

Research Note

Helminth parasites of the endangered Iberian lynx (*Lynx pardinus*) and sympatric carnivores

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Abstract

Five critically endangered Iberian lynxes (*Lynx pardinus*) and 35 other sympatric carnivores (19 feral cats *Felis catus*, 12 Egyptian mongooses *Herpestes ichneumon*, and 4 common genets *Genetta genetta*) were analysed for helminths in Sierra Morena and Doñana area (southern Spain). *Ancylostoma tubaeforme*, which was believed to be harmful for lynx cubs according to a previous study, was present in the only lynx and in 53% of cats analysed in Doñana (80% in adult cats). Other species shared in both areas were *Toxocara cati* (1 lynx, 31% of cats), *Joyeuxiella pasqualei* (1 lynx, 21% of cats) and *Mesocestoides* sp. (2 lynxes, 5% of cats). Only one mongoose was parasitized, harbouring larvae of two acantocephalan species not previously reported in the Iberian peninsula (*Centrorhynchus (Sphaerostris) lancea* and *Centrorhynchus (Longirostris) undulatus*). Feral cats may be a reservoir for hookworms and other helminths affecting the Iberian lynx. In contrast, mongooses and genets may not play a role in the epidemiology of these species.

The Iberian lynx (*Lynx pardinus*) is, according to the World Conservation Union (IUCN) the most endangered felid in the world, with a population of no more than 160 individuals surviving in two separate metapopulations (Sierra Morena (SM) and Doñana area (DA)), both located in Andalusia, southern Spain (Guzmán *et al.*, 2004). The helminthfauna of the lynx has received little attention. Only one scientific paper reported data from eight lynxes found dead from Montes de Toledo (MT), where the lynx is now thought to be extinct, SM and DA (Torres *et al.*, 1998). A second paper communicated parasite egg excretion by lynxes in SM (Rodríguez & Carbonell, 1998). Recently, Vicente *et al.* (2003) observed a high prevalence and abundance of *Ancylostoma tubaeforme* eggs in lynx faeces in Doñana National Park (DNP). All the juvenile individuals

studied (less than 6 months old) were parasitized, showing excretions of up to 21,200 eggs/g of faeces. According to Vicente *et al.* (2003), ancylostomosis may play a role in neonatal morbidity and mortality in this population of lynxes. In fact, hookworms of the genus *Ancylostoma* are the most pathogenic parasites of young dogs and cats (Levine, 1980). Rodríguez & Carbonell (1998) found *Ancylostoma* sp. eggs in faeces of 2 of 9 lynxes in SM. However, only about 30 lynxes currently survive in DA, and about 60–110 in SM (Guzmán *et al.*, 2004). Since the transmission of monoxenous parasites (such as the hookworm) is related to host density (Arneberg *et al.*, 1998), the presence of reservoir hosts may be necessary in the hookworm life-cycle. In northern Spain, prevalence of *A. tubaeforme* in feral cats (*Felis catus*) was 30% (Calvete *et al.*, 1998). Thus, as suggested by Vicente *et al.* (2003), we hypothesized that other abundant, sympatric carnivores, such as feral cats, may play a role in the maintenance and

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transmission of the hookworm. The aim of this study was to analyse feral cats and other sympatric wild carnivores (the Egyptian mongoose *Herpestes ichneumon*, and the common genet *Genetta genetta*), inhabiting the areas where the Iberian lynx is still present, as possible reservoirs of helminths that may parasitize the lynx. We also communicate new information about the Iberian lynx helminthfauna.

