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DIVERSITY AND THREATS OF MEDIUM AND LARGE-SIZED MAMMALS IN AMORO FOREST, WEST GOJJAM ZONE, AMHARA ETHIOPIA

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration among all authors. Author BA was responsible for the concept and design of the study besides the data collection, analysis, and interpretation. He wrote the document's initial draft and implemented the changes suggested by the reviewers. Authors AT, DM and BK provided assistance with the analysis and interpretation of the data, as well as critically reviewed the manuscript. Author BK also made a contribution by paying the cost of securing the financing for publication. All authors read and approved the final manuscript.

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ABSTRACT

The objective of this study was to assess the species composition and relative abundance and to assess major threats of medium and large-sized mammals in Amoro Forest. Line transects surveying and indirect surveys method (including fresh tracks, scats, hair, spines, and burrows) were used to survey mammalian diversity. A survey was conducted in the early morning from 6:00 to 10:00 and late afternoon from 16:00 to 19:00. Key interviews and direct site observationswere carried out to assess the major threat of mammals in the study area. A total of 12 species of medium and large-sized mammals belonging to six orders and eight families were recorded. Porcupine (*Hystrix cristata*), Vervet monkey (*Chlorocebus aethiops*), and Olive baboon (*Papio anubis*) were among the medium-sized mammals while, Spotted hyena (*Crocuta crocuta*), Leopard (*Panthera pardus*) and Common duiker (*Sylvicapra grimmia*) were among the large-sized mammals observed in the study area. Shannon–Wiener Index values were low (H′ = 1.666) whereas, the Simpson's index (1-D) of diversity showed the highest species diversity (0.761) in the study area. Species richness and evenness varied from habitat to habitat in the Amoro forest. Land degradation and different anthropogenic activities such as; illegal logging of trees, overgrazing, agricultural activities, and human-wildlife conflicts were the foremost observed threats to

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the mammals in the study area. Community participation and awareness creation are very important to limit the impact of anthropogenic activities threatening wildlife.

Keywords: Anthropogenic activity; conservation; diversity; mammalian survey.

1. INTRODUCTION

Mammals are among the most widely distributed organisms in the world and occur from the Antarctic to desert ecosystems [1]. They Mammals are biologically the most successful groups of animals with the possible exception of arthropods [2]. Due to diversity in size and morphological, physiological, and behavioral adaptation, mammals colonize diverse habitat types [3].

Mammals have approximately 5,416 numbers of extant species on the globe [4], out of which 2277 (42%) are rodents (Rodentia), 1116 (20.6%) bats (Chiroptera), and 428 (7.9%) shrews and allies (Soricomorpha) comprise the largest species [5, 6, 7]. Ethiopia possesses wide geographic, topographic, and climatic variations, which, and serves as home to a large number of endemic mammalian species [5]. Around 320 species, of 55 are endemic, including 39 endemics (both small and large mammals), which ranks the country among the most diverse mammalian faunas in Africa [7].

They are the most important components of terrestrial ecosystems [8] and provide vital ecological functions such as pollination and seed dispersal [9, 10], keeping ecological stability via predator-prey interaction [10, 11] and source of food and income generation like tusks, horns, and ivory [12]. However, mammals are experiencing greater population declines because of various reasons. These include low reproductive rates, large body size, habitat fragmentation, over exploitation, low rate of body growth, low generation time, and requirement for a large area [14, 15]. Among the known species of mammals, 25% are threatened, 11% are endangered, 4% are critically endangered and approximately 2% of the known modern-day mammals have gone extinct in the last 400 years [13].

Mammal inventories are essential tools for the proper conservation strategies and management practices [16, 17]. Previous research has been done in protected areas in Ethiopia [4, 18–24]. Although National Parks and wildlife sanctuaries were the major focus of studies on animals [21], the survey outside such locations like protected forests and other fragmented areas is still finger counted. The vast area remains biologically unexplored due to a major habitat block within the country. A complete inventory of mammals in different ecosystem types of Ethiopia does not exist and is not well documented [25]. Extensive study is needed to document the diversity of mammals which have ecological and ecotourism value and is also important to design future conservation policies on the biodiversity of the region. Diversity is an essential element for genetic improvement, preserving populations, evolution, and adapting to variable environmental situations [26, 27]. Therefore, the aim of this study was to survey the species composition of medium and large-sized mammals and to assess their major threats in Amoro protected forest.

