

First report of *Angiostrongylus vasorum* in coyotes in mainland North America

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Angiostrongylus vasorum, commonly known as French heartworm, is a metastrongyloid nematode widely distributed in Europe, South America and Africa. This helminth uses gastropods as intermediate hosts, and has as definitive hosts various species of canids including foxes, coyotes and domestic dogs. Clinical signs of *A vasorum* include respiratory distress and bleeding disorders. Infection may take months to detect and present no clinical signs, but can also lead to death. As part of a larger study on coyotes, helminths were extracted from tracheae, hearts and lungs using a flushing technique. Four out of 284 coyotes were infected with *A vasorum*, confirmed by sequencing the cytochrome c oxidase subunit 1 gene (*cox1*) on the mitochondrial genome. To our knowledge, this is only the second report of coyotes infected with *A vasorum* in North America, and the first for mainland North America. Veterinarians now need to watch for clinical signs of this parasite in domestic dogs.

Coyotes (*Canis latrans*) evolved in savannah, prairie and woodland habitats,¹ but now are commonly found in urban areas.²⁻⁴ As contact becomes more frequent between coyotes and humans, coyotes have begun ingesting higher proportions of anthropogenic food.⁴⁻⁷ This change in diet brings coyotes into close contact with domestic dogs (*C familiaris*), leading to increased risk of both species exchanging parasites and permitting prolonged duration of parasitic outbreaks.⁸ Helminths shared between domestic dogs that commonly infect

coyotes include *Crenosoma vulpis* fox lungworms, *Oslerus osleri* tracheal nodules, *Taenia hydatigena* tapeworms, *Toxocara canis* common dog roundworms, *Uncinaria stenocephala* hookworms and *Alaria* species flukes.⁹⁻¹¹

A canine nematode of nearly global concern is *Angiostrongylus vasorum* (Baillet, 1866), commonly called French heartworm.¹² *A vasorum* is a metastrongyloid nematode that causes canine pulmonary angiostrongylosis.¹³ Definitive hosts of *A vasorum* are red foxes (*Vulpes vulpes*); however, infections have been observed in a coyote and domestic dogs.¹⁴⁻¹⁷ Fifteen species of terrestrial gastropods, three species of aquatic gastropods and common frogs (*Rana temporaria*) have been identified as intermediate hosts.^{12,13,18} Infection may cause no clinical signs, but can also lead to death.¹⁹ Clinical signs of *A vasorum* include respiratory distress (coughing and difficulty breathing) and bleeding disorders (eg, prolonged clotting).¹⁹

A vasorum is widely distributed in Europe, South America and Africa.²⁰⁻²² In North America, isolated populations have been documented in West Virginia and on the island of Newfoundland in red foxes.²³⁻²⁵ A single infection in a coyote has been reported from Newfoundland.¹⁴ Introduction of *A vasorum* to the island of Newfoundland may have been occurred via importation of infected dogs or intermediate hosts from Europe.²³ At least five species of European slugs have been introduced to North America that are suitable intermediate hosts for *A vasorum*.²⁶

As part of a larger study on coyotes, helminths were extracted from tracheae, hearts and lungs.²³ Organs were thawed at room temperature for 12–24 hours. Pericardial sacs were cut and an incision was made in walls of the right ventricles. Open ends of tracheae were held over a No 100 stainless steel Fisher sieve with a 150 µm mesh while a polyethylene tube was inserted into the incision, level with the pulmonary artery. The tissue was firmly pinched surrounding the tubing, and a tap was used as a water source, causing lungs to reach

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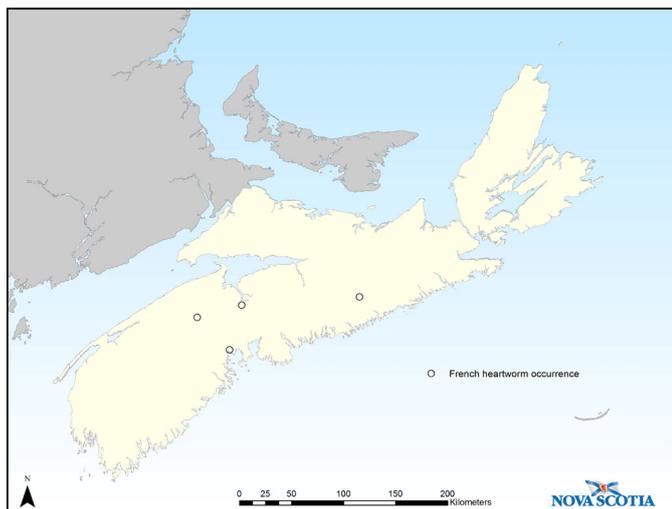


Figure 1 Provenances of four coyotes infected with *Angiostrongylus vasorum* in Nova Scotia.

full expansion. Water and lung contents were flushed out of tracheae and into a sieve for three minutes.¹⁷ Helminths were counted on site and preserved in 70 per cent ethanol.

Four out of 284 coyotes, from four different counties, were infected with *A vasorum* (figure 1). Two of the infected coyotes were adult females and two were juveniles. Species-level identification of the parasite was confirmed by sequencing the cytochrome c oxidase subunit 1 gene (*cox1*) on the mitochondrial genome, which is commonly used to differentiate among closely related animal species.²⁷ PCR reactions were sent to McGill University and Genome Québec Innovation Centre, Montréal, Québec, for sequencing. Previously sequenced samples were obtained from GenBank, compared with our sample, and were a 99 per cent match for *A vasorum*. Male and female *A vasorum* can



Figure 2 Adult female *Angiostrongylus vasorum* recovered from a heart flush of a coyote at necropsy in Nova Scotia.

be differentiated by the ‘barber pole’ appearance of females (reproductive tract and red intestine) visible through the body wall (figure 2).²⁶

Molecular evidence suggests that introduction of *A vasorum* into Newfoundland was from Europe,¹⁷ but how this occurred remains unknown. Dogs infected with *A vasorum* may show no clinical signs of infection, yet shed larval stages in their faeces for years.²⁶ Infected dogs or intermediate hosts imported to Newfoundland from Europe may have facilitated spread of this helminth, while infection remained undetected.²⁶ Now that *A vasorum* has been detected in wild canids in Nova Scotia, there are no physiographic barriers prohibiting movement of wild canids infected with *A vasorum* to the rest of North America.²⁶ Transmission of *A vasorum* to coyotes and domestic dogs is likely most frequent through red foxes.²⁵ Red foxes inhabit most of North America, and have the greatest global distribution of any carnivore.²⁸ Suitable climate and presence of suitable hosts suggests that *A vasorum* could easily spread across North America,²⁶ and may have already done so.

As predicted by Conboy,²⁶ *A vasorum* has now spread outside of Newfoundland, in this case, to coyotes in Nova Scotia, Canada. To our knowledge, this is only the second case of coyotes infected with *A vasorum* in North America,¹⁴ and the first for mainland North America. Veterinarians now need to be on the lookout for clinical signs of this parasite in domestic dogs.

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