FEEDING HABIT AND POPULATION DENSITY OF AFRICAN CIVET (*Civettictis civetta*) IN CHORA DISTRICT, BUNO BEDELE ZONE, SOUTH WEST ETHIOPIA

A RESEARCH PAPER SUBMITTED TO THE DEPARTMENT OF BIOLOGY, COLLEGE OF NATURAL SCIENCES JIMMA UNIVERSITY FOR THE PARTIAL FULFILLMENT OF THE REQUIREMENTS OF MASTERS' DEGREE OF SCIENCE IN BIOLOGY

BY: DAWIT DEBELO

ADVISOR: TSEGAYE GADISA (PhD)

CO-ADVISOR: TADESSE HABTAMU (PhD)

JIMMA, ETHIOPIA

NOVOMBER, 2011E.C

APPROVAL SHEET

Advisor----------Signature----------Date----------

Co-Advisor---------- Signature----------Date----------

Internal Examiner---------- Signature----------Date----------
-

External Examiner---------- Signature----------Date----------

Acknowledgment

First of all I am extremely grateful and proud to thank my advisor Dr.Tsegaye Gadisa and my co-advisor Dr.Tadesse Habtamu for their close supervision, encouragement, guidance, advice and support from the beginning up to the end of this research paper. I am also grateful to thank biology department for their supportive idea. My thanks also goes to Chora agricultural and natural resource office for their document and information and all my assistance those support me from the beginning up to the end of this research.

Table of contents

Contents **Page**

List of Acronymy

CANRO-------Chora agricultural and natural resource office

FAO---------- Food and Agriculture Organization

EWCO--------- Ethiopian Wildlife Conservation Organization

WSPA --------- World Society for the Protection of Animals

List of Figures Page

List of tables Page

Abstract

A study on feeding ecology and population density of African civet (Civettictis civetta) was conducted in Chora district, Buno Bedele Zone, Oromia regional state, South-west Ethiopia. The study was conducted from February 2018 - August 2018 in farmland and coffee plantation during both dry and wet seasons. Feeding habit of the African civets was studied by direct observation and examination of fresh droppings collected from dung piles ('civetries') in different seasons. Mean, minimum and maximum number of civets in each civetry was calculated and then the population density estimated. A total of 648 African civet scat samples were collected from 18 civetries of the study area in the coffee plantation and farmland within five day intervals. More than 5 different prey items were identified from the scat samples. Animals, with 60.9% relative frequency contributed 17.59% African civet diet biomass during wet season. Animals, with 38.59% relative frequency and 8.6% biomass contributed diet of the African civet during the dry seasons, in coffee plantation. Plants, with 6.66% relative frequency contributed 0.31% biomass during wet seasons. Plants with 76.66% relative frequency contributed 36.69% diet biomass during the dry seasons in coffee plantation. There was variation in African civet plant diet between wet and dry season and it was statistically significant (p=0.006). Based on fecal count in the current study area, the number of civets in the study area varied in wet and dry seasons. The variation was statistically significant (p=0.029). The density of civets in the sampled coffee plantation and farmland was 2.2 civets/km^2 (0.022/hectare) and 3.6 civets/km^2 (0.036/hectare) in wet and dry seasons respectively. In all the study area, the mean estimated number of civets during both wet and dry seasons were 0.029/hectare (2.9/ km^2). There was variation in the density of African civets between wet and dry seasons. Seasonal collection of civet musk from coffee forest and farmland economically supports the farmers while increasing the importance of civets in the habitat and hence contributing for its conservation. So in Chora district, there is a relationship between the number of civet farmers and number of wild civets, the number of wild civets and amount of food available and suitable habitat for wild civet.

Key word: *African civet, Civetry site, Feeding habit, fecal count**,** Population density*

1. INTRODUCTION

1.1. Background

African Civet (*Civettictis civetta*) is an elusive, nocturnal, omnivorous and territorial scent marking viverrids, distributed throughout sub-Saharan Africa; usually close to perennial wetlands (Ray, 1995; Bekele Tsegaye *et al.,* 2008a, 2008b). In Ethiopia, African civets are quite abundant species recorded from altitudes ranging between 550 m asl (Alatish National Park) and over 3400 (Bale Mountain National park) (Tadesse Habtamu and Afework Bekele, 2008; Ermias Admasu *et al.,* 2004). They inhabit savanna, forest, dry areas along water course, farmlands, human settlements and in urban areas (Ray, 1995; Ray *et al*., 2008; Dagnachew Melese *et al*., 2014).

All civets have scent-producing perineal glands, located in a double pouch near the genitals. The fatty yellow secretion of these glands has a distinctive musky odor used for olfactory communications. For elusive, solitary and nocturnal species, chemical signals are used as a 'bulletin boards' that relay messages in the absence of the sender (Burger, 2005; Scordato *et al.*, 2007), whereas social species frequently integrate concurrent visual, auditory, and other behavioral cues (Candolin, 2003; Partan and Marler, 2005; Wood *et al.*, 2005). People use it for cultural, medicinal, religious and economic purposes (Randall, 1979;Tadesse Habtamu and Afework Bekele, 2014).

Commercially civet musk is the most required animal product for a fixative agent in the world class perfumery industries (Tadesse Habtamu and Afework Bekele, 2014). The perineal gland secretion (musk) extracted from the civet was exported to various countries, and even it served as a currency in the past (Woodford, 1990). Males produce larger quantity and better quality musk (secretion) than that of females (Tadesse Habtamu and Afework Bekele, 2014). Ethiopia has a worldwide monopoly for civet musk production and annually exports more than 3,000 kg of musk worth about US$ 3,000,000 (FAO, 2000). At present, with over 90% export share, Ethiopia is the world's leading musk supplier to the perfume industries (KumeraWakjira,2005). The majority of it (97%) exported to France (Jemal Mohammed, 1999) to support perfume industries.

The omnivorous feeding habits of the African civet from the western and southern Africa have been reported(Skinner and Smithers, 1990; Ray, 1995; Kingdon, 1997). Wild fruits, insects, rodents, invertebrates, birds and carrions were reported from the stomach (Rautenbach and Nel, 1978; Skinner and Smithers, 1990, Ray, 1995) and scat (Bekele Tsegaye *et al*., 2009) of the African civet. However, none of these were quantified and determined for its food preference and the relative importance of items at different seasons and habitat of the present study area. Information on the feeding habits of wild animals contributes to the understanding of their behavioral ecology (Mills, 1991), diet item diversity, preference and seasonal availability, foraging strategies and their activity patterns (Fuller and Kat, 1990; Henschel and Skinner, 1990). Additionally, understanding the nutritional requirements of animals in the wild provides the required information for formulating feeds for captive wildlife (civets) and to plan supplemental feeding(Tadesse Habtamu *et al., 2014).*

The diversity of food items for the civets were available only for the central and southern African populations which include wild fruits, carrion, and rodents (Ray, 1995),reptiles, insects, birds, amphibians (Randall, 1977; Kingdon, 1977). Seasonal shift of feeding habit based on the availability was also reported (Skinner and Smithers, 1990). Recent report from coffee forest in Limu seka district, south western Ethiopia, indicated that African civets have wider alternative food items shifting from one to the other depend on the seasonal availability(Tadesse Habtamu *et al.,2014).* Animals, with 98.8 and 97% occurrence contributed about 69.1 and 44.4% diet biomass of the African civet during the wet and dry seasons, respectively andabout 28.9 and 54.3% of the civet diet comes from plant materials during the wet and dry seasons, respectively (Tadesse Habtamu *et al., 2014).* However no report is available on the feeding ecology of the African civet in coffee plantation and farmland in Chora district, Buno Bedele Zone, Oromia Regional State, south-west of Ethiopia.

In coffee dominated tropical rain forest habitats of the south-western Ethiopia, the number of African civet is reported to bequite abundant (Yalden *et al*., 1980). However, except for the reports of their occurrence (Kingdon, 1997; Schipper *et al.,* 2008), no attempts was made to systematically estimate the population of African civet in any habitats within its ranges, but only few reports are available to estimate sex ratio, distribution,age structure and density of African civetin the coffee dominated tropical rain forest habitats of the Limu seka district Jimma zone south-western Ethiopia (Tadesse Habtamu and Afework Bekele, 2014). Accordingly, these authors reported that the density of civet estimated to be 5.4 individual/km^2 in some coffe forest habitat of south western Ethiopia.The unique behavior of civets including the strict use of civetries, morphological variation of scats among individuals,texture (shape and size) and the relatively small home range size of the species (Ermias Admasu *et al.*,2004) are good opportunities to generate more information to estimate the population in a defined area.

Scat structure and texture are distinct for sex and different age categories. It was defined that adult male civets produce long, large, hard, fully formed, heaped base, tapered ended feces and place their scats centrally while adult female drop a sausage shape scat with blunt end and the presence of juvenile scats on or near its feces (Tadesse Habtamu and Afework Bekele, 2014). Information on population estimates is critical for the conservation, management and the sustainable use of the species (Zielinski and Truex, 1995; Linnell *et al.,* 1998).

The fecal perimeter of adult male civets ranged between 8 and 15 cm, (average 10.65) and of adult female ranged between 6 and 11 cm, (average 7.86) (Tadesse Habtamu *et al., 2015)*. During this study, the following fecal parameters were considered to vary between individual civets independently sharing a civetry (site of defecation). Fecal structures including the physical appearance of feces such as heaped or non-heaped base, tapered or blunt tip, simple (not fragmented) or complex (fragmented into uneven parts) and fecal texture (including the degree of fecal formation i.e. fully formed, semisolid or loose)(Tadesse Habtamu *et al.*,2015).

Chora district is known to reside hundreds of Civet farmers. Civet farmers form a chain to exchange civets and their products (musk).The abundance of civet farmers in the district might be predicted to be correlated with the abundance of civets in the wild. The abundance of Civets in the wild in turn might be correlated to the favorable diet in the coffee plantation and farmland of the district. However, no report is available on the density of wild African civet in coffee plantation and farmland during wet and dry season in Chora district, south-west, Ethiopia. Hence, assessing the feeding ecology and estimating the population of the African civet in the selected coffee plantation and farmland habitats becomes the priority issue for proposing sustainable utilization. Therefore, the purpose of this study was to record the diversity and seasonal abundance of diet items of the African civet and estimating the population density of the African civet during the wet and dry season from selected coffee plantation and farmland habitats of Chora district, Buno Bedele zone, south-western Ethiopia..

1.2 Statement of the problem

Investigating food habit of animals in the wild is the basis for understanding wildlife ecology, behavior, management, conservation and utilization (Koike, 2009). Civet farming is most practiced in four south-west zones of Oromia (Jimma, Buno Bedele, Ilu Ababor and East Wollega). Report available on the feeding habits of the African civet from coffee dominated forest habitat of the south and south west Ethiopia showed these animal to have as a wider alternative food items shifting from one to the others based on seasonal availability (Tadesse Habtamu *et al.,2014).* It is expected that food items, most frequently consumed by African civets in anarea vary based on availability and preference of feeding. In put on population estimates and feeding ecology is critical for the management, conservation and the sustainable use of the species (Zielinski and Truex, 1995; Linnell *et al.*, 1998).

The perseverance of Civiculture for a long period of time in Chora district might be predicted to be correlated with the abundance of Civets in the wild and in turn it might be correlated to the favorable diet in the coffee plantation and farmland of the district. However, no scientific work has been done to prove these predictions on the feeding ecology and estimation of African civet density in coffee plantation and farmland during wet and dry season in the present study area. Therefore, the present study was designed to collect data on feeding ecology and estimate of population density of African civet to fill the information gap in the district.

1.3. Objectives

1.3.1. General objective

The general objective of this research was to investigate the feeding habit and population density of the African civet in Chora District, Buno Bedele Zone, south west Ethiopia.

1.3.2. Specific objectives

- To investigate seasonal diversity of food items used by the African civet in coffee plantation and farmland habitats in the study area.
- To determine the importance and preference of each food item as civets seasonal diet.
- To estimate population density of African civet in coffee plantation and farmland in the study area.

1.4. Significance of the study

This study is expected to generate information on: diversity, seasonal variation, food preference and relative importance of the African civet diet. It is also expected to generate information on population estimation and variation in season of African civet in Chora district. Therefore, the finding of this study, which is the first of its kind in the area, will help us to understand the effect of seasonal variation and habitats of dry and wet season on feeding habit and population density estimation to wild African civet in the study area.

