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# Competition between domestic dogs and Ethiopian wolf (*Canis simensis*) in the Bale Mountains National Park, Ethiopia

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## Abstract

The potential effects of the domestic dogs (*Canis familiaris*) on the Endangered Ethiopian wolf (*Canis simensis*) through exploitative and interference competition were studied in the Web Valley of Bale Mountains national park between November 2001 and February 2003. All dogs were owned in the study area and no feral dogs were reported or observed during the research period. The diet of domestic dogs was dominated by barley husks and human faeces which contributed 45% and 20.7% of the total 382 meals observed during focal watch observations. Analysis of dog faeces provided similar results with barley husks, human faeces and animal carcasses occurring in 86.8%, 21.4% and 19.4% of the 1200 faecal samples analysed. Both focal watch and faecal analyses revealed that rodents contributed only a very small proportion of the diet of dogs accounting for only 4.2% of the focal watch and 2.8% of the faecal analysis of roaming dogs. As Ethiopian wolves fed almost exclusively on rodent year round, no significant exploitative competition between dogs and wolves were assessed. Only small proportion of the domestic dogs roamed in the Ethiopian wolf range and interference competition did not appear to be a serious threat for the Ethiopian wolf.

*Key words:* Bale Mountains, Competition, diet, dogs, Ethiopian wolf

## Résumé

De novembre 2001 à février 2003, on a étudié les effets potentiels des chiens domestiques (*Canis familiaris)* sur le loup d'Ethiopie (*Canis simensis*) qui est en danger, en raison d'une compétition par exploitation alimentaire ou par interférences, dans la Vallée de Web, dans le Parc National des montagnes de Bale. Tous les chiens de l'étude avaient un propriétaire, et nous n'avons ni rapporté ni observé de chien féral pendant cette période. Le régime alimentaire des chiens comprenait principalement de la balle d'orge et des excréments humains qui composaient respectivement 45% et 20,7% du total des 382 repas observés pendant des observations focalisées. L'analyse des excréments de chiens donne des résultats semblables : la balle d'orge, les excréments humains et les carcasses d'animaux sont présents dans 86,8%, 21,4% et 19,4% des 1 200 échantillons fécaux analysés. Et les observations focalisées et les analyses des crottes ont révélé que les rongeurs ne composent qu'une toute petite proportion du régime des chiens, avec 4,2% des observations et 2,8% des analyses fécales des chiens errant en liberté. Comme les loups d'Ethiopie se nourrissent toute l'année presque exclusivement de rongeurs, nous avons estimé qu'il n'y avait aucune compétition par exploitation significative entre les chiens et les loups. Seule une petite proportion de chiens circulent dans l'aire de distribution du loup d'Ethiopie, et la compétition par interférence a semblé ne pas constituer une menace sérieuse pour le loup d'Ethiopie.

## Introduction

The expansion of human population to remote landscapes has generated pronounced peaks in the extinction of native fauna due to competition with introduced exotic species (Rosenzweig, 2000). Dogs are among the ten mammalian species with the highest number of reported introductions (Lever, 1994); and, at present, all continents and most islands in the world have been colonized by dogs (Wandeler *et al.*, 1993). There are a number of examples of introduced species out-competing indigenous species and

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driving them to extinction or local extirpation. The dingo (*Canis familiaris dingo*), introduced to the Australian mainland continent 3500–11,000 years ago, may have displaced by exploitative competition both the thylacine (*Thylacinus cynocephalus*) and the Tasmanian devil (*Sarcophilus harrisi*) (Lever, 1994). The decline in wolves (*Canis lupis*) in Italy is thought to be partially due to competition with stray dogs (Boitani, 1992). Villagers often allow these dogs to go feral, forcing them to compete with the endemic carnivores for prey (Butler & Dutoit, 2002). Competition can also lead to active avoidance that results in shifts in habitat use from rich resources or decline of the subordinate species (Menge, 1995). For example, cheetah in the Serengeti avoid areas with high prey density which attract large predators such as lions (Durant, 1998) and cheetah populations across Africa are negatively influenced by the density of lions (Laurenson, 1995).

