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The red fox (*Vulpes vulpes* L.) as a source of zoonoses

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ABSTRACT

The red fox (*Vulpes vulpes*) is the most widespread and abundant predator on earth, living in almost all habitats of the Northern Hemisphere, such as woodlands, mountains, deserts or even suburban and urban environments. Moreover, the red fox is the main carrier and vector species of the most important endemic zoonoses, as fox tapeworm *Echinococcus multilocularis*, *Toxocara canis* and nematode *Trichinella* spp. This makes the fox a highly controversial and emotional species with great potential public involvement and of fundamental importance as far as management issues are concerned. The expansive spread of *E. multilocularis* from endemic areas to territories of surrounding countries has not been stopped. The first confirmed finding of *E. multilocularis* in Slovakia was recorded in 1999. The present research is to study of *E. multilocularis*, *T. canis* and *Trichinella* spp. infection in red foxes in the east Slovak region over a 5 year period. A total of 302 red foxes (*Vulpes vulpes*) were examined in the period from 2000 to 2004. Coprological examination, necropsy, digestive method, intestinal scraping technique (IST), sedimentation and counting technique (SCT) were used. During the 5 - year survey period, *T. canis* was found in 78 (25.82%), *Trichinella* spp. in 7 (2.3%) and *E. multilocularis* was found in 32 (10.6%) from a total 302 examined foxes. The prevalence of *E. multilocularis* increased from 9.4% in 2000 to 25.0% in 2002. In 2003, the prevalence was 7.5% and 12.5 % in 2004. A total of 32 foxes were shown to be positive by SCT, were divided according to the number of tapeworms found into: low, medium and high worm burden. Over the whole 5-year period most foxes were included into the low burden class (68.75%), then into medium (25.5%), and high (6.25%). The mean intensity of *E. multilocularis* infection during the survey was 155 worms.

Key words: red fox, *Echinococcus multilocularis*, *Trichinella* spp., *Toxocara canis*, zoonosis, prevalence

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Introduction

There are many diseases that can be linked to transmission from not only domestic but also from wild animals. The greater abundance of wild animals, mainly the red fox, may contribute to the wider distribution and increasing prevalence of their parasites (*Echinococcus multilocularis*, *Trichinella* spp., *Toxocara canis*). Zoonotic infections can be transmitted directly from the environment when infective stages of parasite contaminate water or food.

In several European countries a distinct increase of red fox (*Vulpes vulpes*) populations has been observed in recent years, particularly in urban areas. As a result, foxes live today in close vicinity to humans and their pets in many cities on the European continent.

E. multilocularis is the causative agent of alveolar echinoccocosis in humans (AE), a serious zoonosis of public health significance. It caused up to 100% fatality in untreated patients before the 1970s, when modern methods of treatment had not been established (DEPLAZES and ECKERT, 2001).

The cycle of *E. multilocularis* in Europe is predominantly sylvatic, involving the red fox (*Vulpes vulpes*) as the definitive host and rodents as intermediate hosts (i.e. *Arvicola terrestris*). In some countries, dogs and cats have been identified as definitive hosts; however, all definitive hosts acquire the infection from the sylvatic cycle by consuming rodents.

The parasite has an extensive geographical distribution in the northern hemisphere extending from central Europe throughout northern and central Eurasia to the Far East, including Japan, and North America (ECKERT et al., 2000; DEPLAZES and ECKERT, 2001; WHO/OIE, 2001).

By the end of the 1980s, endemic areas were known to exist in France, Austria, Germany and Switzerland. At this time, the infection rate of red foxes increased enormously, and also included regions in Belgium, Denmark, Liechtenstein, Luxemburg, the Czech Republic, the Slovak Republic, Poland, Netherlands and Hungary (DUBINSKY et al., 1999; ECKERT and DEPLAZES, 1999; KOLAROVA, 1999; ROMIG et al., 1999; ECKERT et al., 2000; SRETER et al., 2003).