As mentioned above, the Iberian lynx persists in SM (northern Andalusia, 38°13'N, 4°10'W), and DA (southern Andalusia, 37°0'N, 6°30'W; this area includes DNP). In both areas, the most abundant felid is the domestic cat (personal observation). However, no scientific information is available regarding cat densities. Another felid, the European wildcat *Felis silvestris*, is present at very low densities in SM but is almost absent from DA. Other sympatric carnivores belonging to the suborder Feliformia that are present with relevant abundances are the mongoose (with an estimated density of 1.2 individuals/km² in DNP; Palomares & Delibes, 1992), the genet (0.67 individuals/km²; Palomares & Delibes, 1994) and the badger *Meles meles* (between 0.21 and 1.02 individuals/km²; Revilla *et al.*, 2002). Between June 2004 and June 2006, 5 lynxes (four from SM, one from DA), 19 feral cats (three from SM, 16 from DA), 12 mongooses and 4 genets (all from DA) were analysed. They were found dead, mainly road-killed, or illegally shot. It was not possible to analyse any badgers during the study period. Each animal was necropsied in detail. The internal organs were removed and systematically analysed with routine techniques for helminths (Soulsby, 1982). All the retrieved helminths were stored in 70% alcohol. Nematodes were cleared with lactophenol and identified under a light microscope. Cestodes were stained with acetic carmine and identified under the microscope. All helminths were identified according to the keys in Miquel *et al.* (1994), Khalil *et al.* (1994) and Petrochenko (1971). Terminology referring to parameters of parasitism is that of Bush *et al.* (1997).

Eleven helminth species were found. Lynxes and cats shared four of these species, whereas mongooses and genets did not share any parasite species with the other carnivores. The observed prevalences and abundances in lynxes and cats are shown in Table 1. Two adult lynxes from SM were not parasitized. The other two lynxes from

SM harboured 2 and 3 helminth species, respectively. The lynx from DA harboured 2 species. The mean number of species per host was 1.2, markedly lower than the number (3.1) observed by Torres *et al.* (1998).

All the species found in lynxes in this work were reported by Torres *et al.* (1998), with the exception of *Joyeuxiella pasqualei*. This species, which uses lizards as intermediate hosts, is common in the south of the Iberian Peninsula (Torres *et al.*, 1996). This species was also relatively frequent in feral cats. *Taenia polyacantha* and *Mesocestoides* sp. showed similar prevalence in lynxes to those reported by Torres *et al.* (1998). *Taenia polyacantha* uses small mammals as intermediate hosts. *Mesocestoides* sp. uses amphibians, reptiles, small mammals and, in the Iberian Peninsula, the red-legged partridge *Alectoris rufa* (Millán *et al.*, 2003). Individuals of *T. pisiformis*, which is transmitted by lagomorphs, were not found. In Torres *et al.* (1998), this cestode also presented the lowest prevalence among cestodes. The main and almost exclusive prey of the Iberian lynx is the, formerly abundant, rabbit *Oryctolagus cuniculus* (Palomares *et al.*, 2001). After the myxomatosis and rabbit haemorrhagic disease epizootics, the rabbit has become a scarce prey species in the Iberian Peninsula, which is the main cause of regression of the lynx (Guzmán *et al.*, 2004). Thus, the absence of *T. pisiformis* and the abundance of other cestode species transmitted by other potential preys may indicate a shift in the lynx diet due to the lack of rabbits. Another possibility is that *T. pisiformis* development in felids may be limited, and this cestode has been shown to have difficulty in becoming gravid in feline hosts (Van Zyll de Jong, 1966; Beveridge & Rickard, 1975).

Ancylostoma tubaeforme was not found in any of the lynxes from SM, but it was found in the one from DA, confirming the presence of hookworms in lynxes in this area, as reported by Vicente *et al.* (2003). Hookworms were also found in 53% of the cats in DA, and were not found in SM (however, the sample size in this area was low). In DA, adult cats were more frequently parasitized by *A. tubaeforme* (80%) than juvenile individuals (0%, $\chi^2 = 6.2$, $P < 0.05$). *Toxocara cati* was found in 37.5% of the cats from DA. Higher prevalences and abundances of *A. tubaeforme* in cats were found compared with the results of Calvete *et al.* (1998), but both parameters were lower in the case of *T. cati*. *Toxascaris leonina*, which was the most prevalent helminth in the lynx

Table 1. Overall prevalence (95% CI) and abundance (\pm SD) of gastrointestinal helminth parasites in the Iberian lynx (*Lynx pardinus*) and feral cats (*Felis catus*) in Sierra Morena and Doñana (southern Spain).

