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— SHORT COMMUNICATION —

Winter food habits of wolves in central Greece

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In the recent years wolf feeding habits have been studied throughout the Mediterranean, but data from Greece, where a viable population exists, are still lacking. This short note presents results on the winter food habits of wolves from central Greece based on a limited sample of scats. We used four scat analysis methods, frequency, occurrence, volume, and biomass to describe wolf diet. Wolves preyed heavily on domestic ungulates, primarily pigs and goats, whereas wild boar was the main wild prey. Although our results should be considered with caution, they appear to support analogous studies from other Mediterranean countries, where domestic animals represent the main target of wolves, resulting in an intensification of human-wolf conflict.

Key words: Wolf, *Canis lupus*, scat analysis, diet, domestic ungulates, Greece.

INTRODUCTION

In Greece, the population of wolves, *Canis lupus* Linnaeus, 1758, has become stabilized in the recent years and is estimated at 500-700 individuals (Iliopoulos, 2000). Despite the relatively stable number of individuals, the ecology of the species is poorly studied in Greece. Wolf food habits have been studied in other Mediterranean countries, where wolf-human conflict is intense, and have consistently revealed a high share of domestic animals in wolf diet, especially in areas with important livestock production (Salvador & Abad, 1987; Cuesta *et al*., 1991; Meriggi & Lovari, 1996; Meriggi *et al*., 1996a; Ciucci & Boitani, 1998; Vos, 2000; Pezzo *et al*., 2003). In contrast, in areas with numerous wild ungulates, these latter constitute the main wolf prey (Smietana & Klimek, 1993; Meriggi & Lovari, 1996; Poullé *et al*., 1997; Capitani *et al*., 2004). Thus, selectivity for both domestic and wild prey appears to depend mainly on abundance and availability of prey, such as grazing behaviour and presence or lack of prevention measures (Meriggi & Lovari, 1996; Meriggi *et al*., 1996b).

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In Greece, the single so far study of wolf food habits revealed considerable proportions of domestic prey in wolf diet (Papageorgiou *et al*., 1994). The present study aims to provide additional data on diet composition of wolves based on a limited number of scats from an area of high livestock production and low diversity and density of wild ungulates in central Greece.

MATERIALS AND METHODS

The study area was located at Mt. Othrys (39°00′ N, 22°30′ E) in the prefectures of Fthiotida and Magnesia in central Greece and covered approximately 500 km^2 (Fig. 1). The area is mountainous with elevations ranging between 400-1500 m a.s.l. (above sea level) and is dominated by evergreen (*Quercus coccifera*) and deciduous oak (*Quercus* spp.) species, as well as pseudo-alpine grasslands above 1000 m a.s.l. Forest roads are extensive and population density is 15 inhabitants per km^2. Livestock production is the main source of income with approximately 11,000 goats (*Capra hircus*), 10,000 sheep (*Ovis aries*), 4,000 pigs (*Sus domesticus*) and 3,000 cattle (*Bos taurus*) grazing inside the study area. Pigs and cattle graze unguarded throughout the day, while goats are kept in well-guarded but highly dispersed herds. In con-

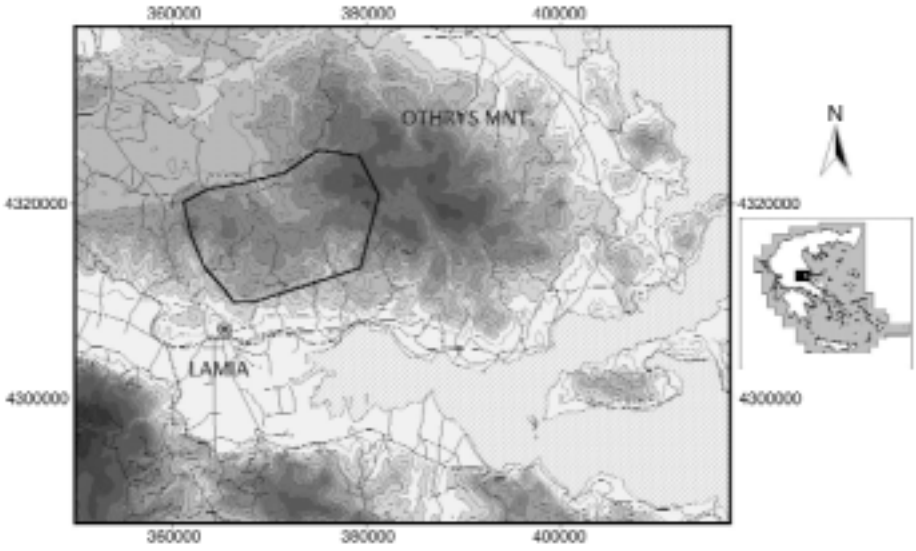

FIG. 1. The study area (black outline) of Mt. Othrys in the prefectures of Fthiotida and Magnesia (central Greece).

trast, sheep graze in cohesive herds that are well-guarded by both humans and shepherd dogs. In the area, wild ungulates are represented by wild boar (*Sus scrofa*), which is locally abundant, and roe deer (*Capreolus capreolus*), which is very rare.

We analysed scats from a single pack of seven wolves with three radio-tracked animals. Scat collection was carried out by experienced personnel, intermittently between January and March 2000. Well-known travel routes of the wolf pack were surveyed avoiding areas used by shepherd dogs. This resulted in a quite limited sample of 36 scats for winter that is assigned with relative confidence to wolves.

