Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.5, No.11, 2015

Scent-Marking by the African Civet Civettictis civetta in Arba Minch Forest, Nech Sar National Park, Ethiopia

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Abstract
Civet musk is one of the natural resources in Ethiopia. Much as Ethiopia is the world's largest supplier of civet musk to perfumery industry in Europe, its Civet farming practices and knowledge about Scent-marking patterns of African Civet needs to be regulated for acceptable welfare standards and important to increase musk production. The scent marking objects and its preference were known by making 70 quadrates of 20 X 10 m^2 which were laid in different parts of the study area. This was done based on the proximity of the area to the latrine site, In the present study area, the African Civets used plants, metallic objects and poles to scent mark. Out of the 92 scent marking sites observed, 96.72% was within 100 m radius of the civetry. About 75% of the scent marks was observed within < 4 m distance from the path way. There was a high level of preference to mark on Bedena tree (*Balanites aegyptiaca)* (38%) followed by metallic objects (19.56%). In the wild, the amount of perineal gland secretion collected from each marked site varied from 0.0047 g to 0.98 g.
Keywords: African Civet, Musk, scent marking.

1. Introduction

The African Civet (*Civettictis civetta* Schreber, 1776) is the largest representative of Viverridae (Ray, 1995) which occurs in the sub-Saharan Africa from around 15°N longitude to 24°S latitude. The east-west range extends from Senegal to the East Coast of Africa. African Civets are present on the Islands of Zanzibar, but absent in other islands such as Madagascar (Kingdon, 1977). They comprise a distinct monospecific genus distinguished from *Viverra* by the much longer molar teeth and broader lower carnassials. It has a short broad neck, pointed muzzle, small rounded ears, small eyes and a long bushy tail. They are also solitary during most of their life (Fig. 1). They are seen in groups of two or more, only during reproductive activities for a brief period of time. They use scent marking as a major means of communication between conspecfics. The scent marks of Civets can stay for a long period in their habitat (Eisenberg and Kleiman, 1972). Most Viverrids have perineal scent glands (Ray, 1995), which secrete a musky secretion used for scent marking. The scent is recognized by conspecifics and is used for olfactory communication (Ralls, 1971; Eisenberg and Kleimen, 1972; Ray, 1995). The perineal glands of Civet produce a fluid secretion generally known as 'civet'(Kingdon, 1997; Balakrishnan and Sreedevi, 2007a, 2007b; Bekele Tsegaye *et al.,* 2008), which is a waxy substance, and spreads on terrestrial sign- posts to claim its range. 'Civet' is the original name for the scent obtained from Civets (Dannenfeldt, 1985). It has a pleasant odour when diluted. This is responsible for its longstanding and extensive use in the perfume industry (Ray, 1995). Both sexes of Civets possess perineal glands, the secretion of which is used for scent marking (Ralls, 1971; Eisenberg and Kleiman, 1972). The perineal glands of males are slightly larger than those of females, and males produce stronger and better quality secretion (Ray, 1995). Civet musk is one of the natural resources in Ethiopia. Much as Ethiopia is the world's largest supplier of civet musk to perfumery industry in Europe, its Civet farming practices and knowledge about Scent-marking patterns of African Civet needs to be regulated for acceptable welfare standards and important to increase musk production. The present study, therefore, focuses on scent marking patterns of Civets to reveal the amount of perineal gland secretion of African Civet in the wild and to initiate measures to conserve the African Civets in Arba Minch, Ethiopia.

2. MATERIALS AND METHODS

2.1. Study area

The study area, Abra Minch Forest is located in southern Ethiopia near Arba Minch town (Fig. 2). It is located about 510 km south of Addis Ababa, the capital city of Ethiopia (Duckworth *et al.,* 1992). Arba Minch Forest, which is part of the Park, covers about 2120 ha (Fig. 3). Of the total area of Nech Sar National Park, 85% is land and 15% is water. It is located between 5° 57'−6° 05' N latitude and 37° 32'−37° 48' E longitude at the centre of the Ethiopian Great Rift valley with an altitudinal range of 1,108−1,650 meters above sea level (Bolton, 1973).