2. LITERATURE RIVIEW

2.1. Taxonomy

African civet is classified under Class Mammalia, Order Carnivora, Family Viverridae and Subfamily Viverrinae. Family Viverridae consists of 20 Genera with 35 species (Nowak, 1999). But, as the recent classification of Wozencraft (2005), this Family consists of 15 Genara with 38 species.

Viverridae is one of the varied groups of the Order Carnivora. Physically, they look like to genets and linsangs (Kingdon, 1977). They are not true cats; however they look like a member of the cat family. Individual can easily identified African civets by their disproportionately larger hindquarter, low-headed stance and erectile dorsal crest(Ray, 1995). They are unique in size with large heavily built, long-bodied, long-legged and dog–like viverrids preferring to be close to water. They have cat–like appearance with long noses, slender bodies, pointed ears, long furry tail, short legs, non-retractile claws, and unlike other cats they are digitigrades (Wright, 2011).

Civets with dotted coat have five toes on each foot. There is webbing between toes, and the claws are non-retractile or semi-retractile. The pointed ears enlarge above their head. Similar to domestic cats, ear flap has pockets or bursae on outside margins. Their teeth are dedicated for omnivorous diet, including shearing carnassials teeth and flat-crowned molars in both upper and lower jaws(Ray *et al*., 2008; Gauberts *et al*., 2005). African civet has gray coats with black markings and long tail. They have different pattern of coat color from place to place. The body weight show difference from region to region, and slightly between sexes.

2.2. Feeding habit of African civet

Civets are omnivorous and opportunistic foragers. They feed on a wide variety of food items like carrion, rodents, birds, centipedes, millipedes, insects, eggs, reptiles, seeds and fruits (Kingdon, 1997; Wondmagegne Daniel, 2006; Ayalew Berhanu, 2007; Bekele Tsegaye *et al*., 2008b). Eighty percent of the stomach contents of African civet contained remainder of wild

fruits, carrion and rodents as reported from South Africa (Bothma, 1971). Insects also constitute significant proportion of civet diet (Smithers and Wilson, 1979).

Though the feeding ecology of most viverrids has been well studied elsewhere (Ho, 2009), limited information is come for the African civet, from Central, South Africa and Zimbabwe (Rautenbach and Nel, 1978; Skinner and Smithers, 1990). However, no ecological information for the eastern part of the continent. Only a small number of report from the central highland (e.g. Bekele Tsegaye *et al*., 2009), however, none from the coffee dominated tropical rain forest habitats of the southwestern Ethiopia, where the animal is reported to be quite abundant(Yalden *et al*., 1980).

The African civet is omnivorous in diet and feeds habitually on fruit and animals. It is even known to depend upon domestic food wastes. Prey is primarily detected by smell and sound rather than by sight of them. Poultry and young lambs are sometimes taken. African civets are active about an hour or so after dark when they forage (Ray and Sunquist, 2001).

African civets do not make use of their claws for catching prey. Instead, they kill the prey with their teeth. The killing system includes shaking their heads to break the prey's spine, throwing it around or the use of a killing bite wherein the grip is not released until the prey is dead. Civets show a variety of hunting behaviors. The prey may be shaken so violently (death shake) that the spinal column is broken or a rodent may be bitten and thrown around (Schliemann, 1990; Estes, 1991; Shalu, 2000).

Several systems have been used to characterize animal diets in the field. However, more stress should be given to non-evasive methods of diet determination (Litvaitis, 2000; Iverson *et al.*, 2004; Trites and Joy, 2005), of which scat analysis was most preferred (Arim and Naya, 2003; Tollit *et al*., 2004; Bacon *et al.*, 2011; Klare *et al*., 2011). The remainder of most species such asseeds, hair, feather, bones, teeth, skin, , exoskeletons that are consumed can be easily identified by using reference collections(Hutchings, 2003; Silva and Talamoni, 2003; Malo *et al.*, 2004; Mukherjee *et al*., 2004). It is generally assumed that the amount of each undigested remains of food matter in feces is proportional to the amount ingested (Maia *et al.*, 2003).

Grasshopper, termites, crickets, beetles and stick insects were among the most common insects in the diet of civets. They also prey on aquatic animals such as, mudskippers and snails (Kingdon, 1977). In Ethiopia, diet of civets is mainly composed of wild and commercial fruits. In addition to these items, they depend on a variety of food items based on seasonal availability in the area. African civet feed on bony materials, but it might not be digested (Wondmagegne Daniel, 2006; Ayalew Berhanu, 2007; Bekele Tsegaye *et al*., 2008b). However, undigested bony materials were not seen in the scats of the small Indian civet (Sreedevi, 2001). Civets have an irregular habit of feeding. They feed large amounts of food matter when available (up to 2 kg of food in a single night), and in the absence of food, they can stay up to two weeks without food (Kingdon, 1977). They are nocturnal in habit and make use of their acute senses of smell and hearing to locate their prey items.

When the prey animal is dead, civet scarf down the food with little chewing in a very short period of time (Estes, 1991). This enables them to eat food rapidly and keep moving to escape from predators. In the lack of shearing carnassials, efficiency of meat cutting in the species is low. For this reason, they swallow the food items with minimal chewing.

Feeding habits of civets can be affected temporally and spatially, depending upon the type of habitats where they live in. Studies in three different parts of Ethiopia have revealed variations in the diet composition, seasonality and preference of food items of civets where the habitat is heterogeneous; they feed on a wide variety of food items with small seasonal variations (Ayalew Berhanu, 2007). In these areas, the main diet of civet is fruits (commercial and wild). Caracas feeding habit was also reported. In forest of Jimma zone and Menagesha-Suba State Forest, the diet ofAfrican civets showed significant seasonal variations (Wondmagegne Daniel, 2006; Bekele Tsegaye *et al*., 2008b). In both these areas, they depend up on fruits for survival.

African civets as carnivores show the ecosystem health and integrity of it. They play a major part in maintaining the structure of food-web and community of lower trophic levels in the ecosystem they occupy (Palomares *et al*., 1995). The African civet frugivorous behavior might influence the dynamics of forest, and shape of plant community structure through seed dispersal (Mudappa *et al*., 2010). As an ecosystem service supplier, civets have a function in facilitating soil fertility

due to the behavior of civetry (dung pile) formation. It is not only the largest representative of Viverridae, but also a bio indicator of forest habitat dynamics like to most other civet species(Mudappa *et al.*, 2010; Rabinowitz, 1991).

2.2.1. Civetry sites

Civetry sites are not only used as a site of defecation for African civet; they may also have roles interritoriality, communication, warning and defense behaviors (Bearder and Randall, 1978; Jordan *et al*., 2007) and in regulation of physiological functions (Espírito-Santo *et al*., 2007; Barja *et al*., 2011). Using similar place to defecate benefits the animal to centralize waste and cut down parasites and infection (Lamoot *et al*., 2004). In addition ecologists also get information regarding the diet composition(Bekele Tsegaye *et al*., 2008b), scent communication (Espírito-Santo *et al*., 2007; Bekele Tsegaye *et al*., 2008a), population size (Solberg *et al*., 2005), mechanism of seed dispersal (Russo *et al*., 2006) and evolution of plant community (Fiorelli *et al*., 2013).

In contemporary ecological research, faeces of wild animals collected from latrine sites are used for genetic variability analysis within and between populations, gene distribution, gene frequencies, individual identification (Schwartz *et al*., 2007) and phylo geographical studies (Beebee and Rowe, 2005). African civets have communal latrines (dung piles) called ‘civetries’. ‘Civetries’(dungpiles) are frequently established around tracks in clearings.

Civetries provide for olfactory communication and to smear territory boundaries. Scats are left in an unburied pile (Kingdon, 1997; Trites *et al.*, 2005; Bekele Tsegaye *et al.*, 2008). During defecation, perineal glandular secretion is added to the faeces of civet, making it to have a long-lasting odor. African civets use each civetry for a long period of time (Wondmagegne Daniel, 2006; Ayalew Berhanu, 2007; Bekele Tsegaye *et al*., 2008b). They create their civetries near pathways in open and relatively dry soil. Latrine sites are as well a good source of communication for civets, having high density of scent marked objects surrounding civetries (Wondimagegne Daniel, 2006; Ayalew Berhanu, 2007; Bekele Tsegaye *et al*., 2008a).

2.2.2 Scent marking

Scent marking is one of the major forms of communications in African civets. Civets scent mark signposts in territories by their perineal glandular secretion and feces. They mark environmental

sign-posts such like tree trunks, stones, stumps, thickets, dry logs, poles and fence or grass along road sides using perineal glandular secretions. The height at which civet scent mark mostly ranges from 35 to 40 cm above the ground (Bekele Tsegaye *et al*., 2008a). They mark sign-posts in their natural habitats, but they mark more frequently on objects near their civetry sites.

The amount of perineal glandular secretion at the marked site varies with season and habitat type. Wondmagegne Daniel (2006) and Bekele Tsegaye *et al*. (2008a) reported an increase in the amount of glandular secretion during dry season than the others. Some of the sign-posts were marked immediately after removal of the glandular secretion from scent marked sites and while others remained without remarking probably due to the information conveyed on each sign-post. Scent marking permits the chemical exchange of information between animals with overlapping home ranges, but tends to travel and forage alone (Eisenberg and Kleiman, 1972).

The scent glands have a major social role, leaving scent along their pathways to convey information on their social and reproductive position (Randall, 1979; Mohan, 1994). Scent marks are deposited either passively when moving through vegetation, or actively through squatting and rubbing the anal region on the ground or on prominent environmental objects or sign-posts. Scent marks permit assessment of social status, individual recognition, kin identification, territory demarcation and sexual receptiveness of the individual responsible for the mark. Vocalizations are well developed in some of the African civet (Gittleman, 1996; Hutchings and White, 2000**;** Burfield, 2005).

2.2.3. Behavior of African civet

African civets are solitary during most of their life (Kingdon, 1997). They are in groups of two or more, only during reproductive activities for short period of time. They use olfactory sign as a major means of communication between conspecfics (Ray, 1995; Bekele Tsegaye *et al*., 2008a). The scent mark of civets can keep on for a long period of time in their habitat. Communication between conspecifics is important not only in social organisms, but also in solitary species, to ensure reproductive success (Clapperton, 1989). Intraspecific communication among solitary carnivores and between social carnivores is achieved primarily by olfactory signals (Macdonald, 1980).

Civets are generally solitary, but they have a variety of olfactory, visual and auditory means of communication. Scent glands play a major role in the social life by leaving scents with specific communication signals such as reproductive, social and individual dominance strategy (Eisenberg and Kleiman, 1972). They are relatively short sighted, but hearing is sensitive, and olfaction is the key sense of communication (Kingdon, 1997). African civets also produce sound for communication, especially to show aggression such as growl, cough-spit and scream (Rosevear, 1974).

To keep away from predators, civets walk with their heads down very close to the ground and the tail parallel to the back. This helps civet to move around freely without being noticed in addition to the modification of the coloring of their back and tail. The white color of the face cannot be visible for predators when the civet is in this position. Occasionally African civet gallop into the surroundings for protection. They can as well make the hair on their back erected so that the bodies double in size (Kingdon, 1988). Frequently predators may not locate civets as they camouflage (Trites *et al.,* 2005).

2.3. Population density of African civet

2.3.1. Population density estimation of African civet

African civet is considered as a common animal in most of the habitats known for its existence (Ray *et al*., 2008). Available data on population dynamics of the African civet is fragmented and represent only few localities in some countries. Population density of 9, 3 and 7 individuals perkm^2 was estimated from Menagesha-Suba State Forest, Jimma and Wondo Genet areas, respectively, based on fecal counts from civetries(dung piles)(Bekele Tsegaye, 2006; Wondmagegne Daniel,2006;Ayalew Berhanu, 2007).

Scats are progressively becoming important informants about the sex, identity, age, relative abundance, diet, home range, genetics, demography, disease and life history of shy, nocturnal, cryptic and elusive species like the African civet(Putman, 1984; Maia *et al.,* 2003; Lance *et al*., 2001; Tuyttens *et al.,* 2001; Trites and Joy, 2005). Features such as scat morphology, texture, length, circumference, color and odor have been frequently inferred parameters to determine certain attributes of a species (Ray and Sunquist, 2001; Ho, 2009).