	Iberian lynx (n = 5)		Feral cat (n = 19)	
	Prevalence	Abundance	Prevalence	Abundance
Total	0.60		0.84	
Cestoda				
<i>Taenia taeniaeformis</i>	0		0.21 (0.7–0.44)	0.79 \pm 2.15
<i>Taenia polyacantha</i>	0.20 (0.01–0.65)	6.80 \pm 15.21	0	
<i>Mesocestoides</i> sp.	0.40 (0.07–0.81)	4.60 \pm 8.69	0.05 (0.00–0.26)	0.05 \pm 0.22
<i>Joyeuxiella pasqualei</i>	0.20 (0.01–0.65)	0.80 \pm 1.78	0.21 (0.7–0.44)	2.21 \pm 6.22
Nematoda				
<i>Ancylostoma tubaeforme</i>	0.20 (0.01–0.65)	0.40 \pm 0.89	0.47 (0.25–0.69)	10.44 \pm 17.05
<i>Toxocara cati</i>	0.20 (0.01–0.65)	0.20 \pm 0.44	0.31 (0.15–0.55)	1.42 \pm 2.75
<i>Vigospirura potekhina potekhina</i>	0.20 (0.01–0.65)	0.60 \pm 1.34	0	

as reported by Torres *et al.* (1998), was not found; however, the small sample size of both studies, and the fact that 5 of the 8 lynxes analysed by Torres *et al.* (1998) came from MT, makes it difficult to compare results.

Only two acanthocephalan species were found in the mongoose: *Centrorhynchus (Sphaerirostris) lancea* (prevalence 8% (95% CI = 0–37); abundance 0.6 ± 2.0) and *Centrorhynchus (Longirostris) undulatus* (8% (0–37); 0.3 ± 1.1). Both were found in the gut of the same mongoose, and both are new species for the Iberian parasitofauna. *Centrorhynchus (S.) lancea* is mainly a parasite of Turdidae and Charadriiform birds in Europe, but is also found in the weasel (*Mustela nivalis*) in western Europe (Golvan, 1956; Petrochenko, 1971). Only the original description of *C. (L.) undulatus* from *Falco brachydactylus* (Falconiformes) in Morocco is available, because no other author found this species out of their type locality (Golvan, 1956; Petrochenko, 1971). The parasitized mongoose probably fed on some infected intermediate host, and this finding may be considered anecdotal. Surprisingly, no helminth was found in the other mongooses. The only previous information about mongoose helminthfauna is, as far as we know, that reported by Blanco *et al.* (1993), which only referred to nematodes. In contrast, no nematode was found parasitizing mongooses in the present work. In the genet, two cestode species parasitizing three individuals were found: *Taenia parva* (50% (10–90); 9.2 ± 16.6) and *Diplopylidium monoophorum* (25% (13–75); 3.2 ± 6.5). Both species have been reported previously in Spain (Feliú *et al.*, 1996; Casanova *et al.*, 2000). Although *J. pasqualei* is widely distributed parasitizing the genet in Spain (Casanova *et al.*, 2000), neither the mongoose nor the genet seem to play an important role in the epidemiology of helminths affecting the Iberian lynx.

In contrast, feral cats may be relevant in the life cycle of some species, mainly in directly transmitted nematodes, such as *A. tubaeforme* and *T. cati* (although the latter can use paratenic hosts) (Anderson, 1992). Up to 80% of the adult cats were parasitized by hookworms in DA, where feral cats are abundant and widespread. Both facts make the cat the more likely reservoir host of hookworms affecting the Iberian lynx, confirming the hypothesis of Vicente *et al.* (2003). However, a comparison of genotypes of hookworms from lynxes and cats would help to confirm this hypothesis.

Acknowledgements

This is a contribution to the 'Programa de Actuaciones para la Conservación del Lince Ibérico en Andalucía II' (Consejería de Medio Ambiente, Junta de Andalucía). We wish to thank D. Cobos and the Rangers from Doñana National Park; M. Delibes, F. Palomares, A. Rodríguez, J.C. Rivilla, J. Román, M. Viota and J.V. López-Bao from Estación Biológica de Doñana; and F. Martínez from El Acebuche. A. Green kindly improved the English.

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(Accepted 18 February 2007)

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