On islands or in isolated landscapes like that of relict mountain tops, the restricted resource base and small population sizes often lead to specialized species that are vulnerable to extinction through interspecific competition (Rosenzweig, 2000). With a global population estimated approximately 600 individuals, Ethiopian wolf is the rarest canid in the world living in the relict isolated patches of moorland and grassland in the Ethiopian mountains (Sillero-Zubiri & Macdonald, 1997; Marino, 2003). However, human and, by extension, dog populations have rapidly increased over the past few decades in all the Ethiopian wolf range, as they seek agricultural land or pasture for their domestic livestock. The previous work has shown that the domestic dog has a profound effect on the Ethiopian wolf through disease transmission and hybridization (Gottelli & Sillero-Zubiri, 1992; Laurenson *et al.*, 1998; Haydon *et al.*, 2006) and suggested that dogs may also compete with wolves for resources. This study examines the potential threat of the domestic dog on the endemic and endangered Ethiopian wolf (*Canis simensis*) though interspecific competition.

## Material and methods

The study was carried out in the Web Valley of the Bale Mountains National Park (BMNP), Ethiopia from November 2001 to October 2002. The area was about 70 km$^2$ and harbours the highest density of the Endangered Ethiopian wolf (Sillero-Zubiri, 1994). There were ten settlements in the area, and the houses of each settlement were in close proximity, without fences and were generally aligned along cliffs

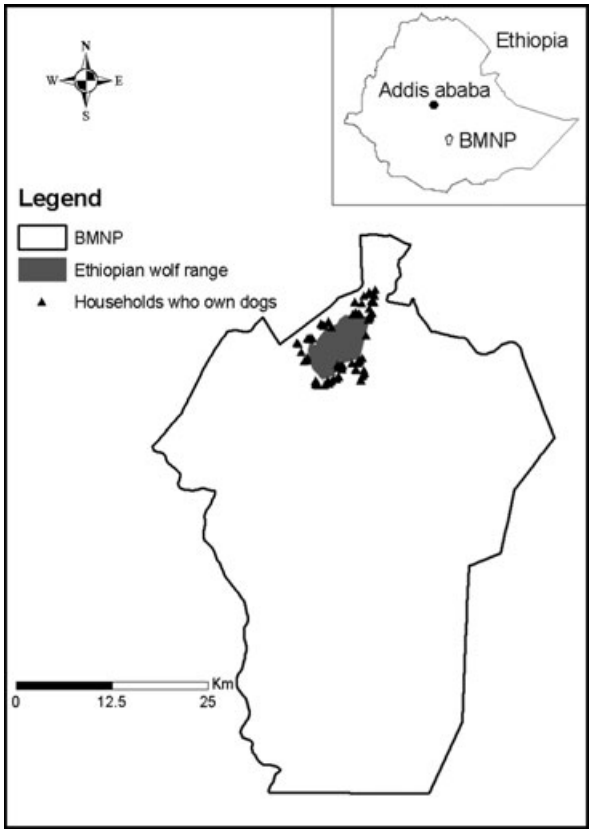


**Fig 1** Human settlements and the Ethiopian wolf range in the Web Valley of the Bale Mountain National Park.

that bounded the valley (Fig. 1). The climate of the area is characterized by 4 month dry season, from November to February and an 8 month wet season, from March to October, with high rainfall and lower day temperatures than in the dry season (Hillman, 1986). The study period incorporated the dry season (from November, 2001 to February, 2002), beginning of wet season (March and April, 2002) and wet season (from May to October 2002).

### *Methods*

A questionnaire survey of households was conducted to provide baseline data on density of domestic dog population to all households in the study area. Information about the presence of feral domestic dogs was also assessed by questionnaire survey to twelve adults in each settlement. According to the WHO (1984) classification, feral dogs are those who do not intentionally receive their essential needs from people.