In Ethiopia, there is no tradition of breeding African civets in captivity (EWCO, 1999). However, civets for farming practices are trapped from the wild. The confinement of civet farmers in the southwestern part of the country and the lack of captive breeding tradition may be attributed to the abundance and easily accessibility of the animals in the coffee dominated tropical forest habitats.

Eventhough the long history of utilization, systematic estimate of the population of African civets in these areas or elsewhere in the country is lacking. In the same way, except for the reports of their occurrence (Kingdon, 1997; Schipper *et al.,* 2008), no attempts were made to systematically estimate the population of the African civet in any habitats within its ranges. However, the unique behavior of African civets including the strict use of civetries, the morphological difference of scats among individuals, and the relatively small home range size of the species (Ermias *et al.,* 2004) are good opportunities to generate more information to estimate the population in a defined area.

Information on population estimates is critical for the conservation, management and the sustainable use of the species (Zielinski and Truex, 1995; Linnell *et al.,* 1998). Therefore, assessing the feeding ecology and estimating the population of the African civet in the preferred coffee forest habitat of the southwestern Ethiopia becomes the priority issue for proposing sustainable utilization.

Scats provide enough information about the bearer (owner) and the population. For example, scat morphology, content and defecation habits (behavior) were employed to determine the presence/absence of some cryptic species (Trites and Joy, 2005) and to differentiate individuals of related species (Linnell *et al*., 1998; Wang and Fuller, 2003; Zhou *et al.,* 2008; Ho, 2009; Bacon *et al.,* 2011). Fecal counts were frequently used as an index of density or habitat use (Bacon *et al.,* 2011), to examine long-term population dynamics at a site (Malloy, 2000; Krebs *et al.,* 2001) and the relative abundance of individuals in different sites (Potvin *et al.,* 2005; Fuller *et al.,* 2007).

The core area for the African civet was 0.4 km^2, and this size was determined by the resource of the area(Ermias Admasu *et al.*, 2004). Population density of 1 individual per km^2 reported from southwest Gabon based on track count along transects in lowland forest (Prins and Reitsma, 1989). However, the population tendency of the African civet in any of its known habitat is unknown in the absence of continuous studies(Ray *et al*., 2008).

2.4. Economic Importance of African civet

African civet has cultural, social and economic importance in Ethiopia (Yilma Delellegn, 2003). Civiculture (civet farming) play an important role in the economic history of the country, particularly during the 18th and 19th century. People in different societies use civets and their goods for different purposes. The perineal gland secretion of African civet is used in perfume industry, traditional medicine and to flavor tobacco (Xavier, 1994; Kingdon, 1997).

Civet musk increases the strength of perfumes and keeps the taste natural. In Ethiopia, people use civet musk in traditional medicinal practice for discoloration of skin, headache, etching and even against cancer (Jemal Mohammed, 1999). In many parts of Ethiopia, African civet farming is practiced as a means of income (EWCO, 1999). Individual civet yields from 800 to 1300 g musk a year. The majority of it (97%) is exported to France (Jemal Mohammed, 1999) to support perfume industry.

In early Ethiopian history, civet musk was expensive and used as a currency(Pankhurst, 1961 as cited in Yilma Delelegn, 2000) and traded with Egypt, Zanzibar and India. Civet musk was prized above ivory, gold or myrrh. Traditionally, it was used as a medicine for various ailments and is taken with tea and coffee (EWCO, 1995; Jemal Mohammed, 1999). The demand for civet musk from perfume industries is high, but Ethiopia is able to supply only a maximum of 25% of the global demand.

3. The study area and Methods

3.1. The Study Area

This study was conducted in Chora district, Buno Bedele Zone, Oromia Regional State, south-west Ethiopia. The district is bordered, by Dega district in the North, Gatira district (Jimma zone) in the South, Bedele district in the East and Yayo district in the West(Fig 3.1.1). The altitude of the district ranges form 1450-2300m above sea level. There are 32 rural and two urban Kebeles(the smallest administrative body in Ethiopia) in the district. Of these Kebeles, the study was conducted in six randomly selected as representative of the district. These are Ababora, Shangala and Tulu Mute that represent farmland and Halelu Hadesa, Hawa Yember and Uta None that represent coffee plantation. The study was conducted from February 2018 - August 2018 to identify the feeding habit and population density of the wild African civets in an area of farmland and coffee plantation during the dry and wet seasons.

The district is known for its extensive coffee forest and broad leaved natural forest with high biodiversity. Its human population is estimated to be 133766, out of which 66259(49.6%) are males and 67507(50.4%) are females (CANRO, 2007). According to CANRO (2018) the total land area coverage of the district is 78,860.79 hectares. Of these, the total cultivated land of the district covers 48050.04 hectares, grazing land 3500 hectares and forest land about 15785.46 hectares.It also has 1772 hectares of wetland and 9753.29 hectare covers human settlement. There are three climatic zones, namely Dega (3.4 %,) Kola (1.5 %,) and Woinadega (95.1%). The rainy season of this district is between mid of April to mid of October, generally for six months and the rests are months of dry season. The annual rain fall of this district ranges from 1500-2200mm and mean minimum annual temperature is 9°Cand mean maximum annual temperature is 31°C (CANRO, 2018).

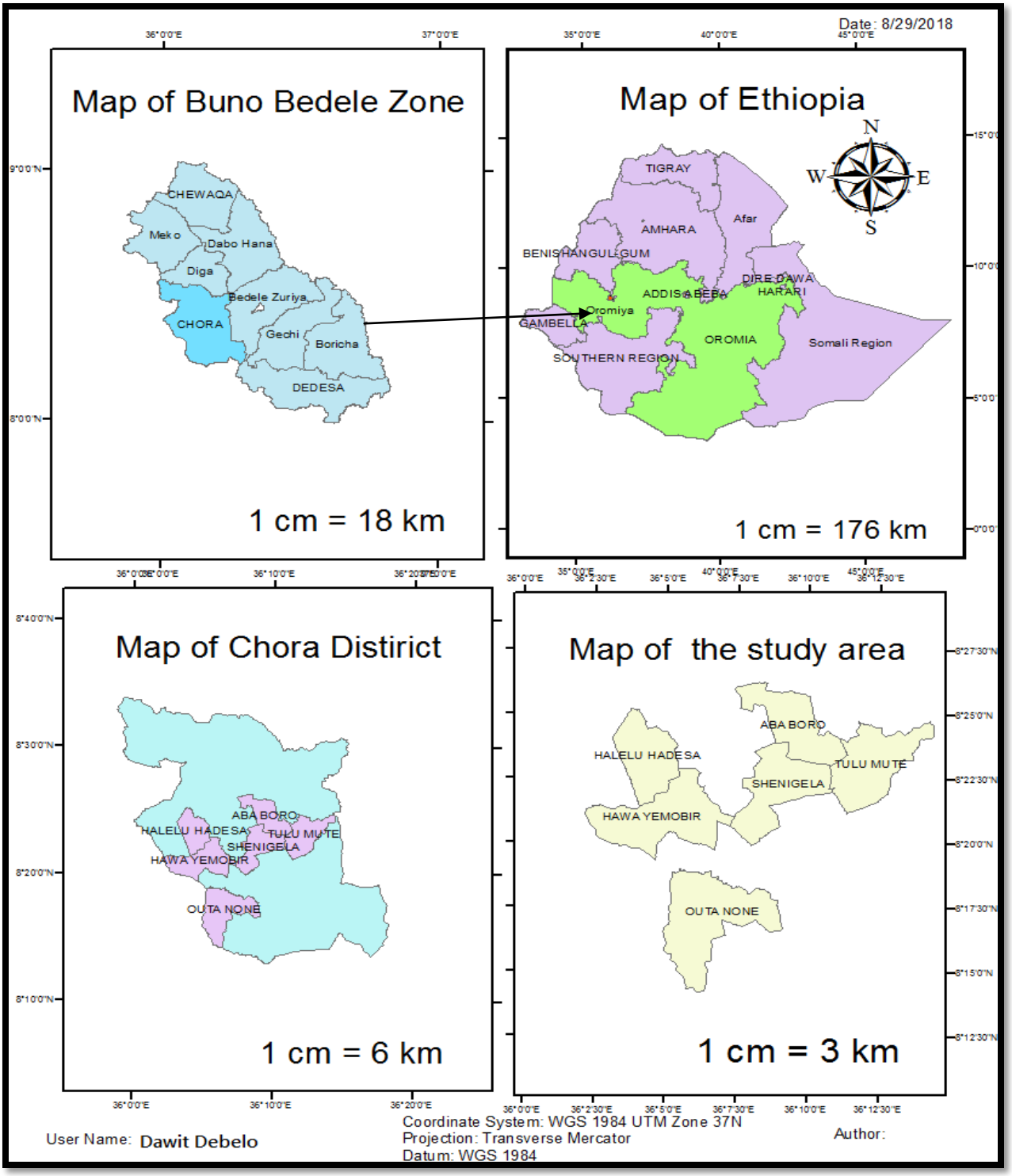

Figure 3.1.1 **Map of Chora District (Source CANRO 2017)**

3.2. Methods

3.2.1. Seasonal diet analysis

Among 34 kebeles in the district, six kebeles were selected for this study. These six kebeles were represents coffee plantation and farmland. Civetry sites were searched in all sampled kebeles. All potential areas within the six kebeles were assessed and all civetry sites were recorded. A total of 92 civetries were identified in the study area, however continuous observation was carried out on 18 representative civetries. Civetry search was focused mainly on wildlife tracks, Civet trappers, forest guards, farmers, cattle herders and firewood collectors were asked whether they have seen civetries anywhere in the study area. We moved along the pathways in opposite direction searching for any sign of civet defecation sites.

In the six kebeles, 92 civetries were identified. From these,18 representative civetries were randomly selected and permanently used to collect scat data. All the recovered civetries within the physical boundaries of the six study area were recorded, geo-referenced and coded. The selected civetries were visited within 5-day intervals throughout the study period between February and April /2018 for dry and between June and August/2018 for wet seasons.

Feeding habits of the African civet in the potential areas was studied using fecal analysis (Mukherjee *et al.,* 2004; Zelalem Tefera *et al.,* 2005; Gilmour *et al.,* 2012). Feeding habits of the African civets were studied by direct observations and examination of fresh droppings collected from dung piles (‘civetries’) in different seasons. Fresh droppings were identified from the old ones by observing the overlaid grasses and leaves after each visit. Fresh dropping samples were analyzed by observing undigested remains of foods such as seeds, bones, hairs, exoskeleton of insects and other undigested remains of plant items. The analysis was made by washing and filtering or by direct physical observation of the droppings. Each scat was washed with running water using locally available sieves with mesh sizes between approximately 1-2mm to remove fecal materials and extract the undigested food items (Elmhagen *et al*., 2002; Breuer, 2003; Koike, 2009; Gilmour *et al.,* 2012).

The prey remains were separated as hairs, feathers, bones, teeth, exoskeleton and appendages of arthropods, and snail shells, seeds and other plant parts and weighed individually to compute for the biomass contributed by the diet items, and hence its relative importance (Vieira & Port, 2007).

3.2.2. Estimation of population density of African civet

The density of African civets was estimated from fecal density of each civetry (Putman, 1984). Population density was estimated using all civetries identified in the sampled areas. Features such as scat morphology, diameter/circumference and length have been frequently inferred parameters to determine certain attributes of a species (Ray and Sunquist, 2001; Ho, 2009).

Fecal perimeter was measured near the base position of feces in relation to the center of the civetry, the abundance of grass at the base of the scat was recorded and the presence or absence of small or medium sized scats on or adjacent to the large feces were recorded. These parameters were employed to determine the number, sex and age of civets using the latrine site, the number of alternative civetries a civet group has and from this, density of civets in the study sites were estimated (Tadesse Habtamu *et al.*,2015).

Adult male civets have unmistakably larger scats, place their scat centrally and piling on over the other. Long heaped base, tapered ended, hard and fully formed feces are characteristic features of adult males (Tadesse Habtamu *et al., 2015).* Females drop a sausage shape scat with blunt end. The most distinguishing feature of adult female scats is the presence of juvenile scats on or near it. Sub adult males and female civets independently and irregularly scatter their feces always at marginal areas of the group civetry. Sub adult males defecates large size (volume) scats than sub adult females. At early age, juveniles place their feces on or very closer to their mothers' feces. After certain age, they tend to move slightly away and mix their scats with the sub adult group (Tadesse Habtamu *et al., 2015).* From the similarities of fecal parameters, all the alternative civetries used by a civet group were clustered into one and this implies that individual civet may use more than one civetries. Fecal frequency defecation were counted within five day intervals and fecal circumference also measured at the base to identify individual civet from each other in number, age and sex. Within five day interval representative scats were collected from representative civetries of each six site for six month's during wet and dry seasons.