2.2. Climate

The closest weather station for the study site is Arba Minch University weather station. Rainfall and temperature data were collected from this station. The rainfall in the Park averages about 800mm a year, but it ranges from 300mm to more than 1200mm in the wettest season (Fig. 5). The main wet season is during April−June with a

second wet period in September−October. The driest season is December− February. Temperature ranges from 36°C−39°C in December–February. The lowest temperature(20−21°C) is during April−June (Fig. 4).

2.3. Perineal gland marking

The study area was searched extensively to locate the scent marking sites of Civets (Balakrishnan and Alexander, 1985; Balakrishnan, 1987; Bekele Tsegaye *et al.,* 2008b). The height of the marking sites on the sign-post was measured to identify suitable height at which Civets scent marked. The species of plants or type of objects marked were identified. Distance from civetries and tracks were measured to analyse the distribution of scent marks in the home range of the animal. The glandular scent marking secretion was removed from sign-posts; the date was recorded and observed for remarking to know the frequency of scent marking in the natural habitat (Wondimagegne Daniel, 2006).Fresh plastic bags of size 12 x 12 cm were used to collect the glandular secretion from the scent-marked sites. Each of the plastic bags was numbered and the same numbers' were attached on the object from which the respective sample was collected. The amount of secretion collected from scent marked sites was weighed on an electric balance.

2.4. Quadrats

To know the preference of scent marking objects, 70 quadrates of 20 X 10 m^2were laid in different parts of the study area. This was done based on the proximity of the area to the latrine site, following the method of Wemmer (1977) and by observing the association of marking with the species of plant in the study area. The distance between each successive quadrat was 100 m. Number of trees on which Civets scent marked were counted. All plants on which they scent marked were identified to species level (Ranadll, 1977).

2.5. Data analyses

16.0 version of SPSS computer program was used to identify the statistical significance of the results. The total scent marked objects were identified. The level of preference to scent mark on these objects was calculated using frequency of occurrence of each of the objects expressed as percentage. The variation between scent marked objects was tasted by using Chi-square test. The height of each of the scent marks was measured from the ground. The mean height at which scent marks were observed was calculated. The distance of scent marks around civetry sites and around the path way of *C. civetta* were measured by a measuring tape.

3. Results

3.1. Scent marked objects in the home range of African Civets

A total of 92 scent marked objects were identified in 2120ha. area during the present study in Arba Minch forest. In the present study area, the African Civet used plants, metallic objects and poles to scent mark (Fig. 6, a, b). There was a high level of preference to mark on *Balanites aegyptiaca* (38.04%), followed by metallic materials (19.56%).The variation between *Balanites aegyptiaca* and other marked objects was statistically significant (χ^2= 70.38, df = 7, P<0.05).Only 2.2% of the observed scent markings were on poles (Table 1). During the wet season, no fresh scent marks were observed on poles and on *Eucalyptus* spp.

Civettictis civetta marked its scent at various heights from the ground (Fig. 7). The height of scent marked objects ranged from 25 to 39 cm. The mean height at which scent marks were observed was 32 cm. In few cases, two different heights were observed on a single object. Out of the total scent marked objects, 32 (34.78%) sign-posts were remarked.

3.2. Perineal gland secretion

The amount of glandular secretion on the scent-marked sites has been gathered and even if it was dispersed, the amount and frequency of marking was high. In the wild, the mean amount of perineal gland secretion that could be collected from each marked site varied from 0.0047 g to 0.98 g (Table 2) (Fig. 8) was measured during study period.

3.3. Distribution of scent marks around civetry sites and pathways of Civettictis civetta

Most of the scent marks (36.95%) were located between 50−100 m of the civetry sites (Table 3). Scent markings were on trees such as *Balanites aegyptiaca, Acacia polyacantha, Kigelia africana, Acalypha fruticosa, Tamarindus indica* and *Eucalyptus* spp. The maximum distance from the civetry to the scent marked sign-post was 200 m (marked on a metallic object). Out of the 92 scent markings observed, 96.72% were within 100 m radius of the civetry.

The minimum and maximum distances from pathways were 0.5 and 5 m, respectively. There were few marks on the pathways. Approximately, 42% of marked objects were distributed within 1 m distance from pathways. Out of the 92 scent marked sites observed, 75% of the scent mark was observed within 0−4 m distance from the path way and 32.61% was within 2−4 m distance from the pathways (Table 4).

