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Seasonal and Spatial Differences in Feeding Ecology and Behavior of the African Civet *Civettictis Civetta* in Arba Minch Forest, Arba Minch, Ethiopia

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I. Introduction

The Order Carnivora includes a wide range of mammals characterized by a diversity of diet. Studies on diet of carnivores help to understand their evolutionary adaptations and distribution throughout their ranges (Rabinowitz, 1991; Chuang and Lee, 1997). 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. Even though, Civets are primarily carnivorous (Dannenfeldt, 1985), they are omnivorous generalist, eating small vertebrates, invertebrates, eggs, carrion, and vegetable matters. Understanding the feeding ecology and behavior of the African Civet with seasonal and spatial variation is important for its conservation, management, disease control and sustainable use of the 'civet'/musk, which is one of the natural resources of Ethiopia. The present study, therefore, focuses on feeding ecology and behavior of Civets to reveal husbandry methods in using natural food items to improve the health of captive Civets in modified habitats in Arba Minch, Ethiopia.

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II. Materials and Methods

a) The Study Area

Arba Minch Forest is part of NechSar National Park (NSNP). It is located about 510 km south of Addis Ababa, the capital city of Ethiopia (Duckworth *et al*., 1992).It is located between 5° 57'–6° 05' N latitude and 37° 32'–37° 48' E longitude at the center of the Ethiopian Great Rift Valley with an altitudinal range of 1,108–1,650 meters above sea level (Bolton, 1973). Arba Minch Forest, which is part of the Park, covers about 2120 ha (Figure 1).

b) Food Items

Civets have specific defecation sites called 'civetries' and looking for such defecation sites, one can be sure of the presence of Civets in an area. Food items were estimated from civetry sites. Numbers of faeces were recorded on a daily basis for both wet and dry seasons. Droppings were collected using 7 cm x 17 cm polyethylene bags, washed with tap water and filtered through 1 mm x 1 mm mesh sieve to observe undigested food items by naked eyes. Undifferentiated parts of the samples were dried, crushed, treated with acetone and examined under a binocular microscope. Acetone (2-3 ml) was added into a gram of the crushed faecal matter to dissolve it. Doubtful contents were identified through comparison with reference materials from the habitat in the study area and using collections in the Herbarium of Addis Ababa University. Fruits and other plant items were identified up to the species level.

c) Statistical Analysis

SPSS software, Version 16.0 was used for the analysis of the data. Diet choice was calculated using frequency of occurrence of each of the food items expressed as percentage. Absolute frequency (n/N) was the number of food items (n) in relation to the scats analyzed (N). Relative frequency (r/R) was the relation of identified food items and the number of food items observed during analysis (R). One-way ANOVA test was used to identify the most preferred food item. Chi-square test of relative percentage frequency was performed to see significant food items in the diet.

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III. Results

a) Seasonal and Spatial Differences in the Natural Food Items of Civets

Data on food items of Civets as observed during the wet and dry seasons are given in Table 1. The most frequently observed food items in the Civet droppings during the wet season were millipede and centipede (15%). *Euclea divonorum* and *Diospiris abyssinica* were absent from wet-season droppings. The least consumed items during this season were leaves and fibres. Figure 2 show the nature of droppings at civetries.

During the dry season, the most frequent food items observed in the Civet droppings were *Diospiris abyssinica* (12.93%) and *Ficus* spp. (12.93%). The least consumed food items were snail and food with plastics. Seasonal differences in the overall diet were statistically insignificant ($\chi 2 = 0.093$, df=1, $P > 0.05$).

b) Bushland Habitat

There were 11 food related items in faecal samples collected from bushland habitat (10 food items and 1 non-food item) (Table 2).

Insects (13.1%) were the most preferred food items. *Euclea divonorum* and *Diospiris abyssinica* were absent in this habitat. Insects (13.1%) consist the highest percentage of consumption of the African Civets in this habitat during the wet season. In this season, plastic (2.18%) was observed as the least item in the Civet droppings. Hair with bone (14.21%) was the most frequent food item during the dry season. Leaves and fibres (5.07%) and plastic (3.55%) were observed in a low proportion in the food of African Civet during this season.

c) Forest Habitat

From this habitat, 13 items (12 food and one non-food item) were observed in Civet droppings (Table 3). *Diospiris abyssinica* was the most frequently observed diet as recorded from the analysis of droppings (17.17%). The preference of food items was statistically significant ($F = 234.528$, df = 261, $p < 0.05$).

