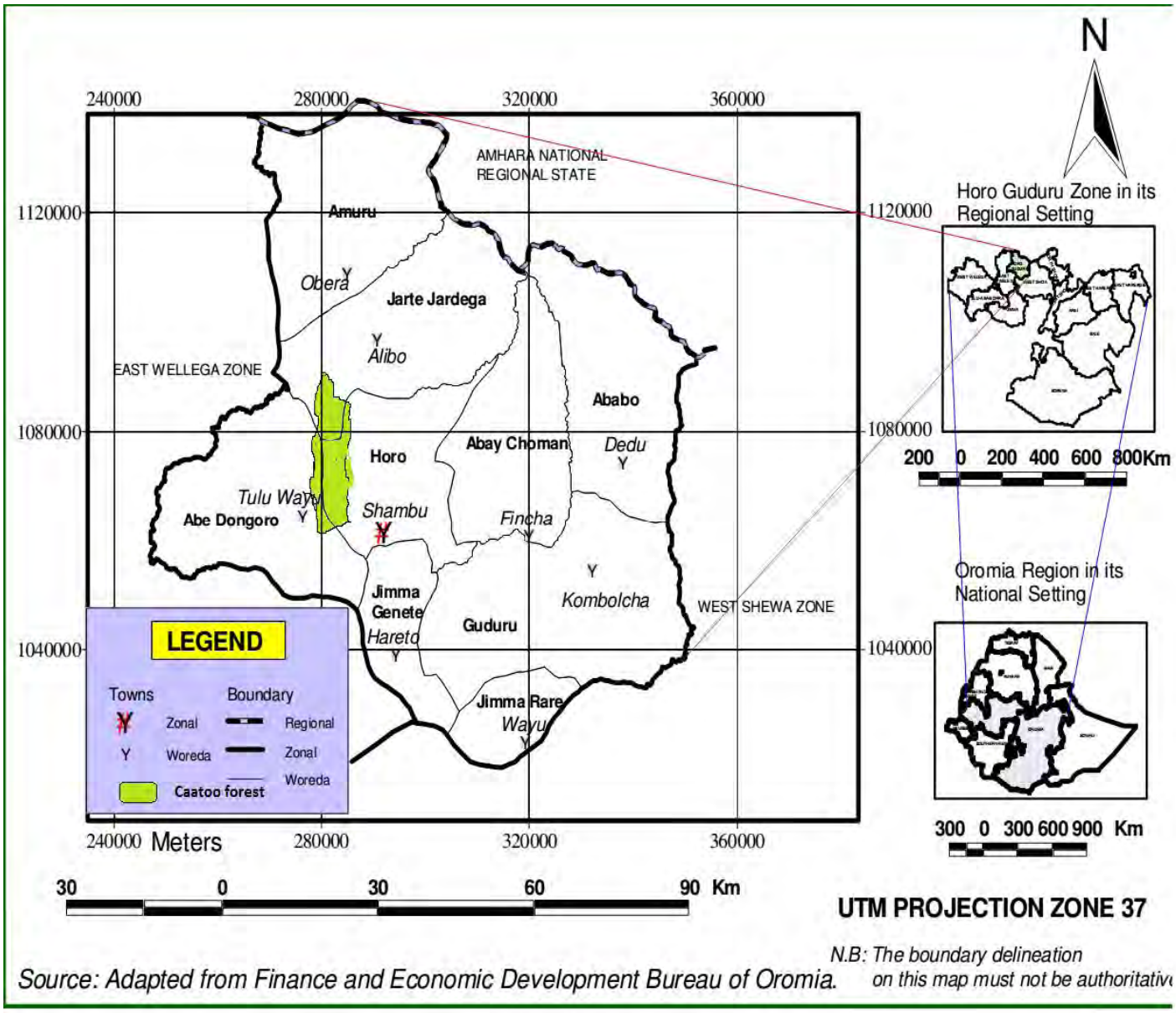

Plate 1.Location Map of Horo Guduru Zone

Plate 2. Varieties of materials and tame animals offered as sacrifice and vow for Caato forest (photo by Lammessa Mergo)

APPENDIX

Appendix 1. Wild animals in Chato Protected Area (L. p. = Local peoples)

Mammals	Local name	Scientific name	Ways of identification	Population status since past 10 years
Anubis Baboon	Jaldeessa	*Papio anubis*	Observed	No change
Gureza	Weennii	*Colobus guereza*	Observed	Fluctuating
Cheetah	Qeerramsa	*Cheetah* sp.	L. p.	Decreasing
Mangoose	Osolee	*Mangoose* spp.	Observed	Fluctuating
Civet	Xirinyii	*Civettictis civetta*	Smell/scent	Decreasing
Ethiopian genet	Hadurre bosona	*Genetta genetta*	L. p.	Unknown
Bush buck	Bosonuu	*Tragelaphus scriptus*	L. p.	Decreasing
Bush pig	Booyyee	*Potamochoerus larvatus*	L. p. and Foot print	Decreasing
Warthog	karkarroo	*Phacochoerus aethiopicus*	Local peoples	Decreasing
Spotted hyena	Waraabessa	*Crocuta crocuta*	Sound and L. p.	Fluctuating
Common duiker	Boortee	*Sylvicapra grimmia*	L. p.	Decreasing
Rabbit	Hilleessa	*Poelagus marjorita*	Observed	Decreasing
Dikdik	Kuruphee	*Madaqua kirkii*	L. p.	Decreasing

Source of information on population status was from local peoples

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