The first remarking was observed two days after removing the glandular secretion from one of the scent marked sites, while the last remarking was observed one month at the removal of the secretion, from the scent marked site. Most sign-posts were remarked within 2−3 weeks of the removal of the glandular secretion from the marked objects. Immediate remarking was not observed even on sign-posts near the civetry site and pathways**.** During the whole study period, 34.78% of sampled scent marked sign-posts were remarked by Civets.

4. Discussion

Scent marking is one of the major forms of communications of *C. civetta*. The African Civets has perineal glands that produce its secretion known as 'civet' (Kingdon 1997; Bekele Tsegaye *et al.,* 2008), which is spread on sign-posts during scent marking. This secretion is heavily used in the perfume industry (Ray, 1995). Civets also mark their territories using faeces. They mark suitable objects in their home ranges using their perineal gland secretion. There was a high level of preference to mark on *B. aegyptiaca* in the present study period. Metallic objects were the second preferred objects for scent marking in the study area. During the wet season, no fresh marks were observed on poles and on *Eucalyptus* spp. Civets have no preference to the size of the plant for scent marking. Scent-marks were seen on a variety of large trees, shrubs, herbs, stems, metallic objects and poles in the present study area. Civet scent-marks were observed on a variety of large trees, shrubs, herbs and grasses observed by Randall (1979). The use of scent marking by Civets might be related to territory defense and to advertise the reproductive status (Alberts, 1992). As stated by Wondimagegne Daniel *et al.,* (2011), it is used in olfactory communication. In solitary species, scent marks could assist a female's reproductive effort in two ways; first by informing males of her reproductive status and second by assisting a potential mate to locate her. Males are more attracted to odours of oestrous females than of non-oestrous females (Brown, 1979; Gorman and Trowbridge, 1989). As observed in other mammals, Civets tend to defend their territories for the purpose of reproduction and when the resources are in short supply (Gosling, 1982; Richardson, 1993).

The distribution of scent marked objects was high around the civetry sites. Scent markings were observed around civetries, forest tracks and roads, and around human settlements (Bekele Tsegaye*et al.,* 2008). According to Wondimagegne Daniel (2006), African Civets prefer to mark objects with smooth surfaces more often than those with rough surfaces. However, it was not the case with the Civets in the Ground Water forest as showed during the present study. During the present study, African Civets scent-mark objects with rough surfaces. There were no smooth stemmed plant species around the civettries (both habitats in the present study area were dominated by rough stemmed plant species specially most pants found in bushland habitat were rough). In addition, plants found in bushland habitats were very thick and thorny at the base. It was suggested by Randall (1979) that the objects unsuitable for Civets to scent mark were those trees with thick and thorny branches at the base. Scent marking on environmental sign-posts was more concentrated on road-sides, especially around the camp site. They preferred to mark on rough-surfaced vertically standing objects. Most of the scent marks (96.72%) were distributed within 100 m radius of their civetry. The maximum and minimum distance was 200 m and 1 m from nearby 'civetry'. Most of the scent marked objects (> 88%) were distributed within 4 m distance from the path way (Randall, 1979). However, in the present study area, only 75% of the marked objects were distributed within 4 m distance from the pathways.

The height at which the scent-marks were laid denotes mostly the height of the posterior quarters of the Civets, which might also give an indication about the approximate height and thus the age of the individuals (Bekele Tsegaye *et al*., 2008).Scent markings at lower heights could be of young and sub-adults. The mean height at which scent marks were observed was 32 cm. The observations of two different heights at which the Civets marked might indicate the use of more than one individual used the same sign-post to scent mark.

Out of the 92 scent marks observed during the present investigation, only 32 were found to be re-marked. The low rate of re-marking might reflect the long lasting nature of the odour (Wondimagegne *et al*., 2011). African Civets mark on leaves, grass and shrubs frequently. This may be an indication for those sign-posts, which are more frequently used for communication by Civets. For instance, the sign-posts which are marked for the purpose of territoriality may have marked more frequently than sign-posts for the purpose of reproduction. The non-remarked sign-posts during the study period may be associated with reproductive behaviour of the Civets.

