Ecology and conservation of spotted hyena (Crocuta crocuta Erxleben 1777)in human dominated landscapes in Northern Ethiopia

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Diet Change of Hyena (*Crocuta crocuta*) during Christian Fasting Period in Northern Ethiopia

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3.1 Introduction

Across the globe, there are several ecosystems in which viable populations of large carnivores can only survive because they coexist in a landscape with people who introduce anthropogenic resources such as livestock, garbage, and pet food (Linnell et al., 2001; Conover, 2002; Woodroffe et al., 2005). Many large carnivores readily use anthropogenic food sources, and this often leads to conflict (Woodroffe & Ginsberg, 1998; Beckmann & Berger, 2003; Packer et al., 2005). Understanding details of the foraging behavior of carnivores in an anthropogenic environment can help reveal the specific causes of conflict, leading to better strategies for reducing the availability of anthropogenic food to prevent clashes (Breck et al., 2009). Urban ecosystems are typically characterized by reduced species diversity but increased abundance of a few species able to exploit anthropogenic food sources (Newsome et al., 2010).

Hyenas show evidence of many particular behaviors that set them apart from other mammals, making them a fascinating model organism for the study of animal behavior (Smith & Holekamp, 2010). They can adapt to habitats with dense human population (Woodroffe, 2001) eating almost any organic matter, even putrid carrion and anthrax-infected carcasses (Johnson, 2006). Hyenas have been known to eat almost any mammal, bird, fish or reptile but they also feed on garbage, cooked porridge and dung (Mills & Hofer, 1998). Although hyenas do scavenge opportunistically, they are efficient hunters, and kill 60–95% of the food they eat in natural habitats of the Maasai Mara ecosystem, Kenya (Smith & Holekamp, 2010). They are capable of eating and digesting all parts of their prey except hair and hooves (Smith & Holekamp, 2010). Bones are digested so completely that only the inorganic components are excreted in the hyena's droppings (Smith & Holekamp, 2010).

An analysis of 15 studies throughout its range in Africa showed that hyenas are both scavengers and active hunters and show a preference for prey in the range of 56-182 kg, but no clear preference for any particular species (Hayward, 2006). Hyenas hunt alone or in a group; an adult hyena is capable of bringing down a prey animal weighing up to four times its own body mass (Mills & Hofer, 1998). They depend primarily on wild prey in East Africa but have long been known to depend more on anthropogenic food sources in the Horn of Africa (Gade, 2006). We have previously demonstrated that hyenas in northern Ethiopia depend exclusively on anthropogenic food sources; mostly scavenged livestock remains (Abay et al., 2011).

In the calendar of the Ethiopian Orthodox Tewahedo Church there are various fasting periods in a year but the longest (55 days) is 'Abye Tsome' or 'Hudade' (Lent), before Easter. During this period, the majority of people in northern Ethiopia do not consume animal products, leading to a sharp decline in demand for meat. The aim of our study was to investigate possible changes in the diet of hyenas before, during and after this fasting period. We hypothesized that reduced availability of waste from slaughtering forces hyenas to supplement their diet with alternative food sources during this period.

3.2 Study area

The research was conducted in three study sites bordering the regional capital of Mekelle (200,000 inhabitants). The first is 12 km to the West and is called Debri, with a total human and livestock population of approximately 7,000 and 12,000, respectively. The second, Aynalem, is five km to the South, with a total human and livestock population of approximately 6,000 and 12,000, respectively. The third site is Arid, the main campus of Mekelle University and an adjacent army camp, three km East of the town with a resident population of approximately 20,000 people. All sites are severely degraded highland of 2200-2300 m a.s.l.

In all areas, the majority of the population is Orthodox Christian. Despite the rampant poverty and scarce resources, people scrupulously follow religious restrictions on the animal parts that may be eaten. The remains of slaughtered animals and all abandoned animals are left at the nearest convenient site, usually simply just outside the peoples' compounds.