During the wet season, millipedes and centipedes (18.91%) and *Ficus* spp. (18.91%) were the most frequent food items of Civets in the habitat. *Euclea divonorum* and *Diospiris abyssinica* were absent during this season. During the dry season, *Diospiris abyssinica* (29.8%) was the most frequent food item, and leaves and fibres were absent in the droppings of Civets during this season. In this habitat, seasonal variations between food items consumed by Civets were significant ($\chi 2 = 6.17$, df=1, $P<0.05$).

IV. Discussion

a) Spatial and Seasonal Habits of Feeding of the African Civet

Data on feeding of the African Civet confirms that they are generalist feeders. The division of the data into two phases was to facilitate a comparison of the seasons as the feeding habit of the African Civet is dependent on the availability of the seasonal food items (Ewer, 1973). The diets vary among seasons, based on the availability of the food items.

Wondimagegne (2006) reported that the feeding habit of Civets was affected due to the spatial orientation. There was high variation between forest and bushland habitats. Because some food items were localized in a certain habitat. *Euclea divonorum* and *D. abyssinica* were eaten only by Civets in the forest habitat, as the distribution of these plants was only in this habitat type. There was also a difference in the relative intake of diet categories. In bushland habitats, the availability of insects, millipedes and centipedes, fruits and other food resources was high. As a result, Civets in the bushland area consume relatively more invertebrates and mammals than those Civets in forest habitats. Invertebrates such as insects, millipedes, and centipedes also formed Civet food and protein source (Dagnachew and Balakrishinan, 2014). The proportion of invertebrates in the diet of Civets was lower in forest compared with bushland habitat, as this habitat was poor in the availability of invertebrates. Civets in this habitat fed more on fruits especially of *D. abyssinica* and *Ficus* spp. to meet the essential nutrient requirements. In this habitat, the availability of fruits was higher than other food items.

The effect of season in the feeding behaviour of Civets in the present study area was insignificant. The effect of season in the feeding behaviour of Civets was reported in both Menagesh-Suba State Forest (Bekele, 2007) and Jimma area (Wondimagegne, 2006). But, insignificant effect of the season in the feeding habit of Civets was observed during the present study in the Arba Minch forest. The area is covered with plants of different species (such as *B. aegyptiaca*, *T. indica,* and *Ficus* spp.) that give fruits throughout the year. Further, the area was supplemented with water from ground water streams during the dry season. Therefore, the vegetation composition of the area was almost similar throughout the year and this was reflected in the food habits with no significant difference in the feeding pattern of Civets in the present study area. However, few items in the diet of *C. civetta* such as *E. divonorum* and *D. abyssinica* were seasonal. These were eaten during the dry season, which were available in the habitat during that season.

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V. Conclusions

Based on the data of the present study, African Civets are considered as omnivorous generalists inhabiting different habitats. African Civet is dependent on the availability of the seasonal food items. They are regarded as omnivores because they consume variety of food items of both plants and animals. The diet vary among seasons, based on the availability of food items.

VI. Acknowledgments

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Table 1 : Relative frequency of food items in the droppings of the African Civet during wet and dry seasons.

Food items	Food items (%)			
	Wet season		Dry season	
	No. of observation	RF (%)	No. of observation	RF (%)
Ficus spp.	45	13.23	45	12.93
Euclea divonorum	0	0	31	8.91
Diospiris abyssinica	0	0	45	12.93
Tamarindus indica	34	10	21	6.03
Balanites aegyptiaca	37	10.88	25	7.18
Banana	26	7.64	27	7.75
Hair with bone	39	11.47	43	12.35
Bird claw	23	6.76	14	4.02
Insects	37	10.88	39	11.21
Millipede and centipede	51	15	28	8.04
Snail	27	7.94	11	3.16
Leaves and fibres	13	3.82	10	2.87
Plastic*	8	2.35	9	2.58
Total	340	100	348	100

RF = Relative Frequency.

** Probably eaten with human food waste deposited in plastic carry bags around by villagers and visitors.*

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Table 2 : Relative frequency of food items in the droppings of the African Civet during wet and dry season in the bushland habitat.

