Review article

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EPIZOOTIOLOGICAL AND CLINICAL SIGNIFICANCE OF *STEPHANURUS DENTATUS* NEMATODE IN SWINE

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Abstract

Stephanuriosis is a disease of the urinary tract of both domestic pigs and wild boars occurring in tropical and subtropical regions, with a tendency to spread to other geographical areas. In endemic areas, the disease occurs more often in extensively bred herds, normally with nonspecific clinical picture. As a result of larval stage migrations and parasitism of adult forms of nematode *Stephanurus dentatus*, the damage occurs in the liver, kidneys, ureters, lungs, pancreas and perirenal adipose tissue. Damage to the liver is reminiscent of lesions caused by *Ascaris suum*, which is of particular clinical significance for differential diagnosis of parasitic swine diseases. *Stephanurus dentatus* is of great economic importance due to direct and indirect damage it causes. Infected animals delay in reaching market weight, their meat is declared unfit for consumption, and they are sent to forced slaughter. Examinations of potential presence of this parasite in Serbia should include populations of wild boars and domestic pigs from extensive traditional breeding outdoors. After intense climate changes that have occurred in recent decades, and also due to the possibility of importing infected animals from endemic areas, the proposed research would have both epizootiological and clinical significance.

Key words: pig, stephanuriosis, diagnosis, control, economic significance

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EPIZOOTIOLOŠKI I KLINIČKI ZNAČAJ NEMATODE *STEPHANURUS DENTATUS* KOD SVINJA

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Kratak sadržaj

Stefanurioza je oboljenje urinarnog trakta domaćih i divljih svinja u tropskim i suptropskim regijama, sa tendencijom širenja i na ostala geografska područja. U endemskim oblastima, oboljenje se češće javlja u zapatima koji se gaje ekstenzivno i protiče sa nespecifičnom kliničkom slikom. Kao posledica migracije larvenih stadijuma i parazitiranja odraslih oblika nematode *Stephanurus dentatus*, nastaju oštećenja na jetri, bubrezima, ureterima, plućima, pankreasu i perirenalnom masnom tkivu. Oštećenja koja nastaju u jetri podsećaju na lezije uzrokovane larvama *Ascaris suum*, što je od posebnog kliničkog značaja za diferencijalnu dijagnozu parazitskih oboljenja svinja. Zbog direktnih i indirektnih šteta koje prouzrokuje, *S. dentatus* ima veliki ekonomski značaj. Inficirane životinje kasne u postizanju tržišne težine, njihovo meso se proglašava neupotrebljivim i upućuju se na prinudno klanje. Ispitivanja eventualnog prisustva ovog parazita u Srbiji trebalo bi da obuhvate populaciju divljih svinja i domaće svinje iz ekstenzivnog tradicionalnog gajenja na otvorenim površinama. Nakon intenzivnih klimatskih promena koje su nastale u poslednjim decenijama, kao i zbog mogućnosti uvoza inficiranih životinja sa endemskih područja, predložena istraživanja bi imala epizootiološki i klinički značaj.

Ključne reči: svinja, stefanurioza, dijagnostika, kontrola, ekonomski značaj

INTRODUCTION

Stephanurus dentatus nematode parasitizes in the urinary tract of domestic pigs and wild boars, mostly causing the disease in tropical and subtropical areas (Gherman, 2013), and in pigs bred in traditional outdoor production systems (Fernández-Vizcaíno et al., 2021).

Larvae migration and parasitism of adult forms of *S. dentatus* leads to damage of internal organs, which results in significant direct economic loss (frequent forced slaughter of cachectic pigs, deposition of confiscates and meat during slaughter). Indirect damage is reflected in reduction of growth and weakening of the general resistance of infected pigs (Gherman, 2013). Since the migration of infectious larvae *S. dentatus* through the liver can cause severe hepatitis, with lesions reminiscent of those caused by *Ascaris suum* larvae (Constable et al., 2017), this helminthiasis has a particular clinical significance.

