

Case report

CASE REPORT OF HEPATIC *CAPILLARIA HEPATICA* INFECTION IN A BLACK-TAILED PRAIRIE DOG (*CYNOMYS LUDOVICIANUS*) IN BELGRADE ZOO

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Capillaria hepatica (syn. *Calodium hepaticum*) is a zoonotic nematode parasite commonly found in the liver of a broad range of mammalian hosts worldwide. This parasite was found in a black-tailed prairie dog (*Cynomys ludovicianus*) from the Belgrade Zoo which had recently been transferred from another Zoo. *Capillaria hepatica* was an incidental finding during necropsy. The gross appearance of the affected liver was characterized by multifocal, firm, white to yellowish, round granulomas, 1–3 mm in diameter situated on the surface of the liver that extended into the underlying hepatic parenchyma. Histopathologically, multiple granulomas encompassed clusters of *Capillaria hepatica* eggs surrounded by central caseous necrosis, cellular debris admixed with epithelioid macrophages, multinucleate giant cells, lymphocytes, eosinophils, and a fibrous capsule. This paper describes the first case report of *Capillaria hepatica* in zoo animals in Serbia.

Keywords: *Calodium hepaticum*, *Capillaria hepatica*, black-tailed prairie dogs, *Cynomys ludovicianus*, histopathology

INTRODUCTION

Capillaria hepatica (syn. *Calodium hepaticum*) is a nematode parasite that affects a broad range of mammalian hosts worldwide, including humans [1-5]. Although infection has been reported in several mammalian orders, rodents represent the most common and epidemiologically important hosts. The parasite is particularly frequent in Norway rats (*Rattus norvegicus*) and black rats (*Rattus rattus*), which may act as important reservoirs in urban and peri-urban environments [6-10]. In addition to Muroidean rodents, infection

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has also been described in non-Muroidean rodents, including members of the family Sciuridae, to which black-tailed prairie dogs (*Cynomys ludovicianus*) belong [1,2].

Infection with *C. hepatica* may occur in zoo settings, where urban rodent populations can serve as reservoirs and potential sources of infection for captive animals [1,2,7,10,11]. The prevalence of *C. hepatica* in rodents varies considerably among studies, ranging from 15.5% to 82% [6,10,12-17]. Adult parasites inhabit the hepatic parenchyma, predominantly the subcapsular regions, where females lay eggs that remain trapped within the liver tissue. After the death of the infected host, eggs can be released into the environment through predation, scavenging, or cannibalism, where they embryonate under suitable environmental conditions and become infective [7,13].

Macroscopically, livers infected with *C. hepatica* are characterized by multifocal, firm, white to yellowish, round granulomas, most frequently located on the liver surface and extending into the underlying hepatic parenchyma [7,10,13]. Histopathological findings typically include granulomatous lesions in the hepatic parenchyma containing clusters of *C. hepatica* eggs. The eggs are barrel-shaped, with characteristic bipolar plugs and prominent radial striations of the outer eggshell and have been reported to measure approximately 40–67 µm in length and 27–35 µm in width. The present case report describes the pathomorphological findings in the liver of a captive black-tailed prairie dog (*Cynomys ludovicianus*) infected with *C. hepatica*.

CASE PRESENTATION

A male black-tailed prairie dog (*Cynomys ludovicianus*), born at Zagreb Zoo on May 20, 2024, arrived at the Belgrade Zoo on July 7, 2025, as part of a shipment of seven prairie dogs from a Croatian zoo, where the animals had been kept in quarantine for more than six months before shipment. The founding population originated from Tierwelt Herberstein, Austria. After arrival at the Belgrade Zoo, the animals were placed in quarantine for clinical observation and showed no signs of illness. On July 14, 2025, seven days after arrival, the male prairie dog was found dead by the keepers at approximately 08:00 h. The animal's body weight was not recorded in the available documentation. The remaining six prairie dogs from the same group showed no clinical signs during quarantine and were subsequently transferred to the exhibit area. Detailed data on fecal examinations and later follow-up findings were not available.

Necropsy of the prairie dog that suddenly died was performed, and macroscopic examination revealed rupture of the urinary bladder, resulting in uroperitoneum and toxemia. No uroliths or obvious traumatic lesions were observed. Dystrophic changes were noted in the kidneys and liver, as well as hyperaemia of multiple organs. Multiple white-yellowish granulomas, 1-3 mm in diameter located subcapsularly on the liver surface and extended into the underlying hepatic parenchyma were observed (Figure 1).