T. canis is a causative agent of larval toxocarosis in humans. The role of the red fox (*Vulpes vulpes)* in the dissemination of eggs of *T. canis* into the environment is significant. A large number of epidemiological surveys were undertaken of this ascarids nematode. Red foxes showed 8.1 to 61.3% prevalence of *T. canis* (RICHARDS et. al., 1993; PFEIFER et. al., 1997; LUTY, 2001; MIZGAJSKA, 2001; SMITH et al., 2003; ANTOLOVA et al., 2004).

Infection of *Trichinella* spp. is widespread among wildlife in Slovakia and the red fox

is the main reservoir of *Trichinella britovi* (HURNIKOVA et al., 2005). The epidemiology of trichinellosis in our country is characterised by a sylvatic cycle, with the prevalence of infection ranging from 2.3% to 16.3% (DUBINSKÝ et al., 2003; LETKOVÁ et al., 2005). In view of the considerable public health significance of *T. canis*, *Trichinella* spp. and *E. multilocularis*, there is an urgent need to evaluate all factors that might influence the spread of this infection.

Materials and methods

In the period from 2000 to 2004, a total of 302 red foxes originating from East Slovakia district were examined. All the red foxes were shot by hunting and prior to examination they were sent to the State veterinary and Food Institute for rabies control.

Helminthological autopsy, digestive method, intestinal scraping technique (HOFER et al., 2000) and sedimentation counting techniques (HOFER et al., 2000) were used.

Intestinal scraping technique (IST). The small intestine was opened in full length. After removal of rough material, deep mucosal scraping was performed using microscope slides and adherent material transferred to a square Petri dish. Scrapings squashed between slides and Petri dishes were examined under a stereoscopic light microscope. Five mucosal scrapings from the proximal, medium and posterior third of the small intestine were prepared.

Sedimentation and counting technique (SCT). The small intestine was cut into five pieces and incised longitudinally. All pieces were placed in a 1l bottle containing water and the mucosa layer was stripped by fingers. After shaking and 30 min of sedimentation, the supernatant was removed and the sediment was washed with water on a 1.5 mm mesh size filter to discard undigested particles. The washed fraction was collected in a conic glass and sedimented for 1 hour. The supernatant was then removed and after stirring the sediment was examined in small portion of 10 ml in a Petri dish under a stereomicroscope (RAOUL et al., 2001). According to the number of tapeworms found, necropsy results were categorized into three classes of infection: low worm burden (1 – 100 worms), medium worm burden (101 – 1000 worms) and high worm burden (>1000 worms) (EWALD and ECKERT, 1993). *E. multilocularis* tapeworms were identified following the morphological criteria of VOGEL (1957) and THOMPSON (1995). Sedimentation and counting technique (SCT) should be considered the "gold standard" for test comparison (DEPLAZES and ECKERT, 2001).

The tapeworms were ascertained, counted, and subsequently washed and stored in 70% ethanol.

Results

During the 5 - year period *T. canis* was found in 78 (25.82%). *Trichinella* spp. in 7 (2.3%) and *E. multilocularis* in 32 (10.6%) from a total of 302 red foxes examined (Table1). All foxes were shot in the east Slovakia region at a distance of 15 – 50 km from the town of Košice. At the beginning of *E. multilocularis* monitoring in 2000, the prevalence rate was 9.4%, then it has rose to 25.0% in 2002. In 2003 it was 7.5% and 12.5% in 2004.

Table 1 Prevalence of helminths in red foxes during five years period (2000 – 2004)

Species of helminths	Number of animals	Positive	%
Mesocestoides spp.	302	185	61.23
Dipylidium caninum		6	1.99
Taenia spp.		63	20.86
Echinococcus multilocularis		32	10.6
Toxocara canis		78	25.82
Toxascaris leonina		53	17.55
Ancylostoma caninum		17	5.63
Uncinaria stenocephala		6	1.98
Trichuris vulpis		21	6.9
Trichinella spp.		7	2.3

The mean intensity of *E. multilocularis* infection during the survey was 155 worms. Most of the foxes were included in the low burden class (68.75%), then medium (25.5%), and high (6.25%) (Fig.2). Both, age and sex differences in the prevalence were observed. In our study there were no differences in both categories.