The differences in the quantity of scent marked secretion available for collection might be linked to the age of the individual, as adults and more dominant individuals might secrete more than the young and subdominant ones (Eisenberg and Kleiman, 1972). In many mammals, sign-posts are repeatedly scent-marked (Wondimagegn Daniel *et al.,* 2011). African Civets scent-mark sign-posts repeatedly, but the present investigation reveals only 34.78% of objects were being remarked, when the marked secretion was removed from the site. Even though more objects around civetries were scent-marked, there was no systematic variation in the amount of secretion available on sign-posts in relation to the distance from the civetry. As the scent once marked would persist for a long duration, re-marking is not essential over a short time-scale for the purpose of communication (Ralls, 1971).

Sexual dimorphism is well known in the size of specialized integumentary glands, frequency and pattern of scent marking in various mammalian species (Ralls, 1971; Eisenberg and Kleiman, 1972), with larger glands in males and which scent-mark more frequently. During the present study, it was not easy to collect all the glandular secretion from the marked sites. The primary environmental factors, which affect spatial and temporal parameters of chemical signals in terrestrial habitats, are temperature, humidity and wind (Alberts, 1992). There were more sites of scent-marking during the dry season than during the wet season and the amount of Civet gland secretion was high during the dry season than during the wet season. This can be associated with the effect of temperature on the secretary output of the gland and on the availability of food.

5. Conclusion and Recommendations

The African Civets depend on perineal glandular marking for olfactory communication signals as revealed by numerous scent marked sign-posts around the civetries. The amount of glandular secretion on the scent-marked sites has been gathered and even if it was dispersed, the amount and frequency of marking was high. The size, colour of the musk and strength of the odour are variable depending up on the duration of the mark.

The larger size of the study area without research on Civets necessitates the need for additional ecological studies on African Civets in Arba Minch area. Therefore, detailed field studies on the population status of African Civets should be undertaken to obtain information on their population, reproduction and activity pattern in relation to all habitats. Most local communities in Arba Minch area do not know about the economic importance of Civets. Hence, creating awareness about the economic importance of Civets for local communities must be encouraged so that the animal might live in harmony with human beings.

6. Acknowledgements

I owe deepest gratitude to my advisor, Prof. M. Balakrishinan for his initiation, encouragement, advice, assistance and unreserved support in all aspects of this research work. His willingness to provide reference materials and above all in sharing his knowledge and experiences are greatly acknowledged. I also appreciate his friendly approach, valuable comments, suggestions, continuous follow-up in the field work and structuring of the draft manuscript. I wish to thank the Ethiopian Wildlife Conservation Authority for their support, providing assistance in the field and allowing me to use their library reference materials. I gratefully acknowledge the Horn of Africa project fund, Addis Ababa University for providing funds and the Department of Zoological Sciences for facilitating my work. I wish to extend special gratitude to my families for their encouragement and helping me in all aspects when I do this paper.

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Table 1.Civet scent marked objects located in the present study area in Arba Minch

Scent marked objects	Species	No. of marked objects	No. of Remarkig	%	Mean height (cm) ± S.Dfrom the ground where the scent markings were obtained
Plants	*Balanite aegiptica*	35	5	38.04	31.6 ± 7.305
	Acacia polyacantha	13	0	14.13	30.31 ± 3.56
	Kigelia africana	7	3	7.61	32.57 ± 5.6
	Acalypha fruticosa	6	4	6.52	30.5 ± 13.1
	Tamarindus indica	7	1	7.61	32.28 ± 5.22
	Eucalyptus spp.	4	1	4.34	32.25 ± 4.24
Metallic materials		18	18	19.56	32.22 ± 6.17
Pole		2	0	2.17	30.5 ± 0.5
Total		92	32	100	Total Mean = 31.52 ± 5.7

Table 2. Amount of perineal gland secretion of African Civets collected from the different scent marked sites

Marked object	Species	No. of marked objects	Amount of civet secretion Mean ± S.D., g
Plants	*Balanite aegiptica*	35	0.154 ± 0.044
	Acacia polyacantha	13	0.0489 ± 0.00185
	Kigelia africana	7	0.0391 ± 0.000926
	Acalypha fruticosa	6	0.0814 ± 0.0107
	Tamarindus indica	7	0.0318 ± 0.00091
	Eucalyptus spp.	4	0.0129 ± 0.0000547
Metallic materials		18	0.3384 ± 0.1026
Pole		2	0.318 ± 0.116
		Total=92	Mean=0.1088 ± 0.033

