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Prevalence of Lungworms in Illinois Coyotes

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ABSTRACT

The increasing abundance and expanding geographic range of coyotes in the eastern U.S. raises questions regarding the importance of parasites as limiting factors and the role of coyotes as a potential reservoir for parasites transmissible to other wild or domestic carnivores. We surveyed the prevalence and intensity of lungworms in 341 coyotes collected throughout Illinois and compared body mass and winter fat levels of infected and uninfected animals. Four lungworm species were found, including *Capillaria aerophila*, *Oslerus osleri*, *Paragonimus kellicotti* and *Crenosoma vulpis*. *C. aerophila* was the most prevalent and widespread lungworm occurring in 15.2% of coyotes, but had the lowest mean intensity of the four species. Body masses were lower and kidney fat indices tended to be lower for lungworm-infected versus uninfected males, but mass and fat levels did not differ in females. We conclude that lungworms may impact the condition of individual coyotes, but the prevalence and intensity of these parasites are currently too low to affect the population dynamics of coyotes in Illinois.

Key words: *Canis latrans*, *Capillaria aerophila*, coyote, *Crenosoma vulpis,* lungworm, *Oslerus osleri*, *Paragonimus kellicotti,* parasites

INTRODUCTION

Coyotes (*Canis latrans* Say) have increased in abundance in Illinois and throughout the eastern U.S. in recent decades (Hoffmeister, 1989; Lovell et al., 1998.). This species may serve as an important reservoir for a variety of parasites transmissible to domestic animals and humans, including several species of lungworms (Gier et al., 1978). Although mild lungworm infections in dogs are asymptomatic, provoking sporadic coughing, nasal discharge, and mild catarrhal inflammation, more severe infections can cause tissue damage, dypsnea, and predispose infected individuals to pneumonia. Parasites might be expected to have a greater impact on highly active wild canids by reducing respiratory function, movements, foraging efficiency, and survival, especially during periods of high host density, severe weather, or when individuals are in poor physical condition (Sacks and Blejwas, 2000).

Several studies have documented the prevalence of lungworms in local or regional coyote populations (e.g. Morrison and Gier, 1978; Custer and Pence, 1981; Carlson and Nielsen, 1985), but few have surveyed large samples of coyotes and none have investigated the potential sublethal effects of lungworm infections on the physical condition and growth of coyotes. Consequently, the effects of these parasites on the health and ecology of coyotes are unclear. The objectives of this study were to: (1) survey the prevalence and intensity of lungworms in coyotes throughout Illinois; (2) assess whether prevalence varied between sexes and age-classes; and (3) determine whether lungworm intensity correlated with physical condition, particularly body mass and winter fat levels.

MATERIALS & METHODS

The survey was conducted using 341 fresh coyote carcasses collected from fur buyers and trappers throughout Illinois during December-March, 1996 and 1997. The county of harvest, sex, and skinned body weight (kg) were recorded for each animal. Coyotes were classified as juveniles or adults based on the width of the pulp cavity measured on radiographs of a lower canine tooth (Kuehn and Berg, 1981). Skinned body weight, kidney fat index (KFI), and percent marrow fat were used as indicators of nutritional condition (Riney, 1955; Neiland, 1970).

Parasites were collected from the respiratory tract by inserting a small tube into the pulmonary artery and flushing with tap water while massaging the lungs for a minimum of 3 minutes. Water and parasites were flushed from the trachea onto a 120 μm sieve, then back flushed into a 90 μm sieve, and the contents examined for parasites at 15x using a dissecting microscope. In addition, the trachea and bronchi were carefully examined and nodules containing parasites were excised. Parasites were preserved in 70% ethanol and 5% glycerol, then mounted in lactophenol and identified using a compound microscope.

