

Prevalence of zoonotic helminth parasites of the small intestine in red foxes from central Poland^{*)}

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Summary

The aim of the study was to determine the occurrence of helminth parasites of red foxes from central Poland (Mazowieckie voivodeship). The analysis of intestinal tracts of 639 red foxes (*Vulpes vulpes*) collected in the Mazowieckie voivodeship (central Poland) during game seasons in 2005–2007 revealed 8 species composing the helminth community. The intestinal scraping technique (IST) was used to detect helminth specimens. The material was then examined under a stereoscopic microscope.

Among foxes examined 604 (94.5%) were found infected. The component species were *Alaria alata* (56.7%), *Mesocestoides* spp. (71.2%), *Uncinaria stenocephala* (35.8%), *Taenia* spp. (29.7%), *Toxocara canis* (19.1%), *Echinococcus multilocularis* (13.9%), *Echinostoma revolutum* (0.9%) and *Capillaria aerophila* (0.3%). Two of the enumerated species, i.e. *Toxocara canis* and *E. multilocularis*, have zoonotic importance for humans leading to toxocariasis and alveolar echinococcosis. Therefore, monitoring of parasitic fauna in wildlife is necessary to recognize the scale of foxes' potential to spread zoonoses in various regions of Poland.

Keywords: red fox, helminth, prevalence

Red foxes (*Vulpes vulpes*) are known to be the most important predators in farmland areas. Their occurrence may be related to the distribution of food resources and the presence of adequate habitats. Several factors are regarded to be responsible for the high quantity of these carnivores, for example the intensive oral vaccination against rabies and the adaptation to new anthropogenic conditions (13).

In the last years in Poland an increase of the fox population was observed from 67 000 in 1995 to over 215 000 in 2007. The expansion of this canid species is, probably as in other European countries, related to the antirabies campaigns. The actions started in 1993 in the western part of Poland, and from 2002 were extended onto the whole territory of the country. The rise of the population is also a result of adaptation to new habitats, such as suburban and urban areas. Examinations carried out in Zürich revealed that more than half of the fox stomachs' content was of anthropogenic origin, and it has been estimated that the overall food supply of households would be sufficient to feed a much higher number of foxes than at present (7). The prey-predator interplay is a key factor in understanding the transmission dynamics of obligatory heteroxenous parasites such as cestodes (15). Red fox can also act as a reservoir maintaining zoonotic helminths. The possibility of their transmission to domestic animals or humans is enhanced in regions where foxes tend to

approach rural and urban areas (38). The endoparasitic helminthofauna of *V. vulpes* is reasonably well characterized throughout Europe (5, 12, 27, 29, 31), but until now complete data from Poland have not been published.

The aim of the study was to determine the occurrence of helminth parasites of the red fox from central Poland (Mazowieckie voivodeship).

Material and methods

Study area. The Mazowieckie voivodeship has an area of 15 100 km² (equal to 4.8% of the area of Poland) and 5.18 million inhabitants (a density 145.2/km²). The landscape is lowland, consisting of agricultural areas and forests (22.3%). The population of red foxes in 2006 was estimated to be 22 600.

Sampling. During the game seasons 2005–2007, 639 red foxes were collected in 39 districts from among 42 belonging to the Mazowieckie voivodeship. Before necropsy the carcasses were deep frozen at –80°C for a minimum 7 days to exclude the risk of infection (35). The samples were individually labeled with an identification number and information about locality, age and gender. The intestinal scraping technique (IST) was used to detect *E. multilocularis* specimens (10). The small intestine was divided into five parts and opened at full length. A microscopic slide was used to make mucosal scrapings, three from each of the five parts of the small intestine (a total of 15 scrapings). Scrapings from each part were transferred to a plastic Petri dish (90 × 90 mm) and mixed with distilled water. The material was then examined under a stereoscopic microscope (20 × magnification). Helminths were differentiated according to Vogel (36) and Soulsby (32).