Table 3. The distribution of scent marked sites around civetry sites

Distance (m)	No. of observations	Percentage
0 - 20	23	25
20-40	14	15.21
20 - 50	18	19.56
50 - 100	34	36.95
100 - 200	3	3.26
Total	92	100

Table 4. The distribution of scent marked sites around pathways

Distance (m)	No. of observation	Percentage
0−1	39	42.39
2−4	30	32.61
> 4	23	25
Total	92	100

Figure 1: African Civet in Arba Minch forest

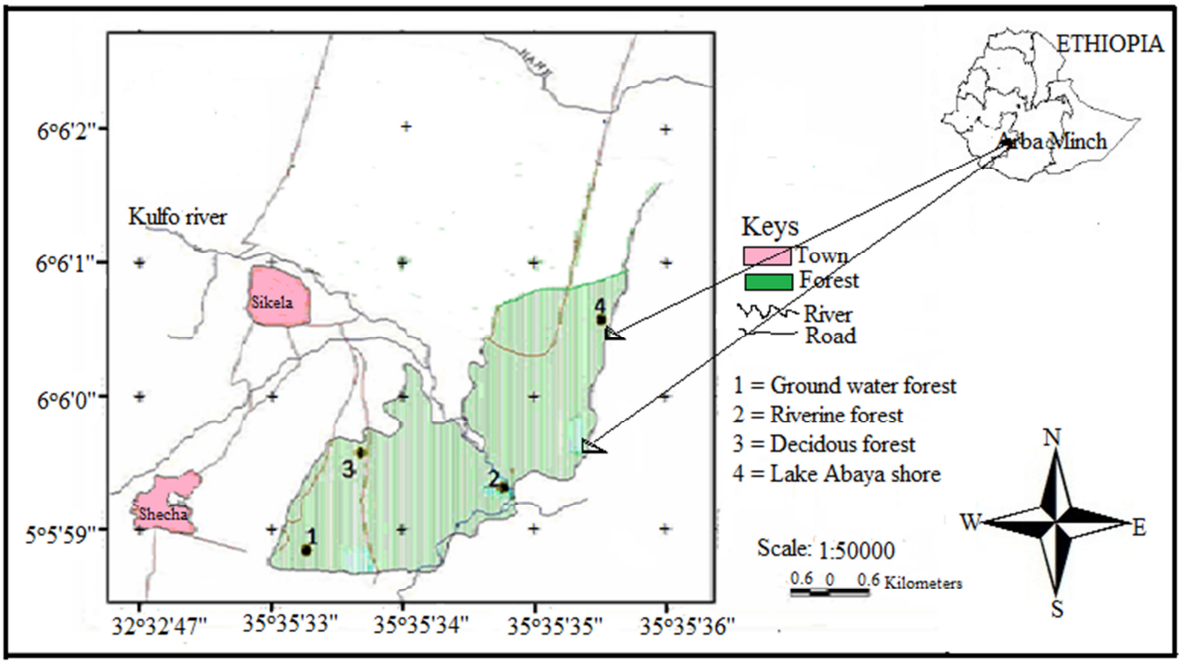

Figure 2. Map of the study area

Figure 3. A view of Arba Minch forest

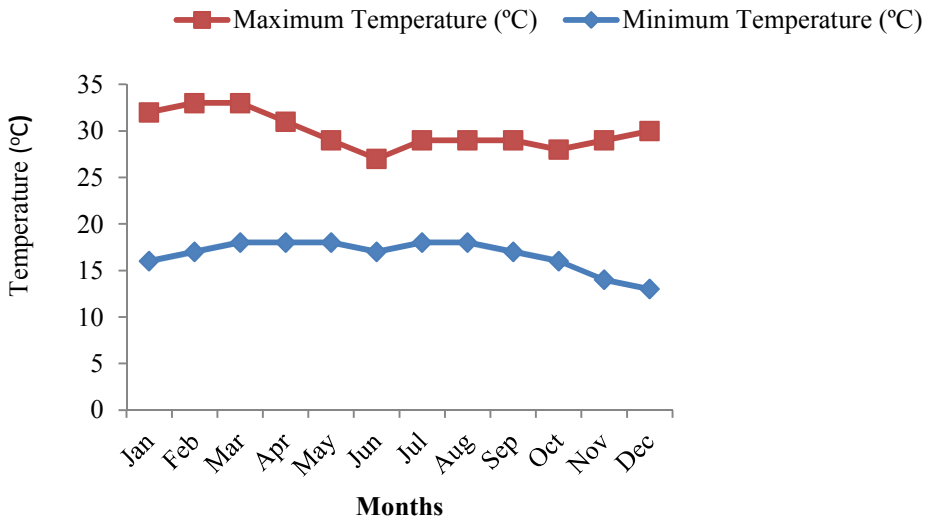

Figure 4.Mean monthly temperature of Arba Minch (1987−2012) (Arba Minch University Meteorology Station, 2012)

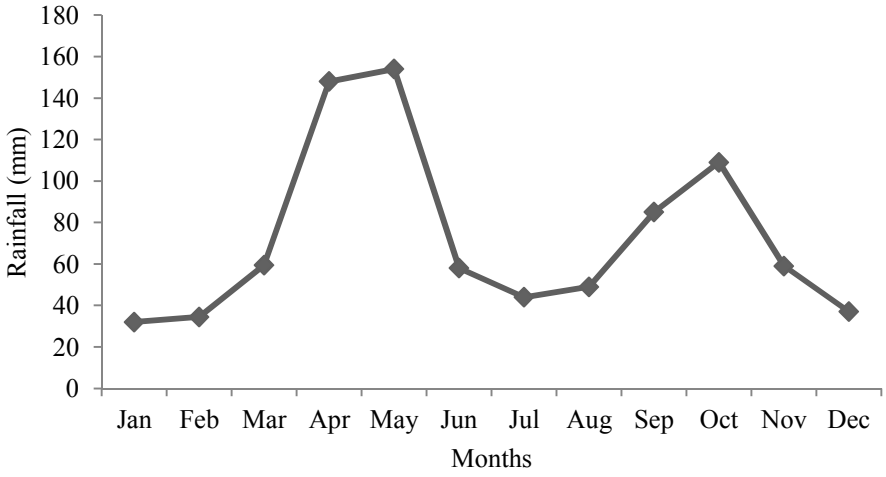

Figure 5. Mean monthly rainfall of Arba Minch (1987−2012) (Arba Minch University Meteorology Station, 2012)

