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Research Note

Parasites with possible zoonotic potential in the small intestines of red foxes (*Vulpes vulpes*) from Northwest Bohemia (CzR)

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Summary

We determined the prevalence of primarily zoonotic parasites in the small intestines of 40 (20 males and 20 females) red foxes living near human dwellings. The total prevalence of parasite infection was 77.5 % (31/40); the prevalence was 37.5 % (15/40) for *Toxocara canis* and 35 % (14/40) for *Toxascaris leonina*. The mean intensity infection was 3 and 11 helminths for *T. canis* and *T. leonina*, respectively. The prevalence of other intestinal helminths and mean infection intensity in this study are given: *Echinococcus multilocularis* 40 % (16/40) with 1000 individuals, *Mesocostoides* spp. 40 % (16/40) with 8 individuals, *Uncinaria stenocephala* 10 % (4/40) with 8 individuals, and *Taenia pisi-formis* 10 % (4/40) with 1 individual. With regards to prevalence and intensity of infection, as well as prevalence of individual parasites, there were no significant differences ($P \geq 0.05$) between male and female red foxes.

Keywords: red fox; human; zoonotic, parasite, infection

Introduction

The red fox (*Vulpes vulpes*) is a representative of the canid family. It is widely distributed in the Northern Hemisphere, and it is the most abundant wild carnivore living in the territory of the Czech Republic. Annual captures in the Czech Republic currently range between 60 000 – 80 000, and populations continue to grow (Placata, 2011). The increase in the distribution and density of the red fox in most European countries could be explained by a mortality rate reduction, which is due to an intensive campaigns of vaccination against rabies (oral baits) as well as to the opportunist behaviour of this species (Hanosset *et al.*, 2008; Červený *et al.*, 2004). The red fox is a common host of several dangerous zoonotic parasites, primarily the tapeworm *Echinococcus multilocularis*, causative agent of alveolar echinococcosis, a parasitic disease that causes a severe hepatic disorder in humans (Letková *et al.*, 2006). Soil contaminated with red fox feces is a significant risk factor for

zoonotic disease infection. Endoparasites (primarily *Echinococcus multilocularis* and *Toxocara canis*, but also *Uncinaria stenocephala*, *Mesocostoides* spp. and *Taenia* spp. tapeworms) or ectoparasites, such as fleas, ticks and mites (Kočičová *et al.*, 2006) of red foxes, can cause numerous health problems in humans and domesticated animals (mainly dogs).

Zoonotic roundworms (mainly *T. canis*) are not only present in their definitive hosts but also frequently occur in other animal species (Reiterová *et al.*, 2013), including humans. In these paratenic hosts, larvae do not develop into the adult stage, but rather migrate throughout the tissues and remain there as L3 arrested larvae for an extended period of time (Strube *et al.*, 2013).

Foxes live in close proximity to humans and domestic dogs, and this may have significant implications for public health. The aim of this study was to investigate the prevalence of zoonotic parasites in the small intestines of red foxes living near human dwellings.

Material and Methods

Forty (20 males and 20 females) red foxes were collected from an area surrounding the city of Karlovy Vary, in the northwest region of the Czech Republic (between October 2010 and March 2012). The study area covered approximately 6 km² with a fox density of 0.9-6 foxes/1km²/year; average animal body weight was 5.5 kg (from 2.96 to 8.32 kg).

During necropsy, the small intestine was isolated and wrapped in plastic bags and frozen at -80°C until examination (app. one month) in order to inactivate the infective material. In order to detect intestinal helminths, a direct detection method was implemented using intestinal scraping or sedimentation techniques (ITS) (Tackmann *et al.*, 2006).

Helminths were identified according to size and morphology using two microscopes: an Olympus CX 21 and an Olympus BX21.