2. MATERIALS AND METHODS

2.1 Description of the Study Area

The study was conducted in Amoro Forest, located in Dega Damot District, Amhara Regional State, North Western Ethiopia (Fig. 1). It is located between 10°50’06.53" latitude 37°35’51.94" longitudes. The major town nearby is Feres Bet and is far from 3 km from the forest. The district is characterized by a good climate for most of the year with annual rainfall between 900 and 1200 ml. Topographically it consists of 35% mountainous, 30% ups and downs, 20% valleys, and 15% plains [28].

Fendiqa River, main river, crosses the forest from the north side and goes to the southeast of the area. The area also has many small rivers that follow from the eastern and northern parts and enters the main river. It is divided into six land use types such as farmland, grazing land, shrub land, settlement, forest, and bare land. Different types of crops are cultivated in the vicinity of the research area, including barley (*Hordeum vulgare*), wheat (*Triticum spp*.), faba bean (*Vicia faba*), teff (*Eragrostis teff*), maize (*Zea mays*) and different potato species. *Juniperus procera, Olea europaea subsp. cuspidata, Allophylus abyssincus,* are the dominate tree, while *Carissa spinarum, Discopodium penninervium, Dombeya torrida, Lobelia giberroa, Myrsine africana and Pittosporum viridiflorum* are the main shrub and short trees [28].

2.2 Reconnaissance Survey

A reconnaissance was carried out during the first week of March 2020 for two days in order to get basic information on accessibility, topography, and the infrastructures of the study area.

2.3 Sampling Design

For this study, the study area was stratified into three patches of habitat (bare lands, scrubland, and natural

forest) based on the vegetation structures and topography of the landscapes. In order to, effectively survey the species diversity of medium and large-sized mammals, two standardized survey techniques, namely direct and indirect evidence were employed [17].

2.4 Data Collection

Diurnal line transect is a cost-effective method for surveying medium and large vertebrates [17]. An indirect survey technique was also employed for the difficult topography and effectively census elusive and nocturnal large mammals [30]. So, combining diurnal line transect with indirect surveys (including fresh tracks, scats, hair, horns, spines, burrows, and digging) can enhance the detectability of the mammalians and maximize species lists [29]. A survey was conducted for 18 days /126 hours when the activities of mammals are more active; in the early morning (06:30 to 10:30) and late afternoon [17]. During data collection, the first author and one field assistant were walking on foot along the pre-established line transect and directly count all the individuals sighted with their respective species using unaided eyes and/or binoculars.

To minimize disturbance during counting, the silent movement followed by a three to five minutes waiting period was allowed. Each encountered species of large and medium-sized mammals was identified in the field using Kingdon Field Guide to African Mammals [31] and Atibiwoch [32]. Mammals weighing between 2Kg and 7Kg were considered medium-sized while, weighing above 7kg was considered large mammals [33]. A total of 8 randomly laid transect lines were established to count the sighted mammals and to record indirect evidence of the animal signs in the area. This study was also increased with key interviews and direct site observation to assess the major threat of mammals in the area [34].

