

Food habits and livestock depredation of two Iberian wolf packs (*Canis lupus signatus*) in the north of Portugal

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Abstract

Two Iberian wolf *Canis lupus signatus* packs were studied in the north of Portugal during spring and summer 1996. The study areas are located in two mountainous areas close to the Spanish border. Both regions presented a very low density of wild ungulates and intensive livestock production. The food habits and the livestock depredation of the wolves were considered. The study material included 87 dropping samples, interviews with shepherds, carcass investigation and government reports of livestock depredation. Prey preference was measured in both areas. Wolves fed exclusively on livestock, especially goats. Wolf attacks on goats affected mostly large flocks of > 100 heads, but where there were horses, wolves preyed preferentially on horses. In both study areas, sheep was recorded as a regular prey by the government reports but never appeared in the scat analysis results. This apparent contradiction will be discussed. The wolf's dependence on livestock can be explained by the scarcity of wild prey and the high density of livestock. Conservation of wolves in such impoverished areas depends on an efficient livestock depredation management plan and the reintroduction of native prey species.

Key words: wolf, food habits, livestock depredation, Portugal, *Canis lupus signatus*

INTRODUCTION

The main problem facing conservation of the Iberian wolf is the high level of livestock depredation by wolves throughout the Iberian peninsula. Research in Spain and Portugal shows a high percentage of domestic ungulates in the diet of the Iberian wolf (Castroviejo *et al.*, 1975; Guitián *et al.*, 1979; Braña, Del Campo & Palomero, 1982; Magalhães & Fonseca, 1982; Magalhães, 1984; Reig, Cuesta & Palacios, 1985; Salvador & Abad, 1987; Tellería & Sáez-Royuela, 1989; Fonseca, 1990; Grande del Brio, 1990; Cuesta *et al.*, 1991; Álvares, 1995). Livestock depredation seems to decrease in areas with higher densities of wild prey (Tellería & Sáez Royuela, 1989; Cozza *et al.*, 1996; Meriggi & Lovari, 1996; Meriggi *et al.*, 1996) but not systematically; with the wolf generally selecting the most easy prey available (Potvin, Jolicoeur & Huot, 1988; Brangi, Rosa & Meriggi, 1992; Matteucci, 1992; Patalano & Lovari, 1993; Mattioli *et al.*, 1995; Lonchampt, 1996; Meriggi *et al.*, 1996). Prey selection has been shown to be related to the hunting history of the pack and to prey availability and size (Pimlott, 1967; Voigt, Kolenosky & Pimlott, 1976; Fritts & Mech, 1981; Huggard, 1993). Where sheep and wolves are present in

the same area, livestock depredation invariably occurs regardless of the presence or absence of wild prey (Kaczensky, 1996).

Previous research on the food habits of the wolf and livestock depredation in Portugal and Spain examined broad patterns in many wolf packs and over large study areas. Focusing on the impact of two wolf packs on livestock would provide a finer scale of analysis. The two study areas considered in this paper have faced impoverished ecological conditions with a low density of wild ungulates. This research describes the survival strategy of wolves in such poor habitats and the conflicts that may occur with the shepherds. To examine wolf foraging ecology, the food habits of the two packs are revealed by scat-analysis. The impact on domestic livestock according to government reports of wolf damage and interviews with local shepherds is compared to the results of the scat-analysis. Prey selection in relation to the availability and hunting risks of domestic ungulates is discussed.

STUDY AREAS

Two study areas of the northern part of Portugal are considered. In both study areas wolves have been

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present since historical times (Fonseca, 1990; Álvares, 1995). The climate of both study areas is Mediterranean with an oceanic component; mean annual precipitation is 2000 mm.

Study area A (c. 130 km²) is located in the north-east of Portugal, south of Porto in the middle of the Arada mountain range (40°55'N, 08°05'W). Elevation ranges from 250 to 1070 m. Livestock production of goats *Capra hircus*, sheep *Ovis aries* and cattle *Bos taurus* is one of the main economical resources in the area. The shepherds frequently use prescribed burning to prevent forest succession and to keep pastures open for their goats. The vegetation is a mosaic of low scattered shrubs and high dense bushes (*Cytisus multiflorus*, *Erica arborea*, *E. australis*, *Genista tridentata*); trees (*Quercus suber*, *Q. robur*) remain in the bottom of the valley. Wild boar *Sus scrofa* are present sporadically and only at low altitudes; no other wild ungulate has been recorded yet in this area (Pereira, 1988). Hunting is regular in the whole area.

