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Full Research Article

THE FIRST RECORD OF *MOLINEUS PATENS* (Dujardin, 1845) IN FOXES (*Vulpes vulpes* L.) IN SERBIA AND THE WESTERN BALKANS

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Abstract

The red fox (*Vulpes vulpes* L.) has the widest global distribution among terrestrial carnivore species and is an important reservoir for a range of parasites. Investigations on parasitic fauna of red foxes have intensified in recent years in Serbia, resulting in the detection of some parasites that have not been recorded before. Within the Programme for the Control and Eradication of Rabies in Serbia, from January to March 2019, 52 legally hunted foxes were was established by standard methods, i.e. dissection followed by microscopic examination. Internal organs of the hunted animals were examined for the presence of parasites. Parasite identification was based on morphological characteristics. Parasites were found in 23 (44.23%) foxes. Eight species of parasites were established, among which, the nematode *Molineus patens* (Dujardin, 1845) was discovered in the small intestine of five foxes (9.61%). The intensity of *M. patens* infection varied from 17 to 43 parasites. To the best of our knowledge, this is the first record of *M. patens* in red foxes in Serbia and in the Western Balkans.

Key words: *Molineus patens,* nematoda, red fox (*Vulpes vulpes* L), Serbia

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INTRODUCTION

The red fox (*Vulpes vulpes* L.) has the widest global distribution among terrestrial carnivore species, occupying most of the northern hemisphere in its native range (Castello, 2018). In many European countries over the past several decades, a dramatic increase in the distribution and density of the red fox population has occurred (Castello, 2018; Vervaeke et al., 2005). Foxes have adapted to a wide range of habitats and have a highly varied diet (Contesse et al., 2004; Segovia et al., 2004). This opportunistic feeding behavior has played an important role in the recent colonization of urban and semi-urban areas (Castello, 2018; Lavriviére and Pasitschniak-Arts, 1996).

The situation is similar in the Belgrade area. The wider area of Belgrade is predominantly rural with much arable land, pastures and branched watercourses. The red fox is widespread in the area of South Banat, South Srem and the forested part south of the Sava and Danube Rivers (Šumadija). The urbanization that has taken place in recent decades has incorporated most of these spaces into the wider city core, followed by the relentless expansion of often illegally constructed housing (Pavlović, 1994). This anthropomorphic activity has affected indigenous animal species inhabiting this area. Some species have adapted to these drastic changes in habitat, but some have disappeared. However, the red fox is certainly among those species that have adapted best (Pavlović, 1994).

Research on the parasitic fauna of foxes in Belgrade the area commenced with Lozanić (1965) and later, Pavlović (1994). Since 1988, research on this topic has been conducted continuously and has been extended to the entire territory of Serbia. Consequently, we have an insight into the parasitic fauna of the red fox and periodically, we have recorded species that were not previously present in foxes from Serbia (Pavlović et al., 2008; 2006; 2001; Pavlović, 1994;). The latest newly discovered species is *Molineus patens*, recorded in 2019 and reported here for the first time.

MATERIALS AND METHODS

Whole corpses of hunted foxes (n = 52) were collected from January to March 2019 during a monitoring program on the efficacy of oral rabies vaccination of red foxes and other wild carnivores in Serbia, conducted according to instructions from the Veterinary Department of the Ministry of Agriculture, Forestry and Water Management.

The presence of parasites in internal organs from the hunted foxes was established by standard methods, i.e. dissection followed by macroscopic examination. The identification of parasites was based on their morphological characteristics (Skrjabin et al., 1954).

RESULTS

Parasites were found in 23 (44.23%) of the examined foxes. The nematode *M. patens* (Dujardin, 1845) occurred in the small intestine of five foxes. The intensity of infection ranged from 17 to 43 parasites. The ratio of male:female parasites was 1:4.

The average body length of male parasites was 6.4 mm with maximum width of 0.141 mm at the level of the tail base. The head vesicle was relatively long (Figure 1) and the length of esophagus was 0.311±0.001mm. Ventral rib of bursa copulatrix lengths: ventro-ventral 0.099±0.002 mm, latero-ventral 0.087±0.001 mm. Lateral rib lengths: externo-lateral 0.097±0.004, medio-lateral 0.126±0.003 mm and postero-lateral 0.127±0.001. Externo-dorsal rib length: 0.100±0.001 mm. Length of spicules: 0.195±0.004 mm and 0.207±0.003 mm. Gubernaculum measurements: length 0.112±0.001 mm and width 0.009±0.002 mm (Figure 2).

Figure 1. *Molineus patens*, head of a parasite

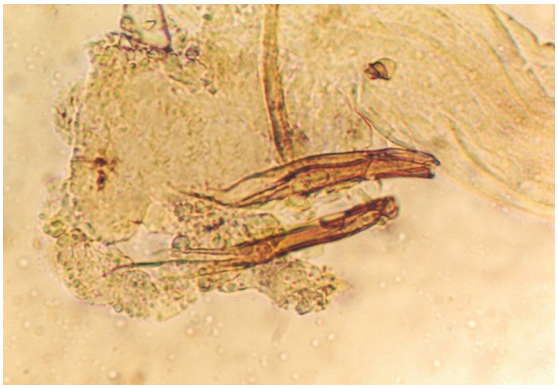

Figure 2. *Molineus patens,* gubernaculum of a male parasite with spicules

The average body length of females was 8.2 mm and maximum width was 0.05 mm. The posterior end of the female is pointed and ends in a thin spine 0.018 mm long (Figure 3).