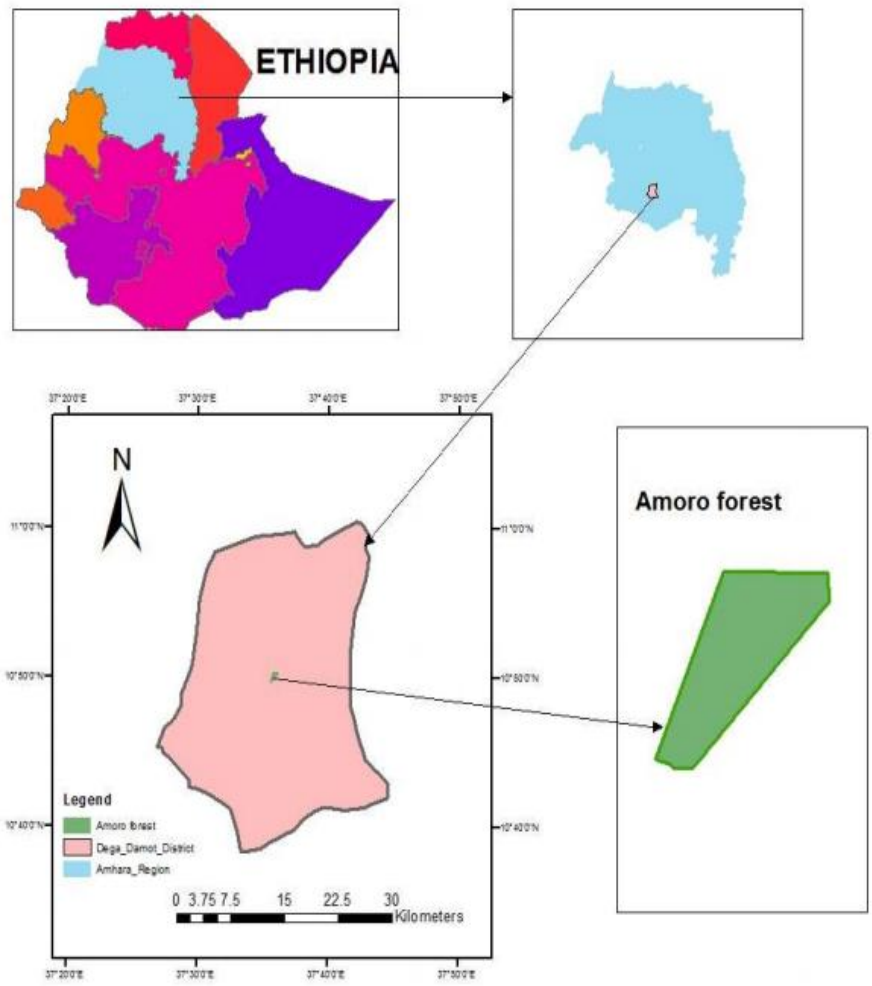

Fig. 1. Map of the study area *(*Source and credit [28])

2.5 Data Analysis

Collected data were organized and entered into a worksheet for analysis. Species diversity of mammals was analyzed following [35]. Shannon−Weiner diversity index was computed by the formula (H´) = ∑PilnPi, Where, Pi is the proportion of each species in the sample: lnPi is the natural logarithm of this proportion. Species evenness was evaluated using the Shannon−Weiner evenness index (E). E= H'/Hmax Where, H' is the Shannon−Weiner diversity index and Hmax =lns, is the natural logarithm of a total number of species in each habitat. Simpson similarity index (SI) was also computed to assess the similarity of mammalian species composition between the study habitats. SI = 2C/I + II = Where: C= the number of common species to the habitats, I= the number of species in habitat one, II= the number of species in habitat two. The relative abundance of each species was calculated by dividing the number of records of each species by the total number of records of all species in the study area. The abundance of observed mammals was categorized as "common" if they were seen during all of the surveys, "uncommon" if they were seen in more than half of the surveys, and "rare" is seen in less than half of the surveys following [17]. Interview surveys and direct filed observations on the threats of mammals were presented descriptively.

3. RESULTS

3.1 Species Composition

A total of 152 observations of 12 species of medium and large-sized mammals belonging to six orders and eight families were recorded within a total time of 126 hours survey. Nine (58.4%) species were obtained by direct sighted, evidence of body parts and vocalization whereas, three species (25%) were recorded through evidence gets from interviewing local peoples. Order Primates was the most abundant order followed by Hyracoidea, whereas order Lagomorpha was the least recorded in the study area. Cercopithecidae and Procaviidae were the dominant families, while Hyeniadea was the least represented family in the study area (Table 1).

3.2 Distributional Patterns and Abundance

The distributional patterns of mammals varied across the study habitats. A high number of species was observed in the scrub lands (7 species) followed by natural forest (6 species). However, a single species was recorded in bare land habitats. Of the total species, 5 (55.6%) species were observed in two of the three habitats, while 4 (44.4%) species were limited to a specific habitat type. Specifically, Ethiopian rock hyrax and Rabbit were only recorded from scrubland. Similarly, Guereza and Spotted hyena were exclusive to scrublands (Table 2). Among the 12 species of mammals, Guereza was the dominant species followed by the Vervet monkey, Olive baboon, and Ethiopian rock hyrax, while, Common duiker, Rabbit, and Common jackal were the less frequent species in the study area.

Spotted hyena and Porcupine were exclusively identified from indirect evidence (scat, spines, footprint, and vocalization) but the presence of Leopard, Serval cat, and Bat-eared fox were guaranteed by villagers. Regarding the occurrence of mammals based on their encounter rate/frequency of observation through the study period, Guereza and Vervet monkeys were common. Only the Olive baboon was considered uncommon, while all the remaining observed medium and large-sized mammals were rare.