3.3 Methods

In March-May 2010, permanent plots were established in each study site by describing natural landscape elements as virtual borders around areas of approximately one ha containing hyena scats as identified using the method of Stuart and Stuart (2000). The plots were demarcated with sticks in each corner. Firstly, all droppings in the plots were collected on the first day of fasting, representing hyena diet before fasting. Secondly, all droppings were collected from the same plots on the last day of the fasting; these droppings had accumulated during the fasting period. Finally we collected all droppings 55 days later, representing the diet after fasting. Scat samples

were put in plastic bags while avoiding cross sample contamination. Following the method of Ramakrishean et al. (1999), hair was extracted from scat and compared with hair in our reference collection to establish prey species composition. Our reference collection contains hair of all domestic and wild species in the study area and includes human hair. We tested for differences in species composition between collection periods with a non-parametric Wilcoxon test using JMP-5 Software. We conducted a randomization nonparametric vander Waerden test to examine whether the differences between the time periods are significant by taking the total number of samples for each species, and randomly assigning each sample to each period.

3.4 Results

A total of 553 hyena scats were analyzed; the number of scat samples collected after the fasting period was low because the Arid and Aynalem plots had been plowed by farmers (Data deposited in the Dryad Repository: doi:10.5061/dryad.pq050620). There was a statistically significant difference in hair composition between scat collected before and during fasting ($P < 0.05$) and between scat collected during and after fasting ($P < 0.005$). There was no significant difference between scat collected before and after the fasting. These results were further corroborated by the randomization tests using nonparametric vander Waerden test, with observed differences falling outside the distribution of randomized samples ($P < 0.01$, $\chi^2 = 21$, $df = 8$).

3.5 Discussion

Our study shows a remarkable change in diet of hyena during the fasting period, from predominantly scavenging on waste to active predation on donkeys. In northern Ethiopia, the natural prey base has been greatly depleted and hyenas are highly dependent on human-related resources (Gade, 2006; Abay et al., 2011). The rural and urban populations of the district are predominantly Orthodox Tewahedo Christians and their vegan diet during fasting leads to a sharp reduction in available animal waste. This is apparently compensated for by increased donkey depredation.

We previously reported that hyenas obtain most of their food from scavenging on urban and rural waste; depredation accounted for less than 20%

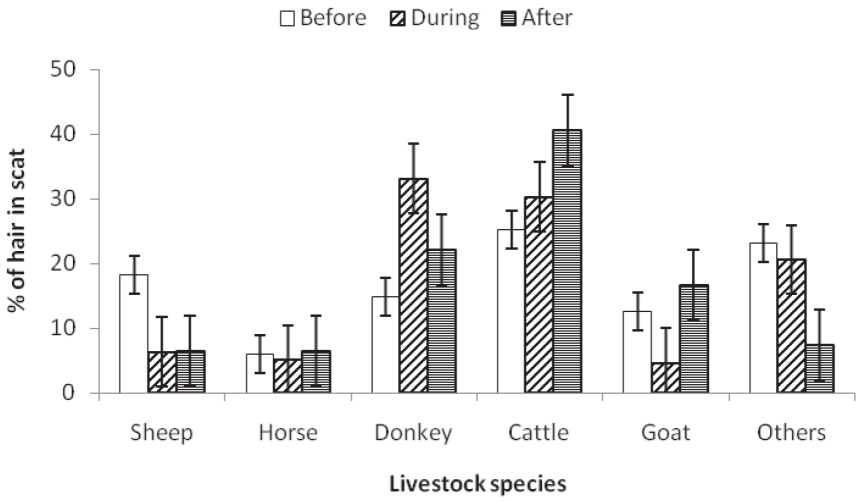

Figure 3.1
Percentage of hair in scat before, during and after the fasting period in 2010, error bars on the columns indicate variations

of food intake in Debri and Aynalem (Abay et al., 2011). We infer that hyenas scavenge less and hunt more during fasting, selecting opportunistically for donkeys. Donkeys are in the preferred prey body mass range suggested by Hayward (2006), and in northern Ethiopia they are extremely abundant (Ghebreab et al., 1999). In contrast to other livestock species, donkeys are kept outside the compound at night, and weak donkeys are abandoned altogether, which makes them a relatively easy food source.

