Lungworm *(Crenosoma vulpis)* infection in dogs on Prince Edward Island

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Abstract — *Crenosoma vulpis* is a nematode lungworm that is highly prevalent in the red fox population of Atlantic Canada. Dogs are susceptible to infection with clinical signs consisting primarily of a chronic cough. A recent report of *C. vulpis* infection in 3 dogs on Prince Edward Island prompted an investigation into the importance of this parasite as a cause of chronic respiratory disease in Island dogs. A general prevalence was determined through the necropsy of dogs euthanized at the local humane society. Lungs were removed and examined for parasites using a lung flush technique. Rectal feces was collected and examined for first-stage larvae using the Baermann technique and zinc sulfate centrifugal flotation. Ten of 310 dogs (3.2%) were positive with 0–35 worms (mean = 11.0 ± 13.4) recovered. First-stage larvae of *C. vulpis* were recovered in the rectal feces of the one animal in which no worms were recovered on lung flush. A second survey was conducted examining fecal samples with the Baermann technique from afebrile dogs with presenting signs of chronic cough that had no history of recent anthelmintic treatment and showed no signs of cardiac disease, based on physical examination. Fifteen of 55 dogs examined (27.3%) were definitively diagnosed as *C. vulpis*-positive. All of the infected dogs were treated with fenbendazole (50 mg/kg body weight, PO, q24h for 3–7 days). Clinical signs resolved in all of the dogs and fecal samples were negative 2–4 weeks posttreatment. It was concluded that *C. vulpis* infection was a significant cause of upper respiratory disease in dogs on Prince Edward Island and should be considered in all dogs with presenting signs of chronic cough.

Résumé — Infections par le ver du poumon *(Crenosoma vulpis)* chez des chiens du l'Île du Prince-Édouard. *Crenosoma vulpis* est un nématode parasite du poumon ayant une prévalence élevée dans la population de renard rouge du Canada atlantique. Les chiens sont susceptibles à l'infection qui se manifeste essentiellement par une toux chronique. Un récent rapport sur l'infection à *C. vulpis* de trois chiens à l'Île du Prince-Édouard suggérait l'idée d'une étude sur l'importance de ce parasite comme cause de maladie respiratoire chronique chez les chiens de l'île. La prévalence générale a été établie suite à des nécropsies de chiens euthanasiés à la société humanitaire locale. Les poumons ont été prélevés et examinés pour découvrir des parasites selon la technique du lavage pulmonaire. Des fèces ont été prélevés dans le rectum et examinés dans le but d'y observer des larves au premier stade en utilisant la technique de Baermann et la flottation dans le sulfate de zinc après centrifugation. Dix des 310 chiens (3,2 %) étaient infectés et un nombre de 0 à 35 vers (moyenne — 11,0 ± 13,4) étaient récupérés. Des larves de *C. vulpis* au premier stade du développement ont été retrouvées dans les fèces rectales de l'animal ne presentant pas de vers au lavage pulmonaire. Une deuxième étude des échantillons fécaux provenant de chiens afébriles présentant des signes de toux chronique mais n'ayant pas reçu récemment d'antihelminthiques et ne presentant pas des signes de maladies cardiaque à l'examen physique a été effectué en utilisant la technique de Baermann. Quinze des 55 chiens examinés (27,3 %) ont été diagnostiqués de façon certaines comme positifs à *C. vulpis*. Tous les chiens ont été traités au fenbendazole (50 mg/kg de poids corporel, PO, q24h pour 3–7 jours). Les signes cliniques ont disparu chez tous les chiens et les échantillons fécaux étaient négatifs 2–4 semaines après le traitement. Il a été conclus que les infections à *C. vulpis* étaient une cause importante de maladies du système respiratoire supérieure des chiens du l'Île du Prince-Édouard et devraient être pris en ligne de compte chez tous les chiens présentant des signes de toux chronique.

