Trends in game meat hygiene
From forest to fork

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13. Sylvatic trichinellosis in the Vojvodina region (Serbia)

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Summary

Trichinellosis is a parasitic zoonosis caused by larvae of genus Trichinella. Serbia belongs to a group of countries where Trichinella is present in domestic animals, but also in synanthropic and sylvatic animals. The research on trichinellosis that has been carried out in Serbia so far, aimed at reducing the risk of transmission of trichinellosis to people and at reducing economic losses in pig production. However, sylvatic trichinellosis has been poorly studied. In this paper data on the life cycle of Trichinella in sylvatic populations is presented as well as those on the prevalence of trichinellosis in Vojvodina, with the purpose to determine the role of sylvatic animals in the natural cycle of Trichinella in Serbia. The given data point out that implementing measures for reducing trichinellosis in domestic animals need to include those that prevent the transmission of trichinellosis from domestic pigs to sylvatic animals.

Keywords: Trichinella, wildlife, domestic animals

13.1 Introduction

Trichinellosis is a parasitic zoonosis caused by larvae of the genus Trichinella. In Europe, wildlife represents the most important reservoir of Trichinella, which makes eradication impossible and explains why the parasites continue to circulate, even though the prevalence in wildlife can be very low for many years (Rafter et al., 2005). In Serbia, the endemic regions for trichinellosis are Srem, the valleys of the Danube, Drina and Kolubara (Cuperlovic et al., 1989). The domestic pig is the main reservoir of trichinellosis for humans and the infection usually occurs after consumption of undercooked meat that contains live worms. The average annual prevalence of trichinellosis in endemic regions of Serbia over the period 1995-2004 in domestic pigs was 0.42%. In the same period human trichinellosis was diagnosed in 432 persons (Tesic et al., 2011). Serbia belongs to a group of countries where Trichinella spiralis is present in domestic but also in sylvatic and synanthropic animals. Synanthropic animals are species of wild animals that live near to and benefit from humans and include some species of rodents and pigeons (Cvetkovic et al., 2011; Petrovic et al., 2012; Pozio, 2007). Research on trichinellosis, carried out in Serbia so far, aimed at reducing the risk of transmission of trichinellosis to humans and at reducing economic losses in pig production, but sylvatic trichinellosis has been poorly studied. Meat inspection of wild boars and bears is required.
after each hunt. The data on prevalence of *Trichinella* in other wild animal species are scarce (Brglez, 1988).

In this paper data on live cycle stages of *Trichinella* in sylvatic population and on the prevalence of trichinellosis in some areas in Vojvodina are presented, with the purpose to determine the role of domestic animals in the natural cycle of *Trichinella* in Serbia.

### 13.2 Trichinella

Several species belong to the genus *Trichinella*: *T. spiralis*, *T. britovi*, *T. nativa*, *T. pseudospiralis*, *T. papuae*, *T. nelsoni*, *T. murrelli*, *T. zimbabwensis* and three unclassified genotypes: T6, T8 and T9 (Murell et al., 2000; Nagano et al., 1999). Conventional microscopy cannot determine the type of *Trichinella* because there are no morphological differences between the various *Trichinella* species. *Trichinella* species differ in their characteristics (the ability to form capsules, the resistance to freezing, and the production of newborn larvae), which determine the susceptibility of animal species to different types of *Trichinella*.

Trichinellosis is an endemic disease which is present in most EU countries. In Europe four species have been diagnosed so far: *T. spiralis*, *T. pseudospiralis*, *T. britovi* and *T. nativa* (Cvetkovic et al., 2011; Pozio, 2000, 2007).

*T. spiralis* is widespread around the world and is most frequently found in domestic and wild pigs, and compared to other strains of *Trichinella* is the most pathogenic for humans. It is the only *Trichinella* species which is highly infective for domestic pigs, rats and mice, but also for sylvatic animals, including wild pigs, bears, rodents, foxes and jackals. Compared to other species, *T. spiralis* has the highest production of newborn larvae in vitro and is the least resistant to freezing (Murell et al., 2000; Pozio, 1998, 2000, 2007).