Study area B (c. 240 km²) is located in Peneda-Gerês National Park near the Spanish border in the north of Portugal (41°57'N, 08°15'W). The area is encompassed by the Cavado and Homem rivers, it is situated in the Gerês mountain range with elevations from 140 to 1483 m. Livestock production is also important: sheep, goats, cattle and 'Garrano' horses *Equus caballus* graze all year in this mountainous area with little guarding. The vegetation, more diversified than in study area A because of Park management and fire control, consists of low shrubs (*C. multiflorus*, *E. arborea*, *E. australis*, *E. tetralix*, *Genista* sp., *Ulex minor*), inland trees (*Betula alnus*, *Ilex aquifolium*, *Pinus sylvestris*, *Quercus pyrenaica*, *Q. robur*) and plantations of exotic trees (*Acacia dealbata*, *Pinus pinaster*). Wild boar are present in the valley bottoms. Roe deer *Capreolus capreolus* are also present in all the National Park area in low numbers (Pereira, 1988; Vignon, 1995). No hunting is allowed inside the National Park but poaching is regular (F. J. Álvares & F. P. Fonseca, pers. comm.).

METHODS

Wolf scats collected along forest roads and foot paths (Peters & Mech, 1975). Collecting routes were checked every 2 or 3 days from April to October 1996. A total of 617 km in study area A and 517 km in study area B was covered on foot and bicycle. Discriminating between wolf and dog was made by the scat smell and shape and the presence of wolf tracks (F. P. Fonseca, pers. comm.). If doubt persisted about identification, the scats were not included in analyses. The scats were first preserved in plastic bags and then stored in a freezer (−30 °C) for later analysis. The micro- and macro-components were separated by thorough washing in a sieve (0.5 mm mesh). The macro-components were hand-sorted by food item (hairs, bones, seeds, etc.) (Debrot *et al.*, 1982). The methods of Debrot *et al.* (1982) and Keller (1984, 1992) were used to determine

the species of hair. Hairs collected from live specimens during this study and the Keller sample collection (1984, 1992) were used as reference collection.

The frequency of occurrence of each prey expressed as the percentage of scats containing the item considered and the relative volume of each food item in the scat was measured (Ciucci *et al.*, 1996; Poulle, Carles & Lequette, 1997). To determine the preference for 1 prey category, the Chesson index was used (Chesson, 1978):

$$\mu = r n^{-1} \left(\sum_{j=1}^m r_j n_j^{-1} \right)^{-1},$$

where r is the proportion of each prey category in the diet and n is the relative abundance of the same prey category in the environment. M is the number of prey categories. The sum of all μ is 1. The preference goes to the largest value of μ .

Shepherd interviews were conducted in all the villages (52) in the 2 study areas. Shepherds were asked for information on livestock depredation, species involved, suspected predator, location and specifics of each depredation. If there was no evidence of wolf presence after a depredation report without any livestock remains and if no wolf was seen during the attack, the report wasn't considered a wolf depredation. When possible, the depredation reports were investigated. The presence of feral dogs in the study areas was evaluated by inquiries and personal observations. For further information, I consulted reports on wolf damage in the region. Husbandry and protection methods of the shepherds were investigated, as well as the number of animals they owned. The numbers of goats, sheep, horses and cattle given by their owners were considered and confirmed by field counting in the evaluation of the relative abundance of each species in the environment for the calculation of prey preference μ (see above).

RESULTS

Food habits

A total of 87 wolf scats was collected from April to October 1996 (41 scats in study area A and 46 in study area B). In both study areas, mammal hair and bones were the main items in the scats. In study area A, an almost monospecific diet was found. Domestic goat *C. hircus* comprised 97.5% of all prey items in scats. The domestic dog *Canis familiaris* was an occasional prey (Table 1). No hair or other evidence of consumption of sheep *O. aries* was found in the scats analysed. In study area B, goats and horses *E. caballus*, made up 58.7% and 41.3% respectively, of the number of all prey items in the wolf scats. Dogs were occasional prey and no evidence of predation or consumption of sheep was detected in their scats. No losses of cattle were recorded during the study in either study area.

Table 1. Composition of the diet of wolves and livestock depredation in study areas

Food items	No. of scats (n)		Frequency of occurrence (%)		Mean relative volume in the total sample (%)		Mean relative volume in the sample ^a (%)	
	A	B	A	B	A	B	A	B
<i>Capra hircus</i>	40	27	97.5	58.7	95.5	54.1	97.5	60.0
<i>Equus caballus</i>	0	19	0.0	41.3	0.0	34.5	0.0	38.3
<i>Ovis aries</i>	0	0	0.0	0.0	0.0	0.0	0.0	0.0
<i>Canis familiaris</i>	1	1	2.4	2.2	2.4	1.5	2.5	1.7
Fruits, grasses	25	41	60.9	89.1	1.7	9.4	–	–
Unidentified material	1	1	2.4	2.2	0.4	0.5	–	–
Total	67	89	163.2	193.5	100	100	100	100

^a Calculated on goat, horse and dog.