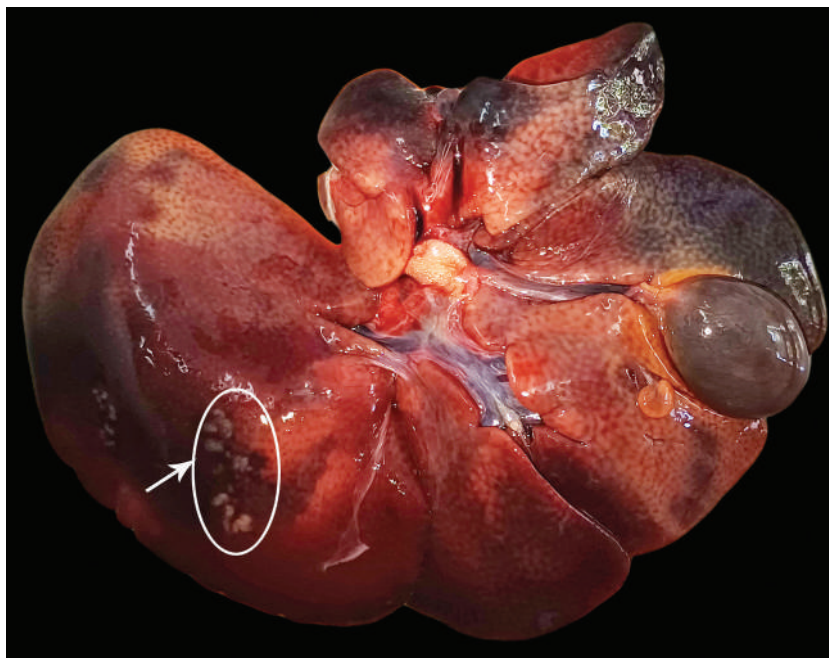


Figure 1. Macroscopic appearance of the liver – multiple white-yellowish granulomas on the liver surface

After macroscopic examination tissue samples of liver were fixed in 10% neutral buffered formalin, and after processing in automated tissue processor KD-TS3D (Kedee, PR China), embedded in paraffin, sectioned at 3-5 μm thick sections, and stained with hematoxylin and eosin (H&E) for microscopic examination. The results of histochemical staining were analyzed on a BX51 light microscope (Olympus Optical, Japan) and photographed with an Olympus Color View III® digital camera.

Histopathological examination revealed multiple granulomas encompassing clusters of nematode eggs morphologically consistent with *Capillaria hepatica* (syn. *Calodium hepaticum*) (Figure 2). The eggs were barrel-shaped and characterized by typical bipolar plugs and prominent radial striations of the outer eggshell (Figure 3). Egg length ranged from 46.82 to 52.80 μm , while egg width ranged from 28.75 to 30.74 μm . Based on these characteristic morphological features and their intrahepatic localization, the eggs were identified as *C. hepatica*.