The prevalence (proportion of coyotes infected), mean abundance (number of lungworms/coyote examined), and mean intensity (number of lungworms/infected coyote) of all lungworms and each separate species were calculated for both sexes and age-classes of coyotes (Bush et al., 1997). Chi-square tests were used to test for differences in prevalence between the sexes and age-classes. Differences in the intensity of infections between sexes and age-classes were tested using t-tests (Sokal and Rohlf, 1995). We divided our sample into infected and uninfected groups to test whether lungworms affect body mass and fat reserves. Sample sizes varied among tests because individual organs were not used if they were damaged. All statistical tests were conducted at $\alpha = 0.05$

RESULTS & DISCUSSION

Prevalence and distribution

We identified 4 species of lungworms in coyotes: *Capillaria aerophila* (Creplin, 1839; Travassos, 1915), *Oslerus osleri* (Cobbold, 1879), *Crenosoma vulpis* (Dujardin, 1845), and *Paragonimus kellicotti* (Ward, 1908). *C. aerophila* was the most prevalent lungworm, occurring in 15.2% of coyotes (Table 1). The species was common throughout the state and found in 19 counties (Fig. 1). Nodules containing *O. osleri* were found in 2.9% of our sample from 7 counties across the state. Eight coyotes (2.3%) in 7 counties were

infected with *P. kellicotti.* The least common lungworm was *C. vulpis*, found in 2 (0.6%) individuals, both from Clay Co. in southeastern Illinois (Fig. 1).

The prevalence of lungworms did not differ between sexes ($X^2 = 1.26$; $P = 0.262$) or age-classes ($X^2 = 1.78$; $P = 0.182$). A total of 67 coyotes (19.6%) were infected with at least 1 lungworm species. Five of these infected individuals were parasitized by 2 species; 4 by *C. aerophila* and *O. osleri* and 1 by *C. aerophila* and *C. vulpis*. The mean abundance of all 4 species combined was relatively low at 0.43. Intensity ranged from 1 to 10 with a mean of 2.2 (SE = 0.3) worms. Lungworm intensities did not differ significantly between sexes ($P = 0.25$) or age-classes ($P = 0.74$). Most infected coyotes had low intensity infections; 75% carried ≤3 worms and only 7.5% were infected with >5 worms. Mean intensity was highest for *P. kellicotti* (mean = 4.3; SE = 1.3) and lowest for *C. aerophila* (mean = 1.7; SE = 0.2). No regional trends were apparent in the intensity of any of the 3 parasites found statewide.

None of these lungworms have been recorded previously from coyotes in Illinois, but 3 of the 4 have been reported previously in other regions (Custer and Pence, 1981; Ramsden and Presidente, 1975). Our study is the first to find *Crenosoma vulpis* in this host. *Capillaria aerophila*, which was prevalent in coyotes throughout the state, is a fairly common nematode in canids and was reported from 6% of dogs, 31% of red foxes (*Vulpes vulpes*), and 11% of gray foxes (*Urocyon cinereoargenteus*) in previous Illinois studies (Levine and Ivens, 1965; Dyer, 1984a). The parasite is transmitted directly and might be expected to pass from infected adults to pups during grooming or regurgitation of food. However, we did not find it to be more prevalent in juveniles. *C. aerophila* can be pathogenic, particularly in foxes, but its effects on coyotes are unknown. The current prevalence and mean intensity of this lungworm in Illinois coyotes are probably too low to impact survival or recruitment, but coyotes may serve as a reservoir for transmission of this parasite to dogs and other wild carnivores.

O. osleri is a nematode with worldwide distribution in canids (Soulsby, 1982). Custer and Pence (1981) found the species in 52% of coyotes in Texas where it had little impact on the host's health. We found this species most commonly in small (5-6 mm), submucosal nodules that projected into the trachea. No lesions were apparent and obstruction of the airways was minimal. Severe infections of *O. osleri* cause dypsnea and emaciation in juvenile dogs, leading to high mortality in affected litters (Dorrington, 1968). Similar effects in coyotes would be difficult to detect because diseased pups are likely to die undetected in the den and sublethal cases may restrict their movements and likelihood of harvest. However, it is doubtful whether this parasite can cross-infect dogs and therefore coyotes do not appear to be an effective reservoir for *O. osleri* infection in dogs (Foreyt and Foreyt, 1981).