Table 2. Analysis of livestock depredation based on inquiries and official records (data from April to October 1996) in study areas A and B

Food items	Livestock numbers (N)		Livestock density (heads/km ²)		Percentage of losses		No. of attacks		Frequency of occurrence	
	A	B	A	B	A	B	A	B	A	B
<i>Capra hircus</i>	5764	7207	44.3	30.0	1.0	0.3	59	21	81.9	42.9
<i>Equus caballus</i>	0	895	0.0	3.7	0.0	2.1	0	19	0.0	38.8
<i>Ovis aries</i>	257	2200	2.0	9.2	5.1	0.4	13	9	18.1	18.3
<i>Bos taurus</i>	280	1323	2.2	5.5	0.0	0.0	0	0	0.0	0.0
Total	6301	11575	48.5	48.4	1.1	0.4	72	48	100	100

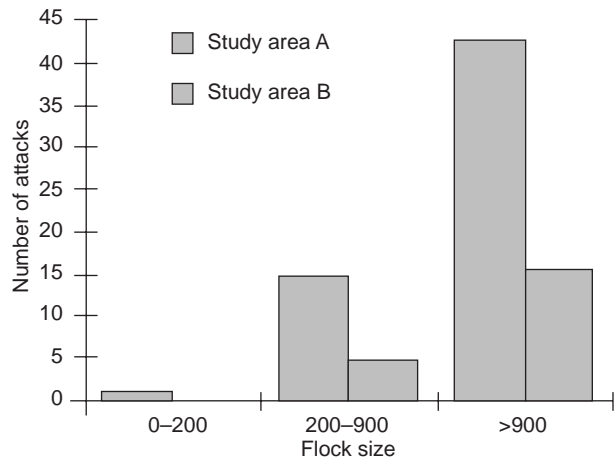
Livestock depredation

In study area A, wolves preyed mainly on goats (81.94% of the attacks, $n = 72$; Table 2). Wolf preference based on prey availability and scat analysis favours goats (Chesson index: 0.99). In study area B, wolves preyed mostly on goats (41.7% of the attacks, $n = 48$) and horses (39.6%). Wolf preference in this region favoured horses (Chesson index: 0.85) instead of goats (Chesson index: 0.15). Although, government records revealed predation on sheep, no remains of sheep were found in the scats in either study area. Wolves killed a relatively small percentage of the population of available prey: 1.0% of the goats and 5.1% of the sheep were killed in study area A, 0.3% and 0.4%, respectively, in study area B. In area B, 2.1% of all horses were subjected to wolf predation.

Wolf attacks favoured large flocks of goats ($P = 0.002$; Fischer exact probability test). Flocks of > 900 goats suffered the highest number of attacks (91% of the attacks, $n = 59$ in study area A and B). Flocks of < 200 goats were not subjected to wolf predation (Fig. 1).

DISCUSSION

The importance of large herbivores as prey of wolves has been emphasized by several studies (Pulliainen, 1965; Fritts & Mech, 1981; Salvador & Abad, 1987; Fuller, 1989). Livestock predation by wolves is well

**Fig. 1.** Wolf attacks on goats according to flock size ($n = 80$).

documented (Pulliainen, 1965; Fritts & Mech, 1981; Gunson, 1983; Tompa, 1983; Reig *et al.*, 1985). In Portugal, Spain, Italy and France, many authors reported a high dependence of wolves on livestock (Salvador & Abad, 1987; Blanco, Cuesta & Reig, 1990; Fonseca, 1990; Fico, Morosetti & Giovannini, 1993; Álvares, 1995; Mattioli *et al.*, 1995; Lonchamp, 1996; Meriggi *et al.*, 1996; Poulle *et al.*, 1997). Only one other scientific record of wolves feeding exclusively on domestic ungulates was found in the literature. It is a study made in the north-west of Spain (Galicia), not far from the study areas of this paper (Cuesta *et al.*, 1991).

Although this study encompasses a short period in

spring and summer, it is surprising that the wolves studied in these areas survive completely on domestic livestock. It is probable that this situation has existed for many years, because wild ungulates in both areas have been absent or scarce for >30 years (Pereira, 1988). The decline of the wolf population probably has more to do with the decrease of livestock production and the lack of wild prey than to human persecution (Fonseca, 1990; Álvares, 1995).