Despite the overall statistically significant diet change, cattle hair remained prevalent in hyena scat from Arid, also during fasting. This may have two reasons. First, the 35th anniversary of Tigray People's Liberation Front (TPLF) was celebrated by the soldiers during the fasting period, which included some slaughtering. Secondly, the College of Veterinary Science continued its activities and continued discarding some carcasses. In Arid and Mekelle, hyenas clean up the organic waste; they are the most efficient means of maintaining sanitation of the campus.

Despite incidences of depredation, hyenas are tolerated as efficient means of sanitation. People are aware of the presence of hyenas; they can easily be observed and heard almost every night. Hyenas almost never attack people; people are afraid of them but accept their presence. Hyenas clear up butchers' and household waste from the city, and are traditionally known as 'mu-

nicipal workers'. This is in fact opposite to the findings of Croes et al. (2011) who found that hyenas avoid villages in Cameron, because of persecution. This indicates that hyenas are highly adaptable to human behavior.

Our study contributes further evidence that wildlife species can modify their behavior to successfully survive in their environment. This may have implications for urban carnivore management, which may differ considerably from rural habitats. Certain animal species have adapted well to human-dominated habitats and benefit directly or indirectly from human activities including food (Shochat et al., 2004; Faeth et al., 2005; Adams et al., 2006). Diet supplementation with anthropogenic food augmented predator's densities and altered their diets in the Santa Monica Mountains, California, USA (Fedriani et al., 2001). Refuse and livestock carcasses at pastoral villages may influence the frequency of hyena visits to these areas (Mills & Hofer, 1998; Kolowski & Holekamp, 2007). Seasonal variation in the use of refuse sites has been documented in a number of carnivores and is often associated with variation in prey availability (Craighead & Craighead, 1971; Salvador & Abad, 1987). Kolowski and Holekamp (2007) reported that hyenas were more likely to be found near open refuse pit during times of relative prey scarcity, indicating the potential impact of human refuse at pastoral villages on livestock losses to hyenas. They also found that livestock depredation was higher where hyenas were more abundant due to their attraction to waste. In our case the scarcity of food is not due to natural prey fluctuations, but to religiously inspired changes in human behavior; the result is the same, however. In addition to the abundant literature on improved livestock management to mitigate depredation (Ogada et al., 2003; Bauer et al., 2010) these observations suggest mitigation by improved waste management.

In the context of prey-depleted northern Ethiopia, waste management would immediately impact hyena abundance, with possible impacts on their viability and subsequently on the ecology of the region. In our study, carrying capacity and hyena survival are dependent on anthropogenic food. Bauer (2003) included livestock in his assessment of an area's carrying capacity, as livestock constituted a large share of lion (*Panthera leo*) diet and therefore had a substantial impact on lion population viability. However, tolerance for lion depredation is very low in Nechisar National Park, southern Ethiopia; reportedly any lion that ventures anywhere near herds of livestock are preemptively shot (Yirga et al., subm.). Advanced substitution of ungulates by cattle there has meant a reduction in carrying capacity, leading to very low lion population viability. These cases confirm that changes in

the availability of anthropogenic food may affect carnivore population density (Borkowski et al., 2011).

In conclusion, our study showed that hyenas mainly scavenge for butchers' and households waste, but during fasting periods, donkeys provided an alternative food source. We conclude that hyenas are highly adaptable and opportunistic scavengers and hunters. Frequencies with which the various prey species occur among collections of scats are easily compiled to describe the diet, and can be used to compare diets between periods.

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