Article

A retrospective investigation of feline gastrointestinal parasites in western Canada

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Abstract — Between 1998 and 2008, feline fecal specimens were submitted to provincial veterinary diagnostic laboratories in Regina and Saskatoon, Saskatchewan, for sucrose centrifugation-flotation (*n* = 635), parasite identification (*n* = 17), and/or *Giardia* (*n* = 283) or *Cryptosporidium* (*n* = 266) commercial direct immunofluorescence assay (IFA). The most commonly detected parasites on flotation were *Toxocara cati* (4.7%), *Isospora* (3.8%), and taeniid eggs *(Echinococcus* or *Taenia)* (1.3%). Cats less than 2 years of age were twice as likely to have a positive parasite test as cats older than 2 years. Using IFA, *Giardia* was detected in 9.9% of samples, and *Cryptosporidium* in 2.3% of samples. Relative to IFA, flotation had sensitivity values of 39% and 50% for detection of *Giardia* and *Cryptosporidium,* respectively. *Giardia* and *Isospora* were detected in a higher proportion of samples in our study population than reported in the general cat population in western Canada. This study highlights the importance of sensitivity when interpreting diagnostic tests and provides information to guide region-specific recommendations for helminth parasite prevention and treatment.

Résumé — Enquête rétrospective des parasites gastro-intestinaux félins dans l'Ouest canadien. Entre 1998 et 2008, des échantillons fécaux félins ont été soumis aux laboratoires de diagnostic vétérinaires provinciaux à Regina et à Saskatoon, en Saskatchewan, pour une centrifugation-flottaison par saccharose (*n* = 635), l'identification des parasites (*n* = 17), et/ou d'un essai par immunofluorescence direct commercial pour *Giardia* (*n* = 283) ou *Cryptosporidium* (*n* = 266). Les parasites les plus couramment détectés à la flottaison étaient *Toxocara cati* (4,7 %), *Isospora* (3,8 %) des œufs de ténia (*Echinococcus* ou *Taenia*) (1,3 %). Il était deux fois plus probable que les chats âgés de moins de 2 ans aient un test positif pour les parasites que les chats âgés de plus de 2 ans. À l'aide d'un essai par immunofluoresnce, *Giardia* a été détecté dans 9,9 % des échantillons et *Cryptosporidium* dans 2,3 % des échantillons. En rapport avec l'essai par immunofluorescence, la flottaison avait des valeurs de sensibilité de 39 % et de 50 % pour la détection de *Giardia* et de *Cryptosporidium,* respectivement. *Giardia* et *Isospora* ont été détectés dans une proportion supérieure d'échantillons dans notre population étudiée comparativement à celle des résultats signalés dans la population générale de chats de l'Ouest canadien. Cette étude souligne l'importance de la sensibilité lors de l'interprétation des tests diagnostiques et des renseignements pour guider des recommandations spécifiques à des régions pour la prévention et le traitement du parasite helminthe.

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Introduction

An understanding of local parasite diversity is essential for optimal recommendations for parasite prevention and treatment. For western Canada, current recommendations are outlined in the "Canadian Guidelines for Treatment of Parasites in Dogs and Cats" developed by the Canadian Parasitology Expert Panel (CPEP) and published in March 2009 (1). As there are limited reports of the parasite fauna of cats in western Canada, these recommendations are based primarily on expert opinion. The diversity and prevalence of gastrointestinal parasites in cats in Saskatchewan and Alberta appear to be low (2,3). In particular, protozoan parasites (e.g., *Giardia*, *Cryptosporidium,* and *Isospora*) are thought to be rare in cats in western Canada (1,3). However, this may reflect the lower sensitivity of flotation of a single fecal sample for protozoan cysts and oocysts relative to more recently adopted immunofluorescence assays. The objectives of this study were, therefore, to determine the diversity and abundance of gastrointestinal parasites in cats in Saskatchewan based on retrospective analysis of diagnostic test results from

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Table 1. Positive tests in feline fecal samples submitted (1998–2008) to the PDS laboratories in Saskatchewan for centrifugation-flotation, adult helminth identification, and immunofluorescence assay (IFA) for protozoan parasites

	Number of tests	Number of positive tests (%)
Centrifugation-flotation	635	73 (11.5%)
Adult helminth identification	17	17
Giardia IFA	283	28 (9.9%)
Cryptosporidium IFA	266	6 (2.3%)

1998 through 2008, and to compare the relative sensitivity of fecal flotation and a commercially available immunofluorescence assay (IFA) for detection of *Giardia* and *Cryptosporidium* in diagnostic submissions.