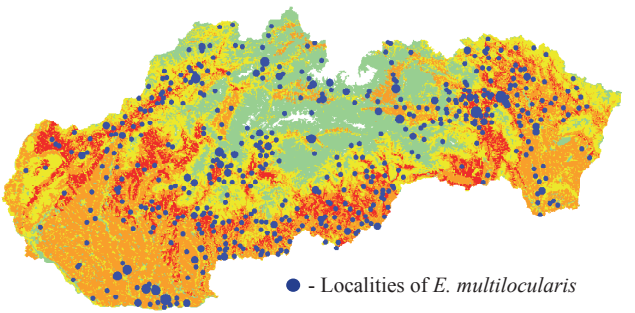

Fig. 1 Occurrence of *E. multilocularis* in 2000 - 2002 (DUBINSKÝ et al., 2003)

Discussion

The prevalence of *Trichinella* in foxes ranged from 2.3% to 16.3%. *Trichinella* larvae from foxes were identified as *T. britovi* (HURNIKOVA et al., 2005) (Fig.1). In Italy POZIO et al. (1992) in vulpine isolates from 1462 foxes were identified as *T. britovi*. The prevalence of trichinellosis in the red fox population was higher in the mountain areas than in the lowland and indicates the key role played by this carnivore in the epidemiology of *T. britovi* (ROSSI et al., 1992).

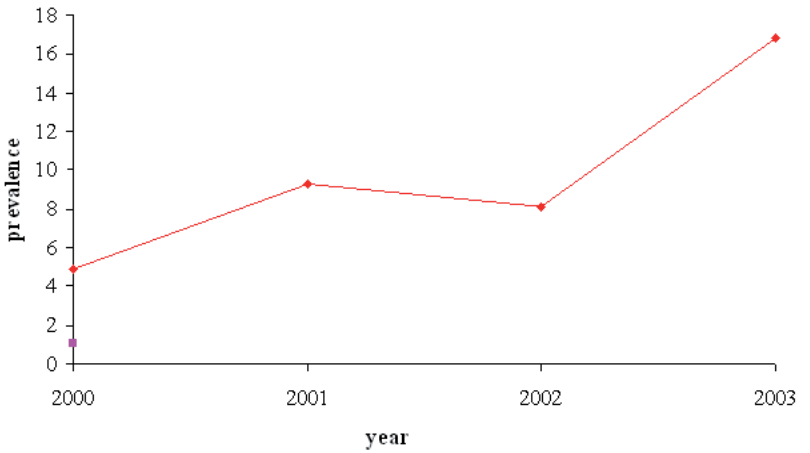

Fig. 1 Prevalence of red foxes trichinellosis in Slovakia during 2000 -2003 (DUBINSKÝ et al., 2003)

The high prevalence of *Toxocara* in foxes results in the contamination of soil with infective eggs of *Toxocara* spp. which are found in soil samples from urban, suburban districts, public and private places worldwide. Age–prevalence and age–intensity profiles show that worm burdens are significantly higher in cubs than in subadult or adult foxes and higher in subadults than in adult foxes. Seasonal variations in worm burdens occur, with the highest prevalence and intensities being found during the spring, when cubs are born, and in summer months (RICHARDS et al., 1993).

Human alveolar echinococcosis (AE), caused by the metacestode stage of *E. multilocularis*, is a serious zoonosis. In recent years, infection with the metacestode stage of *E. multilocularis* has not only been diagnosed in humans in several regions, including at least eight countries in central Europe, but accidental infections with the

metacestode stage of *E. multilocularis* have been observed in various animal species (dog, domestic pig, wild boar, nutria and monkeys). The mean annual incidence rates of alveolar echinococcosis in humans are low, varying between 0.02 and 1.4 cases per 100,000 inhabitants in several European countries and regions (ECKERT, 1997).

Recently, the parasite has spread to new regions in Europe and the proportion of foxes carrying the disease has increased. This has been aided by the increase in fox numbers. Furthermore, parasite-carrying foxes have also been encountered near and within large towns.