Line transects were carried out in the study area to identify roaming dogs which were used as focal animals at the beginning of the study. A roaming dog is defined as a dog that roams outside the human settlement in the Ethiopian wolf range and surrounding mountains. When sighted, roaming dogs were identified individually by natural markings and later used as focal animals. Households that own roaming dogs were also identified to start the focal watch on the identified animals early in the morning during the study period. Roaming dogs were those individuals that would be expected to be hunting on rodents and/or interfering with Ethiopian wolves roaming outside of the settlements. Sixteen line transects, totalling 135 km, were walked or ridden perpendicular to the long axis of the study area commencing on random points of one side of the study area. Each transect was carried out twice in a single day, morning and afternoon.

Focal watches were carried out from 06:00 to 18:00 h each day and focal animals were observed for a total of 2064 h of observation for a total of 182 days incorporating dry (58 days), early wet (52 days) and wet seasons (72 days). During the dry and early wet seasons, twenty animals were followed as focal animals. These were all the dogs that roamed in the study area. Twelve of these were selected during the transects and eight others were identified opportunistically in the field. During the wet season, all except two focal animals stopped roaming. These two individuals and a further ten animals that had previously roamed but had now stopped were followed as focal animals. The watches focussed primarily on foraging behaviour, including food acquisition and interference competition with Ethiopian wolf.

During the focal watch, the position of the focal animal was recorded using a GPS every 15 min. Home ranges of individual dogs were estimated with the Animal Movement add-in (Hooge, Eichenlaub & Solomon, 1999) for ArcView GIS 3.2a, using the Minimum Convex Polygon (MCP) and Kernel Density Estimator Methods (Powell, 2000).

Faeces were collected from all domestic dogs, whenever they were observed defecating, to avoid the potential bias of collecting scats from other carnivores. The scats were air-dried and then were broken carefully by hand. The scat contents were then analysed using a hand-held lens and binocular microscope against a reference collection of potential food sources of dogs from field work and Ethiopian Wolf Conservation Program animal specimen collection. Hair was used in identifying the animal remains when found in the scat (Brunner & Comman, 1974). Hair and teeth were used to identify rodents when rodent remains were found in the scats. Since any one sample could contain multiple prey items, the frequency of a particular prey item that occurred in all samples was calculated (Civcci *et al.*, 1996). One of the principal staple foods for the local people was roasted barley (*kollo*). During the focal watches, no dogs were observed feeding directly on *kollo*. Thus, when found in the dog scats, *kollo* was assumed to indicate the consumption of human faeces. This assumption was further tested by collecting and analysing 39 human faeces, thirteen in each season (dry, early wet and wet season) for the presence of kollo in the majority of human faeces and could be source of kollo in the scat of dogs. The analysis of thirteen human faeces collected during the dry season showed that 91% of it had remains of barley seeds (*kollo*). During the early wet and wet season, *kollo* was found in 84% (of a total of thirteen samples) of the faeces in each season.

## Results

### *Spatial and temporal variation of dogs*

Dog densities in the study area varied with season. During the wet season, the density of dogs reached as high as 10 dogs $km^{-2}$ and it declined to four dogs $km^{-2}$ during the dry season. The seasonal variation in dog density was primarily due to the seasonal movement of pastoralists and their livestock in the study area.

All the dogs were owned and there were no reports ($n$ = 120 questionnaires) or observations of feral dogs in the study area by the principal investigator. However, no dog was observed to be tied up by its owner and no other mechanism was observed to restrict the movement of dogs by the local people. Despite this, only a small proportion of dogs (3% of a total of 697 individual dogs in the study area) were found to roam out of settlements. Most dogs roam on the cliffs hunting rock hyraxes (*Procavia capensis*), which is an area in which Ethiopian wolves were not observed during this study. Only very few of the dogs (0.4% of a total of 697 dogs) were found to roam in the wolf range to hunt rodents.