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Results and discussion

Among the 639 red foxes examined, 604 were found to be infected (94.5%). 16%, 37%, 32%, 12%, 3% and 0.5% of the animals were infected with one, two, three, four, five or six species, respectively. The most prevalent were *Mesocestoides* spp. (71.2%) and *Alaria alata* (56.7%); the results are given in tab. 1. The most prevalent was fluke *A. alata*, which is probably related to the large number of rivers, ponds and irrigation trenches present in the studied area. The fluke life cycle includes an aquatic snail as the first, and amphibian as the second intermediate host. Rodents are paratenic hosts for *A. alata*. This parasite has been reported in previous studies in 18.7%, 33.8%, 15.4% and 2.2% of examined foxes from central, north-western, central-western and south-western part of Poland (25, 28). In other countries reported prevalence amounts to 27.4% in Portugal, 10.9% in Netherlands, 15.4% in Denmark and 42.6% in Belarus (6, 12, 29, 30). The present study is the first record of *E. revolutum* infection in red foxes in Poland. This fluke-worm was recorded in the intermediated host-snail *Lymnaea stagnalis*, collected from different lakes of central Poland (39), and definitive hosts – aquatic birds (ducks and baldcoots) from eastern Poland (37). The other representative of *Echinostomatidae* – *E. perfoliatus* was noted only in 1.1% of foxes in Belarus (30).

Mesocestoides spp. are the most frequent cestodes (71.2%) occurring in red foxes from the Mazowieckie voivodeship and other regions of Poland. The prevalence recorded is higher than that obtained in the previous study (28) in the same area (31.6%), but it is similar to that revealed in the south-west of Poland (63.7%) (26) and in the south of Poland (76.7%) (23). *Mesocestoides* spp. constitute the most common parasite fauna in foxes in Europe, with a prevalence of 77.3% in Spain, 30.7% in Portugal, 35.6% in Denmark, 5.7% in Switzerland, 4.6% in France and 13.8% in Belarus (12, 14, 24, 27, 29, 30). As reptiles, amphibians, birds and mammals are second intermediate hosts for *Mesocestoides*, its common occurrence in Europe influences the frequent occurrence of these parasites in red foxes and other canids.

In the present study 190 foxes of the 639 examined (29.7%) were infected with cestodes from the *Taeniidae* family. The prevalence of *Taenia* spp. was much higher than that recorded previously in central Poland (3.9%) (28), but similar to that found in the west (39.5%) (26) and the south of Poland (22.2%) (23). In Europe, *Taeniidae* are common parasites of red foxes. Borgsteede (6) found 53.3% of them infected in the Netherlands, Reperant et al. (27) 41.9% in Switzerland and Saeed et al. (29) 22.8% in Denmark.

The present study showed 13.9% of foxes infected with *E. multilocularis*. The highest prevalence (20%-53.8%) was found in six of 39 examined counties. In the previous study (28) carried out in 1996-1997, 0.6% of infected foxes were detected in the Mazowieckie voivodeship. Studies performed in Poland within the period 1994-2000, when a total of 3573 foxes were sampled from 90% of the territory, showed a mean prevalence of 2.8% (18, 20, 28). Later, within the EchinoRisk project (2), among 1514

Tab. 1. Prevalence of helminths detected in red foxes (n = 639) from central Poland

Helminths	Number of infected	Prevalence (%)
Digenea		
<i>Alaria alata</i> (Goeze, 1782)	362	56.7
<i>Echinostoma revolutum</i> (Rudolphi, 1809)	6	0.9
Cestoda		
<i>Mesocestoides</i> spp. (Vaillant, 1863)	455	71.2
<i>Taenia</i> spp. (Linnaeus, 1758)	190	29.7
<i>Echinococcus multilocularis</i> (Leuckart, 1863)	89	13.9
Nematoda		
<i>Uncinaria stenocephala</i> (Railliet, 1854)	229	35.8
<i>Toxocara canis</i> (Werner, 1782)	122	19.1
<i>Capillaria aerophila</i> (Creplin, 1839)	2	0.3