(Traduit par docteur André Blouin)

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Introduction

Crenosoma vulpis is a metastrongylid nematode lungworm that infects the bronchioles, bronchi, and trachea of wild and domestic canids and various other carnivores (1). *Crenosoma vulpis* is endemic in the northeastern region of North America (New York, Nova Scotia, New Brunswick, Newfoundland) with reported prevalence rates ranging from 21% to 50% in the red fox (*Vulpes vulpes*), the natural definitive host (2–5). Isolated cases of infection in dogs have been reported in New York (6), England (7,8), Ontario (9), and most recently Prince Edward Island (10). Infection appears to be nonlethal with clinical signs consisting mainly of chronic cough. The clinical signs of *C. vulpis* infection mimic closely those of allergic respiratory disease. Diagnosis of *C. vulpis* infection is based on detecting first-stage larvae in fecal samples using the Baermann technique (11). Larvae are not generally detected using the standard fecal flotation examination techniques utilized at most veterinary clinics; therefore, a significant number of *C. vulpis*-infected dogs could be misdiagnosed as having allergic respiratory disease. Compounding the misdiagnosis would be the likely response of lungworm infected dogs to the ameliorating effects of long-term corticosteroid therapy. The purpose of this study was to determine the prevalence of infection of *C. vulpis* in dogs and the role that lungworm infection plays as a cause of chronic respiratory disease in dogs on Prince Edward Island.

Materials and methods

Necropsy survey

Dogs euthanized by the Prince Edward Island Humane Society during the time period October 1995 to September 1996 were examined for the presence of *C. vulpis*. Normal operating procedures at the Humane Society at that time included treating all incoming animals with pyrantel pamoate (5 mg/kg body weight (BW), PO; Strongid-T, Pfizer, London, Ontario). Pyrantel pamoate is not absorbed from the intestine and, therefore, is not considered to have any effect on extraintestinal parasites such as *Crenosoma* (12). Animals were necropsied within 48 h of death or were frozen and stored for periods up to 1 wk prior to necropsy. Worms were recovered using the modified Inderbitzen lung flush technique (13). In brief, the heart and lungs were removed. An incision was made in the right ventricle through which a water hose was inserted into the pulmonary artery. The lungs were fully inflated with tap water, which passed through the trachea onto a 150-μm sieve. The sediment was collected from the sieve and examined under a dissecting microscope for the presence of parasites. The bronchial tree was then opened and inspected macroscopically for the presence of worms. The lungs were placed in a bucket of warm tap water for 1 h and the sediment was collected in the 150-μm sieve and examined under a dissecting microscope. Additionally, rectal fecal samples were collected and searched for first-stage larvae using the Baermann technique and a zinc sulfate ($ZnSO_4$) centrifugal flotation examination. Animals were grouped roughly by age estimates as juvenile (≤ 1 y of age) or adult (> 1 y of age), based on dentition and history, as available. Information regarding gender, breed, and living environment was documented, as available, for each animal. Infections and worm recoveries were analyzed in terms of prevalence, infection intensity, and abundance, as defined by Margolis et al (14). These data were analyzed by using a standard test for comparing proportions based on large sample normality (SAS 6.11 for Windows, SAS Institute, Cary, North Carolina, USA) of infected animals with regard to sex, age and living environment.

Baermann survey

Requests for referrals were sent to all veterinary clinics on Prince Edward Island for fecal samples from dogs with clinical signs of cough presented for veterinary care. Animals included in the study were those that were afebrile, had no signs of heart disease based on physical examination, and had not been treated with an anthelminthic within the last 30 d. The survey was conducted from July 1995 to June 1996. The samples were examined using the Baermann technique and, if sample size allowed, a $ZnSO_4$ centrifugal flotation. Information such as gender, age, living environment, and breed, as well as duration of cough, was requested. Posttreatment fecal examinations were performed on positive animals and information concerning response to therapy was requested from referring clinics.

Results

Necropsy survey

Between 19 and 33 dogs were examined each month, except for October (10 dogs), August (9 dogs), September (0 dogs), and January (60 dogs). The majority of the dogs were mixed breeds, including Labrador retriever, German shepherd, husky, border collie, and terrier crosses. The pure breed dogs included Labrador retrievers, German shepherds, border collies, malamutes, and beagles. *Crenosoma vulpis* infection was detected in 3.2% of the dogs (10/310) (Table 1). There was no evidence of a predisposition to infection with respect to sex or age. There was a significant difference in the infection proportions ($P < 0.0166$) showing a predisposition to *C. vulpis* infection in dogs residing in rural vs urban areas. Infection intensities ranged from 0 to 35 worms recovered from the 10 infected dogs (Table 1). Mature adult worms were recovered from 8/10, immature worms from 1/10, and 0 worms from 1/10 of the infected dogs. The one dog in which no worms were recovered was diagnosed as positive, based on the detection of *C. vulpis* first-stage larvae on a Baermann examination of rectal feces. First-stage larvae were detected in 9/10 of the infected dogs with the Baermann technique and in 8/10 with the $ZnSO_4$ centrifugal flotation examination. Other parasites detected on $ZnSO_4$ centrifugal flotation examination of rectal feces included *Toxocara canis* (12/310 = 3.9%), *Ancylostoma caninum* (4/310 = 1.3%), *Isospora* spp. (5/310 = 1.6%), and *Eucoleus (Capillaria) aerophila* (1/310 = 0.3%). One of the dogs infected with *T. canis* and the dog infected with *C. aerophila* were also infected with *C. vulpis*.