Figure 3. *Molineus patens,* posterior part of a female parasite

DISCUSSION

M. patens belongs to the genus *Molineus*, family *Molineidae*, order Strongylida. The parasite was first described by the French biologist Félix Dujardin (Dujardin, 1845). The parasite is rather specific for mustelids (badger, mink, ermine, stone marten, etc.) and is established throughout the world (Popiołek et al., 2009; Di Cerbo et al., 2008; Shimalov and Shimalov, 2001). The infection likely occurs accidentally in foxes through predation on intermediate or definitive hosts (Suchentrunk and Sattmann, 1994). In ex-Yugoslavia, the parasite was recorded for the first time in a badger in Serbia by Bošković and Valter (1979) and later in Slovenia by Paradižnik (1983).

Female parasites lay small eggs measuring 0.63-0.65 x 0.037-0.042 mm which, in the morula stage, are passed in the host's feces. The development cycle of this parasite is not fully clarified, but is assumed to be similar to the development of *Molineus barbatus,* parasites of raccoon (*Procyon lotor*) and skunk (*Mephitis mephitis*) in North America (Anderson, 2000).

We are witnesses of global changes in climatic conditions, novel biotic and abiotic factors in natural habitats and constant pollution of the environment. These degradative changes are reflected in wild animals, and particularly in foxes, the natural habitats of which often become parts of the suburbs of large cities (Contesse et al., 2004). Foxes have consequently changed some of their habits, adapting and expanding their menu (poultry, slaughter confiscations, food waste) and getting much closer to human settlements than in the past. In Serbia, this has led to a change in the parasitic fauna of foxes, which are now being infected with species of parasites that were not previously present in this area. During the thirty-year research on the parasitic fauna of foxes in the Belgrade area and other parts of Serbia, more than 30 species of helminths have been found. During this period, a significant change in the biodiversity of fox parasitofauna was established. Parasitic species such as *Diphyllobothrium latum, Mesocestoides litteratus, Spirocerca lupi, Echinococcus multilocularis* and *Angiostrongylus vasorum*

(Gavrilović et al., 2018; Lalošević et al., 2018; Pavlović et al., 2008, 2004, 2001), which were not previously present in the Western Balkans, were identified.

The present investigation revealed *M. patens* in 9.6% of investigated foxes. This prevalence is similar to that reported from other European countries where this nematode has been recorded in foxes: 1.3% in Austria (Suchentrunk and Sattmann, 1994), 3.6% in Ukraine (Varodi et al., 2017), 4.8% in Portugal (Eira et al., 2006), 5.1% in the Netherlands (Borgsteede, 1984) and 7.3% in Germany (Mramor, 2001). Only Slovenia has a higher prevalence of this parasite in foxes – 30.6% was reported (Vergles Rataj et al., 2013).

CONCLUSION

To the best of our knowledge, this is the first report of *M. patens* in red foxes in Serbia and in the Western Balkans. The present finding contributes to the knowledge of the geographical distribution of *M. patens*.

Authors' contributions

IP performed parasitological examination and identification of parasites. PG cooperated in parasitological and patho-morphological examinations. NZ worked on processing photo documentation and proofreading. SS performed epidemiological research and sampling. DV and JK participated in drafting the paper.

Competing interests

The authors declare they have no conflict of interest.

The results presented in this paper were shown in the form of a short communication at the 24th Annual Counseling of Doctors of Veterinary Medicine of the Republic of Srpska (Bosnia and Herzegovina) International Scientific Meeting Bijeljina, Ethno Village Stanišići, June, 12th-15th, 2019. The paper was not published in its entirety or sent to any other journal.

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PRVI NALAZ *MOLINEUS PATENS* (Dujardin, 1845) KOD LISICA (*Vulpes vulpes* L.) U SRBIJI I NA ZAPADNOM BALKANU

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Kratak sadržaj

Lisica (*Vulpes vulpes* L.) ima najširu globalnu rasprostranjenost među kopnenim mesojedima i važan je rezervoar za mnoge parazite. Istraživanja parazitofaune lisica intenzivirana su poslednjih godina u Srbiji što je dovelo do otkrivanja nekih parazita poput *Molineus patens* (Dujardin, 1845) koji ranije nisu bili ustanovljeni. U okviru programa kontrole i iskorenjivanja besnila u Srbiji, u periodu od januara do marta 2019, 52 legalno ulovljene lisice ispitane su primenom standardne metode parazitološke sekcije. Unutrašnji organi ulovljenih životinja ispitani su na prisustvo parazita. Determinacija parazita je rađena na osnovu morfoloških karakteristika. Prisustvo parazita je nađeno kod 23 (44.23%) lisice, a ukupno je ustanovljeno osam parazitskih vrsta. U tankim crevima pet lisica (9.61%) ustanovljena je nematoda *M. patens* (Dujardin, 1845). Broj nađenih primeraka je bio od 17 do 43 parazita. Ovaj nalaz je prvi nalaz *M. patens* kod lisica u Srbiji i na zapadnom Balkanu.

Ključne reči: nematoda, *Molineus patens*, lisica (*Vulpes vulpes* L), Srbija