*T. britovi* is found in wild animals. It is the second most spread *Trichinella* species in humans and it is widespread in Europe, Asia, North and West Africa. It is infectious to sylvatic carnivores (wolves, jackals, foxes), sylvatic omnivores (bears, wild boars) and domestic pigs, horses and humans. Biological characteristics are very similar to *T. spiralis* and are characterised by low infectivity for rats, greater resistance to freezing and moderate infectivity for swine. It is transmitted primarily among sylvatic hosts, probably due to the low reproductive capacity in pigs and synanthropic rodents. The first cases in Serbia were reported by Cvetkovic et al. (2011), and it prevails in the neighbouring countries: Bulgaria, Romania, Croatia, Italy and Macedonia (Murell et al., 2000).

*T. pseudospiralis* has been detected in wild animals in Italy, France, Russia, Lithuania, Sweden, Slovakia, the Netherlands and Finland. *T. pseudospiralis* is slightly smaller than other *Trichinella* species. In addition to *T. papuae*, it is the only type of *Trichinella* that does not form a capsule. *T. pseudospiralis* is infectious to birds and mammals, has low reproductive capacity in the body of rats and moderate in pig. It may be rarely found in animals and humans, but cases of human trichinellosis caused by *T. pseudospiralis* (Cvetkovic et al., 2011; Pozio, 1998, 2000, 2007) are recorded across the world.
T. nativa may be found in sylvatic animals which live in cold areas. It has been reported in mammals in the region of the Baltic Sea, but is not expected in game in Serbia. T. nativa is resistant to freezing. Compared to T. spiralis, T. nativa is not highly infective for domestic pigs and rats, provokes a strong immune response in domestic pigs and can be found in the muscles of young animals. Human trichinellosis caused by T. nativa is extremely rare and such cases have been reported in literature where the source of infestation was black bear meat (Hill et al., 2005; Murell et al., 2000).

13.3 Human trichinellosis in the Vojvodina region

According to Ofori-Belic et al. (2010) the occurrence of human trichinellosis in Serbia shows a strong seasonality (P<0.0001), most of the cases occurring in winter. The incubation period ranges between 1 and 33 days. The average interval between onset of symptoms and admission is nine days. Family outbreaks are the most frequent, smoked pork products being the dominant source of infection (76%). Fever is the most frequent clinical manifestation (90%), followed by myalgia (80%) and periorbital edema (76%).

Our investigations (Urosević et al., 2013) presented in Table 13.1, covered the 9 years period from 2002 to 2011, in which in the Vojvodina region 983 humans became infected with Trichinella species: 56.45% male and 43.54% female. The highest numbers of patients were recorded in 2005 (277 persons) and in 2002 (275 persons). In these years 3 people died from trichinellosis.

Human trichinellosis is most common in the age group of 40 to 49 years (19.83%), followed by 30 to 39 years (17.50%). Trichinellosis is rare in children under 6 years (4.06%). The source of infection is usually traditional uncooked meat products, only salted and smoked. Eating habits have a direct influence on gender and age distribution of affected humans. These traditional products which are strong in taste and salty, are mostly eaten by adult males. Human trichinellosis often occurs as a result of the consumption of pork from domestic pigs slaughtered in the backyard and not having been inspected by a veterinarian. There was no correlation between the prevalence of infection among swine and the frequency of human outbreaks in the corresponding districts. Based on the analysis of the data obtained

<table>
<thead>
<tr>
<th>Humans</th>
<th>Age of infected humans</th>
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<tbody>
<tr>
<td>year</td>
<td>&lt;6</td>
</tr>
<tr>
<td>Male</td>
<td>17</td>
</tr>
<tr>
<td>Female</td>
<td>23</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
</tr>
<tr>
<td>%</td>
<td>4.06</td>
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from veterinary and medical authorities, Sofronic-Milosavljevic et al. (2013) suggest that the absence of human disease in the above mentioned districts reflects the effectiveness of control measures and public education conducted in the field.

Although in Serbia inspection of game meat for the presence of trichinellae is obligatory, several outbreaks related to the consumption of game meat have occurred.

13.4 The life cycle of *Trichinella* in the sylvatic habitat

Two ways of maintaining and transmitting *Trichinella* are distinguished, the cycle in domestic animals, and the sylvatic cycle. It is questionable whether the sylvatic cycle is independent from the cycle in domestic animals, and it is unknown to which extent game is a reservoir for *Trichinella*. The main indicators of the sylvatic cycle are: prevalence of trichinellosis in different species of wild animals, the degree of infestation and the species of *Trichinella*. In the sylvatic cycle, transmission of the parasite primarily occurs among carnivores (foxes, wolves, jackals), and to a lesser extent among omnivores (wild boar, bears and rats). The natural habitat and its characteristics influence the life cycle of *Trichinella*. Climatic conditions in Vojvodina favour the presence of *T. spiralis*, whilst both cold and tropical areas are unfavourable.