Statistical evaluation

Basic descriptive statistics were computed. The normality of the data was tested separately using a Shapiro-Wilks test. Considering the results of the normality test, a nonparametric Mann-Whitney U test was used to evaluate differences between males and females. Statistica ver. 12 (Statsoft, 2013) was used for all statistical analyses.

Toxocariasis is a soil-transmitted helminthozoonosis, which is caused by *Toxocara* spp larvae infection in humans. Human infection is acquired through the ingestion of embryonated *Toxocara* eggs (eggs reach the environment via canid or felid stools and become infectious for humans and other hosts over the course of a few weeks). Dubná *et al.* (2007a) reported an 11.90 % prevalence of *Toxocara* eggs in 126 composite samples taken from child sand-pits in Prague (Czech Republic). In paratenic hosts, such as humans and mice, hatched larvae migrate systematically throughout the body and have the ability to reach critical sites such as the eyes and central nervous system. Larvae of *Toxascaris leonina* can also invade the tissues of laboratory animals, and this species has the potential to cause human disease. Of the 42.5 % (17/40) of red foxes infected by roundworms (*T. canis* and/or *T. leonina*), 70.59 % (12/17) of them were infected simultaneously by both *T. leonina* and *T. canis*. Two of the red foxes (11.76 %) were infected with only *T. leonina* whereas three (17.65 %) were infected with only *T. canis*. The total prevalence of roundworms was 37.5 % (15/40) and 35 % (14/40) for *Toxocara canis* and *Toxascaris leonina* respectively. Letková *et al.* (2006) reported a 17.55 % prevalence of *T. leonina* and a 25.82 % prevalence of *T. canis* in red foxes (*V. vulpes*) from eastern Slovakia. Reperant *et al.* (2007) reported a lower prevalence of *T. leonina* in urban areas (8 %) in comparison to that of rural areas (59.6 %). This raises the question of whether

Table 1. Intestinal helminth prevalence and mean infection intensity in monitored red foxes

Species	Prevalence (%)	Mean intensity of infection (min – max)
<i>Echinococcus multilocularis</i>	40 (16/40)	1000 (32 – 3500)
<i>Mesocostoides</i> spp.	40 (16/40)	8 (4 – 123)
<i>Taenia pisiformis</i>	10 (4/40)	1 (1)
<i>Toxascaris leonina</i>	35 (14/40)	11 (1 – 96)
<i>Toxocara canis</i>	37.5 (15/40)	3 (1 – 24)
<i>Uncinaria stenocephala</i>	10 (4/40)	8 (1 – 12)

Results and Discussion

Parasitic contamination of urban and rural environments by Canidae excrements is a growing problem (Ondriska *et al.*, 2013; Papajová *et al.*, 2014). The presence of red fox feces in the soil of urban and suburban areas can threaten the health of animals and humans, mainly due to the presence of zoonotic parasite eggs (primarily *Echinococcus multilocularis* and *Toxocara canis*). We examined the gastrointestinal tracts of 40 red foxes from the above-mentioned monitored area and found 77.5 % (31/40) of them to be infected by intestinal helminths. There were no statistically significant differences ($P \geq 0.05$) between male and female red foxes with respect to prevalence and intensity of infection and prevalence of individual parasites. The prevalence of intestinal helminths and their mean intensity is presented in Table 1.

rodent paratenic hosts play a major role in population dynamics of this species. Reiterová *et al.* (2013) reported anti-*Toxocara* antibodies in 6.6 % of small rodents trapped in Slovakia. Research carried out by Reperant *et al.* (2007) in Switzerland showed that as many as 59.6 % of foxes from rural areas were infected with *T. leonina* as opposed to only 8 % in urban areas. Reperant *et al.* (2007) found that *T. canis* and *T. leonina* co-occurred in 14 % of the red fox population of Geneva, Switzerland. In our study, infection intensity ranged from 1 – 96 roundworms (*Toxocara* spp. and *T. leonina*) per fox. The co-occurrence of *Toxocara* spp. and *T. leonina* in the definitive host is highly variable and is dependent on several factors: climate, environmental conditions, seasonal period and host age. This applies to infected wildlife as well as domestic animals (Okulewicz *et al.*, 2012). Antolová *et al.* (2004) reported a 47.1 % prevalence of *T. leonina* and an 8.1 % prevalence of *T.*