The wolves diet is based principally on goats. The presence of thousands of goats in both study areas and their tendency to spread all over the mountains makes them by far the most available prey. According to the government records of wolf attacks, sheep seem to be a regular prey, but no evidence of wolves feeding on sheep was found in the scats collected during this study. It could be statistically possible that those scats have been missed during the field collection, but the difference between government records and scat analysis results is too great to be explained by this bias only. Alternatively, the wolves may kill sheep, but not feed on them. This can happen when shepherds scare the wolves away, and because sheep stay close to the villages, such situations may occur frequently. Another explanation could be that shepherds illegally attribute the cause of sheep deaths to wolves when death was caused by some other factor. Wolf attacks on goats occur mostly in the mountains, where the wolves drag the carcass out of sight, preventing the shepherds from finding the remains of their goat. Sheep remains are easily found because of their proximity to the village. These hypotheses are not mutually exclusive and a combination may be the most probable explanation for the difference between scat-analysis results and the government data on wolf predation. Thus, researchers need to be careful when using data collected by official means and not in a scientific manner. The preference of wolves for equids in study area B can be explained by the herders' practice of leaving the horses to range freely all year round and during night and day. Wolves can attack them during the night, reducing the risks of any encounters with human. In summer, horse foals are an easy prey for wolves. The preference of wolves for equids has been recorded by various authors in Portugal (Álvares, 1995), Spain (Braña *et al.*, 1982) and Italy (Patalano & Lovari, 1993; Meriggi *et al.*, 1996). Dogs were only occasional prey, apparently herder or hunting dogs, because no feral dog was recorded in both study areas. Cattle were avoided by wolves; their ability to protect themselves and their offspring against wolves seemed to be the main reason for this result (Álvares, 1995).

Wild boar were not found in the wolf diet. They are not present in the study areas during spring and summer. They leave the low plains and come to feed on corn in the mountains around the villages only at the end of summer. Roe deer is present in study area B but was not subjected to wolf predation. Roe deer is very rare in the National Park area due to poaching (Álvares, 1995). The percentages (frequency of occurrence) of graminaceae and other plant material in the

diet were much larger than the corresponding volumes (% of volume), suggesting that this material could have been ingested by chance while swallowing other food. In some scats, an important volume of graminaceae remains was found, showing that sometimes the wolves swallow a relatively large amount of grasses (Salvador & Abad, 1987; Patalano & Lovari, 1993; Poulle *et al.*, 1997). As vegetable matter is poorly digested by carnivores, grass remains in scats are likely to over-represent the actual importance of this item, especially in volume (Meriggi & Lovari, 1996).

In study area A, livestock depredation was selective according to flock size. Flocks of <200 goats were almost never attacked during the study period, in contrast to the big flocks of >900 goats. In the regions considered in this paper, goats are herded by one to three shepherds with one or two small mongrel dogs, depending on the flock size. There are no real livestock guardian dogs used, but the shepherds take out their flocks at dawn and bring them in every evening to prevent wolf predation. Goats usually spread all over the mountain and do not stay together. When flocks consist of >200 goats it is impossible for one or two shepherds to protect them against wolf attacks in such mountainous and bushy areas.

The main problem for wolf conservation in the north of Portugal is the absence or scarcity of wild prey. The wolf survives completely on the presence of livestock, although depredation can be reduced by using livestock guardian dogs and reducing flock size. Unfortunately, in mountainous areas like study areas A and B, local people seem to have abandoned such protection means. Furthermore, no information and no efficient government help is provided to the shepherds of these regions. The compensation promised by the local government are at least >3 or 4 years late (F. P. Fonseca, pers. obs.), and the conditions required to receive them are difficult to meet. The shepherds must phone within the 48 h of the attack and the remains of the animal killed must be shown, but as mentioned above, most of the attacks occur in the mountains and few carcasses are found. This situation does not encourage shepherds to mention their losses, and they manage livestock depredation problem themselves. It is likely that for several years, an equilibrium ensured the survival of wolves in spite of their impact on livestock and the human hunting that ensued from that. If the losses do not exceed a certain percentage, the shepherds do not persecute the wolves. Nowadays, sheep and goat numbers are decreasing, and the villages are abandoned in many regions owing to the difficulty of survival in the valleys. With the main food source for wolves decreasing and no wild prey being available, wolves may disappear from these regions. Reintroduction projects of wild goat *Capra pyrenaica* and red deer *Cervus elaphus* in the north of Portugal are in preparation by the 'Grupo Lobo' of Professor F. P. Fonseca. The regions described here deserve a more detailed study, to understand the close relationship between humans and wolves, and wolf survival strategy in such impoverished areas. Conservation of

wolves in such areas will depend on the restoration of native ungulates and the management of livestock predation.

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