Materials and methods

Between 1 January, 1998 and 31 December, 2008, fecal samples and parasite specimens from cats were submitted to the Prairie Diagnostic Services (PDS) laboratories in Regina and Saskatoon for tests for endoparasites. Results for samples submitted for fecal sucrose centrifugation-flotation (4), parasite identification, and/or commercial IFA for *Giardia* cysts and *Cryptosporidium* oocysts (Cyst-A-Glo™, FL, Comprehensive Kit, Waterborne, New Orleans, Louisiana, USA) were accessed in the PDS database (Table 1). Information regarding patient history and individual patient characteristics (age, gender, and breed) was collected when available. The percentage of positive samples for each parasite species for each test (flotation or IFA) was calculated. The sensitivity [true positives/(true positives + false negatives)] and negative predictive value [true negative/(true negative + false negative)] of routine fecal flotation (relative to IFA) for detection of *Giardia* and *Cryptosporidium* were determined for those samples for which both tests were performed (261 and 247 samples, respectively). Age ($<$ or $\geq$ 2 years of age) and infection status were entered into a 2 $\times$ 2 contingency table. The strength of association between variable (age) and outcome (parasite status) was reported as a Taylor series odds ratio (OR) with 95% confidence intervals (CI) (OpenEpi version 2.3.1, Atlanta, Georgia, USA).

Results

The diversity of parasites detected and the proportion of samples containing each parasite on flotation are reported in Table 2. Eggs of *Toxocara cati,* taeniid cestode eggs, and oocysts of *Isospora* were the 3 parasites most commonly detected on flotation. There were 17 adult helminth parasites submitted for identification: *Taenia* (n = 8), *T. cati* (n = 6), *Toxascaris leonina* (n = 1), *Spirometra* (n = 1), and an unidentified cyclophyllid tapeworm (n = 1).

Of those submissions in which age (n = 583) and gender (n = 621) were reported, the mean age and standard deviation of the cats sampled was 4.2 $\pm$ 4.9 years, and there were 267 (43%) female and 354 (57%) males. Cats younger than 2 y of age were twice as likely to have positive fecal samples as those $\geq$ 2 y of age [odds ratio (OR): 2.07, 95% CI: 1.34 to 3.19]. The proportions of samples that were positive for any parasite among 4 age groups of cats are reported in Figure 1. Of the cats positive for at least 1 endoparasite species, sample submission forms for 96 (78.5%) included a reason for submission: diarrhea (70.2%), parasite noted (14.3%), previous parasitic infection (11.9%), vomiting (8.3%), blood or mucus in the feces (9.5%), and sudden death or near-fatal illness of unknown cause (10.7%).

Table 2. Parasites detected in feline fecal samples submitted (1998–2008) to the PDS laboratories in Saskatchewan for sucrose centrifugation-flotation (n = 635)

Parasite	Number positive	Percent
Toxocara cati	30	4.7
Taeniid (*Taenia* or *Echinococcus* spp.)	8	1.3
Toxascaris leonina	1	0.2
Ancyclostoma	1	0.2
Physaloptera	1	0.2
Unidentified helminth	3	0.5
Isospora	24	3.8
Giardia	13	2.0
Cryptosporidium	3	0.5

On IFA, 9.9% of 283 samples were positive for *Giardia,* and 2.3% of 266 were positive for *Cryptosporidium* (Table 1). On routine fecal flotation, *Giardia* was detected in only 2% of 635 samples, and *Cryptosporidium* in 0.5% of 635 samples (Table 2). Of the 261 samples submitted for both flotation and *Giardia* IFA, 4% of samples were positive for *Giardia* on flotation compared to 10.0% on IFA. Compared to IFA, the sensitivity of fecal flotation for detecting cysts of *Giardia* was 38.5%, with a negative predictive value of 93.6%. Of the 247 samples submitted for both flotation and *Cryptosporidium* IFA, 1.2% were positive on flotation compared to 2.4% on IFA. Compared to IFA, the sensitivity of fecal flotation for detecting oocysts of *Cryptosporidium* was 50%, with a negative predictive value of 98.8%.

