



Fecal survey of parasites in free-roaming cats in northcentral Oklahoma, United States

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ABSTRACT

Cats can be infected by various intestinal parasites, some that are zoonotic. Although surveys of parasite prevalence in owned and shelter cats have been published, none addressed free-roaming, wild-trapped, domestic cat (*Felis catus*) populations. An opportunity to determine the prevalence of intestinal parasites in wild-trapped, free-roaming cats in northcentral Oklahoma, United States occurred through a trap-neuter-return (TNR) program conducted at Oklahoma State University, Boren Veterinary Medical Hospital, between February 2015 and April 2016. Approximately 1 g to 5 g of feces was collected from 846 free-roaming cats either from cage traps, when available, or rectally using disposable fecal loops and examined by centrifugal fecal flotation tests with 33% zinc sulfate solution. Parasite infections were confirmed by microscopic detection of eggs, cysts, or oocysts and visual detection of proglottids. Approximately 63.9% (541/846) of free-roaming cats were infected by at least one parasite, and 24.9% (211/846) of cats were infected by multiple parasites. The most common intestinal parasite infections detected were: *Toxocara cati* (44.6%; 377/846), followed by *Alaria* (13.4%; 113/846), *Ancylostoma* (11.2%; 95/846), *Cystoisospora* (9.7%; 82/846), taeniids (7.7%; 65/846), *Dipylidium caninum* (4.5%; 38/846), *Physaloptera* (2.2%; 19/846), *Eucoleus aerophilus* (1.4%; 12/846), *Giardia* (1.2%; 10/846), and a small (10–12 μm in diameter) *Toxoplasma*-like oocyst (0.1%; 1/846). A few ectoparasites, *Demodex gato* (0.5%; 4/846) and *Cheyletiella* (0.1%; 1/846), were also detected by fecal flotation. Our findings indicate that a higher prevalence of parasite infections occurs in free-roaming cats in Oklahoma than in owned cats, and these free-roaming cats contribute to contamination of the environment with several zoonotic parasites. Regional data on the prevalence of parasites in free-roaming cats can aid in the justification for parasite control programs in owned cats since both can share the same environment and supports the current practice of routine broad-spectrum anthelmintic and ectoparasite treatments for owned cats.

1. Introduction

Feral or stray, non-owned cats that live exclusively outdoors are sometimes referred to as community cats or free-roaming cats (Centonze and Levy, 2002). Additionally, others may include pet cats that are permitted outdoors in these designations (Wyrosdick et al., 2017). These free-roaming cats have a close association with human activities; however, many of these cats have little access to veterinary care and may not receive endoparasite and ectoparasite control. Therefore, they can provide a valuable sampling population to estimate the risk of parasite exposure for cats and evaluate contamination of the environment with zoonotic parasites. Since there are no published surveys on the prevalence of endoparasite infections in free-roaming cats in Oklahoma, the objective of our study was to determine the

prevalence of parasite infections by a centrifugal fecal flotation in free-roaming cats trapped from 14 counties in northcentral Oklahoma. Additionally, the impact of sex, age, and sampling time on prevalence of parasite infection were compared.

2. Materials and methods

2.1. Sample collection

Fecal samples were collected from free-roaming cats that presented to a trap-neuter-return (TNR) program conducted monthly between January – May and September – November at Oklahoma State University (OSU), Boren Veterinary Medical Hospital (BVMH) located in northcentral Oklahoma (OK), United States (US). Cats were trapped

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from 14 different counties in Oklahoma. Specific geographical details of the areas cats were trapped in were not available. All cats were required to be a minimum of 3 months old in order to participate in the TNR program. Cats were anesthetized prior to examination in accordance with the program's protocols (Williams et al., 2002). Sex and age of the cats were determined during physical examination and recorded. Dentition (Humane Society of the United States, 1996) was used to determine approximate age of the cats and to group them into 3 categories: 3 to 5 months old (3–5mo), 6 to 12 months old (6–12mo), and > 12 months old (> 12mo) at the time of presentation. A minimum of 1 g of feces was collected from cage traps, when available, or rectally using a disposable fecal loop (VetOne®; Boise, Idaho, US). Fecal samples were immediately placed into individual plastic bags, stored at 4 °C, and examined within a week. All research procedures and sample collections were approved by the Oklahoma State University Institutional Animal Care and Use Committee (IACUC).