The lung fluke, *P. kellicotti*, normally parasitizes mink, but has been reported in coyotes and a wide range of other vertebrate hosts (Ramsden and Presidente, 1975; Dubey et al., 1978). It can be transmitted to domestic animals and is a potential zoonotic (DeFrain and Hooker, 2002). In Illinois, Dyer (1984b) found this trematode in 2.4% of red foxes and 1.2% of gray foxes. We found the species to be rare, but widely distributed in coyotes. Its impact on infected individuals appeared to be negligible. *C. vulpis* was found only in 2 males from 1 location. The species has not been reported in coyotes, but has been

found in dogs, gray wolves (*Canis lupus*), and foxes in the eastern U.S. (Levine, 1968). Gregory (1998) found its prevalence to be higher (6.6%) in a sample of 15 red foxes from Illinois. The potential impact of *C. vulpis* on wild canids is poorly understood, but it has been studied in dogs where it can cause respiratory distress, bronchitis, pneumonia, and emphysema (Stockdale and Hulland, 1970).

Body mass and fat levels

Body mass and marrow fat levels differed between males and females ($t = 7.5$, $P < 0.001$; $t = 2.3$, $P = 0.023$), but not between juveniles and adults of either sex, so we pooled the age-classes and tested each sex separately to investigate whether body mass and fat levels differed between lungworm-infected versus uninfected coyotes. Lungworm-infected male coyotes weighed less ($t = 2.25$; $P = 0.026$) and tended to have lower KFIs ($t = 1.43$; $P = 0.134$) than uninfected males, but marrow fat levels did not differ between these groups ($t = 0.33$; $P = 0.744$; Table 2). None of the condition indices differed between infected and uninfected females ($P = 0.651$-0.893).

Given the relatively low intensities of lungworm infections in most of the coyotes that we examined, we were surprised to find lower winter body mass in infected males. This trend may reflect the sublethal effects of lungworms on respiratory efficiency and physical condition of infected individuals, but causal relationships should not be inferred from our data. We conclude that lungworms may affect the physical condition of some infected coyotes, but the current prevalence and intensity of these parasites appear to be too low to impact the population dynamics of coyotes in Illinois.

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Table 1. Age-specific prevalence of 4 species of lungworms in Illinois coyotes collected during 1996-97.

Species	Juveniles		Adults		Total
	Males (N=105)	Females (N=84)	Males (N=88)	Females (N=64)	
C. aerophila	22 (21.0%)	11 (13.1%)	11 (12.5%)	8 (12.5%)	52 (15.2%)
O. osleri	4 (3.8%)	2 (2.4%)	2 (2.3%)	2 (3.2%)	10 (2.9%)
P. kellicotti	4 (3.8%)	1 (1.2%)	2 (2.3%)	1 (1.6%)	8 (2.3%)
C. vulpis	1 (0.9%)	0 (0.0%)	1 (1.1%)	0 (0.0%)	2 (0.6%)

Table 2. Comparisons of body mass and fat indices for lungworm-infected versus uninfected coyotes in Illinois, 1996-97. Standard deviations are shown in parentheses.

Subsample	N	Mean skinned body weight (kg)	Mean KFI[1]	Mean percent marrow fat
Uninfected males	131	11.3[2] (2.0)	47 (20)	88.4 (4.9)
Infected males	35	10.4 (2.0)	42 (17)	87.8 (4.0)
Uninfected females	104	9.2 (2.1)	50 (23)	90.8 (3.7)
Infected females	23	9.0 (2.0)	52 (28)	90.6 (4.5)

[1] Kidney fat index = (weight of kidney fat / weight of kidneys) x 100.
[2] Mean body weights of males differs significantly at $\alpha = 0.05$.

Figure 1. Distribution maps for 4 lungworm species found in coyotes collected from Illinois during 1996-97.