A total of 3884 fixes were obtained from the focal animals that roam out of the settlements for home range analysis. The average home ranges of roaming dogs recorded in this study was 4.37 $km^2$ in the dry and 4.32 $km^2$ in the wet season by using minimum convex polygon method. The maximum home range recorded for

an individual focal animal in any given season was 20.6 $km^2$ (thus, 29.4% of the study area but using the minimum convex polygon method of home range estimation, which tends to overestimate the home ranges because it includes outliers). The 95% probability kernel estimator for the same dog during the same season was 2.44 $km^2$. There was also seasonal variation in home range of the focal animals. During the dry season, home ranges were significantly larger than during the wet season (Wilcoxon-test, $P = 0.875$; $mean_{dry}$= 5.9 $km^2$, standard $error_{dry}$= 1.1, $n_{dry}$= 14 focal animals with a mean of 44.5 location fixes per animal; $mean_{wet}$= 0.3 $km^2$, standard $error_{wet}$= 0.2, $n_{wet}$= 12 focal animals with a mean of 272 location fixes per animal; analyses using 95% probability kernel estimators).

*Foraging behaviour and diet*

A total of 382 meals (141 during the dry season, 86 early wet season and 155 wet season) were observed during the study period from focal animals. The meals include barley husks, human faeces, different wildlife species, cheese/milk, nectar of *kniphofia* spp., carcass, potato peelings and porridge made of barley (Table 1). Barley husks which were discarded in the process of food preparation by local people and human faeces formed the largest proportions of the diet of the domestic dogs in all seasons. The wildlife species that were successfully hunted during the dry season by dogs ($n = 20$) included rock hyraxes ($n = 12$), rodents ($n = 7$; five rat sized rodents, two molerats (*Tachyoryctes* spp.) and a Starck's hare (*Lepus starcki*) ($n = 1$). During the early wet season, the wildlife that was observed to be successfully hunted by the dogs ($n = 9$) included rock hyraxes ($n = 6$), rat-sized rodents ($n = 2$) and an unidentified molerat (*Tachyoryctes* spp., $n = 1$). Wildlife that was observed during the wet season were six rat sized rodents and one rock hyrax. Over all, hunted animals accounted only for 9.42% of all meals recorded from focal animals ($n = 382$). The hunted animals include rock hyrax, rodent and starck's hare contributed 4.97%, 4.19% and 0.26%, respectively.

**Table 1** The percentage frequency of different food items observed while ingested by focal animals over the course of the study period

| Food item | Dry | Early wet | Wet | Over all |
|---|---|---|---|---|
| Barley husks | 46.81 | 44.19 | 43.87 | 45.03 |
| Human faeces | 28.37 | 23.26 | 12.26 | 20.68 |
| Hunted animals | 14.18 | 10.47 | 4.52 | 9.42 |
| Cheese/milk | 6.38 | 15.12 | 5.81 | 8.12 |
| Nectar of *Kniphofia* spp. | – | – | 16.12 | 6.54 |
| Carcass | 4.26 | 6.98 | 5.16 | 5.25 |
| Potato peelings | – | – | 9.68 | 3.93 |
| Porridge made of barley | – | – | 2.58 | 1.05 |

*Scat analysis*

A total of 1200 scats were collected to analyse the diets of the dogs. In all seasons, 400 scats were collected form 210 individuals during the dry season, 170 individuals during the early wet season and 124 individuals during wet season including from the focal animals.

Barley husk, human faeces and carcass (identified domestic animal remains) were the most frequently occurred food items found in the scats of all seasons (Table 2). During the dry season, barley husks were significantly more frequent than human faeces ($\chi^2 = 156.99$, d.f. = 1, $P < 0.001$) and carcass remains ($\chi^2 = 165.08$, d.f. = 1, $P < 0.001$), but there was no significant difference between the frequency of carcass remains and human faeces ($\chi^2 = 0.31$, d.f. = 1, $P = 0.579$). Of the nineteen rodents identified, five were *Arvicanthis blicki*, seven were *Otomys typus*, three were *Tachyoryctes splendens* and two were *Tachyoryctes macrocephalus*. The other two were rat-sized rodents but could not be identified.