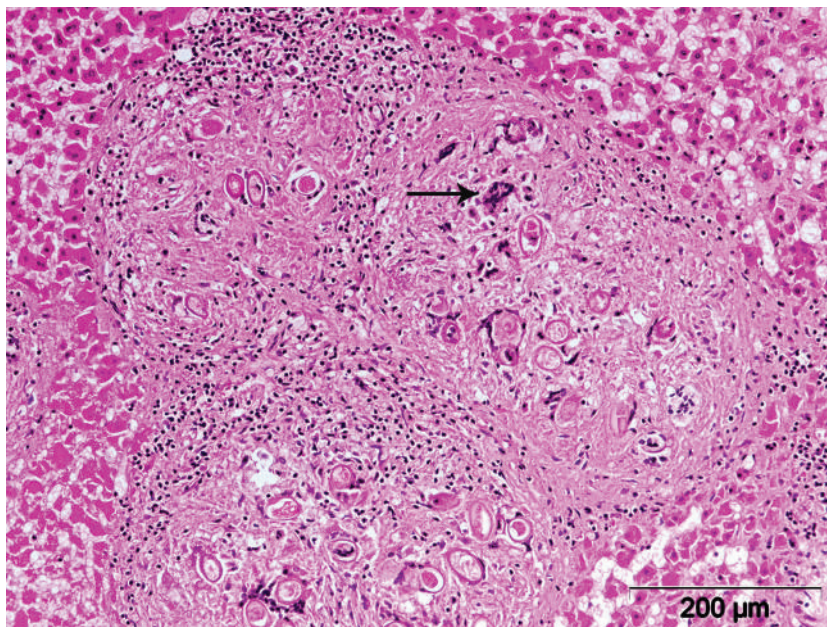


Figure 2. Microscopic appearance of the liver – multiple granulomas encompassing clusters of *Capillaria hepatica* eggs. The arrow indicates a multinucleated giant cell. H&E staining; scale bar = 200 μm .

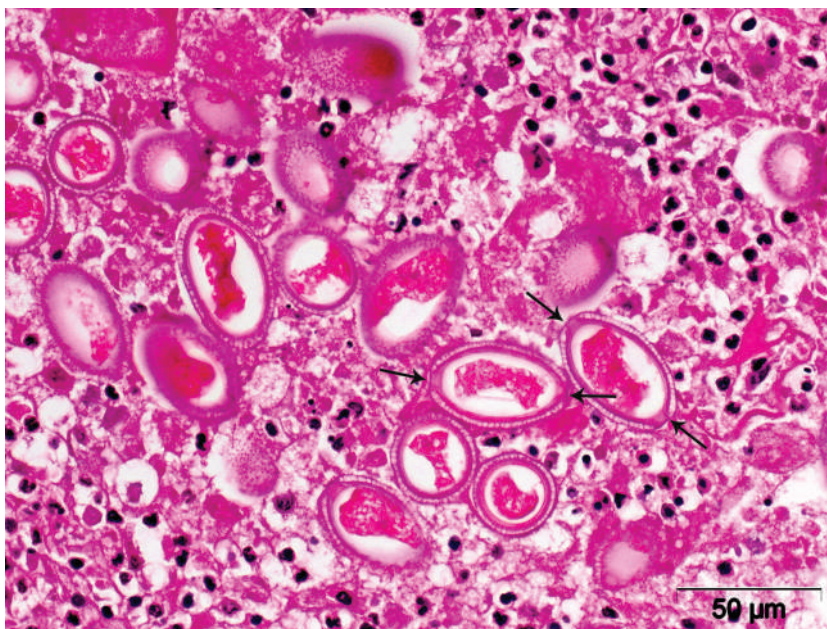


Figure 3. Microscopic appearance of the liver – *Capillaria hepatica* eggs with typical bipolar plugs with prominent radial striations on the outer eggshell. Arrows indicate bipolar plugs. H&E staining; scale bar = 50 μm .

Clusters of eggs were surrounded by caseous necrosis, cellular debris and epithelioid macrophages, multinucleate giant cells (Figure 4), and fewer numbers of lymphocytes and eosinophils. The granulomas were surrounded by fibroblasts and collagenous matrix forming a fibrous capsule. These multiple granulomas were coalescing replacing large portions of the normal hepatic parenchyma and surrounded with hyperaemic tissue. No adult parasites were noted in the histopathological sections. In addition, moderate atrophy of the hepatic cords with sinusoidal dilatation, as well as cholestasis were noted. Mild biliary duct hyperplasia and scattered infiltrates of lymphocytes and macrophages were present in the periportal regions, occasionally accompanied by periportal fibrosis.