Table 1. Necropsy survey results of Humane Society dogs for *Crenosoma vulpis* infection on Prince Edward Island: Prevalence, intensity, and abundance

	Prevalence[a] % Infected (No. infected/total)	Infection intensity[b] Worm recovery mean (*s*)	Range	Infection abundance[c] Worm recovery mean (*s*)	Range
Male	3.7% (6/161)	10.0 (± 13.9)	0–35	0.37 (± 3.1)	0–35
Female	2.7% (4/149)	12.5 (± 14.4)	2–33	0.34 (± 2.9)	0–33
< 1 y	2.3% (4/171)	18.2 (± 18.2)	2–35	0.43 (± 3.7)	0–35
> 1 y	4.3% (6/139)	6.2 (± 7.2)	0–18	0.27 (± 1.9)	0–18
Rural	4.6% (9/196)	12.1 (± 13.7)	0–35	0.56 (± 3.8)	0–35
Urban	0.9% (1/113)	1.0		0.01 (± 0.09)	0–1
Overall	3.2% (10/310)	11.0 (± 13.4)	0–35	0.35 (± 3.00)	0–35

[a]The proportion of infected animals among all animals sampled, expressed as percentage (12)
[b]The mean number of worms recovered from all infected animals (12)
[c]The mean number of worms recovered from all animals, infected and healthy (12)
s — standard deviation

Table 2. Baermann fecal examination survey results of dogs suffering from chronic cough on Prince Edward Island, July 1995–June 1996

Baermann	Sex		Age (years)		Duration of Cough (days)		Environment	
Result	Male	Female	(Mean ± *s*)	Range	(Mean ± *s*)	Range	Urban	Rural
Positive (*n* = 15 dogs)	9	6	5.0 ± 3.7	1–12	24.9 ± 19.5	5–60	6	9
Negative (*n* = 40 dogs)	16	24	5.6 ± 3.6	1–14	40.7 ± 50.2	2–180	16	24
Overall (*n* = 55 dogs)	25	30	5.4 ± 3.6	1–14	35.7 ± 43.2	2–180	22	33

s — standard deviation

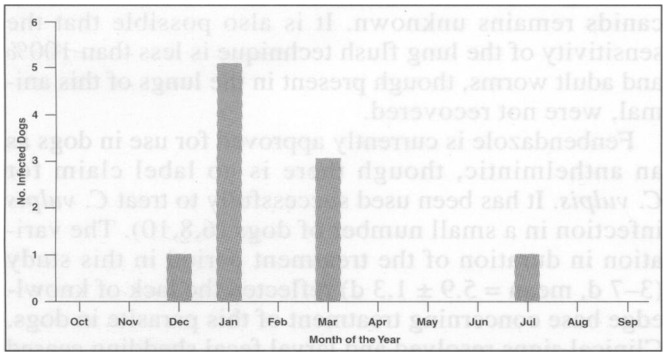

Figure 1. Number of *Crenosoma vulpis* infected dogs detected at necropsy from dogs euthanized at the humane society and examined during the time period October 1995–September 1996.

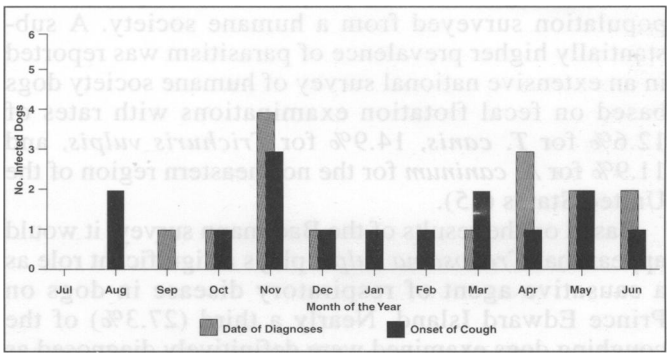

Figure 2. The number of dogs with chronic cough infected with *Crenosoma vulpis* as detected by Baermann fecal examination during the time period July 1995–June 1996. Data plotted as date of diagnoses and onset of clinical signs.