These and other factors may lead to an infection risk for human. This parasite is endemic in Belgium, Luxembourg, France, Switzerland, Liechtenstein, Austria, Germany, Poland, the Czech Republic, the Slovak Republic and Hungary. The prevalence rates of E. multilocularis in foxes are alarmingly high in some areas with average rates > 40% (DUBINSKÝ et al., 2003) (Fig.1). Infection rates in dogs and cats are much lower. In recent years accidental infections with the metacestode stage of *E. multilocularis* have been observed in various animal species (dogs, domestic pigs, wild boar, nutria and monkeys) and in humans. The mean annual incidence rates of alveolar echinococcosis in humans are low, varying between 0.02 and 1.4 cases per 100,000 inhabitants in several European countries and regions (ECKERT, 1997)

Prevalence of *E. multilocularis* in red foxes differs widely within and between endemic areas from about 1% to over 60% (LUCIUS and BILGER, 1995; ROMIG et al., 1999; ECKERT et al., 2000). The appearance of *E. multilocularis* in Slovakia was first recorded in 1999 (DUBINSKÝ et al., 1999) and it seems to have a growing tendency. In the current study the E. multilocularis prevalence in East Slovakia was 9.4 to 25%. A similar pattern was observed in other regions of Slovakia (MITERPÁKOVÁ et al., 2003).

According to most of authors, age is not regarded as an important factor influencing the *E. multilocularis* prevalence in definitive hosts. In Europe, a few surveys revealed that foxes younger than 1 year exhibited higher prevalence rate and intensity of infection than adults (BALLEK et al., 1992; EWALD and ECKERT, 1993; WESSBECHER et al., 1994), whereas in other studies no significant age dependent differences were detected (TACKMANN et al., 1998; HOFER et al., 2000). Information on the relationship between fox sex and prevalence of E. multilocularis is conflicting. Some studies revealed no effect of the sex of foxes on *E. multilocularis* prevalence (MITTERPÁKOVÁ et al., 2003). Also in the current study there were no sex and age differences in red foxes regarding the prevalence of *E. multilocularis*.

As wildlife is an essential component in the epidemiology of many, if not most, zoonoses, it should be taken into account in the risk analysis framework. To increase the

capability of recognizing zoonoses within a wildlife reservoir, better national surveillance systems for humans and animals are needed, as well as better international integration and sharing of information from such systems. More research is needed to better understand the epidemiology and pathogenesis of various zoonoses, to improve diagnostic methods, and to develop cost-effective vaccines and drugs.

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SAŽETAK

Lisica kao najrasprostranjeniji grabežljivac na Zemlji, nastanjuje gotovo sva staništa sjeverne polutke, od šuma, planina, pustinja pa sve do predgrađa i samih gradova. Lisica je također i glavni prijenosnik i širitelj uzročnika značajnih zoonoza poput lisičje trakavice (*Echinococcus multilocularis*), trihinela (*Trichinella* spp.) i pseće trakavice (*Toxocara canis*). Navedeno čini lisicu vrlo kontroverznom i značajnom vrstom. Ovaj rad potvrđuje prisutnost lisičje trakavice, pseće trakavice i trihinela u populaciji lisica na području Slovačke u razdoblju od 5 godina. Od 2000. do 2004. godine, metodama koprološke pretrage, razudbe, umjetne probave, sedimentacije i pregledom strugotina crijeva pretraženo je ukupno 302 uzorka lisica. U tom je razdoblju utvrđena prisutnost *T. canis* u 78 (25,82%), *Trichinella* spp. u 7 (2,3%) i *E. multilocularis* u 32 (10,6%) od ukupno 302 pretražene lisice. U razdoblju od 2000. do 2002. godine učestalost *E. multilocularis* je porasla s 9,4% na 25,0%. U 2003. godini zabilježena je učestalost od 7,5%, a u 2004. od 12,5%. Ukupno 32 lisice pozitivne na pretragu crijevnih strugotina podijeljene su prema broju trakavica na slabo, srednje i visoko invadirane. Tijekom cjelokupnog razdoblja većina je lisica svrstana u kategoriju slabo invadiranih (68,75%), zatim u srednje invadirane (25,5%) i visoko invadirane (6,25%). Srednja učestalost *E. multilocularis* je iznosila 155 parazita.

Ključne riječi: lisica, *Echinococcus multilocularis*, *Trichinella* spp., *Toxocara canis*, zoonoze, učestalost