**Table 2** Percentage frequency of occurrence of food items identified from 400 scats of dogs collected in each of the dry, early wet, wet season

| Food item | Dry | Early wet | Wet | Overall |
|---|---|---|---|---|
| Barley husks | 85.25 | 92.5 | 82.75 | 86.83 |
| Human faeces | 20.5 | 20.75 | 22.75 | 21.33 |
| Bone/skin | 12 | 11.5 | 18.75 | 14.08 |
| Goat | 5.75 | 4.75 | 4.75 | 5.08 |
| Horse | 5.7 | 8 | 3.75 | 5.81 |
| Sheep | 5.5 | 10 | 5 | 6.83 |
| Rodents | 4.75 | 1.75 | 1.75 | 2.75 |
| Potato peel | 3.25 | – | 12.5 | 5.25 |
| Rock hyrax | 2.5 | 1.75 | 1 | 1.75 |
| Grass | 1.75 | 1.25 | 6.25 | 3.08 |
| Cattle | 1.5 | 0.25 | 2.25 | 1.33 |
| Wheat husks | 0.75 | – | 1 | 0.58 |
| Undefined feather | 0.25 | 0.25 | 0.25 | 0.25 |
| Porcupine | 0.25 | – | – | 0.08 |
| Hare | – | – | 0.5 | 0.17 |

During the early wet season, barley husks again occurred significantly more frequently than carcasses ($\chi^2 = 165.72$, d.f. = 1, $P < 0.001$) and the third frequently occurring item, human faeces ($\chi^2 = 181.83$ d.f. = 1, $P < 0.001$). There was no significant difference between the occurrence of human faeces and carcasses ($\chi^2 = 0.568$ d.f. = 1, $P < 0.451$). From the seven rodents identified, three were *Arvicantis blicki*, one was *Otomys typus*, one was Tachyoryctes spp, and the other two were not identified.

In a very similar pattern, barley husks were the most frequently occurring food item in the scats analysed from the wet season. Barley husks occurred significantly more frequently than human faeces ($\chi^2 = 136.49$, d.f. = 1, $P < 0.001$) and also than the third most frequently recorded food item, carcasses ($\chi^2 = 180.48$, d.f. = 1, $P < 0.001$). There was a significant difference between the occurrence of carcasses and human faeces ($\chi^2 = 4.7$, d.f. = 1, $P = 0.03$). From the seven rodents identified, four were *Arvicantis blicki* and one was *Otomys typus*. The remaining two could not be identified to species level as only hair remains were found.

There was no significance difference between frequencies of barley husks ($\chi^2 = 2.36$, d.f. = 2, $P = 0.278$), human faeces ($\chi^2 = 1.18$, d.f. = 2, $P = 0.307$) and carcass ($\chi^2 = 5.47$, d.f. = 2, $P = 0.065$) between dry, early wet and wet seasons. Out of a total of 1200 faecal analysis, hunted animals altogether contributed only 4.67% of all the scats collected. All remains of rodents were found from scats of roaming dogs and no scat from dogs that did not room outside of the settlement contained remains of rodents.

### *The rate and nature of dog–wolf interaction*

Over the course of the study, a total of 36 dog–wolf interactions were observed. In the interactions, if there was more than one dog, the dogs chased the wolf ($n = 21$). If there were more wolves than dogs, the wolves dominated the interaction and they chase the dogs away ($n = 9$). When dogs that were not defined as roaming dogs entered the wolf range occasionally following their owners and met a wolf, they avoided contact and moved apart ($n = 3$). Roaming dogs which were observed hunting rodents in the Ethiopian wolf range during the study period were observed greeting and mingling with the Ethiopian wolves ($n = 3$). As most settlements were established near to the Ethiopian wolf habitat, 92% (21 interactions) of the time when wolves were chased by dogs happened when a wolf approached the settlements.