So far, stephanuriosis has been diagnosed in Africa, east and west India, Brazil, Hawaii, The Philippines, The United States of America and Australia (Constable et al., 2017). There is no relevant data on the presence of parasites in wild boars on the European continent, therefore additional research is necessary in order to define the role of wild boars as a potential natural reservoir of *S. dentatus* for domestic pigs (Fernández-Vizcaíno et al., 2021).

In the Republic of Serbia, the presence of the parasite *S. dentatus* has not been established during controls on the slaughter line in slaughterhouses. In the territory of the Republic of Serbia, there are reports related to problems of parasitic infections of the gastrointestinal tract in pigs (Ilić and Dimitrijević, 2005; Ilić and Dimitrijević, 2006; Ilić et al., 2011; Ilić et al., 2013; Ilić et al., 2021a), but there is no data in the literature on urinary tract parasitoses in this species of ungulate. Besides recent reports on urinary capillariasis of domestic and wild carnivores (Aleksić et al., 2020; Ilić et al., 2021b), not enough attention has been paid on studying urinary diseases of parasitic etiology of other animal species in previous research on animals in Serbia.

The aim of this paper is to point out the need for examination of potential presence of this parasite in the Republic of Serbia in wild boars and domestic pigs from extensive traditional breeding outdoors. The proposed examinations are of particular importance at a time of global climate change occurring over the last decade, as well as due to the intensification of commerce and pig trade, which pose a potential risk for import of infected animals.

ETIOLOGY

Stephanurus dentatus belongs to *Stephanurus* genus, Stephaurinae subfamily, *Syngamidae* family, *Strongylida* order and *Secernentea* class (Ballweber, 2001).

Morphological characteristics of the causative agent

Adult forms of parasite have a strong body and mottled appearance. They have a cuticle that is transparent and enables visualization of internal organs

(reproductive and intestinal system). Sex dimorphism is clearly stated. Females are longer (39.0 - 44.0 mm) and thicker (2.0 - 2.6 mm) compared to males who are 30.5 - 36.0 mm long and 1.2 - 1.4 mm thick (Gherman, 2013). At the anterior end of the body, they have buccal capsule with thick walls which contains teeth of different sizes. The parasite's esophagus is thinner in the front than in the back. The tail of a female sharply narrows and the vulva is located near the anus. At the posterior end of the body, a square-shaped bursa copulatrix is found in males, with two laterals and one dorsal lobe. The spicules are approximately the same size (0.70 to 0.98 mm). Eggs are broadly ellipsoid, with thin membranes and 32 to 64 blastomeres, with dimensions of 70 μm to 120 μm (Islam et al., 2015).

Life cycle

Adult parasites are mainly localized in the renal pelvis, in cysts around renal pelvis, in perirenal adipose tissue, ureter and in adipose tissue surrounding ureter. Other than these organs, they can rarely be found in the pancreas, lumbar muscles, spinal cord and lungs (Gherman, 2013).

Adult female parasites produce up to a million eggs a day, which are excreted in the urine of the host into the environment. Most eggs are excreted during the first morning urination. In optimal environmental conditions (warm, humid and shaded places), the eggs embryonate for 1 to 2 days and the larvae of the first stage (L1) are released from them. After two "sheddings" in the environment, 3 to 4 days later, larvae of the third stage (L3) are formed from the L1 larvae and they are infectious for the host. Infectious larvae can enter the pig organism directly (percutaneously or perorally) and indirectly by swallowing paratenic host- worms (Gherman, 2013).