foxes examined a high prevalence of *E. multilocularis* was found in the north-east (Warmia and Mazuria) and the south-east of Poland (Carpathian Foothills), with 39.6% and 36.8% infected respectively (2). It seems that the growing prevalence of *E. multilocularis* in foxes is apparent in the whole territory. The dissimilarity in the prevalence of *E. multilocularis* in various regions can be considered to be due to differences in geomorphological and ecological factors, which are crucial for the survival of tapeworm eggs and the biology of the definitive as well as the intermediate host of the parasite (11). The increased number of infected foxes is undoubtedly a reason of a growing number of alveolar echinococcosis (AE) cases in humans. Until now 61 AE cases were registered in Poland (Chief Sanitary Inspectorate 2008).

The most frequently occurring nematode in this survey was *U. stenocephala* followed by *T. canis*. In the former study *U. stenocephala* was found in 16.8% of foxes from Mazowieckie voivodeship (28), in the south-west the reported prevalence was 26% (3), in the west 13.4% (26) and in the south of Poland 11.1% (23). Hookworms are common parasites of foxes in Europe, as they were found in 77.4% in Portugal (12), 20.4% in Spain (14), 52% in France (24), 41.3% in Great Britain (31), 78.2% in Switzerland (27), 59.9% in the Netherlands (6), 68.8% in Denmark (29), 26% in Germany (17) and 40.4% in Belarus (30).

Nematodes from *Toxocara* genus have zoonotic importance, being the reason for human toxocarosis. *T. canis* is a common parasite occurring in dogs, foxes and wolves throughout the world. The parasite eggs excreted in feces by the animal embryonate in the environment within 2-3 weeks and, under suitable conditions, can remain infective for several years. Humans become infected by ingesting embryonated eggs from soil or contaminated food. In previous studies in Poland the recorded level of foxes infected with *T. canis* was 25.8% in the western part (26) and 39.8% in the south-west of the country (3). *T. canis* was detected in 4.5 % of foxes in Spain, 37.1% in Portugal, 59.4% in Denmark, 73.3% in the Netherlands, 44.3% in Switzerland, 44% in France,

61.6% in Great Britain, 32% in Germany and 25.5% in Belarus (6, 12, 14, 17, 24, 27, 29-31). Due to the high number of infected dogs, the risk of infection for humans is high. The seroprevalence in adult humans in central Europe is 1-4% (22), but may be much higher in young children, up to 20% in developed countries and 60% in developing countries (34).

C. aerophila was recorded in the present study at a very low prevalence (0.3%). It was due to accidentally swallowed nematodes, usually localized in lungs or the esophagus. The previous data come from the sixties, when red foxes from central regions of Poland were found infected (19). *C. aerophila* was detected in 4.4% of foxes in Spain (7), 74.1% in Denmark (29), 46.8% in Netherlands (6), 44% in Austria (16), 31% in Germany (4), 64% in Hungary (33) and 88% in Norway (9).

The difference in the distribution of parasites of foxes depends on a prey-predator system (dixenous helminths *Echinostoma* spp., *A. alata*, *E. multilocularis*, *Taenia* spp., *Mesocoestoides* spp.) or on the specific environmental conditions that enable the survival of free-living stages (monoxenous helminth *U. stenocephala*).

The spread of foxes in suburban and urban areas of European countries including Poland and the high prevalence of zoonotic *E. multilocularis* may create the risk of tapeworm occurrence in domestic animals and as a result the risk for human infection. There is a necessity to screen representatives of risk groups (owners of cats or dogs, foresters, hunters, farmers, gardeners) to detect early cases of the disease. The educational actions of alveolar echinococcosis and toxocarosis is indispensable among people from risk groups in areas where the population of foxes is high.

Conclusions

The present results revealed a broad spectrum of helminths occurring in red foxes in central Poland. Some of them are known to be present in dogs; two (*E. multilocularis* and *T. canis*) pose a potential risk for humans. Therefore the monitoring of parasitic fauna in wildlife is necessary to recognize the scale of foxes' potential to spread zoonoses in various regions of Poland.

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