13.5 The prevalence and degree of *Trichinella* infestation in sylvatic animals in Vojvodina

In Serbia trichinellosis was found to occur in wild boars, foxes, jackals, raccoons, wolves, and bears (Cvetkovic et al., 2011). Regardless of the etiological agents and geographic region, the main reservoir of sylvatic *Trichinella* are carnivores with cannibalistic and scavenging behaviour (Campbell, 1983). So far, the red fox has been the main reservoir of sylvatic *Trichinella* in this area. However, the increasingly important role of jackals must be pointed out. The presence of jackals in Serbia has been evident for last 20 years. Coming over the Carpathian Mountain and across the Danube basin, the jackals first settled in eastern Serbia, and later expanded to Belgrade and the territory of Vojvodina. Today the jackal population is large. They inhabit different terrains and can be found in the lower mountains and on open hunting plains. The jackals are usually caught during wild boar hunting and hunting of other game. The increase in jackal population resulted in reducing the deer and fox population.

Our studies (Petrovic et al., 2012) determined a relatively high prevalence of *Trichinella* in jackals (8.33%), foxes (5%) and boars (1%) in the Vojvodina district. In the countries where trichinellosis of domestic animals has been eradicated, such as Denmark, the prevalence of sylvatic trichinellosis is very low (0.001%) (Enemark et al., 2000). The degree of infestation in omnivore and carnivore game in our country is higher (3 larvae/10 g) as compared with the countries without trichinellosis in domestic animals (e.g. Denmark 1 larva/10 g). Our investigations show that in wild boar infestation is very high, i.e. 1,100 larva/g (Petrovic et al., 2012). If the incidence of sylvatic trichinellosis in a particular geographical area is high, then the risk of the spread of infestations of domestic pigs is significant, especially in the grazing habitat.
Investigations conducted in eastern Serbia during the 2009-2010 period (Zivojinovic et al., 2013) showed that Trichinella infections occurred in 344 out of 282,960 (0.12%) domestic pigs. Trichinella infections in wildlife were detected in 11 out of 94 (11.7%) wild boars (Sus scrofa), 7 out of 57 (12.3%) red foxes (Vulpes vulpes), 7 out of 13 (53.8%) golden jackals (Canis aureus), and in all 3 examined wolves (Canis lupus). T. spiralis and T. britovi were the only 2 species identified. T. britovi was identified in 31% of isolates from wildlife of the Branicevo district and T. spiralis was found in 53% of wild animals; mixed infections were observed in 16% of the animals examined.

13.6 Different Trichinella species detected in sylvatic animals in Vojvodina

In Serbia T. spiralis and T. britovi have been detected in wild animals (Cvetkovic et al., 2011). In the area of Vojvodina only T. spiralis has been found (Petrovic et al., 2012). In the areas with high prevalence, two species of Trichinella were found in wild animals. It is likely that they were repeatedly infested. In Spain and Finland T. spiralis and T. britovi were detected in the same animal, whereas in Finland and Sweden T. nativa and T. spiralis, and in Estonia and Poland T. nativa and T. britovi were found (Pozio, 2000).

13.7 The role of Trichinella species in the cycle expansion in the Vojvodina region

The presence of T. spiralis in wild animals is related to the Trichinella in domestic animals. Murell et al. (1987) proved that jackals, foxes, rats and other synanthropic animals are a link between sylvatic and domestic animals’ trichinellosis if the infestation is caused by T. spiralis. The incidence of T. spiralis is directly related to the spatial proximity of habitat in which wild and domestic animals coexist. T. spiralis is rarely found in wild animals that live far away from villages and farms. Sylvatic Trichinella, such as T. britovi, can be found in domestic animals. However, this type of infestation presents the end of a life cycle because sylvatic Trichinella can be maintained only within sylvatic population of carnivores that live in a natural habitat (Pozio et al., 1998). The main factor responsible for the occurrence of T. spiralis in wild carnivores relates to their eating habits. Animals with cannibalistic and scavenging behaviour in a sylvatic habitat represent the pathway of spreading of sylvatic trichinellosis. However, in areas such as Vojvodina, where jackals and foxes live near human settlements and have access to the remainings of domestic animals, the risk of infestation with T. spiralis is increased.