In *per os* infections, L3 larvae, after ingestion, migrate from the digestive tract through the stomach wall and small intestine to the mesenteric lymph nodes, where "shedding" can occur from L3 to L4 larvae. A certain number of larvae migrate to the liver, and part of them goes to other organs (lungs, lymph nodes, pancreas and spleen) and in fetus in gravid sows. In the liver, L4 larvae migrate through parenchyma reaching the capsule which they penetrate three months after infection. Further migration through the peritoneal cavity, juvenile forms of the parasite mostly reach the perirenal and periurethral adipose tissue, kidneys and ureters, where a cyst is formed and in it adult forms parasitize. The cyst communicates with the organs of the urinary system through the fistula and through the urine the eggs reach the environment. Female parasite can start laying eggs six months after infecting the animal, but the prepatent period is usually longer (9 to 16 months). An infected animal can release eggs into the environment for three years (Constable et al., 2017).

Infectious (L3) larvae that enter the organism through the skin, migrate to the lungs through systemic circulation and then reach the trachea, pharynx and after swallowing, the intestines. Further migration is the same as with the peroral infection and the infectious larva reaches the liver after 1 to 6 weeks (Gherman, 2013).

An indirect infection occurs through worms that contain infectious L3 larvae. If the host ingests worms containing infectious larvae during feeding, they are released during the digestion and undergo further development, as in the case of direct infection, through the stomach wall and/or small intestine (Roepstorff and Nansen, 1998; Constable et al., 2017).

EPIZOOTIOLOGY

S. dentatus is greatly widespread in tropical and subtropical regions, with a tendency to spread to other geographical areas. It is most commonly found in Africa, The United States of America, India, Brazil, Hawaii, The Philippines and Australia, where the climate is mild enough to enable survival of eggs and larvae. Eggs and larvae are very sensitive to cold and drying (Constable et al., 2017).

In a dry environment, the eggs decay within an hour. Temperatures below 10 °C are harmful to eggs and temperatures below 4 °C and above 35 °C have an ovicidal effect. In optimal conditions of humidity, heat and sunlight, most larvae survive for up to three months, rarely up to five months. As a facultative parasite, larvae can survive in worms for a long period of time even when microclimate conditions are unfavorable. They can also develop in the ground at a depth of 25 cm and beneath the water surface as well (Gherman, 2013; Constable et al., 2017).

All age categories of pigs, including fetuses, are sensitive to parasites. Infection occurs per orally (by swallowing of infectious L3 larvae or worms that contain L3 larvae). This is, probably, the most common route for the onset of the infection. Infection can also occur percutaneously and prenatally (Gherman, 2013). Infection found in piglets less than five months of age was caused by L3 larvae during gravidity (Islam et al., 2017).

An area with adequate microclimate conditions, which favors parasite development, becomes endemic over time. Both wild boars and domestic pigs are susceptible to the disease. In domestic pigs the infection is more common in herds that are bred freely outdoors, when pastures are continuously contaminated. It also occurs in pigs that are bred extensively in closed facilities, with the possibility of staying at the outlet. The likelihood of the occurrence

of this parasite in intensive pig breeding is low on the farms where biosecurity measures are applied and with good zoo hygienic practice (Nansen and Roepstorff, 1999).

The prevalence of the infection varies in different parts of the world and primarily depends on climate conditions. According to data found in the literature, the disease has been established in 33% of pigs in Ghana, 42% in Belize (Central America), 9.7 to 40.5% in India and it is 62.5% in the south of China (Gherman, 2013). In an epizootiological study in Bangladesh the organs of slaughtered pigs aged 1 to 5 years were examined and the prevalence of stephanuriosis was determined to be 21%. The parasites were localized in renal pelvis, renal cortex, ureter and in perirenal adipose tissue of pigs that were four and five years old (Islam et al., 2015).

Examining parasite spreading in pigs on slaughter line in Benu region, Nigeria, the prevalence of *S. dentatus* was determined to be 13.2%. The authors deemed that this prevalence is a result of adequate microclimate conditions for development and survival of parasites in the external environment. Two climate seasons alternate in the examined region - rainy from April to October and dry from October to March (Obisike et al., 2018).