canis in red foxes from the Slovak Republic. Borecka *et al.* (2009) and Balicka-Ramisz *et al.* (2003) determined a 19.1 % and 39.8 % prevalence of *T. canis* in red foxes from Central and Western Poland respectively; they also determined a 0.0 % and 0.9 % prevalence of *T. leonina* in red foxes from Central and Western Poland respectively. Dubná *et al.* (2007b) monitored the prevalence of intestinal parasites in dogs from metropolitan Prague, rural areas surrounding Prague, and dog shelters in the Czech Republic; they reported *T. canis* in 6.2 % and 2.0 % of dogs in Prague and rural areas respectively; *T. leonina* was observed in 0.9 % and 1.7 % of canine faecal samples in metropolitan Prague and rural areas respectively.

In our study, we also observed the hookworm *Uncinaria stenocephala*, however, only 10 % (4/40) of foxes were infected with this helminth, with a mean infection intensity of 8 hookworms (Table 1). *Uncinaria stenocephala* is a nematode that belongs to the *Ancylostomatidae* family. Members of this family infect millions of people and animals worldwide. *U. stenocephala* is most pathogenic in dogs and other *Canidae*, which serve as the main hosts, and infection causes anemia or even death (Wasył *et al.*, 2013). Rataj *et al.* (2013) reported *Uncinaria stenocephala* as the most frequently identified nematodes in red foxes from Slovenia.

Mesocostoides spp. are zoonotic cestodes of wild and domesticated carnivores. Although the adult tapeworms are relatively harmless intestinal parasites, the metacestode stages (tetrathyridia) can cause life-threatening peritonitis and pleuritis in several species including dogs, cats, non-human primates and, most likely, humans (Széll *et al.*, 2015). In our study, *Mesocostoides* spp. tapeworms were found in 40 % (16/40) of red foxes, with a mean infection intensity of 8 individuals (table 1). Széll *et al.* (2015) reported a similar prevalence of *Mesocostoides* spp. tapeworms in red foxes from Hungary (45.8 %).

Our study also revealed the presence of *Taenia pisiformis* (in 10 % 4/40 of red foxes), with a mean infection intensity of 1 individual (Table 1). The natural life cycle of *Taenia pisiformis* includes canines as normal definitive hosts and lagomorphs as typical intermediate hosts. *Cysticercus pisiformis*, the larval stage of *T. pisiformis*, can bring about economic impacts in rabbit breeding and cause serious health problems to the host, including liver lesions, digestive disorders, growth retardation, weight loss, and even death (Rajasekariah *et al.*, 1985). Rataj *et al.* (2013) reported a 2.1 % prevalence of *Taenia pisiformis* in red foxes from Slovenia. Our study revealed a 40 % (16/40) prevalence of *Echinococcus multilocularis* - the most dangerous zoonotic parasite for man - with a mean infection intensity of 1000 individuals (Table 1). Alveolar echinococcosis is a rare human disease that is often lethal if left untreated (Szilágyiová *et al.*, 2015). It is caused by *Echinococcus multilocularis* at the larval stage. In Central Europe, the main definitive host of *E. multilocularis* is red fox. Red foxes from our monitored region (Northwest Bohemia) can wander into areas populated by humans, dogs and other domesticated animals, and can pose a significant threat to these inhabitants.

Conclusion

The tapeworm *Echinococcus multilocularis* and roundworm *Toxocara canis*, which possess severe zoonotic potential, were observed in red foxes from the monitored area. For this reason, these individuals were treated monthly with anthelmintic bait (50 bait pieces/km²) for an entire year following the study.

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