Wild pigs are an important reservoir for the spread of Trichinella and are a direct source of infestation for humans. Very high infestation in wild pigs is not uncommon (Nöckler et al., 2006; Petrovic et al., 2012). In Serbia, there were several cases of human trichinellosis after consuming wild boar meat. Our studies confirm the presence of T. spiralis in sylvatic animals in Serbia. Besides domestic pigs, wild boars are the species most susceptible to this type of Trichinella. It is believed that the life cycle of T. spiralis may include circulation from domestic pigs to wild boars and vice versa, which is associated with behaviour of this animal species. Wild boars are very tolerant to the presence of humans and often graze in cultivated areas.
An important source of Trichinella for wild pigs and rats are improperly disposed slaughter by-products and offal, which may be found in the areas with inadequate veterinary-sanitary control.

The fact that T. spiralis prevails both in domestic pigs and wild animals hunted near human settlements can be explained by the common practice to raise pigs near rivers (e.g. Danube, Morava, Mlava, and Pek), small waterways and ponds where they can come in touch with wildlife. The husbandry conditions on 90% of these backyard farms are very poor due to the intentional feeding of food waste containing pork scraps, scavenging of pigs in garbage dumps, and the improper disposing of pig carcasses in the field (Zivojinovic et al., 2013).

Jackals are synanthropic animals and may present a link between sylvatic trichinellosis and domestic animals. If the prevalence of sylvatic trichinellosis in a particular geographical area is high, than a significant risk of spreading the infestation to domestic pigs exists. Sylvatic trichinellae, like T. britovi, may be found in domestic animals but this type of infection represents an end of their life cycle because they can survive only among populations of sylvatic carnivores living in natural ecosystems (Pozio et al., 1998). According to our previous studies (Petrovic et al., 2012) T. spiralis can be found in jackals from Vojvodina. The key factor responsible for the presence of T. spiralis is the feeding behaviour of jackals. Cannibalism and scavenger behaviour occur more frequently in the wilderness than in areas like Vojvodina, because animal remains are not an attractive food source for jackals living near human habitats where other food sources, such as rubbish dumps and domestic animals are accessible.

13.8 Conclusions

13.8.1 What has been achieved?

The presence of T. spiralis in sylvatic animals is strictly related to trichinellosis in domestic animals. Murell et al. (1987) reported that jackals, foxes, rats and other synanthropic animals present a link between sylvatic and trichinellosis in domestic animals caused by T. spiralis. Spread of T. spiralis is directly influenced by the vicinity of habitats where domestic and wild animals live. T. spiralis is rarely found in sylvatic animals which live far away from farms. The T. spiralis from jackals may return to the domestic habitat when humans fail in the management of wildlife by pasturing domestic pigs in or near wild areas (which is common in some regions of Vojvodina) and feeding domestic animal with offal of sylvatic animals.

Sylvatic animals serve as reservoirs of Trichinella infestation. Trichinellosis in the domestic pig population increases the risk of spreading the infestation from domestic animals to rats and wild boars, and further on to sylvatic carnivores as evidenced by the prevalence of T. spiralis in wild animals.

13.8.2 What has been neglected?

The spread of trichinellosis is influenced by poor socioeconomic conditions, insufficient education of hunters and farmers, insufficient veterinary control and improper disposal
of dead animals. Prevalence of trichinellosis of domestic swine is high in Serbia and it is a significant risk for human health but also for sylvatic animals. These data suggest that preventive measures for reduction of trichinellosis in domestic animals should include measures for reduction of spread of trichinellosis to sylvatic animals.

13.8.3 What needs to be done?

A decrease in Trichinella prevalence in domestic as well as in sylvatic animals can be achieved by the continued application of the control programme which is based on: (1) systematic rodent control and improvement of biosafety measures at pig production facilities; (2) anthelmintic treatment of pigs with mebendazole; (3) the tracing of infected animals; and 4) the education of farmers, hunters and consumers (Zivojinovic et al., 2013).

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References