Discussion

The diversity of helminth parasites in cat fecal samples submitted to the provincial veterinary diagnostic laboratories in Saskatchewan over an 11-year period was comparable to that reported in earlier studies in Canada. *Toxocara cati* and taeniid cestodes were the most commonly detected helminth parasites, similar to findings in a previous study in Saskatchewan (2) and elsewhere in Canada (1,3,5). *Toxascaris leonina, Ancyclostoma, Spirometra,* and *Physaloptera* were rare (each detected in $<$ 1% of samples). Parasites were more commonly detected in cats $<$ 2 y of age, as observed elsewhere (3,6). Although reported in cats in Canada, we did not find evidence of *Aelurostrongylus, Aoncotheca, Capillaria, Diphyllobothrium, Eucoleus aerophila, Ollulanus tricuspis, Paragonimus,* or *Strongyloides* (2,5,7–9). This reflects the rarity as well as the unique life cycles of these parasites (some of which, such as *O. tricuspis,* may not be detected on routine fecal flotation). As well, this was not a true prevalence study in a representative feline population, as samples were submitted for diagnostic purposes in client-owned animals with an underlying reason for submission, compared with cats sourced from shelters in most previous studies.

Meaningful comparisons of helminth diversity and abundance with other studies are difficult because of differences in laboratory techniques and anthelmintic use since the earlier studies.

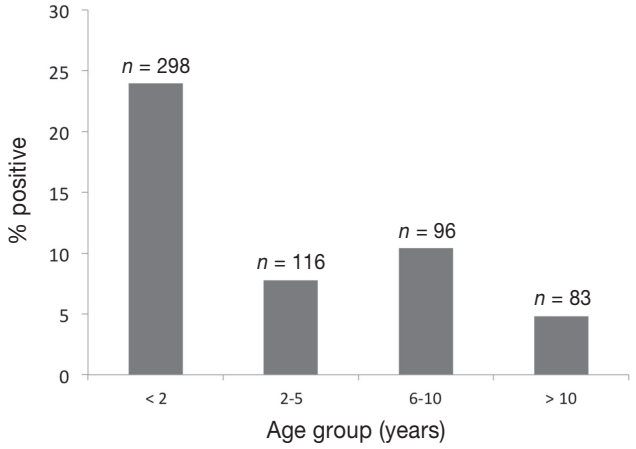

Figure 1. Percentage of fecal samples positive for at least 1 parasite in 4 age groups of cats. Samples were submitted to the PDS laboratories in Saskatchewan (1998–2008) for parasitological testing.

Although the sample population in our study was biased towards clinically ill animals, perhaps more likely to be parasitized than the general population, the proportions of samples positive for helminths were lower than those found in previous surveys of pet cats in eastern and central Canada. Therefore, our finding supports previous reports that gastrointestinal helminths seem to be uncommon in cats in western Canada (3,5,6,8,10). Such geographic variation in relative parasite abundance might be attributable to differences in climate, landscape, relative abundance of alternate host species, and the demographics of the sample population.