Mean, minimum and maximum number of civets in each civetry was calculated and then the population density estimated during dry and wet seasons.

3.4. Data Analysis

The fecal contents were presented as frequency of occurrence and relative frequency of occurrence.

%Relative frequency occurrence=Number of occurrence of each item/Total number of scat x100%

To determine the relative importance of the different prey items in civet diet, %biomass was used.

The % biomass = biomass contribution of each prey i/ total biomass x 100) were calculated for each food item(Garcia and Kittlein, 2004; Goldenberg *et al.*, 2010; Rex et al., 2010; Bacon *et al*., 2011). Seasonal difference for preference and the relative importance of diet categories were also evaluated (Bartel and Knowlton, 2005; Goldenberg *et al.*, 2010; Koike, 2010).

To estimate population density of African civet in coffee plantation and farmland, mean minimum and maximum number of civets in each civetry was calculated and then the population density estimated for the habitat during dry and wet seasons.

Statistically independent t-test was used for computation. Independent sample test were computed to see a statistically significance ($P<0.05$) ($Sig.<0.05$) difference on biomass contribution of the animal and plant diet in the food of the African civet in coffee plantation and farmland during wet and dry seasons. It also computed to see statistical significance difference on density of African civet during wet and dry seasons.

4. RESULT

4.1. Diets of African civet

A total of 648 African civet scats samples were collected from the six 18 civetries of the study sites. Overall the undigested remains of scats weighted 32420(g). Over 5 (five) prey items were identified from the analyzed of scat samples. The prey remains were roughly classified in to four categories, namely mammals, birds, arthropods and plants. The number of prey items per scat ranged between 1 and 3, for the wet season and it ranged between 2 and 4 for the dry season.

Animals with 60.9% relative frequency contributed about 17.59% diet biomass of the African civet during the wet season. Animals with 38.59% relative frequency contributed about 8.6% diet biomass of the African civet during the dry seasons in coffee plantation. Plants with 6.66% relative frequency contributed about 0.31% diet biomass of the African civet during the wet season. Plants with 76.66% relative frequency contributed about 36.69% diet biomass of the African civet during the dry season in coffee plantation (Table 4.1. 1)(Figure 4.1.1).

Table 4.1.1 Percent relative frequency and percent biomass contribution of plant and animal items in the farmland and coffee plantation of African civet diet during the wet and dry seasons

	Coffee plantation				Farmland			
	Wet season		Dry season		Wet season		Dry season	
	% relative frequency	% biomass	% relative frequency	% biomass	% relative frequency	% biomass	% relative frequency	% biomass
Animals	**60.9**	**17.59**	**38.59**	**8.6**	**36.44**	**7.77**	**20.07**	**4.59**
Mammals	13.7	4.62	11.8	3.1	7.07	2.78	5.3	1.85
Birds	12.05	3.70	11.04	2.93	6.5	2.47	4.8	1.23
Arthropods	35.15	9.27	15.75	2.59	22.87	2.53	9.97	1.52
Plants	**6.66**	**0.31**	**76.66**	**36.69**	**10.01**	**7.71**	**43**	**17.42**
Coffea arabica	-	-	14.8	9.25	-	-	8.5	3.85
Cordia africana	-	-	15.7	10.8	-	-	9.02	4.01
***Other plant seed**	6.66	0.31	46.16	16.65	10.01	7.71	25.48	9.95

Figure.4.1.1 Diets of African civet in coffee plantation during the dry season (5/7/2018 field observation)

In coffee plantation from the total of 60.9% relative frequency and 17.59% of animal biomass, mammals contributed 13.7% relative frequency and 4.62%biomass during the wet season. From the total of 38.59% relative frequency and 8.6% of animal biomass, mammals contributed 11.8% relative frequency and 3.1% biomass during the dry season. Of 12.05% relative frequency, birds contributed 3.70% of African civet diet biomass during the wet season. During the dry season from 11.04% relative frequency birds contributed 2.93% of African civet diet biomass (Table 4.1.1).

Arthropods with relative frequency of 35.15% and 15.75%, contributed 9.27% and 2.59% biomass during wet and dry season respectively. Arthropods with 9.27% biomass contributed more to the wet season diet biomass than the dry season with 2.59% biomass. There was variation between wet and dry seasons in coffee plantation (Table 4.1.1).

During this study of coffee plantation with 6.66 and 76.66% relative frequency, plants contribute about 0.31 and 36.69% biomass of the civet diet during wet and dry seasons, respectively. Two different plant species and other unidentified plant seed were identified from civet's scat, however, their abundance and relative importance varied within seasons (Table 4.1.1).

In coffee plantation, of the 76.66% relative frequency and 36.69% biomass of plant diet during the dry season, *Cordia africana* contributed the highest proportion with 15.7%relative frequency and 10.8% biomass. With 14.8% relative frequency and 9.25% biomass *Coffea arabica* contributed more 9.25% next to *Cordia africana.* However; they were totally absent during the wet season. Other unidentified plant seed also with 46.16% relative frequency contributed 16.65 biomass in dry season (Table4.1.1).

With 76.66% relative frequency and 36.69% biomass, more plants biomass was presented during the dry than the wet seasons. The highest proportion were from, *Cordia africana and Coffea arabica*, during the dry season and there was variation in preference and importance in coffee plantation (Table4.1.1).

During the wet season, plant materials were obtained 6.66% relative frequency of the civet scats,with 0.31% plant biomass in coffee plantation. Overall *Cordia africana and Coffea arabica*, comprised the highest of dry season diet of the African civet. There was variation in preference within plant materials in both wet and dry seasons in coffee plantation (Table 4.1.1).

In farmland from the total of 36.44% relative frequency and 7.77% of animal biomass, mammals contributed 7.07% relative frequency and 2.78%biomass during the wet season. From the total of 20.07% relative frequency and 4.59% of animal biomass, mammals contributed 5.3% relative frequency and 1.85% biomass during the dry season. Of 6.5% relative frequency, birds contributed 2.47% of African civet diet biomass during the wet season. During the dry season from 4.8% relative frequency birds contributed 1.23% of African civet diet biomass (Table 4.1.1).

Arthropods with relative frequency of 22.87% and 9.97%, contributed 2.53% and 1.52% biomass during wet and dry season respectively. With 2.53% biomass, arthropods contributed more to the wet season diet biomass than the dry season with 1.52% biomass and there was variation between wet and dry seasons in coffee plantation (Table 4.1.1).

During this study of farmland with 10.01% and 43% relative frequency, plants contribute about 7.71% and 17.42% biomass of the civet diet during wet and dry seasons, respectively. Over two (2) different plant species and other unidentified plant seed were identified from civet's scat. However, their abundance and relative importance varied within seasons in the farmland (Table 4.1.1).

In farmland, of the 43% relative frequency and 17.42% biomass of plant diet during the dry season, *Cordia africana* contributed the highest proportion with 9.02%relative frequency and 4.01%biomass. With 8.5% relative frequency and 3.85% biomass *Coffea arabica* contributed more 3.85% next to *Cordia africana.* However; they were totally absent during the wet season. (Table4.1.1).Other unidentified plant seed also with 10.01% and 25.48% relative frequency contributed 7.71% and 9.95% biomass in wet and dry season respectively (Table4.1.1).

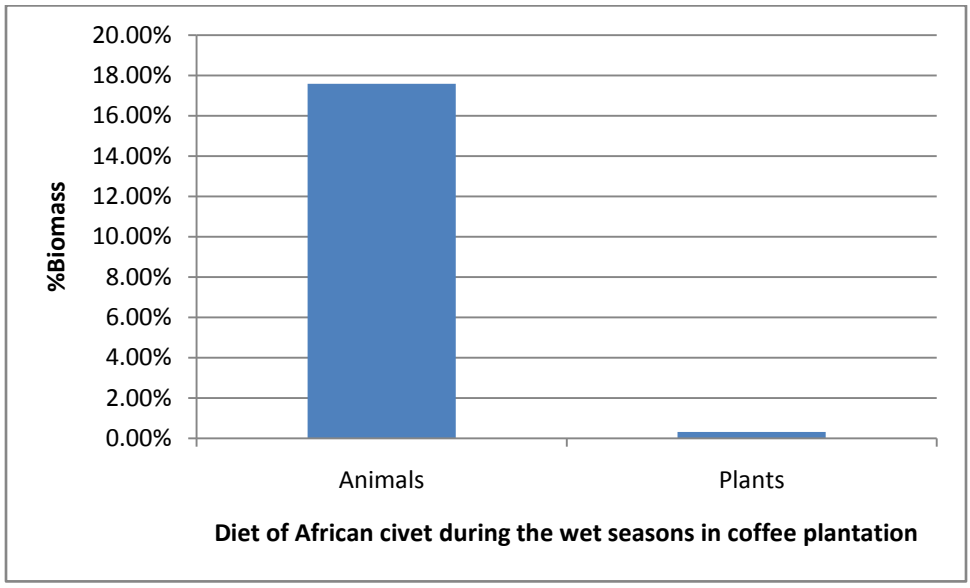

Figure4.1.2. Percent biomass of African civet diet during wet seasons in coffee plantation

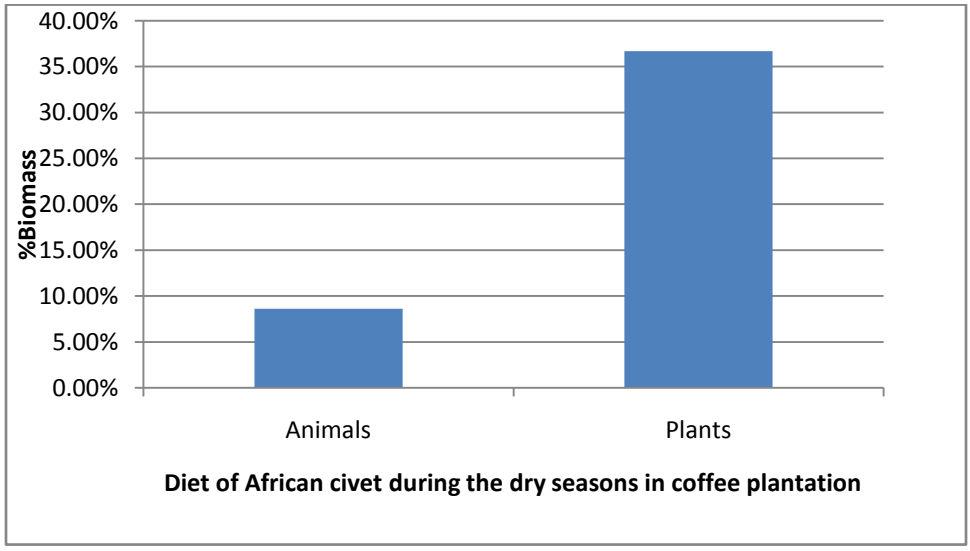

Figure4.1.3. Percent biomass of African civet diet during dry season in coffee plantation

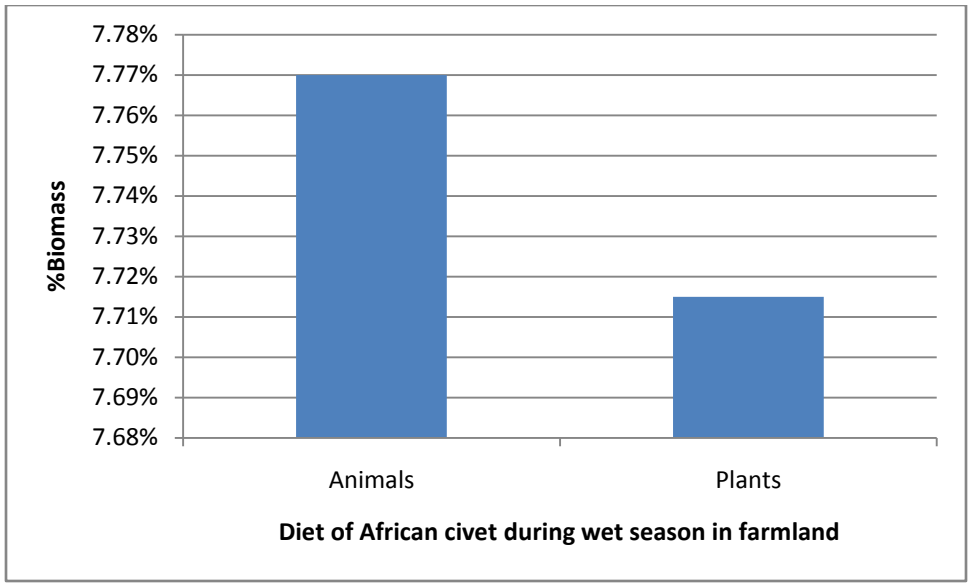

Figure4.1.4. Percent biomass of African civet diet during the wet season in farmland