## Discussion

In this study, there appeared to be very little potential for exploitative competition between dogs and Ethiopian wolves in the Web Valley. As indicated by Boitani *et al.* (1995), Lantis (1980) and Macdonald & Carr (1995), the basis of many dog populations diet is waste human food due to their close association with people. According to the study of Butler (1998), in the communal lands of Zimbabwe, *sadza* (porridge made from maize) was the most important food item used by the people and by their dogs. Similarly, in the present study, the most important food for the dogs was barley husks discarded by the people when preparing their staple food.

In many parts of the world dogs have been recorded to feed upon human faeces (Lantis, 1980; Butler, 1998). In the present study, human faeces comprised the second most important food item for the dogs, even though it is likely that their occurrence in the scat analysis was underestimated because not all human faeces contained roasted barley (*kollo*) that was used as the indicator of their consumption. Dogs fed upon carcasses opportunistically – particularly when animals were killed by hyenas. In the study of Butler & Dutoit (2002) and Scott & Causey (1973), dogs were known to be one of the most successful scavengers of carcasses.

It is apparent that domestic dogs in the study area feed predominately on human refuse – the waste products of human food preparation, human faecal matter and any carcasses near the villages. Hunted wildlife contributed only a small proportion of the diets of dogs. This result is in contrast to the suggestion by Sillero-Zubiri (1994) that dogs compete with the highly endangered Ethiopian wolf for rodents. While Ethiopian wolves feed almost exclusively on rodents (Sillero-Zubiri and Gottelli, 1995), only very few dogs hunted rodents and, of those that did, the rodents formed an insignificant proportion of their diet. This means that it is highly unlikely that exploitative competition would be an important interaction between domestic dogs and the Ethiopian wolves.

In contrast to Gottelli and Sillero-Zubiri (1992) findings, that feral dogs are living off offal and carrion, no feral dogs were observed during this study nor were their presence reported by the local people. However, the home ranges of roaming dogs recorded in this study (mean minimum convex polygon = 4.37 $km^2$ which is equivalent to 437 ha in the dry, and 4.32 $km^2$ which is equivalent to 431.5 ha in the wet season) were large when compared to other reported home ranges of owned, urban domestic dogs (e.g. 26 ha for urban dogs in Baltimore, Maryland, Beck

(1975); 52 ha in St Louis, Missouri (Fox, Beck & Blackman, 1975); 4 ha in New York (Rubin & Beck, 1982); 0.7 ha in New York, New Jersey, (Daniels, 1980) and 97.2 ha in rural Zimbabwe (Butler, 1998). While dogs which are primarily dependent on human waste or fed by human may remain in the immediate vicinity of human settlement, roaming dogs that feed on wild game may forage over larger area that makes their home range larger. The home range of the present roaming dogs approximated to those of feral dogs in Alabama; USA, reported to be between 444 and 1050 ha by Scott & Causey (1973). The home range of domestic dogs during the dry season was much larger than the wet season. The scarcity in the abundance of rock hyrax during the wet season may be the reason for the roaming dogs to stay around house instead of roaming out in the mountain tops.

Interference competition between wolves and dogs was found to be potentially important threat for the Ethiopian wolf in the future that needs further detailed study. In contrast to reports by Sillero-Zubiri (1994), where dogs dominated all dog–wolf interactions, wolves were also observed dominating interactions, particularly when they had the numerical advantage. Other dogs were observed to be 'accepted' by the wolves and were observed greeting and walking together with the Ethiopian wolves. As the number of people in the study area is growing and with it the domestic dog population, interference competition may become increasingly important in the future. In most cases, chasing of Ethiopian wolves by domestic dogs was observed when an Ethiopian wolf roamed around the settlements. This clearly shows that, if the settlements expand more towards the Ethiopian wolf range, domestic dogs are likely to displace the Ethiopian wolf from their habitat.

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