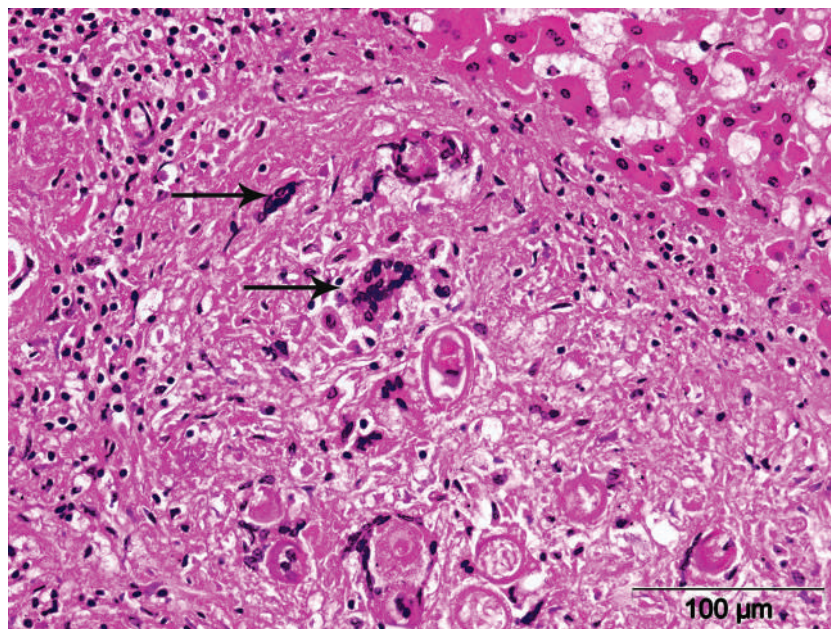


Figure 4. Microscopic appearance of the liver – multinucleated giant cell surrounding *Capillaria hepatica* eggs within granuloma. Arrows indicate multinucleated giant cells. H&E staining; scale bar = 100 µm.

DISCUSSION

Capillaria hepatica is a nematode parasite commonly found in the liver of a wide variety of mammals represented by over 90 Muroidean rodent species, also non-Muroidean rodents, as well as other mammalian species – Insectivora, Chiroptera, Lagomorpha, Artiodactyla, Perissodactyla, Hyracoidea, Marsupialia, Carnivora, and Primates, including humans. Adult *Capillaria hepatica* live in the hepatic parenchyma, mostly in the subcapsular regions where females lay hundreds of unembryonated eggs deposited in clusters. These unembryonated eggs provoke the host immunologic system to form fibrous tissue which surrounds them and as a result they cannot be

released from the living hosts and remain in unembryonated stage unless freed in the environment [7,13]. Eggs are not released in the feces but remain in the liver when the animal dies, and the liver is consumed by other animals during predation, scavenging, or cannibalism these ingested unembryonated eggs pass through the gastrointestinal system of these disseminator animals and are then dispersed into the environment with the feces. In the soil unembryonated eggs require oxygen, moisture, and warm temperature to embryonate and reach the infective first stage larvae. It can take as long as 4-5 weeks to terminate this transformation [7]. When embryonated eggs are ingested, they hatch in the small intestine or cecum, and first-stage larvae penetrate the intestinal wall and migrate to the liver via the portal circulation, where they molt and mature, reproduce, and die [7,13,16,18]. Prairie dogs live in a complex underground tunnel system and this burrow system provide a protected environment for the eggs, since they are not exposed to sunlight and desiccation, and their embryonation is more effective. According to literature data prairie dogs probably became infected with *Capillaria hepatica* principally within their burrow system [7,19]. This parasite has high prevalence and low pathogenicity of infection in the Norway rats (*Rattus norvegicus*). Because contact between Norway rats and prairie dogs may occur within burrow systems in zoo settings, Norway rats may represent a potential source of infection for prairie dogs [7,10,20].

In our case the cause of death of this animal was rupture of the urinary bladder, resulting in uroperitoneum and toxemia. The precise cause of the bladder rupture could not be determined based on the available findings. *Capillaria hepatica* found in the liver of this animal was an incidental but still important finding due to its zoonotic disease. Based on the life cycle of *C. hepatica*, the chronic character of the hepatic lesions, and the short interval of seven days between arrival at the Belgrade Zoo and death, the infection was most likely acquired before the animal's arrival in Belgrade. The animals had been kept in quarantine at the previous zoo for more than six months before shipment. However, because detailed information on possible rodent exposure at the previous facility was not available, the exact source of infection could not be confirmed. The most likely transmission route involved urban rodent populations, especially the widely distributed Norway rat (*Rattus norvegicus*), which is consistent with findings of other authors [6-10]. Rats are widely distributed throughout the entire world, and they are commonly present in the zoos because exhibition areas are regular supply of food for them. Among rat populations dominant mechanism of *Capillaria hepatica* eggs spread is cannibalism, but other mechanisms such as predation and scavenging are also possible [10,21]. Rats and other rodents serve as main reservoirs for this parasite and thus represent the most significant zoonotic threat. For the purpose of protection of exhibition animals, zoo employees, and visitors from *Capillaria hepatica* infection, rodent control is very important and should be conducted regularly in zoo settings.