On the European continent *S. dentatus* can be found in different regions of the Iberian Peninsula - Cadiz, Granada, Madrid and Portugal (Moratal et al., 2018). By examining wild boars on several locations in southern and central Spain, an extremely high prevalence was determined (76.5%). These results suggest grouped distribution of infection theory in certain areas and are particularly important for this region, considering well developed pig production. Since stephanuriosis has not been previously identified as a health issue in pig breeding in this area, the authors suggest studying the importance of wild boars as a reservoir of disease in the nature and the possibility of transmission to domestic pigs (Fernández-Vizcaíno et al., 2021). During the study that was conducted in the Caribbean (St. Kitts), between 2012 and 2013, *S. dentatus* was diagnosed in 5. 9% of the shot wild boars (Morosco et al., 2017).

The presence of *S. dentatus* has not been established in regular inspection surveillance on the slaughter line in slaughterhouses in the Republic of Serbia. However, we should keep in mind the fact that pigs from the intensive breeding are mainly slaughtered in these facilities. Studying the potential presence of parasites in the Republic of Serbia should include examinations of both wild boars and domestic pigs from extensive breeding, particularly from herds that are bred outdoors. An additional risk factor may be the effects of global warming in the last decade and the possibility of presenting this nematode by importing infected animals.

PATHOGENESIS AND PATHOMORPHOLOGICAL CHANGES

In pigs infected by *S. dentatus* nematode, tissue damage occurs as a result of larval forms migrations and parasitism of adult forms of causative agents. Necrosis, fibrosis, cirrhosis and abscesses can form during the migration of larval forms. The liver is often enlarged with pronounced scars, and it can sometimes be accompanied by ascites. Extensive bleeding and irregular whitish changes called "milk spots" are present in the liver parenchyma. Thrombosis may be present in the blood vessels of the liver. As a result of the harmful effects of adult parasites, gray necrotic fields, infarcts and scars are present on the kidneys. The kidneys are edematous with a tense capsule. Frequent findings are pleurisy and peritonitis with numerous adhesions of internal organs (Islam et al., 2015; Constable et al., 2017).

In perirenal and periurethral adipose tissue cysts that are linked to organs of the urinary system by fistulas can be found (Gherman, 2013; Islam et al., 2015). The changes can also affect the mesenteric lymph nodes, spine, umbilical cord, pancreas, heart, lungs, spleen and skeletal muscles by forming eosinophilic nodules in these organs (Gherman, 2013).

Morosco et al. (2017) report on pathomorphological changes in the kidneys, perirenal adipose tissue and ureters of wild boars which were infected with *S. dentatus* nematode. Macroscopic examination found the cysts of thick walls in perirenal and periurethral adipose tissue as well as adult nematodes up to 3.5 cm long. Histopathological examination of the tissue surrounding the parasite revealed bleeding, edema, necrosis, erythrophagocytosis, hemosiderosis, fibrosis and a large number of eosinophil granulocytes. In addition to adult parasites, ellipsoid eggs of about 100 μm in size are occasionally observed in the renal pelvis and in cysts surrounding the ureter, too.

Eosinophilia is observed 2 to 3 weeks after infection, it reaches a peak in 6 to 7 weeks and is present even after 20 weeks. Although it often occurs, it has little specific diagnostic value because it is also present in other parasitic infections. In addition to dominant eosinophil granulocytes, lymphocytes, plasma cells, macrophages and occasionally multinucleated giant cells are also present in the tissue surrounding parasite and inside the cyst (Morosco et al., 2017).

As a result of interstitial nephritis, infiltration of eosinophilic granulocytes, neutrophilic granulocytes and mononuclear cells are observed in the kidney tissue (Islam et al., 2015).

It has been proved that the cattle can be a non-specific host for *S. dentatus* and that the parasite is rarely in them, mostly as a consequence of accidental infections. In experimentally infected calves, the liver and pancreas suf-

fer damage similar to those caused in pigs. Abscesses, fibrosis and eosinophil granulocytes infiltration are present. However, since parasite cannot complete its life cycle in cattle, pathomorphological changes in the organs where adult forms of the parasite should parasitize are absent (Morosco et al., 2017; Constable et al., 2017).