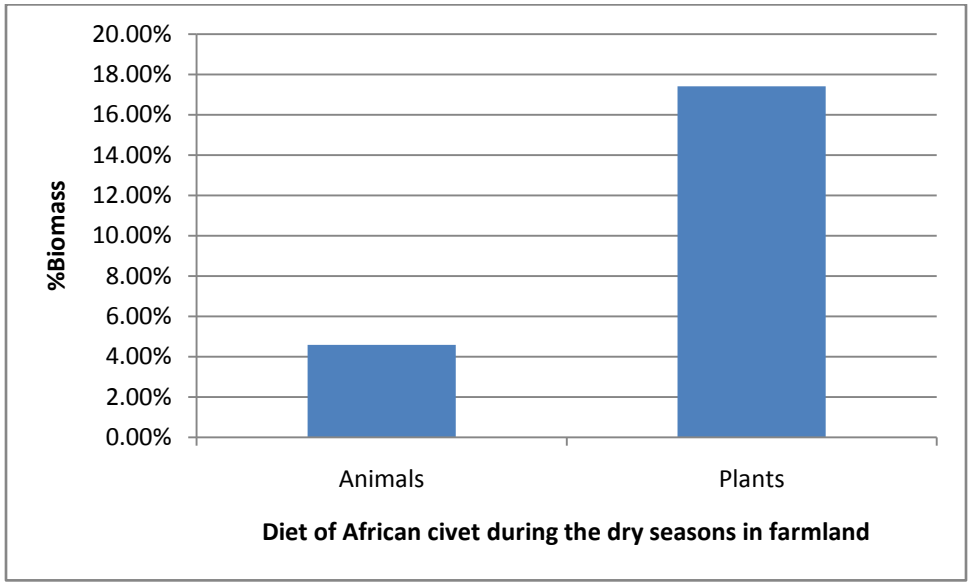

Figure4.1.5. Percent biomass of African civet diet during the dry seasons in farmland

Figure 4.1.6.*Cordia africana* and *Coffea arabica* the main food items of African civet during the dry season(10/7/2018 field observetion)

Independent sample test were computed to see a statistical significance difference on biomass contribution of the animal diets in the food of the African civet in coffee plantation during wet and dry seasons.

Table4. 1.2: Independent t-test for biomass contribution of different items of the animal diets in coffee plantation during wet and dry seasons

	Mean	SD	T	Df	Sig.
Wet seasons	1906.66	975.77	1.728	4	0.0159
Dry seasons	930.00	81.85			

As indicated in Table 4.1.2 above, there is significant difference in scores for the wet seasons mean=1906.66 SD=975.77 and the dry seasons, Mean= 930.00, SD=81.85; p= 0.0159. This shows that there is statistical significant difference between dry and wet seasons on biomass contribution of the animal diets in the food of the African civet in coffee plantation.

Independent sample test were computed to see a statistical significance difference on biomass contribution of the plant diets in the food of the African civet in coffee plantation during wet and dry seasons.

Table4.1.3: Independent t-test for biomass contribution of different items of the plant diets in coffee plantation during wet and dry seasons

	Mean	SD	T	Df	Sig.
Wet seasons	33.34	57.73	-5.375	4	0.006
Dry seasons	3966.66	1266.22			

As indicated in Table4.1.3 above, there is a significant difference in scores for the wet seasons mean=33.34, SD=57.73and the dry seasons, Mean= 3966.66, SD=1266.22; p= .006. This shows that there is a statistical significant difference between dry and wet seasons on biomass contribution of the plant diets in the food of the African civet in coffee plantation.

Independent sample test were computed to see a statistical significance difference on biomass contribution of the animal diets in the food of the African civet in farmland during wet and dry seasons.

Table4.1.4: Independent t-test for biomass contribution of different items of the animals diets in farmland during wet and dry seasons

	Mean	SD	T	Df	Sig.
Wet seasons	840.00	52.91	5.249	4	0.007
Dry seasons	496.66	100.16			

As indicated in Table 4.1.4 above, there is a significant difference in scores for the wet seasons mean=840.00, SD=52.91 and the dry seasons, Mean= 496.66, SD=100.16; p= .007. This shows that there is a statistical significant difference between dry and wet seasons on biomass contribution of animal diets in the food of the African civet in farmland.

Independent sample test were computed to see a statistical significance difference on biomass contribution of the plant diets in the food of the African civet in farmland during wet and dry seasons.

Table 4.1.5 : Independent t-test for biomass contribution of different items of the plant diets in farmland during wet and dry seasons

	Mean	SD	T	Df	Sig.
Wet seasons	833.34	1443.36	-912	4	.414
Dry seasons	1800.00	1135.78			

As indicated in Table 4.1.5 above, there is no significant difference in scores for the wet seasons mean=833.34, SD=1443.36 and the dry seasons, Mean= 1800.00, SD=1135.78; p= .414. This shows that there is no statistical significant difference between dry and wet seasons on biomass contribution of plant diets in the food of the African civet in farmland.

Independent sample test were computed to see a statistical significance difference on biomass contribution of the animal and plant diets in the food of the African civet in coffee plantation and farmland.

Table4.1.6: Independent t-test for biomass contribution of plant and animal diets in coffee plantation and farmland

	Mean	SD	T	Df	Sig.
Coffee plantation	1909.16	1872.86	1.296	22	0.0209
Farmland	992.50	934.77			

As indicated in Table 4.1.6 above, there is significant difference in scores for the wet seasons mean=1909.16, SD=1872.86 and the dry seasons, Mean= 992.50, SD=934.77; p= .0209. This shows that there is statistical significant difference between coffee plantation and farmland on biomass contribution of animal and plant diets in the food of the African civet.

4.2. Estimation of population density of African civet in coffee plantation and farmland during wet and dry seasons

The estimated number of civet varied between 1 and 4 among civetries during both seasons of the study area. During the wet season the estimated number of civet varied between 1and 2 individuals with average of 1.5 per civetry and between14 and 32 individuals with average of 23 per six kebeles or per coffee plantation and farmland in the study area. With this estimate, the density of civets in the study area were 0.022civets /hectare (2.2 civets/ km^2).

The highest numberof civets were recorded from coffee plantation with 80 individuals (58.82%), while 56 individuals (48.32%) recorded in farmland. From the total of 136 individuals, 24(17.65%) were adult male, 33(24.26%) were adult female, 19(13.97%) were sub adult male, 25(18.38%) were sub adult female, 17(12.5%) were juvenile male and 18(13.23%) were juvenile female. The number of civets recorded inclined towards adult females and sub adult females in wet season of Chora district (Table 4.2.1).

Table 4.2.1: Estimated number of civet based on sex and age in the six study kebeles(AM-=adult male, AF=adult female, SAM=sub adult male, SAF=sub adult female, JM=juvenile male and JF=juvenile female) in wet season.

Study areas	Area/h	Total civetry	Total clusters	Total recorded scats	Average number of individual civets						
					AM	AF	SAM	SAF	JM	JF	TOTAL
Coffee plantation	870	22	4	80	7	9	4	5	3	4	32
	1300	14	3	64	5	7	4	5	3	3	27
	1025	16	3	44	3	5	3	4	3	3	21
Farmland	1000	18	3	50	4	5	3	4	3	3	22
	1015	10	2	46	3	4	3	4	3	3	20
	1010	12	3	44	2	3	2	3	2	2	14
Total	6220	92	18	328	24	33	19	25	17	18	136

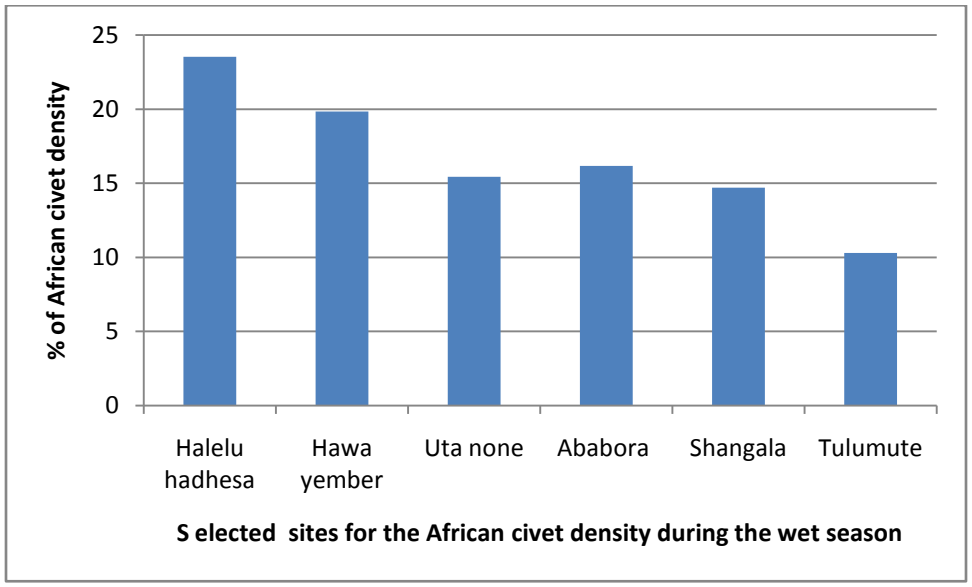

Figure 4.1.7 % of African civet density in each site during the wet season

During dry season the estimated number of civets varied between 1and 3 with average of 2.2 per civetry and 20 and 54 individual with average of 37 per 6 kebeles or per coffee plantation and farmland. With this estimate, the density of civets in the present coffee plantation and farmland habitat were 0.036/hectare(3.6 civets/ km^2).

The highest estimated number of civets were recorded from coffee plantation during the dry season with 142 individuals (63.4%), and in farmland 82 individuals (36.6%). From the total of 224 individual civets, 44(19.6%) were adult males, 55(24.55%) were adult females, 29(12.95%) were sub adult males, 39(17.41%) were sub adult females, 26(11.6 %) were juvenile male and 31(13.84 %) were juvenile female. The average number of civet in the dry season inclined towards adult female and sub adult females (Table 4.2.3). During both wet and dry seasons, the highest estimated number of civets were recorded from coffee plantation. Overall in the six study areas of chora district the average estimated number of civets during both wet and dry season were 0.029/hectare (2.9/km^2)of the total of 6220 hectare (62.2km^2).

Table 4.2.2: Estimated number of civet on sex and age in the six study kebeles (AM= adult male, AF=adult female, SAM=sub adult male, SAF=sub adult female, JM=juvenile male and JF=juvenile female) in dry season.