In the animal from this case multiple granulomas encompassing clusters of *Capillaria hepatica* eggs surrounded by caseous necrosis, cellular debris and epithelioid

macrophages, multinucleate giant cells, and fewer numbers of lymphocytes and eosinophils, as well as fibroblasts and collagenous matrix forming fibrous capsule were present in the liver parenchyma as described by other authors [7,10,13]. These multiple, multifocally distributed granulomas distorted the normal morphology of the hepatic parenchyma and may have affected hepatic function. However, no clinical signs attributable to hepatic disease were recorded before death. Also, it is important to mention that no adult parasites were seen in the liver tissue sections. In the present case, species identification was based on the characteristic histomorphological features of the eggs, including their barrel-shaped morphology, distinct bipolar plugs, prominent radial striations of the outer eggshell, size and their localization within granulomatous lesions in the hepatic parenchyma. Molecular confirmation was not performed because fresh or frozen liver tissue was not available, and only formalin-fixed, paraffin-embedded material was available for examination. Nevertheless, the observed morphology and tissue localization were consistent with *Capillaria hepatica* (syn. *Calodium hepaticum*).

Capillaria hepatica was described in Norway rats in Serbia by Kataranovski *et al.* [22]. Although the exact source of infection could not be confirmed, the infection was most likely acquired before the animal's arrival at the Belgrade Zoo. Nevertheless, this case report represents the first described case of *C. hepatica* infection in a prairie dog in Serbia. Because *C. hepatica* has zoonotic potential and is difficult to diagnose antemortem by routine coprological examination, post-mortem surveillance is particularly important in zoo settings. Regular rodent-control programs should be supported by necropsy and histopathological examination of animals that die unexpectedly, especially when hepatic lesions are present. In fossorial species such as prairie dogs, management of burrow systems should also be considered, as protected underground environments may support egg survival and embryonation.

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Authors' contributions


DM and MA contributed to the conception and design of the case report. DM, MA and SJ performed the necropsy, gross pathological examination, histopathological examination, and interpretation of pathological findings. DB contributed to the parasitological evaluation and interpretation of the findings. KO and MV contributed to the acquisition of animal history, background information, and zoo-related data. DM drafted the manuscript. MA, SJ, DB, KO and MV critically revised the manuscript for important intellectual content. All authors approved the final version of the manuscript and agree to be accountable for all aspects of the work.


Declaration of conflicting interests


The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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PRIKAZ SLUČAJA INFEKCIJE CRNOREPOG PRERIJSKOG PSA (*CYNOMYS LUDOVICIANUS*) VRSTOM *CAPILLARIA HEPATICA* U BEOGRADSKOM ZOOLOŠKOM VRTU

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Capillaria hepatica (sin. *Calodium hepaticum*) je nematodni parazit koji se često nalazi u jetri velikog broja sisara, uključujući više od 90 vrsta nadfamilije Muroidea (Murinae, Deomyinae, Arvicolinae, Neotominae, Cricetinae, Sigmodontinae, Gerbillinae i Cricetomyinae), kao i glodare koji ne pripadaju nadfamiliji Muroidea i druge vrste sisara — Insectivora, Chiroptera, Lagomorpha, Artiodactyla, Perissodactyla, Hyracoidea, Marsupialia, Carnivora i Primates, uključujući i čoveka. Ovaj parazit je utvrđen kod crnorepog prerijskog psa (*Cynomys ludovicianus*) iz Zoološkog vrta u Beogradu, koji je nedavno premešten iz drugog zoološkog vrta. *Capillaria hepatica* je predstavljala slučajan nalaz tokom obdukcije. Makroskopski izgled zahvaćene jetre karakterisale su multifokalne, čvrste, bele do žućkaste, okruglaste granulomatozne promene prečnika 1–3 mm, smeštene na površini jetre i sa širenjem u dublji parenhim jetre. Histopatološki, uočeni su multipli granulomi koji su sadržali nakupine jaja *Capillaria hepatica*, okružene centralnom kazeoznom nekrozom, ćelijskim detritusom pomešanim sa epiteloidnim makrofagima, multinuklearnim gigantskim ćelijama, limfocitima, eozinofilima i fibro-

znom kapsulom. Ovaj rad predstavlja prvi prikaz slučaja infekcije vrstom *Capillaria hepatica* kod životinja iz zooloških vrtova u Srbiji.