Baermann survey

Fecal samples from 55 dogs fitting the study profile were examined with the Baermann technique. The breeds of the dogs included beagles, Labrador retrievers, German shepherds, terriers, and poodles, and mixes consisted of terrier, German shepherd, Labrador retriever, and spaniels. *Crenosoma vulpis* larvae were detected in 27.3% (15/55) (Table 2). Dogs were diagnosed in the months of September through December and March through June with peaks in November and April (Figure 2). Due to insufficient fecal amounts, only 7 of the 15 positive samples were also evaluated with a $ZnSO_4$ centrifugal flotation examination. First stage *C. vulpis* larvae were detected in 2/7 (28.5%) of these samples. Of the 55 dogs examined, one *Crenosoma*-positive dog was also found to be infected with *Toxocara canis*.

Geographically, *Crenosoma*-positive dogs were located in all 3 of the counties on Prince Edward Island. One infected dog was located approximately 130 kilometres from Charlottetown in Kings County, 2 resided approximately 50 kilometres from Charlottetown

in Prince County, and the remaining 12 were from Queens County, all occurring within a 30-km radius of Charlottetown. Positive dogs were treated with fenbendazole (50 mg/kg BW, PO, q24h; Panacur; Hoechst-Roussel Vet, Regina, Saskatchewan) for periods ranging from 3 d to 7 d (mean = 5.9 ± 1.3). Clinical signs resolved in all 15 dogs and Baermann fecal examinations were negative 2 to 4 wk posttreatment. In addition, 7 of the 40 Baermann-negative coughing dogs were also treated with fenbendazole as a precautionary measure for periods ranging from 3 to 7 d (mean = 5.5 ± 1.52). Clinical signs resolved within 1 wk of treatment in 6 of these dogs.

Discussion

The results of the necropsy survey indicated a low but significant (3.2%) prevalence of *C. vulpis* infection in dogs on Prince Edward Island. Placed in context, this prevalence can be compared with the prevalence rates of the more common and familiar intestinal parasites of dogs. Unfortunately, the prevalence cannot be compared with the prevalence rates of the intestinal parasites detected in the humane society dogs, since these helminths represent those that survived treatment with pyrantel pamoate. Atlantic Veterinary College Teaching Hospital records for the study time period (October 1995 to October 1996) indicated prevalence rates based on fecal examinations of 5.8% for *Toxocara canis,* 3.4% for *Isospora* spp., 2.4% for *Giardia,* and 1.4% for hookworm. Similar results were obtained from a recent survey of dogs from veterinary clinics in the east coast of the USA (Smith G, Schad G, personal communication). It is likely that prevalence of parasitism would be lower in dogs receiving proper veterinary care vs a population surveyed from a humane society. A substantially higher prevalence of parasitism was reported in an extensive national survey of humane society dogs based on fecal flotation examinations with rates of 12.6% for *T. canis,* 14.9% for *Trichuris vulpis,* and 11.9% for *A. caninum* for the northeastern region of the United States (15).

Based on the results of the Baermann survey, it would appear that *Crenosoma vulpis* plays a significant role as a causative agent of respiratory disease in dogs on Prince Edward Island. Nearly a third (27.3%) of the coughing dogs examined were definitively diagnosed as being infected with *C. vulpis.* At the present time, the relative importance of *C. vulpis* infection as a cause of chronic respiratory disease in dogs in the other provinces of Atlantic Canada is unknown. Further studies specific to the mainland are warranted, given the high prevalence of infection in the red fox populations reported for Nova Scotia and New Brunswick (4).

Diagnosis of the infected dogs depended on detecting the first-stage larvae present in the feces. The results of this study indicated the Baermann technique to be the method of choice. Zinc sulfate centrifugal flotation examinations were positive for a proportion (28.5%) of the infected dogs but did not appear to work as well as the Baermann technique. Six of seven treated dogs from the 40 negative Baermann survey dogs were reported to show a clinical response to treatment with fenbendazole. Whether these animals were false negatives or the resolution of clinical signs was coincidental to the anthelmintic treatment remains unknown. False negatives could occur due to prepatency, erratic shedding of nematode larvae, or technical error. Multiple fecal examinations (3 samples collected over the span of 1 to 2 wk) might have improved the detection rate for both methods.