IMMUNITY

Along with innate and general resistance, the organism has specific humoral and cellular protection mechanisms that fight against parasites. The results of the study of the immune response of the animals infected with the *S. dentatus* are mostly based on the study of the serological response of experimentally infected animals.

In the cases of low-intensity infections, the level of antibodies is not measurable. Moreover, a direct link between the rate of serological response and the intensity of infection has not been proven. During the examination of the serological response of pigs experimentally infected with *S. dentatus* parasite, various tests were used: double immunodiffusion, immunoelectrophoresis and Enzyme Linked Immunosorbent Assay (ELISA) test. Double immunodiffusion and immunoelectrophoresis tests showed a positive reaction from the fourth week after the infection. A test of double immunodiffusion performed between 6th and 18th week and the application of immunoelectrophoresis between 6th and 15th week after the experimental infection showed that the percentage of positive reactions was over 60%. Both tests showed simultaneous onset of antibodies. ELISA test, which used rabbit antibody marked by alkaline phosphatase and gland extract to excrete parasites as antigen, proved high sensitivity of this method. The presence of antibodies against *S. dentatus* was established as early as two weeks after infection and the percentage of positive findings higher than 60% was obtained during the 20th week after infection. At the same time, the ELISA test is a quantitative method - based on the results we can define degree of infection; thus, it is recommended in conducting serodiagnostic research during prepatent period of *S. dentatus* (Partoutomo et al., 1983).

In experimental conditions, nine somatic antigens obtained from excretory glands of the adult *S. dentatus* parasite were used in the production of the *S. dentatus* vaccine. The efficacy of the produced vaccine was evaluated by monitoring the resulting lesions due to larvae and adult parasites migration in autopsied animals, after *per os* infection of pigs with infectious larvae. None of the produced vaccines completely prevented the migration of larvae through the liver as well as development of adult forms of parasites. However, the on-

set of the disease has been reduced as much as 92%. Therefore, it can be said that the vaccines are efficient, especially if combined with other disease control measures (Tromba and Romanowski, 1976).

CLINICAL PICTURE

Stephanuriosis is characterized by nonspecific clinical symptoms which usually occur as a consequence of migration of larvae forms as well as parasitism of adult forms of parasites (Gherman, 2013).

In the cases of low-intensity infections, the most common sign of the disease is delayed progress despite a good appetite. Numerous nodules can be observed on the skin and abdominal wall. Peripheral lymph nodes are enlarged and painful, while deaths are not common (Constable et al., 2017).

In the cases of high intensity infections, a more severe form of disease occurs, and it is characterized by poor food conversion, weight loss and cachexia with a tendency to develop ascites. As a result of changes caused by aberrant larvae during migration, nonspecific clinical signs are manifested and are difficult to be linked to the presence of *S. dentatus.* Thrombi occur in larger blood vessels (*v. portae*, *a. hepatica*, *v. cava caudalis),* damaging lung tissue with consequential respiratory disorders, peritonitis, pleurisy, paresis and paralysis of the posterior parts of the body. As a result of peritonitis and intestinal intussusception, death of the animal can occur in 20 to 30 days after infection. A significant clinical symptom is weakness and paralysis of the hind legs, which occurs as a result of larval migration through the spinal cord (Cianciolo and Mohr, 2016; Constable et al., 2017). Unlike hypovitaminosis, fertility disorders were not observed in females /sows suffering from stephanuriosis. Blood test results of diseased animals revealed that eosinophilia and haematuria are also a common (Gherman, 2013).