Study areas	**Area/h**	**Total civetry**	**Total clusters**	**Total recorded scats**	**Average number of individual civets**						
					AM	AF	SAM	SAF	JM	JF	TOTAL
Coffee plantation	870	22	4	100	12	14	7	8	6	7	54
	1300	14	3	84	10	13	6	8	5	6	48
	1025	16	3	80	7	10	5	7	5	6	40
Farmland	1000	18	4	84	7	8	4	6	4	5	34
	1015	10	2	76	5	6	4	6	3	4	28
	1010	12	2	50	3	4	3	4	3	3	20
Total	6220	92	18	474	44	55	29	39	26	31	224

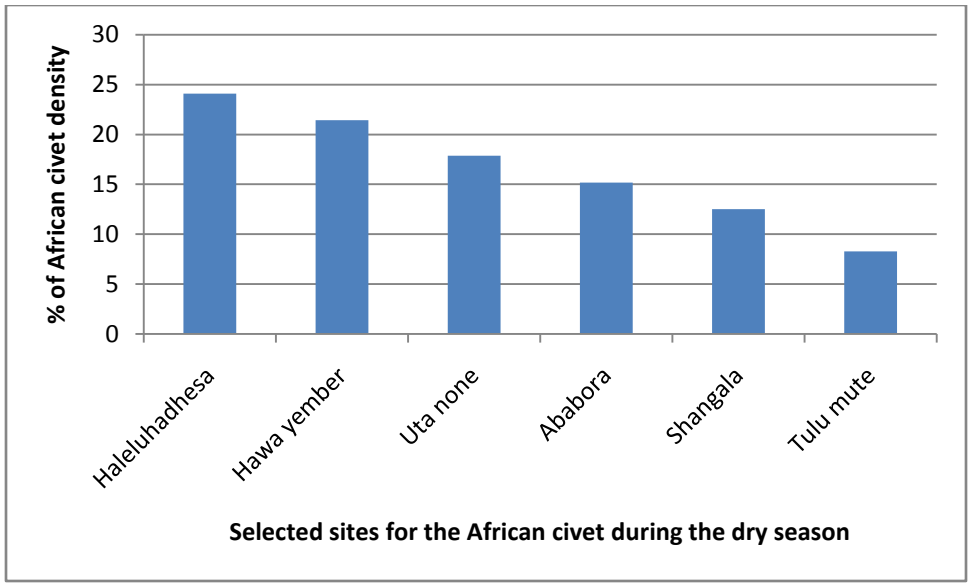

Figure 4.1.8 % of African civet density in each site during the dry season

Independent sample test were computed to see a statistical significance difference on estimated number of civet in study site during dry season in coffee plantation and farmland.

Table 4.2.3: Independent t-test on estimated number of civet in study site during dry season

	Mean	SD	T	Df	Sig.
Coffee plantation	47.33	17.02	3.487	4	0.025
Farmland	27.33	7.02			

As indicated in Table 4.2.3 above, there is a significant difference in scores for coffee plantation mean=47.33, SD=17.02 and the farmland, Mean= 27.33, SD=7.02; p= .025. This shows that there is a statistical significant difference between coffee plantation and farmland on estimated number of civet in study site during dry season.

Independent sample test were computed to see a statistical significance difference on estimated number of civet in study site during wet season in coffee plantation and farmland.

Table 4.2.4: Independent t-test on estimated number of civet in study site during wet season

	Mean	SD	T	Df	Sig.
Coffee plantation	26.66	5.51	2.007	4	0.115
Farmland	18.66	4.16			

As indicated in Table 4.2.4 above, there is no significant difference in scores for coffee plantation mean=26.66, SD=5.51and the farmland Mean= 18.66, SD=4.16; p= .115. This shows that there is no statistical significant difference between coffee plantation and farmland on estimated number of civet in study site during wet season.

Independent sample test were computed to see a statistical significance difference on estimated number of civet in study site during wet and dry season in coffee plantation and farmland.

Table4.2.5: Independent t-test on estimated number of civet in study site during wet and dry season

	Mean	SD	T	Df	Sig.
Dry season	37.33	12.62	2.555	10	0.029
Wet season	22.66	6.18			

As indicated in Table 4.2.5 above, there is a significant difference in scores for dry season mean=37.33, SD=12.62 and the wet season mean= 22.66 6.18; p= .029. This shows that there is a statistical significant difference between dry and wet season on estimated number of civet in coffee plantation and farmland.

5. Discussion

5.1. Diets of wild African civet

During the present study over 5 different food items from animals and plants were identified from the feces of civets. This indicates that they are generalist omnivores (Table 4.1.1). This adaptation of the African civets might have helped them to have high survival rate under different environmental conditions and habitat types in the district. Feeding habit of the African civets is known to have diverse feeding habit and they are adapted to eat a wide range of food items of plants and animal origin in their natural environment (Ray and Sunquist, 2001). African civets, are adapted to eat fruits of different plants and animal species such as invertebrates and vertebrates (Bekele Tsegaye *et al*., 2008) also reported.

In the present study area, animals diet with 60.9% relative frequency contributed about 17.59% diet biomass of the African civets during the wet season. Animals with 38.59% relative frequency contributed about 8.6% diet biomass of the African civet during the dry seasons in coffee plantation.

Animals diet with 36.44% relative frequency contributed 7.77% biomass during the wet season and animal diet with 20.07% relative frequency contributed 4.59% biomass in farmland. This show that they consume more animal diet during the wet season than the dry season and there was variation between wet and dry season of animal diet (Table 4.1.1) (Figure 4.1.2).There was variation of African civet animal diet biomass between dry and wet season and the variation was statistically significant (p=0.007) (Table4.1.4) (Figure 4.1.3). In the same way seasonal shift of feeding habit based on the availability was reported from central and southern African (Skinner and Smithers, 1990). The recent report by (Tadesse Habtamu *et al.,2014)* from coffee forest in Limu seka district, south western Ethiopia, agrees with the finding in that African civets have wider alternative food items shifting from one to the other based on the seasonal availability.

During this study, of the 17.59% animal biomass, arthropods prey items contributed the highest with 9.27% biomass during the wet season. Out of 8.6% animal biomass, arthropods prey items contributed only 2.59% during the dry season in coffee plantation. Of the7.77% animal biomass arthropods prey items contributed 2.53% during the wet season. Out of 4.59% animal biomass arthropods prey items contributed only 1.52% during the dry season in farmland. This imply that

there were variations in the availability of arthropods during the wet and dry seasons and civet prefers more arthropods during the wet season than dry season in both coffee plantation and farmland (Table4.1.1).

The present investigation revealed that, plant diet with 6.66% relative frequency contributed about 0.31% diet biomass of the African civet during the wet season. With 76.66% relative frequency they contributed about 36.69% diet biomass of the African civet during the dry season in coffee plantation. Plant diet with 10.01% relative frequency contributed 7.71% diet biomass of the African civet during the wet season. With 43% relative frequency plant diet contributed about 17.42% during the dry season in farmland (Table 4.1.1). This indicate African civet consume different proportion of plant diet between wet and dry season. This may be due to the abundance of plant diet during dry than the wet season.

Only 0.31% and 7.71% biomass plant prey items were identified in both coffee plantation and farmland during wet season respectively. This might be due to the absence of ripe fruits of the species during wet season. In this study there was variation in the proportion of plant diet between wet and dry seasons in coffee plantation. The variation was statistically significant (p=0.006)(Table4.1.3). This agrees with the finding of (Tadesse Habtamu *et al., 2014),* plant diet are more important during the dry season.

The number of food items identified during the present study are limited (only about 5 items). It is less than the food items identified from coffee forest of Jimma zone south western Ethiopia(Tadesse Habtamu *et al., 2014)* but this does not mean that civets consumed only these identified food items, since some food items are soft, and have been completely digested and were difficult to identify by physical observations of droppings. According to Maia *et al.*,(2003) the amount of each undigested remains of food items in feces is proportional to the amount ingested.

During this study, seasons have impacts in limiting the food items available for the civets. The dominant food items in the wet season were arthropods while the dominant food items in the dry season were *Cordia africana* and *Coffea arabica* in the coffee plantation and farmland (Table 4.1.1)(Figure 4.1.6). Shifting diets seasonally, as a result of availability and abundance of food items, is a common behaviour of animals (Giannatos *et al*., 2009). In the coffee forest habitat, fruits and seeds were scarce during the wet season; most plants were at vegetative or flowering

stages. Contrasting to most viverrids and other small carnivores (Garcia and Kittlein, 2004; Ho, 2009), no leaves and other plant parts were detected from both season scats of the African civets.

In the current study area; civets were not considered as pests because people use their musk for medicine, commercial purpose and they collect musk from sent marked objects and use it for cultural, medicine as well as commercial purpose(personal communication with civet farmers). People in the area also collect coffee seeds from civet scat and use it for their livelihood. However African civets were reported to be notorious garden raiders (Rosevear, 1974; Kingdon, 1977; Ray, 1995).

During the present study depending on habitat type the highest plant biomass were recorded from the scats of African civet in coffee plantation with 76.66% relative frequency and 36.69% biomass than farmland with 43% relative frequency and 17.42% biomass during the dry season (Table 4.1.1). This might be due to the abundance of fruits those preyed by civet in the coffee plantation than in the farmland since plant species like *Cordia africana and Coffea arabica* were found there. There was variation of African civet diet biomass between coffee plantation and farmland and it was statistically significant (p=0.0209) (Table4.1.6). The highest animal items also were recorded from the scats of African civet in coffee plantation with 60.9% relative frequency and 17.59% biomass than farmland with 36.44% relative frequency and 7.77% biomass during the wet season (Table 4.1.1)(Figure 4.1.2). This might be due to the abundance of animals those preyed by civet in the coffee plantation than the farmland. Overall the highest animal and plant biomass were recorded from coffee plantation than farmland (Table 4.1.1).

5.2. Population density estimates of the African civet during wet and dry seasons

Based on fecal count, the number of civets during the wet season in the six kebeles varied between 14 and 32 individuals with mean number of 23 individuals (Table 4.2.1). With this estimate, in wet season the density of civets in the present study was 2.2 civets/ km^2 (0.022 civets/ hectare). In dry season, the number of civets in the six kebeles varied between 20 and 54 individuals with mean number of 37 individuals (Table 4.2.2). With this estimate the density of civets in the present study was 3.6 civets per km^2 (0.036 civets/hectare).This indicates that there is variation between wet and dry season of African civet density. This implies that civet might be migrated to the study area from other area during the dry season as dry season is fruiting season.

The number and density of African civet was less in wet season than dry season. This might be due to dense formation of coffee plantation during wet season as they were simply attacked by their enemies and they might be migrated to the other area from the coffee plantation of the study area.

The density of civet in the current study area was less compared to coffee forest of Limu seka district Jimma zone south western Ethiopia of civet density. Population density of 9, 3 and 7 individuals per $km^2$was estimated from Menagesha-Suba State Forest, Jimma and Wondo Genet areas, respectively, based on fecal counts from civetries (Bekele Tsegaye, 2006; Wondmagegne Daniel,2006;Ayalew Berhanu, 2007) and Population density of 1 individual per km^2 reported from southwest Gabon based on track count along transects in lowland forest (Prins and Reitsma, 1989).

In the present study the total estimated number of civet was 136 individuals during the wet season (Table4.2.1). During the dry season the total estimated number of civets was 224 individuals (Table4.2.2). There was variation between wet and dry season and the variation was statistically significant (p=0.029)(Table4.2.5). From this the estimated number of civet was high during the dry season than the wet season. The average number of civets inclined towards adult females and sub adult females during both wet and dry seasons. The reason for this may be farmers and civet trappers trap adult male civet than female as male produce more musk than female (personal communication with civet farmers). Likewise researcher reported that male civet produce larger quantity and better quality musk than that of females (Tadesse Habtamu and Afework Bekele, 2014).

6. Conclusions and recommendations

Coffee plantation and farmland of Chora district provided opportunities for the abundance of African civets. Several food items were most frequently consumed by African civets in coffee plantation and farmland of the study area based on availability and preference of feeding as evidenced by the presence of over 5 food items from the scat analysis. During this study African civet consumed more animal diet during the wet season than dry season. Arthropods were the highest animal diet contributed during the wet season than the others.

During present study more plant species were consumed by African civet during the dry season than wet season. The highest plant species were contributed from *Cordia africana and Coffea arabica* during the dry season and they were totally absent during the wet season. There was variation between wet and dry season between African civet diet and it was statistically significant. Variation of African civet diet recorded during wet season between animal and plant diet. There is also variation of civet diet during dry season between animal and plant diet. Generally there was variation of African civet diet biomass between two seasons and it was statistically significant.

African civet diet biomass was more in coffee plantation than farmland and it was statistically significant. During the present study high number and density of civet was recorded during the dry season than wet season. The highest estimated numbers of civets were recorded from coffee plantation during the dry season. Generally, individual number and density of African civet was high during the dry season than wet season.

The perseverance of Civiculture for a long period of time in this area attributed to the abundance and easily convenience of civets. Hence preservation of coffee plantation and farmland which was in turn attributed to the presence of plants like *Cordia africana and Coffea arabica* and these highly favored the survival and abundance of the African civet in the area. Input from the feeding ecology of the African civet in Chora district show the malleability of the African civet to live on diversified resources given that the opportunity for sustainable natural resource exploitation for economic benefits and poverty diminution.