3.3 Species Diversity and Evenness

The highest diversity of mammals was recorded from scrublands followed by natural forests in the area. But, only a single species was seen in the bar land habitat, as a result of no species diversity here. The medium and large-sized mammalian similarity was high between scrublands and natural forests (SI=0.62), followed by scrubland and bar land habitats (SI=0.25). But, there was no mammalian species similarity between natural forests and bar land (SI=0.00). On the other hand, the higher and lower evenness of the mammalian species was recorded in scrublands (E = 0.826) and natural forests (E = 0.636). The highest Simpson's index (1-D) of mammalian species was recorded from the scrublands (0.803) and the natural forests habitat had a lower diversity (0.647). The overall species richness of the Amoro forest was 12, and Shannon–Wiener Index values were low (H′ = 1.666) whereas Simpson's index of diversity showed the highest species diversity (0.761) in the study area (Table 3).

3.4 Major Threats to Mammals of Amoro Forest

Field observations have shown that anthropogenic activities and land degradation have greatly influenced the diversity and abundance of mammals in the study area. Those observed human activities were activities were agricultural land expansion, timber production, illegal logging for fuel wood, and grazing by livestock (Fig. 2). Moreover, a particular/small respondent, claimed illegal hunting (especially for leopards and olive baboon) is common.

Table 1. Medium and large-sized mammal species composition in Amoro Forest

Order	Family	Scientific name	Common name	Local name	ID Evidence
Artiodactyla	Bovidae	*Sylvicapra grimmia*	Common duiker	Midako	Visual
Hyracoidea	Procaviidae	*Procavia capensis*	Ethiopian Rock Hyrax	Eshekoko	Visual
Lagomorpha	Leporidae	*Lopus starkii*	Rabbit	Tenchel	Visual
Primates	Cercopithecidae	*Papio Anubis*	Olive baboon	Zingero	Visual
		Colobus guereza	Guereza	Gureza	Visual
		Chlorocebus aethiops	Vervet monkey	Tota	Visual
Carnivora	Hyeaniadea	*Crocuta crocuta*	Spotted hyena	Jib	Scat/ vocalization
	Felidae	*Panthera pardus*	Leopard	Nebre	Personal information
		Felis Serval	Serval cat	Aner	Personal information
	Canidae	*Canis aureus*	Common jackal	Kebero	Visual
		Otocyon megalotis	Bat-eared fox	Afine	Personal information
Rodentia	Hystricidae	*Hystrix cristata*	Porcupine	Jart	Scat/Spines

Table 2. Medium and large-sized mammal species distribution, occurrence, and relative frequency observations during the survey period

Scientific name	Common name	Occurrence	Habitat types			Total observation	Relative frequency observation
			Bar lands	Scrubland	Natural forest		
Sylvicapra grimmia	Common duiker	Rare	3	1		4	2.6
Procavia capensis	Ethiopian Rock Hyrax	Rare		14		14	9.2
Lopus starkii	Rabbit	Rare		3		3	2.0
Papio Anubis	Olive baboon	Uncommon		3	18	21	13.8
Colobus guereza	Guereza	Common			53	53	34.9
Chlorocebus aethiops	Vervet monkey	Common		7	39	46	30.3
Crocuta crocuta	Spotted hyena	Rare			2	2	1.3
Panthera pardus	Leopard	*	-	-	-	-	-
Felis Serval	Serval cat	*	-	-		-	-
Canis aureus	Common jackal	Rare		2	1	3	2.0
Otocyon megalotis	Bat-eared fox	*	-	-	-	-	-
Hystrix cristata	Porcupine	Rare		5	1	6	3.9

*(Key: ***** their presence is assured by the villagers', **-** no direct observed)*

Table 3. Medium and large mammal richness and diversity indices during the survey period

Variables	Habitats			Overall diversity indices
	Bar lands	Scrubland	Natural forest	
No. of species	1	7	6	12
No. individuals	3	35	114	152
SWI(H')	-	1.606	1.149	1.666
H_{max}	-	1.946	1.792	0.670
Simpson's index of diversity (1-D)	0.00	0.803	0.647	0.761

Fig. 2. Major threats to mammals of Amoro protected forest. Timber production (A), illegal logging for fuel wood (B), land degradation (C), agricultural land expansion near to the forest (D), (Photo by Belayneh Ayechew)

According to their response, the leopard is the known livestock predator in and around the Amoro forest. In addition to this, clearing forests from adjacent croplands to avoid mammal pests (especially, Olive baboon and Vervet monkey) is another threat to mammals in the area.

4. DISCUSSION

During the present preliminary survey of medium and large- sized mammals from the Amoro forest, a total of 12 species were identified using direct and indirect evidence. Similarly, [17] recorded 12 mammal species in Wabe forest fragments Gurage zone; Ethiopia within a similar survey period [24] also noted similar results from the communal forest of northern Ethiopia. In contrast, research carried out in Tululujia Wildlife Reserve, Southwestern Ethiopia showed a total of 19 mammalian species [36]. Moreover, 18 medium- and large-sized mammals were discovered in a Cerrado remnant in the Triângulo Mineiro region of southeast Brazil [37].