Food items	Food items (%)			
	Wet season		Dry season	
	No. of observation	RF (%)	No. of observation	RF (%)
Ficus spp.	24	10.48	25	12.69
Tamarindus indica	24	10.48	15	7.61
Balanites aegyptiaca	27	11.79	20	10.15
Banana	16	6.98	25	12.69
Hair with bone	26	11.35	28	14.21
Bird claw	18	7.86	11	5.58
Insects	30	13.1	26	13.2
Millipede and centipede	30	13.1	20	10.15
Snail	17	7.42	10	5.07
Leaves and fibres	12	5.24	10	5.07
Plastic*	5	2.18	7	3.55
Total	229	100	197	100

RF = Relative Frequency.

** Probably eaten with human food waste covered in plastic bags thrown around by villagers and visitors.*

Table 3 : Relative frequency of food items in the droppings of the African Civet during wet and dry season in the forest habitat.

Food items	Food items (%)			
	Wet season		Dry season	
	No. of observation	RF (%)	No. of observation	RF (%)
Ficus spp.	21	18.91	20	13.24
Euclea divonorum	0	0	31	20.52
Diospiris abyssinica	0	0	45	29.8
Tamarindus indica	10	9.0	6	3.93
Balanites aegyptiaca	10	9.0	5	3.31
Banana	10	9.0	2	1.32
Hair with bone	13	11.71	15	9.93
Bird claw	5	4.5	3	1.98
Insects	7	6.3	13	8.6
Millipede and centipede	21	18.91	8	5.29
Snail	10	9.0	1	0.66
Leaves and fibres	1	0.9	0	0
Plastic*	3	2.7	2	1.32
Total	111	100	151	100

RF = Relative Frequency.

** Probably eaten with human food waste covered in plastic bags thrown around by villagers and visitors.*

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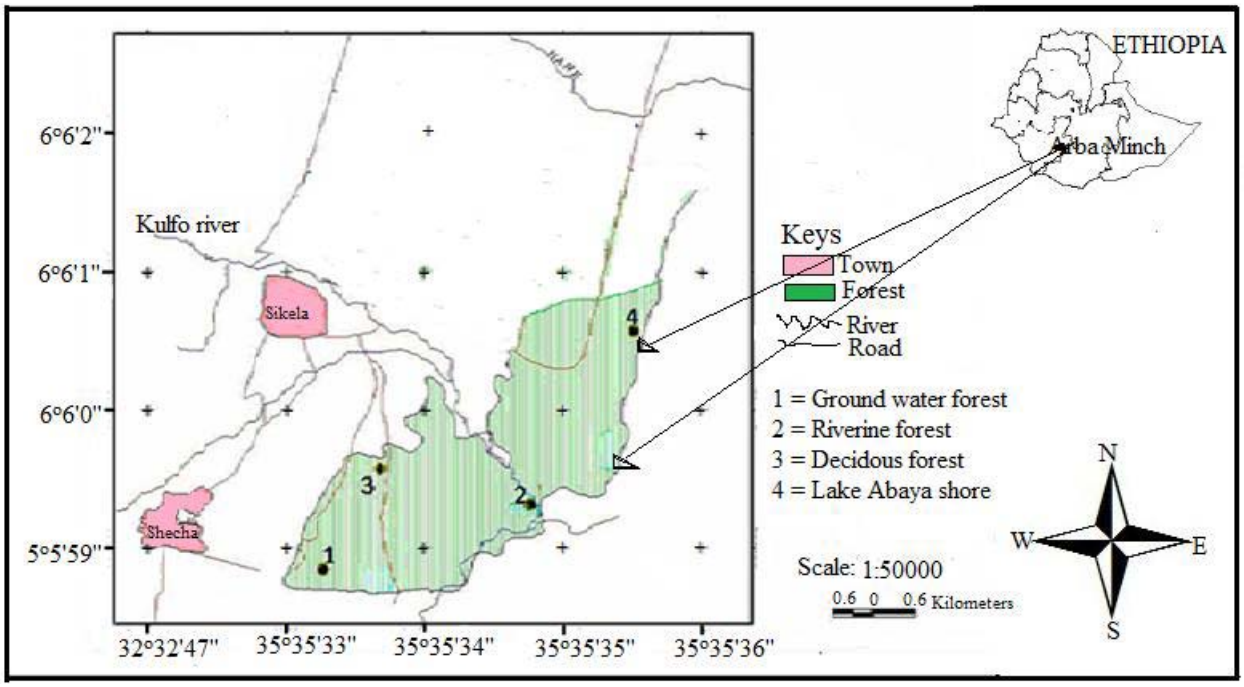


Figure 1 : Map of the study area.



Figure 2 : Civetry showing droppings of adult Civets.

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