2.2. Fecal examination

Samples were examined grossly for adult parasites and proglottids, which were removed and identified. Approximately 1 g to 5 g of feces was suspended in 33% zinc sulfate solution (specific gravity 1.18), strained with a tea strainer to remove debris, and placed in a 15 mL centrifuge tube. The tube was filled with flotation solution until a convex meniscus was formed and a coverslip was added. The samples were centrifuged in a Centra CL2 centrifuge (Thermo Fisher Scientific; Waltham, Massachusetts, US) at approximately 500–650 x g for 5 min. The coverslips were removed, placed on a glass slides and examined microscopically using 100 and 400 magnification. Parasite stages observed were identified morphologically primarily to genus and recorded (Zajac and Conboy, 2012). Free-roaming cats were considered to be infected with tapeworms when either eggs or proglottids were found and identified.

2.3. Data analyses

The prevalence of parasites was calculated according to Bush et al. (1997). Confidence intervals (95%) were calculated according to Sterne's exact method (Rozsa et al., 2000). Comparisons of the effects of sex, age, and sampling months on prevalence of parasite infections were done by Chi-square (Sokal and Rohlf, 1997) using SAS (SAS Version 9.4, SAS Institute, Cary, NC, US). Statistical significance was assumed at $\alpha = 0.05$.

3. Results

A total of 846 fecal samples were collected during 9 TNR programs held between February 2015 and April 2016. Overall, 541 (63.9%) samples contained at least one parasite, and 211 (24.9%) samples contained multiple parasites. *Toxocara cati* (44.6%; 377/846) was the most prevalent parasite detected, followed by *Alaria* (13.4%; 113/846), *Ancylostoma* (11.2%; 95/846), *Cystoisospora* (9.7%; 82/846), taeniids (7.7%; 65/846), *Dipylidium caninum* (4.5%; 38/846), *Physaloptera* (2.2%; 19/846), *Eucoleus aerophilus* (1.4%; 12/846), *Giardia* (1.2%; 10/846), and a small (10–12 µm) *Toxoplasma*-like oocyst (0.1%; 1/846). A few ectoparasite species, *Demodex gatoi* (0.5%; 4/846) and *Cheyletiella* (0.1%; 1/846), were also detected by fecal flotation.

3.1. Sex

Sex of 846 cats was determined and recorded; 417 cats (49.3%) were male and 429 cats (50.7%) were female. Of 417 male cats, 269 cats (64.5%) were positive for at least one parasite. Similarly, 272 of 429 female cats (63.4%) were positive for at least one parasite. Commonly detected intestinal parasites were similar in males and females; *T. cati* was the most common, followed by *Alaria*, *Ancylostoma*,

Table 1

Prevalence of parasites in fecal samples from free-roaming cats by age group.