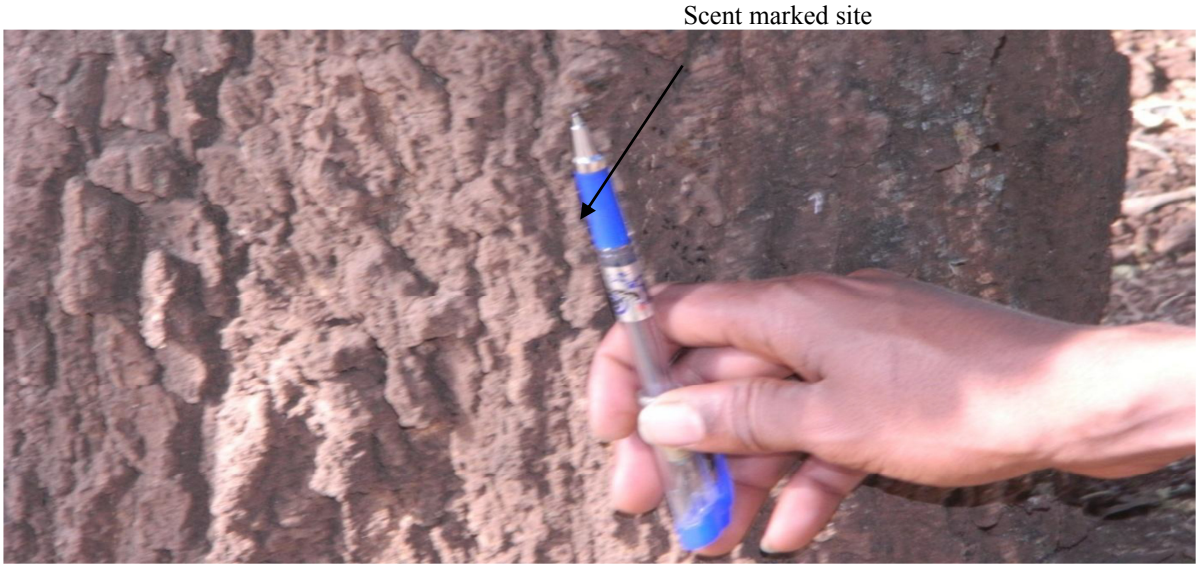

Figure 6a. Scent mark of African Civets on *Balanite aegiptica*

Figure 6 b. Scent mark of African Civets on a metallic object for many times

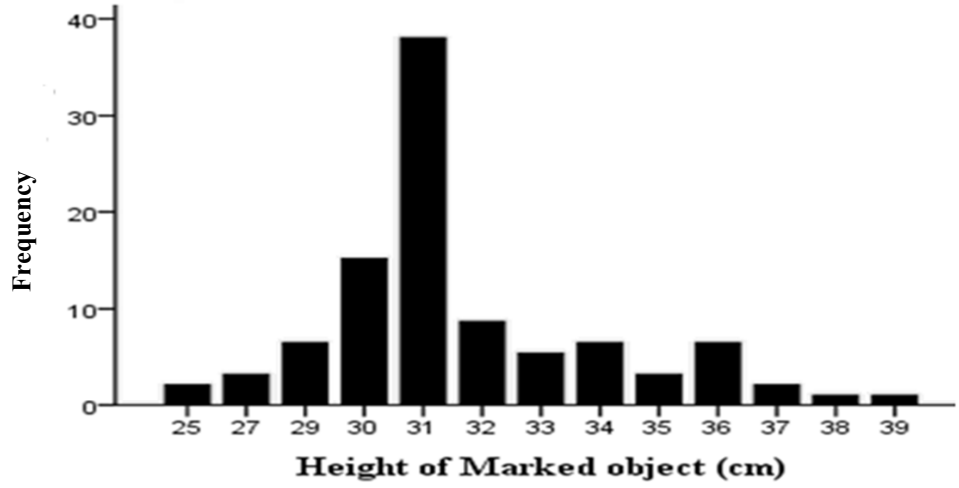

Figure 7. The height of sign-posts at which Civets scent marked in Arba Minch forest

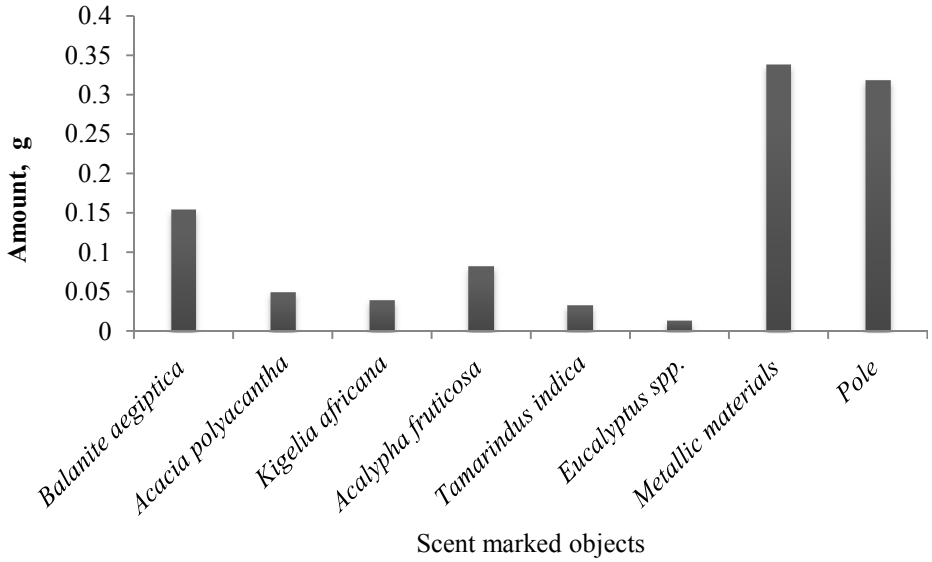

Fig 8. Mean amount of perineal gland secretion of the African Civets available on scent marked objects

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