Based on the finding of this research the following specific recommendations are suggested:

- Government, different stakeholders and local people are give attention to the conservation and sustainable utilization of African civet.
- Farmers and local people should give attention to protect the main food items identified from the study area to increase the density of civet in the wild.
- Farmers and local people should give attention to plant coffee and coffee shade like *Cordia africana* those which are identified as major diets during this investigation

7. REFERENCE

Abebe, Y. (2003) Sustainable consumption of the African Civet(Civettictis civetta) in Ethiopia. In: Second Pan-African Symposium on the Sustainable Use of Natural Resources In Africa, IUCN, Gla(Ed. W. M. BIHINI). Cambridge, U.K.

Arim, M., and Naya, D. E. (2003).Pinniped diets indirect from scats: analysis of biases in prey occurrence. *Can. J. Zool*., **81**: 67–73

Ayalew Berhanu (2007).*Feeding Ecology, Scent Marking and society Patterns of the African Civet in Wondo Genet Forest, Ethiopia*. M.Sc. Thesis,Addis Ababa University, Addis Ababa.

Bacon, M.M., Becic, G.M., Epp, M.T. & Boyce, M.S. (2011) Do GPSclusters really work? Carnivore diet from scat examination and GPSTelemetry methods. Wildl. Soc. Bull. 35,409–415.

Bakaloudis, D. E., Vlachos, C. G., Papakosta, M. A., Bontzorlos, V. A. and Chatzinikos, E. N. (2007). *Diet piece of music and Feeding Strategies of the Stone Marten (Martesfoina) Ina Typical Mediterranean Ecosystem*.Hunting Confederation of Greece.Athens.PP 20.

Barja, I., Silván, G., Martínez-Fernández, L. and Illera, J. (2011).PhysiologicalStressresponses, fecal marking behavior and reproduction in wildEuropean pine martens(*Martesmartes*).*J. Chem. Ecol.* **37**: 253–259.

Bartel, R. A. and Knowlton, F. F. (2005). Functional feeding responses of coyotes, *Canis latrans*, to fluctuating prey abundance in the Curlew Valley, Utah, 1977–1993. *Can. J. Zool.*, **83:** 569–578.

Bearder, S.K. and Randall, R.M. (1978). The utilize of fecal marking sites by spottedhyena and civets. *Carnivore* **1**: 32−48.

Beebee, T. and Rowe, G. (2005).*An Introduction to Molecular Ecology*.Oxford University Press, New Delhi.

BekeleTsegaye.,Afework Bekele and Balakrishnan M. (2008a). Feeding habit of the African Civet *Civettictis civetta*in the Menagesha–SubaState Forest,Ethiopia. *Small Carnivores Conservation* 39: 19-24.

BekeleTsegaye.,Afework Bekele and Balakrishnan, M. (2008b). Scent-markingby the African Civet *Civettictis civetta*in the Menagesha- SubaState Forest, Ethiopia.

*Small Carnivores management*38: 29-33.

BekeleTsegaye (2006).*Ecological Studies on African Civets (Civetticts civetta)*.M. Sc. Thesis,Addis Ababa University, Addis Ababa.

Bothma, J. D. (1971). Food behavior of some carnivora (Mammalia) from Africa.*Ann. Trans. Mus*.**27**: 15−25.

Breuer, T. (2003) Distribution and conservation of African wild dogs in Cameroon.Cani. News 6, 1–11.

Burfield, T. (2005).*Ambergris Update: customized from Monograph in Natural AromaticMaterials – Odours and Origins.*Written and updated by AIATampa.Burger, B. V. (2005).Mammalian Semiochemicals.*Top.Curr. Chem*., **240:** 231–278.

Candolin, U. (2003). The use of multiple cues in mate choice.*Biol. Rev*., **78**: 575–595.

CANRO,(2018).Recorded information about the total hectare, climate and Temperature of the Chora District.

CANRO,(2007). Recorded information on human population.

Clapperton, B. K**. (**1989). Scent-marking behavior of the ferret, *Mustelafuro*L.*Anim.Behav.* **38:** 436–446.

Dagnachew Melese, Suryabhagavan, K.S., MelaknehGelet and Balakrishnan, M.(2014). Remote sensing and geographic in sequence system-basedAfrican civet habitat Mapping in Andracha, Ethiopia.*J. Appl. Rem.Sense*.**8**: 1−12.

Eisenberg, J. and Kleliman, D.G. (1972).Olfactory communication in mammals.*Annual assessment of Ecology and Systematics* 3: 1-32.

Elmhagen, B., Tannerfeldt, M. and Angerbjorn, A. (2002). Food-niche overlaps among arctic and red foxes. *Can. J. Zool.,* **80:** 1274–1285.

Ermias, A., Thirgood, S. J., Bekele, A. and Laurenson, K. M. (2004).A note on the spatial ecology of African civet *Civettictis civetta* and common genet *Genetta genetta* in farmland in the Ethiopian Highlands. *Afr. J. Ecol*., **42:** 160–162.

Espírito-Santo, C., Rosalino, M.L. and Santos-Reis, M. (2007). Factors upsettingthe placement of common genet latrine sites in a Mediterraneanlandscape in Portugal. *J. Mammal*. **88**: 201−207.

Estes, R.D. (1991). *The Behaviour Guide to African Mammals:Including Hoofed Mammals,Carnivores and Primates*. University of California Press,

Berkeley.

Ester, R. D. (1991) The Behavior Guide to African Mammals.University of California Press, CA, USA.

EWCO (1995).*A Conference Manual on Civet Farming, Civet Musk Productionand Marketing* (Unpublished). Ethiopian Wildlife managementOrganization,Addis Ababa.

EWCO (1999).*General Information on Oromia Wildlife Resource*. Ethiopian Wildlife management Organization, Addis Ababa.

FAO, (2000).World Watch List for Domestic Animal Diversity.FoodandAgriculture Organization of the United Nations, Rome.

Fiorelli, L.E., Ezcurra, M.D., Hechenleitner, E.M., Arganaraz, E.,Taborda, J.R.A.,Trotteyn, M.J., von Baczko, M.B. and Desojo, J.B. (2013). The oldestknown communal latrines supply evidence of gregarism in Triassicmegaher bivores. *Scient. Rep.* **3**: 3348−3356.

Fuller, A. K., Harrison, D. J. and Vashon, J. H. (2007). Winter habitat selection by Canadian Lynx in Maine: prey abundance or accessibility? *J. Wild. Man.*, **71:** 1980–1986.

Garcia, V. B. and Kittlein, M. J. (2004).Diet, habitat use, and relative great quantity of pampas fox (*Pseudalo pexgymnocercus*) in northern Patagonia, Argentina.*Mam. Biol.*, **70:** 218–226.

Gaubert, P., Taylor, P. and Veron, G. (2005). Integrative Classification and Phylogenetic Systematics of the Genets (Carnivora, Viverridae, *Genetta*): A New Taxonomy ofthe most SpecioseCarnivoran Genus in Africa.**In**: *African Biodiversity: Molecules,Organisms, Ecosystems*, pp. 371–383, (Huber, B. A., Sinclair, B. J. and Lampe, K.H.,eds). Springer, Bonn.

Giannatos, G., Karypidou, A., Legakis, A. &Polymeni, R. (2009)Golden jackal (Canis aureusL.) food in Southern Greece. Mamm.Biol. 75, 227–232.

Gilmour, R.J. & Skinner, M.F. (2012) Forensic scatology: preliminary investigational study of the preparation and potentialforrecognition of captive carnivore scat. J. For. Sci. 57, 160–165.

Gittleman, J. L. (1996). *Carnivore Behavior, Ecology, and Evolution.*Vol. 2. Cornell University Press, Ithaca.

Goldenberg, M., Goldenberg, F., Funk, S.M., Henschel, J. &Millesi,E. (2010) Diet composition of black-backed jackals, Canismesomelasin the Namib Desert. J. Folia Zool. 59, 93–101.

Hillman, J. C. (1992). *Review of the conventional Civet Musk Extractionand a Proposal for Establishing a Model Civet Research Project in Ethiopia*. Ethiopian Wildlife Management Organization, Ministry of Agriculture, Addis Ababa.

Hillman, J. C. (1993). *Ethiopia: Compendium of Wildlife maintenanceInformation*, Vol.2. Ethiopian Wildlife Conservation

Hillman, J. C. (1993). *Ethiopia: Compendium of Wildlife Management Information*, Vol.2. Ethiopian Wildlife Management Organization, Addis Ababa.

Ho, W. P. (2009). *The function of masked palm civet (Pagumalarvata) and small Indian civet (Viverriculaindica) in seed dispersal in Hong Kong*. Thesis, The University of Hong Kong. pp 162.

Hussain, S. A. (1999). Mustelids, viverrids and herpestids of India:species profile and conservation status. *ENVIS Bull.***2:**1–38.

Hutchings, M. R. and White, P. C. L. (2000).Mustelid scent-marking inManaged ecosystem: implication for population management .*Mamm.Rev.* **30**:157–169.

Hutchings, S. (2003). The food of feral house cats (*Feliscatus*) at a regional rubbish tip, *Vict. Wildl. Res.,***30:**103–110.

Iverson, S. J., Field, C., Bowen, W. D. and Blanchard, W. (2004). Quantitative fatty acid signature analysis: a new method of estimating predator food. *Ecol. Mon.,***74:** 211–235.

Jemal Mohammed (1999). The African civet (*Civttictis civetta*) and its farm prospect in Oromia Region. *A Paper Presented at theWorkshop on the Preliminary Assessment of Traditional Civet Keeping in Oromia, Nekemet.* Agricultural and Development Bureau of Oromia, Addis Ababa.

Jordan, N. R., Cherry, M. I. and Manser, M. B. (2007).Latrinedivision and patterns of use by wild meerkats: implications for territory and mate defense. *Anim. Behav.* **73**: 613–622.

Kingdon, J. (1977). *East African Mammals: An Atlas of Evolution in Africa*. *Carnivores*. Academic Press, London.

Kingdon, J. (1977), East African Mammals: an Atlas of Evolution inAfrica. Academic Press, NY, USA.

Kingdon, J. (1988). *East African Mammals: An Atlas of Evolution inAfrica, Vol. 3, Part 1*. University of Chicago Press, Chicago.

Kindgon, J. (1997). *The Kingdon Field Guide to African Mammals*. Academic Press, London.

Kingdon, J. (1997) The Kingdon Field Guide to African mammals. Academic Press, London, U.K.

Koike, S. (2009), Long-term trends in food habits of Asiatic blackbears in the Misaka Mountains on the Pacific coast of centralJapan. Mamm. Biol. 75, 17–28.

Krebs, C. J., Boonstra, R., Nams, V., O'Donoghue, M., Hodges, K. E. and Boutin, S. (2001). Estimation of snowshoe hare population mass from pellet plots—a further evaluation. *Can. J. Zool*., **79:** 1–4.

Kumera, W. (2005), Improving civet cat farming for quality muskproduction (Amharic version). Agr. Rural Dev. Bul. 2, 31–34.

Lamoot, I., Callebaut, J.,,Degezelle, T., Demeulenaere, E., Laquiere, J.,Vandenberghe, C. and Hoffmann, M. (2004). Eliminative behavior of free-ranginghorses: do they show latrine actions or do they defecate where they graze? *Appl.Anim. Behav. Sci.* **86**: 105–121.

Lance, M. M., Orr, A. J., Riemer, S. D., Weise, M. J. and Laake, J. L. (2001).Washington Department of Fish and Wildlife, USA.PP 41.

Linnell, J. D. C., Swenson, J. E., Landa, A. and Kvam, T. (1998). Methods for monitoring European large carnivores - A worldwide review of relevant experience.*J. NINA. Opp*., **549:** 1-38.

Litvaitis, J. A. (2000). Investigating food habits of terrestrial vertebrates.**In:**Investigate techniques in animal ecology: controversies and consequences, (Boitani, L. and Fuller, T. K. eds.). Columbia University Press, New York. PP 165-190.

Louw, G. &Seely, M. (1982) Ecology of Desert Organisms. Longman,NY, USA.

Macdonald, D. W. (1980). Patterns of scent marking with urine andfaeces between Carnivore communities.*Symp. Zool. Soc*. **45**:107−139.

Macdonald, D. W. (2001). *The New Encyclopedia of Mammals.*OxfordUniversity Press,Oxford.

Maia, M. J., Rego, F. and Machado, F. S. (2003). Determining Optimal Sampling Schemes to Study Red Deer Diets by Fecal Analysis.*Silv.Lus*.,**11:** 91 – 99.