DIAGNOSIS AND DIFFERENTIAL DIAGNOSIS

The diagnosis of stephanuriosis can be established by autopsy or parasitological examination of pig urine, which proves the presence of parasite eggs. By serological ELISA test, which is not a routine diagnostic procedure, it is possible to detect infection two weeks after infection with *S. dentatus* larvae. Young pigs with high intensity infection entirely by larvae (without the presence of adult parasites and organ damage), can be a major problem in disease diagnostic (Constable et al., 2017). Clinical examination is insignificant in the diagnosis of stephanuriosis due to non-specific symptoms occurring in infected pigs (Gherman, 2013).

The diagnosis is usually made in autopsy, by finding larval or adult forms of parasites, as well as lesions that are a result of migration or parasitism in organs. Pathomorphological changes present in the liver are of the greatest importance in endemic areas. The liver is enlarged with gray-white lesions, which are the signs of cirrhosis and the presence of abscesses. Lesions are usually more severe than those caused by *Ascaris suum* larvae. Abscesses may occur in the lungs and / or pancreas and phlebitis may occur in the portal vein with occasional thrombi. Mesenteric lymph nodes are enlarged. Pleurisy and peritonitis (sometimes with intestinal intussusception) may develop as a result of larval migration. The finding of adult forms of parasites in the kidneys, perirenal adipose tissue and ureter walls during autopsy, confirms the diagnosis (Gleyderson Silva et al., 2015).

The diagnosis is most often made by finding characteristic *S. dentatus* eggs by examining urine sediment of infected pigs. Most eggs are excreted during the first morning urination, and female parasites release up to a million eggs a day in the maximum potent phase in the external environment (Hendrix and Robinson, 2006; Gherman, 2013).

Reliable parasitological diagnostics is performed by applying methods for egg detection in urine, whose sensitivity is 100%. One of these techniques is the flotation technique (saturated aqueous solution of ZnSO4 with specific gravity of 1.200). Gravitational deposition technique – sedimentation (at a room temperature lasting for an hour) and centrifugal deposition technique (at 800 rmp for 5 minutes) allow detection of a larger number of *S. dentatus* eggs and are more reliable for a quantification of infection (determining the number of eggs in urine). However, the determined number of parasite eggs in urine does not correspond to a number of adult nematodes parasitizing in the same host (Fernández-Vizcaíno et al., 2021).

The number of determined eggs in 1 mL of urine can be influenced by various factors like number of adult forms, male and female parasites ratio, time of the day when sampling is performed, diagnostic method and the characteristics of a host (sex, age, nutritional status and mating season). Therefore, the numbers of eggs determined by the above-mentioned methods can only be used to roughly determine the numbers of adult parasites (Fernández-Vizcaíno et al., 2021).

In the differential diagnosis of stephanuriosis, it is necessary to consider the epizootiological anamnesis of a herd in detail. In clinical trial it is vital to identify all causes of delayed progress and weight loss. Poor and unbalanced diet, as well as chronic bacterial diseases (necrotic enteritis, swine dysentery), which may be accompanied by diarrhea, are also significant. In cases of paralysis and weakness of the posterior part of the body, it is necessary to eliminate

the following: vitamin A deficiency, rickets, osteomalacia, lumbar spine fractures, abscesses, spinal cord lymphomas, brucellosis, chronic form of erysipelas as well as infections with nematodes *Ascaris suum* and *Hyostrongylus rubidus* (Constable et al., 2017). The nematode *Dioctophyme renale*, leptospirosis and renal dysfunction of various etiologies are also important for differential diagnosis (Gherman, 2013).

THERAPY

Doramectin, ivermectine, fenbendazole, levamisole and flubendazole have good efficacy in the treatment of stephanuriosis. Doramectin administered at a dose of 0.3 mg per kg of body weight showed the efficacy of 100%. Ivermectine is administered at a dose of 30 μg per kg of body weight, achieving 100% efficacy, 14 to 21 days after the treatment. Fenbendazole mixed in food at a dose of 3 mg per kg of body weight, administered in the course of three days leads to healing in three weeks after the treatment. Levamisole at a dose of 10 mg per kg of body weight and flubendazole at a dose of 50 mg per kg of body weight are also effective in the treatment of stephanuriosis.