Following collection, the scats were oven-dried for 24 h at 100 °C and weighed. Dried scats were immersed in a measuring cylinder to estimate total scat volume. Subsequently, scats were soaked into water with detergent and were washed under a fine sieve (0.45 mm) in order to isolate scat components. All elements belonging to different food remains, such as vegetal matter (seeds, stems, leaves) and animal matter (hair, bones, hooves), were separated and their relative volume proportions were estimated visually. Hairs were classified macroscopically and when hair determination occurred, each prey species was attributed a certain percent of relative volume.

Hairs were used to identify prey species based on reference collections and published manuals. Techniques for their preparation and microscopic examination followed Papageorgiou & Sfougaris (1989) and Teerink (1991). All three authors of this paper were involved in the laboratory determination and were repeatedly checked for their ability to identify hairs at a specific level. Following Ciucci *et al*. (1996), we used four different methods to assess wolf diet: (a) percentage of frequency = frequency of each food category/total frequencies of all observed food categories, (b) percentage of occurrence = number of occurrences of each food category/number of scats, (c) percentage of relative volume = sum of relative volumes of each food category/total volume of all food categories, and (d) percentage of biomass = biomass of each food category/biomass of all food categories. Ingested biomass was calculated from the linear regression model of Weaver (1993) using published data for both livestock (Chatziminaoglou *et al*., 2001) and wild prey weights (MacDonald & Bennett, 1993). It is possible that relative biomass will overestimate prey that was acquired by scavenging, as it was impossible to identify if remains were from carcasses or killed animals. In addition, the Shannon Diversity Index (H′) and the Levins Niche Breadth Index (B′) were calculated for each scat analysis method. Different rankings of diet components from different methods were tested with the Kendall coefficient of concordance W, using a criterion of $p < 0.05$ for statistical significance (Zar, 1996).

RESULTS AND DISCUSSION

The present results on the winter diet of wolves in central Greece are based on a restricted sample of scats and any conclusions should be considered as indicative. Our results showed that the winter wolf diet was largely dominated by animal prey (Table 1). The number of prey species per scat ranged from one to three, with 47.2% of scats containing two prey species. No correlations were found between scat weight or scat volume and the number of prey species per scat (weight: $p = 0.793$; volume: $p = 0.691$).

Table 1 shows that wolves fed mainly on domestic ungulates (frequency: 82.3%, occurrence: 155.5%, volume: 74.3%, biomass: 86.3%). In all analyses, pig (*Sus domesticus*) and goat (*Capra hircus*) were the dominant prey (Table 1; Kendall coefficient of concordance: frequency/occurrence: $W = 1.000$, $p = 0.034$; frequency/occurrence/volume: $W = 0.861$, $p = 0.001$; frequency/occurrence/volume/biomass: $W = 0.567$, $p = 0.009$). However, when relative volume and biomass were considered, wild boar (*Sus scrofa*) ranked third, over sheep (*Ovis aries*) and roe deer (*Capreolus capreolus*) (Kendall coefficient of concordance: frequency/volume: $W = 0.444$, $p = 0.221$; frequency/biomass: $W = 0.000$, $p = 1.000$). Furthermore, wolves appeared to utilize a limited number of food sources, as indicated by the low values of the trophic diversity (H') and niche breadth (B') indices (frequency: $H' = 1.45$, $B' = 2.55$; volume: $H' = 1.32$, $B' = 3.78$; biomass: $H' = 1.21$, $B' = 2.65$).

The dominance of domestic ungulates in wolf diet in central Greece appears to support a previous study that was based on stomach analyses from different periods and sites in Greece (Papageorgiou *et al*., 1994). Moreover, the similar pattern of high trophic dependence on livestock is also reported in other Mediterranean countries, and particularly in areas with high livestock production (Salvador & Abad, 1987; Cuesta *et al*., 1991; Patalano & Lovari, 1993; Meriggi *et al*., 1996a; Ciucci & Boitani, 1998; Vos, 2000; Pezzo *et al*., 2003). In all Mediterranean countries, depredation rates on domestic ungulates depend mainly on abundance and availability of prey (Meriggi & Lovari, 1996). The results of the present study indicate that domestic ungulates, that graze either unguarded, such as pigs, or in highly dispersed herds difficult for efficient guarding, such as goats, could compose the main prey, despite their relatively small absolute numbers (e.g. pigs in our study area). Similar patterns of domestic prey selection regulation based on grazing habits of prey and presence or lack of prevention measures, have been also described elsewhere in Europe (Patalano & Lovari, 1993; Poullé *et al*., 1997; Vos, 2000; Nowak *et al*., 2005).

The present short note implies that wolves in central Greece may depend largely on domestic prey, and that prey choice appears to be based on local availability. Fragmentation of forested habitats and decline of wild ungulate populations appear to enhance wolf-human conflict via increased livestock depredation as in most Mediterranean countries (Meriggi & Lovari, 1996; Ciucci & Boitani, 1998). Ongoing research in other areas of central Greece will provide more robust data, upon which prey selection strategies for wolves can be postulated in order to establish measures to minimise wolf-human conflict.

TABLE 1. Food habits of wolves in central Greece (scat total = 36)

	n	% frequency	% occurrence	% volume	% biomass
Pig (*Sus domesticus*)	29	42.65	80.55	40.86	54.03
Goat (*Capra hircus*)	22	32.35	61.11	29.03	26.27
Sheep (*Ovis aries*)	4	5.88	11.11	4.08	4.15
Cattle (*Bos taurus*)	1	1.47	2.77	0.33	1.89
Wild boar (*Sus scrofa*)	4	5.88	11.11	10.42	12.10
Roe deer (*Capreolus capreolus*)	4	5.88	11.11	2.45	1.56
Mammal indeterminate	1	1.47	2.77	0.69	–
Vegetal matter	3	4.41	8.32	12.14	–
Total	68	100.00	188.85	100.00	100.00

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