Contradictory results were indicated from the necropsy and Baermann surveys with respect to the infection risk of rural versus urban dogs. This may reflect the relatively close proximity of "urban" and "rural" areas on Prince Edward Island. There appears to be an element of seasonality associated with infection risk as indicated by the Baermann survey results (Figure 2). Dogs acquire *C. vulpis* infection by the ingestion of gastropods (slugs and terrestrial snails) that serve as intermediate hosts for the parasite (16). Gastropods are presumably more active during months with high moisture and moderate temperatures, suggesting that peak numbers would occur in spring and fall. Since the lifespan of *C. vulpis* is approximately 8 to 10 mo (17), infections in dogs should be detectable throughout the entire year, with peaks following periods of peak slug activity. There were insufficient numbers of dogs examined in the necropsy survey in the months of August, September, and October to allow examination of seasonality. However, the results obtained were consistent with peak lungworm exposure times occurring in the fall and spring.

Baermann survey and necropsy results did not correlate in one of the humane society dogs. False-positive Baermann results have been reported due to the contamination and prolonged survival of protostrongylid larvae on glassware (18). Whether this could be a complicating factor in the detection of *C. vulpis* infections in canids remains unknown. It is also possible that the sensitivity of the lung flush technique is less than 100% and adult worms, though present in the lungs of this animal, were not recovered.

Fenbendazole is currently approved for use in dogs as an anthelmintic, though there is no label claim for *C. vulpis.* It has been used successfully to treat *C. vulpis* infection in a small number of dogs (6,8,10). The variation in duration of the treatment period in this study (3–7 d, mean = 5.9 ± 1.3 d) reflected the lack of knowledge base concerning treatment of this parasite in dogs. Clinical signs resolved and larval fecal shedding ceased in the one dog that received a 3-day treatment. A similar response was observed in one dog treated in New York (6). Although the information is based on a limited number of cases, it would appear that there may be no benefit to extending the treatment period beyond the 3-day standard recommendation for fenbendazole use for intestinal helminth parasites. Other treatment options include febantel, levamisole, and ivermectin (for use in noncollie type breeds only). Febantel (in combination with praziquantel and pyrantel embonate, Drontal Plus, Bayer, UK) was used at a dosage of 14 mg/kg BW, PO, q24h for 7 d in one naturally infected dog (7). Levamisole (8 mg/kg BW, PO) was reported to be effective in 3 experimentally and 2 naturally infected dogs (9,19). Ivermectin (200 µg/kg BW, SC) was used to treat 2 naturally infected silver foxes and 2 naturally

infected dogs (9,20). Neither levamisole nor ivermectin (at the 200 µg/kg BW dose) are currently approved for use in dogs, making fenbendazole or febantel the recommended drugs of choice for the treatment of canine crenosomiasis.

Crenosoma vulpis infection should be considered in all dogs with presenting signs of chronic cough on Prince Edward Island and, perhaps, other parts of Atlantic Canada. Fecal samples should be examined for first-stage larvae by using the Baermann technique, and infected animals should be treated with fenbendazole or febantel. Due to the possibility of false negative fecal examination results, it may be advisable to consider multiple fecal sampling or treatment with anthelmintics, prior to a presumptive diagnosis of allergic respiratory disease and the administration of long-term corticosteroid therapy.

Acknowledgments

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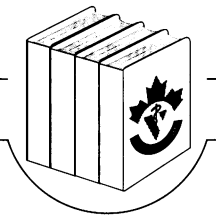
BOOK REVIEW



COMPTE RENDU DE LIVRE

Simpson G, England G, Harvey M. ***Manual of Small Animal Reproduction and Neonatology.*** Iowa State University Press, Ames, Iowa, 1998, 242 pp. ISBN 0-905214-36-6. $83.95.

This book is an excellent and welcome addition to the veterinary literature. The intent of the authors/editors was to provide coverage of all aspects of reproduction in the dog and cat, including the mammary gland and the neonate. I believe they have done this. The book is divided into 17 chapters written by many authors.

The first 2 chapters review the physiology and endocrinology of reproduction of the female dog and cat and lead into the chapter on "The Infertile Female." The subsequent chapters discuss conditions of the nonpregnant female, the mammary gland, and reproductive aspects of the male, as well as natural and artificial mating, pregnancy, parturition, and neonatology. The last 3 chapters describe surgical procedures of the genital tract and pharmacological control of reproduction in the dog and cat.

All chapters are very readable and will prove an excellent reference for veterinary practitioners, veterinary students, and veterinary technologists. The book has many excellent black-and-white and colored photographs, graphs, and tables, which are of great benefit to the book. Each chapter is thoroughly referenced with up-to-date citings.

This book is highly recommended and meets its objectives. It is a valuable addition to anyone with an interest in small animal reproduction.

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