PROPHYLAXIS

The absence of stephanuriosis in intensive breeding systems is a result of several factors: a long prepatent period of the parasites**,** high sensitivity of preinfectious stages to the microclimate of the environment as well as the absence of paratenic hosts (Nansen and Roepstorff, 1999).

Disease control is based on general sanitary measures and improvement of pig breeding conditions. In infected herds, boars and gilts should be bred separately and used for only one cycle of breeding; after that they are moved out of the premises and excluded from breeding. During the prepatent period of the parasite (9 to 16 months), piglets are weaned from sows and transferred to another facility before the development of adult parasites whose eggs are eliminated in urine. After 3 to 4 seasons of farrowing, this method of breeding can eradicate the disease on farms (Gherman, 2013).

Young animals should be physically separated from adults and should not be moved into facilities where adults have stayed for three to six months after the adult animals have moved out. Due to the great importance of adult animals as a source of infection, early replacement of breeding material is crucial in disease prevention. Regular dehelminthization of all pigs with Fenbendazole or Ivermectine at intervals of four months is also significant (Constable et al., 2017).

In order to prevent the development of infectious forms of parasites in the free breeding of pigs outdoors, it is necessary to provide dry substrate without vegetation in the places where animals stay and sleep and absence of vegetation in the places where animals mostly urinate, because that reduces the potential of eggs to survive. It is necessary to regularly maintain the hygiene where the watering places are located and provide sufficient amounts of clean water. Since worms can be reservoirs in which parasite remains vital for at least a year, it is necessary to apply the measures aimed at reducing their number (Constable et al., 2017).

In all production systems, except on farms with organic production, regular application of anthelmintics in the prevention of stephanuriosis is the most common way to control this disease.

The first dehelmenthisation protocol is applied to adult animals. Gravid sows can be treated one to two weeks before farrowing with the aim of releasing adult parasites. This consequently reduces the possibility of intrauterine infection, infection of newborn piglets, as well as contamination of the environment where the newborn piglets will live. The second protocol is based on treating all farm animals simultaneously, at certain times of the year, which has proven to be a more economical solution due to reduced costs associated with hiring farm workers (Nansen and Roepstorff, 1999).

The control of parasitic infections in modern production must be based on monitoring of the conditions which favor their occurrence, maintenance and spreading in the herd and on reliable diagnostics (coprological surveillance, surveillance at the slaughter line in the slaughterhouses). The knowledge of the etiopathogenesis, prevalence and epizootiological characteristics of individual infections provide an adequate approach in their treatment and control (Nansen and Roepstorff, 1999).

Guided by these principles, a certain system of surveillance should be established for the presence of the parasite *S. dentatus* in the Republic of Serbia, with the purpose of its early detection, timely treatment and control measures.

CONCLUSION

S. dentatus is of great economic and clinical importance. The result of migration and parasitism of causative agents in the urinary tract of pigs is weight loss, delay in reaching market weight and frequent forced slaughter of cachectic pigs whose meat is declared unfit for human consumption. Due to the possibility of replacing this nematode with other parasites, veterinarians on the field should be warned about this helminthiasis when diagnosing parasitic diseases and diseases of the urinary tract of pigs.

To this day, no cases of this disease have been diagnosed in pigs in the Republic of Serbia. However, after the intense climate change that has happened in recent decades, as well as the possibility of importing infected animals from endemic areas, it is suggested that domestic pigs in traditional production systems should be examined for the possible presence of this parasite in the Republic of Serbia as well as wild boars as potential reservoirs of *S. dentatus*.

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Author's Contribution:

All authors (IT, DM, PR, and BD) contributed to manuscript design, performed literature searches, wrote and revised the article, and approved the final manuscript.

Competing interest

The authors declare that they have no competing interests for a work presented in the Manuscript.

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