Limited survey period, size of the study areas, and changes of habitats to various anthropogenic pressures; variation in sample sites, sampling effort spent, season considered, and variation in vegetation physiognomy [17,38], size of the area, habitat fragmentation and destruction [15] have a significant effect on species presence, abundance, and distribution.

In Amoro forest this might be due to, a limited survey period, an agricultural land expansion, illegal logging for fuel wood, grazing by livestock, illegal hunting and clearing of forest, and the small size of the study area. Furthermore, [38] noted that fewer mammals can be found in Lebu Natural Protected Forest as a result of the existence of top predators. Top predators are available in the current study area too. Olive baboons have been killed along the journey when it migrates to the near forest, Felatite Selasa Protected forest, during a shortage of food in the area.

Like most mammalian studies [4, 24, 36, 37, 38, 39] the current study showed inclination of mammals to favor one habitat over the other resulting the availability and quality of resources. In the current study, scrublands have a high species diversity of medium and large-sized mammals. On other hand, most studies showed that high species diversity of mammals recorded either in woodlands and/or forest habitats [4, 30, 36, 38, 40]. This might be due to the existence of a higher disturbance rate in the forest habitat of Amoro forest than in scrub lands. Most mammal species were recorded by direct observations. A study [17] reported as mammals can be easy observed due to the openness of the habitat. This is in line with the current study.

The most frequently sighted species were Guereza, Vervet monkey, and Olive baboon in descending order. Several studies have reported that primates are the most abundance order in different study sites [4, 24]. Beyond their widespread distribution, primates' high reproduction rates varied foraging strategies, and capacity for adaptation to a variety of ecosystems and human disturbances are reasons for their success [40].

The distribution and abundance of the order Hyracoidea were ranked next to primates. This finding contrasts with the finding of [4] and [38]. This might be due to the difference in the habitat characteristics of the study areas. The current study area has different degraded land with caves which is suitable habitat for Ethiopian rock hyrax (Table 2).

The study area had very little diversity or abundance of the order Carnivore. As a result, there is a high rate of livestock depredations, which leads to illegal hunting as retaliation [39]. Similarly, the Felis serval was observed at a low density at Geremba Mountain Fragment [30]. The distribution and abundance of order Atriodictayla were the least in the Amoro forest. A single species, the Common duiker, was represented in this order. This might be due to the presence of excess numbers of top predators, the number and presence of herbivores in the area will decrease [17]. In addition to this, the respondents decided as common duiker hunted for meat and it is a common crop raider next to Olive baboon and Vervet monkey. Due to this conflict, their number became decreasing from time to time. Land degradation and different anthropogenic activities such as agricultural land expansion, timber production, illegal logging for fuel wood, and continuous and intensive grazing by livestock were the major identified threats to mammals in the study area. Besides, small respondents claimed that there is a human-wildlife conflict especially, with primates and carnivores. Poaching, agricultural encroachments especially by investors, deforestation, illegal settlement, and human-wildlife conflict are the main threats to mammals [30]. The expansion of habitat fragmentation, deforestation, human settlement, and infrastructure developments like roads are major threats for mammals [4, 38].

5. CONCLUSION

The number of medium and Large-Sized Mammal species recorded from the Amoro protected forest was small. However, the result of this study will serve as a

signal for further study on the biodiversity of the area and management actions to be applied in the future. Land degradation and different anthropogenic activities such as agricultural land expansion, timber production, illegal logging for fuel wood, continuous and intensive grazing by livestock were common threats to the mammals in the study area. Human wild animals' conflict was also recorded frequently with mammals such as Olive baboon and Vervet monkey because of crop damage such as barley, maize, and pea bean. Similarly, Leopard and Bat-eared–fox were common livestock predators in the area. To, minimize such conflict and anthropogenic activities on wildlife of the study area, community participation, enforcement of the law, and rehabilitating the degraded area play paramount significance in the sustainability of wildlife in the Amoro protected forest. The communities and the data collector were highly enamored of the area's topography, river falls, and different species of mammals and birds found in the study area, which are extremely attractive and refresh the spirit. Hence, the district culture and tourism office should work jointly with other governmental and non-governmental groups to increase the potential of the forest. If such activities are implemented, the area will have a pronounced biodiversity potential.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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