Malo, A., Lozano, J. Huertas, D. .and Virgos, E. (2004). A change of diet from rodents to rabbits (*Oryctolaguscuniculus*). Is the wildcat (*Felissilvestris*) a specialist predator? *J. Zool.,* **263:** 401–407.

Malloy, J. C. (2000). Snowshoe hare, Lepusamericanus, fecal pellet fluctuations in western Montana. Can. *Fiel. Nat.*, **114:** 409–412.

Mohan, L. (1994), Trade in civetone from the Indian small civet (*Viverriculaindica*) form Malabar, India. *Small CarnivoreConserv.***10**:13.

Muckherjee, S..Goyal, S. P., Johnsingh, A. J. T. and Pitman, M. R. (2004). The importance of rodents in the diet of jungle cat (*Felischaus*), caracal (*Caracal caracal*) and golden jackal (*Canis aureus*) in Sariska Tiger Reserve, Rajasthan, India. *J. Zool*., **262:** 405–411.

Mudappa, D. Kumar, A. and Chellam R. (2010). Diet and fruit choice of the brown palm Civet Paradoxurus jerdoni, a viverrid endemic to theWestern Ghats rainforest, India.*Tropical Conservation Science* 3: 282- 300.

Narendran, T. C. and Balakrishnan, M., (2008) Systematics andBiodiversity Conservation. Agrobios, NewDelhi, India.

Nowak, R.M. (1999). *Walker's Mammals of the World*.Johns Hopkins University, Baltimore.

Palomares, F., Gaona, P., Ferreras, P. and Delibes, M. (1995).Positive effects on game species of top predators by controlling smaller predator populations: an example with lynx, mongooses,and rabbits.*Conserv,. Biol.* **9**: 295−305.

Pankhurst, R. (1961).,*An Economic History of Ethiopia: From Early Times to 1800*. Lalibela House, Addis Ababa.

Partan, S. R. and Marler, P.. (2005). Issues in the classification of multimodal communication signals. *Am. Nat.,***166**: 231–245.

Perlo, B. V. (1995). Birds of Eastern Africa. Harper Collins Publisher, Netherlands,.PP 301.

Potvin, F., Breton, L. and Courtois, R. (2005). Response of beaver, moose, and snowshoe hare to clear-cutting in a Quebec boreal forest: a reassessment 10 years after cut. *Can. J. Res*., **35:** 151–160.

Prins, H. H. T. and Reitsma, J. .M. (1989). Mammalian biomass in an African equatorial rain forest. *J. Anim. Ecol.* **58**: 851–861.

Pugh,M.(1998).Civet Farming.An Ethiopian Investigation,World Society for the Protection of Animals,London 272-273.

Putman, R. J. (1984). Facts from feces.*Mam, Rev*., **14:**79–97.

Rabinowitz, A.R.. (1991). Behavior and movement of sympatric Civet species in HuaiKhaKhaeng Wildlife Sanctuary, Thailand.*Journal of Zoology*223:281-298.

Ralls K. (1971). Mammalian scent marking.,*Science*171: 443−449.

Randall, R. M. (1979). Perineal gland marking by free-ranging Africancivets,

Civettictis civetta.*J.Mamml*.**60**: 622–627.

Rautenbach, I., L., and Nel, J. A. J. (1978).Co-existence in Transvaal Carnivora.*Bul.Car.Mus. Nat. His.*, **6:** 138- 145.

Ray, J. C. and Sunquist,, M.E. (2001). Trophic relations in a communityof African rainforest carnivores. *Oecologia***127**: 395–408.

Ray, J.C, Gaubert, P. and Hoffmann., M. (2008).*Civettictis civetta*.**In**: *IUCN 2013. IUCN Red*

Ray, J.C., Hunter, L. and Zigouris,, J. (2005).*Setting Conservation and Research Priorities ForLarger African Carnivores*. WCS Working Paper No. 24. Wildlife ConservationSociety, New York.

Ray, J.C. (1995). *Civettictiscivetta*.*MammlianSpcies*488: 1-7

Rex, K., Czaczkes, B.I., Michener., R., Kunz, T.H. & Voigt, C.C.(2010) Specialization and omnivory in diverse mammalianassemblages. J. Ecosci. 17, 37–46.

Rosevear, D.R. (1974). *The Carnivores of West Africa*. British Museumof Natural History,London.

Russo, S. E., Portnoy, S. .andAugspurger, C. K. (2006). Incorporatinganimal behavior into seed dispersal models: Implications for seed shadows. *Ecology* **87**: 3160–3174.

Schipper, J., Hoffmann, M.,, Duckworth, J. W. and Conroy, J. (2008).The 2008 IUCN red listings of the world's small carnivores.*Sm. Carn. Cons*., **39:** 29–34.

Schliemann, H. (1990). *Grzimek's Encyclopedia of Mammals.*,*Vol.3*.McGraw-Hill Publishing. New York.

Schwartz, M.K., Pilgrim, K.L. and McKelvey, K.S., (2007).DNAmarkers for identifying individual snowshoe hares usingfield collected pellets. *North West Sci*. **81**: 316–322.

Scordato, E. S. and Drea, C. M. (2007). Scents and sensibility: information content of olfactory signals in the ringtailed lemur, *Lemur catta*. *Ani.Beh.*,**73:** 301–314.

Shalu, T. (2000).,*Civettictiscivetta*, Animal Diversity Web. Accessed 27 July, 2009 http://animaldiversity.ummz.umich.edu/site/accounts/information/Civettictis_civetta.html**.**

Silva, J. A. and Talamoni, S. A., (2003). Diet adjustments of maned wolves, *Chrysocyon brachyurus* (Illiger) (Mammalia, Canidae), subjected to supplemental feeding in a private natural reserve, southeastern Brazil. *Rev. Bras. Zool.*, **20:** 339–345.

Skinner, J. D., and Smithers, R. H., N. (1990).The mammals of the southern Africa Subrigion. University of Pretoria, Pretoria, South Africa.PP 771.

Smithers, R. H. and Wilson,, V. J. (1979). Checklist and atlas of the mammals of Zimbabwe Rhodesia. *Nat. Mus.Monu. Rhodesia***9**:1–47.

Smithers, R. H.(1986).,The mammals of the south African subregion. University of Pretoria,Pretoria.pp.160-169.

Solberg, K.H., Bellemain, ,E., Drageset, O., Taberlet, P. and Swenson,J.E. (2005). An evaluation of field and non-invasive genetic methods to estimate brown bear (*Ursusarctos*) population size.*Biol.Conserv*.**128**: 158–68.

Sreedevi, M. B. (2001). *,A Study on Certain Aspects of Breeding andBehavior of the Small Indian Civet, Viverricula indica*(Desmarest).,PhDDissertation, University of Kerala,Thiruvananthpuram.

Tadesse Habtamu (2014),.*Ecological Studies of the African Civets (Civettictis civetta) in Coffee Forest Habitat,.Limmu Seka District, and an Assesment of Captive Maintenance as a Viable Economic Sources*. Ph.D. Dissertation, Addis Ababa University, Addis Ababa.

Tadesse Habtamu and Afework Bekele (2008). Habitat association of insectivores and rodents of Alatish National Park, northwestern Ethiopia. *J.,Tro. Ecol*. **1:** 1-11.

Tadesse Habtamu(2015). Estimated density of African civet in coffee forest of Jimma zone south western Ethiopia (un published)

Tollit, D. J., Heaslip, S., Zeplelin, T., Joy, R. Call, K and Trites, A. W. (2004). A method to improve size estimates of walleye pollock and Atka mackerel consumed by pinnipeds using digestion correction factors applied to bones and otoliths recovered inscats.*Fish. Bull.*,**102:** 498–508.

Trites, A., Joy,, W. and Ruth, (2005). Dietary analysis from fecalsamples: how many scates are enough? *J. Mamml*. **86**: 704–712.

Tuyttens, F. A. M, Long, B., Fawcett, T., Skinner, A., Brown, J. A., Cheeseman, C. L., Roddam, A. W. and Macdonald, D.W. (2001). Estimating group size and population density of Eurasian Badgers *Melesmeles* by quantifying latrine use.*J. Appl. Ecol*., **38:** 1114–1121.

Vieira, E.M. & Port,, D. (2007) Niche overlap and resourcepartitioning between two sympatric fox species in southernBrazil. J. Zool. 272, 57–63.

Wang, H., and Fuller, T. K. (2003). Food habits of four sympatric carnivores in southeastern China. *Mam*.,**67:** 513-519.

William J. **(**2003). The story of civet.*Pharmace. J.* **271**: 859–861

Wondmagegne Daniel,,Afework Bekele, Balakrishnan, M. and Gurja Belay (2011). Collection of African Civet *Civettictis civetta* perineal gland secretion from naturally scent-marked sites. *Small Carniv.Conserv*.**44**: 14−18.

Wondmagegne Daniel, (2006). *Ecological Studies on African Civet(Civettictis civetta) in Jima, Ethiopia*. M.Sc. Thesis, Addis Ababa University, Addis Ababa.

Woodford, J.D. (1990). *Conservation and Utilization: The Status of Wildlife in Ethiopia*.Ethiopian Wildlife Conservation Organization,Addis Ababa.

Wood, W. F., Terwiilliger, M. N. and Copeland, J. .P. (2005). Volatile Compounds from anal glands of the Wolverine, *Gulogulo. J. Che. Ecol.*,**12:** 2111-2117.

Wozencraft, W. C. (2005). Order Carnivora. **In**: *Mammals Species of the World*, pp. 548−559, (Wilson, D. E., Reeder, D. M., eds).JohnsHopkins University Press,, Baltimore.

Wright, J. (2011), Cats, musk, gold and slaves: staples of the north bound Sahara trade.*J. North Afr. Stud*. **16:** 415–420.

Xavier, F. (1994a),*A Study on Small Indian Civet (Viverricula indica)as a Suistanble Wildlife Resources*.PhDDissertation,University of Kerela, Thirhvananthrium.

Yalden, D. W., Largen, M.J. and Kock, D. (1980). Catalogue of the mammal of Ethiopia: 4 Carnivora.*Ital. J. Zool*., **8:**169-272.

Yilma Delelegn (2000), Sustainable utilization of the African civet (*Civettictiscivetta*) in Ethiopia.*IUCN 2nd Pan-African Symposium on the Sustainable use of Natural Resources inAfrica.*Ouagadougou.

Yilma Delellegn.(2003). Sustainable Utilization of the African Civet (*Civettictis civetta*) in Ethiopia.**In**: *Second Pan-African Symposium on the Sustainable Use of Natural Resources in Africa*, pp. 197−208, (Bihini, W., Musiti, W., eds). IUCN,Gland.

Zelalem Tefera Ashenafi, Coulson, T., Sillero-Zubiri, C. and Leader-Williams, N. (2005). Behaviour and ecology of the Ethiopian wolf (*Canis simensis*) in a human-dominated landscape outside protected areas. *Anim. Cons*., **8:** 113–121.

Zhou, Y. B, Slade, E., Newman, C., Wang, X. M. and Zhang, S. Y. (2008).Frugivory and seed dispersal by the yellow-throated marten, *Martesflavigula*, in a subtropical forest of China. *J. Trop. Ecol*., **24:** 219 – 223

8. LIST OF APPENDEX

Appendix 1: Frequency and biomass in gram (g) African civet diet in coffee plantation and farmland during wet and dry seasons

	Coffee plantation				Farmland			
	wet		dry		Wet		dry	
	Frequency	Biomass(g)	Frequency	Biomass(g)	Frequency	Biomass(g)	Frequency	Biomass (g)
Animals								
Mammals	89	1500	76	1000	46	900	34	600
Birds	78	1200	72	950	42	800	31	400
Arthropods	228	3020	102	840	140	820	64	490
Plants								
Coffeaarabica	-		96	3000	-	-	55	1000
Cordiaafricana	-	-	101	3500	-	-	58	1300
**Others plant seeds*	43	100	300	540	65	2500	165	3100

***(**Other plant seeds)* –those were clearly unidentified plant seed (individually unidentified plant seed) by observation

Appendex 2: Mammalian diet of African civet during wet season in coffee plantation

Appendex 3: African civet food items during wet season

Appendex4: Diets of African civet in farmland during the wet season

Appendex 5: African civet fecal count for density estimation in coffee plantation during the dry season