Parasite	Prevalence % (95% CI)		
	3–5mo (n = 161)	6–12mo (n = 297)	> 12mo (n = 388)
<i>Toxocara cati</i>	63.4 (55.4–70.8) ^a	40.1 (34.4–45.9) ^b	40.7 (35.8–45.8) ^b
<i>Alaria</i>	19.9 (4.0–26.9) ^a	16.2 (12.2–20.9) ^a	9.0 (6.4–12.3) ^b
<i>Ancylostoma</i>	9.9 (5.8–15.6)	13.1 (9.5–17.5)	10.3 (7.5–13.8)
<i>Cystoisospora</i>	18.0 (12.4–24.8) ^a	9.1 (6.1–13.0) ^b	6.7 (4.4–9.7) ^b
Taeniids	5.0 (2.2–9.6)	7.1 (4.4–10.6)	9.5 (6.8–12.9)
<i>Dipylidium caninum</i>	4.3 (1.8–8.8)	3.7 (1.9–6.5)	5.2 (3.2–7.9)
<i>Physaloptera</i>	1.9 (0.4–5.4)	2.7 (1.2–5.2)	2.1 (0.9–4.0)
<i>Eucoleus aerophilus</i>	0.6 (0.0–3.4)	2.0 (0.7–4.4)	1.3 (0.4–3.0)
<i>Giardia</i>	0.6 (0.0–3.4)	1.7 (0.5–3.9)	1.0 (0.3–2.6)
<i>Demodex gatoi</i>	0.6 (0.0–3.4)	0.3 (0.0–1.9)	0.5 (0.1–1.9)
<i>Cheyletiella</i>	0.0 (0.0–2.3)	0.3 (0.0–1.9)	0.0 (0.0–1.0)
Small coccidia	0.0 (0.0–2.3)	0.3 (0.0–1.9)	0.0 (0.0–1.0)
All parasites	75.8 (68.4–82.2) ^a	62.6 (56.9–68.2) ^b	60.1 (55.0–65.0) ^b

Two percentages with the same letter in the same row are not significantly different at the 0.05 level.

Cystoisospora, taeniids, *D. caninum*, and *Physaloptera*. Statistically, there was no significant difference in the prevalence of intestinal parasites between sexes ($X^2 = 0.11$, $df = 1$, $P = .74$).

3.2. Age

Age was also determined and recorded for 846 cats examined; 161 cats (19.0%) were 3–5mo, 297 cats (35.1%) were 6–12mo, and 388 cats (45.9%) were > 12mo (Table 1). Of the 161 cats in the 3–5mo group, a total of 122 cats (75.8%) were infected by at least one parasite. Similarly, a total of 186 cats (62.6%) in the 6–12mo and 233 cats (60.1%) in the > 12mo groups were infected by at least one parasite. The overall prevalence of intestinal parasites was significantly higher in the 3–5mo group than the older cats ($X^2 = 12.2$, $df = 2$, $P = .002$). The six most commonly observed parasites in all age groups were the same: *T. cati*, *Alaria*, *Cystoisospora*, *Ancylostoma*, taeniids, and *D. caninum*. *Toxocara cati* was consistently the most prevalent parasite seen in all age groups. However, the prevalence of the five other commonly detected parasites varied by age. Significant difference between age groups was observed for *T. cati* ($X^2 = 27.7$, $df = 2$, $P < .0001$), *Alaria* ($X^2 = 14.0$, $df = 2$, $P = .0009$), and *Cystoisospora* ($X^2 = 16.8$, $df = 2$, $P = .0002$), with prevalence of infections significantly higher in the 3–5mo group than in the older cats.

3.3. Seasonality

Fecal collections were performed in 2015 (February – April and September – November) and 2016 (January, February, and April). The highest and lowest prevalence of intestinal parasites were observed in September and March 2015, respectively (Table 2).

4. Discussion

To the best of our knowledge, this is the first fecal survey of parasite prevalence in wild-trapped, free-roaming cats in northcentral Oklahoma. Studies in owned (Blagburn, 2009; Nagamori and Wohltjen, 2018) and shelter cats (Little et al., 2015) in the central United States reported lower prevalence of parasite infections in owned cats and a similar prevalence in shelter cats to what was detected in free-roaming cats of the current study. Free-roaming and shelter cats are more likely to be exposed to infectious parasitic stages and the intermediate and paratenic hosts of parasites since they have more access to outdoor environments; they receive little or no veterinary care; and they are more likely to be dependent on predation and scavenging for survival.

The most commonly detected parasite in our study was *Toxocara cati*, which is in agreement with findings in previously published

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