For protozoan parasites, we found a higher proportion of samples positive for *Isospora* (3.8%) in diagnostic submissions from cats in Saskatchewan than reported in the general population of cats in a recent study from Calgary, Alberta, in which only 1 of 85 shelter cats was positive for a coccidian parasite, and none of 68 client-owned animals were shedding oocysts (3). Prevalence of *Isospora* in cats elsewhere in Canada ranged from 4.0% to 10.0% (1,10). *Giardia* was the most commonly detected parasite in the current study. The proportion of samples positive for *Giardia* (10%) using IFA was considerably higher than the 1% to 2% previously reported in healthy cat populations in Canada (6), and on par with findings of 4% to 8% of 389 cats with gastrointestinal signs (11). These findings suggest an association between these protozoan parasites and clinical illness (primarily diarrhea) in cats; however, limitations of the current study include its retrospective nature, with inconsistent reporting of clinical signs and incomplete histories (such as parasiticide treatment and diet). As such, further research is needed to determine links between parasitism (mono- or polyparasitism) and clinical manifestations of disease in client-owned cat populations.

Our study indicated that the sucrose-centrifugation flotation method is relatively insensitive for the detection of *Giardia* and *Cryptosporidium* in feline fecal samples, relative to commercial IFA. Generally, fecal smears and flotations are less sensitive for these protozoans compared with fecal antigen testing such as the IFA or other commercially available tests (e.g., enzyme-linked immunoassay snap test) (6,11,12). As well, the intermittent nature of excretion of *Giardia* cysts and low sensitivity of conventional testing methods make it difficult to interpret negative results. For example, using a zinc sulphate centrifugation-flotation, *Giardia* and *Cryptosporidium* were not detected in a recent study in cats in the Calgary area (3). Our findings serve as a reminder for veterinary practitioners to request IFA or other immunological tests for *Giardia,* which is difficult to detect on routine fecal flotation, particularly in cats presenting with chronic or intermittent diarrhea unresponsive to conventional treatment. Further research with repeated sampling of animals would help address false negatives due to inconsistent fecal shedding.

Several of the parasites reported in this study have zoonotic potential, including *Toxocara cati,* the hookworm *Ancylostoma,* taeniid eggs (potentially *Echinococcus multilocularis*), and *Giardia* and *Cryptosporidum* (13–18). Human infection from *Toxocara* has been associated with the development of visceral and ocular larval migrans (13,14). *Ancyclostoma* has been associated with the development of cutaneous larval migrans in humans (15). The cestode *E. multilocularis* is endemic to prairie Canada and has been reported in cats in Saskatoon (16); however, cats are not thought to be a primary source of human exposure and only 1 human case of alveolar hydatid disease has been reported in Canada (17). Species of *Giardia* and *Cryptosporidium* most commonly present in cats are *G. cati* (previously *G. duodenalis* Assemblage F) and *C. felis,* both of which are believed to be uncommon in humans, other than those infected with HIV (18–20). Zoonotic species of these protozoans found rarely in cats include *G. duodenalis* (previously *G. duodenalis* Assemblage A), *G. enteritica* (previously *G. duodenalis* Assemblage B), *C. parvum,* and *C. muris.* For *G. duodenalis,* it is not yet known whether the predominant genotype in cats is AI (present in animals and humans), AIII or AIV (present mainly in animals), or AII (present mainly in humans) (21). In a recent study in Ontario (22), fecal samples from 12 of 13 cats contained Assemblage A *(G. duodenalis)*; the samples from 1 cat contained Assemblage B *(G. enteritica)*. Both these assemblages are considered zoonotic. Further molecular genotyping is required to determine the role of zoonotic transmission in the epidemiology of enteric protozoan disease in humans.

A recent survey of veterinarians in western Canada indicated that *Toxocara canis* or *T. cati, Giardia lamblia, T. gondii,* and *Echinococcus* spp. were associated with the highest perceived zoonotic risk (23). Despite the potential for transmission of feline enteric parasites to their owners, only about half of veterinarians in western Canada followed established guidelines for recommending anthelmintic treatment in kittens, which include treatment at 2, 4, 6, and 8 wk of age, and then monthly until 6 mo of age (1,23). A possible reason for this is that the guidelines recommend that treatment should start when the kittens are $<$ 1 mo old, when most have no contact with a veterinarian. Our results suggest that routine anthelmintic protocols for cats in western Canada should continue to focus on nematodes such as *T. cati,* and also consider enhanced testing and treatment for cestodes and protozoans in high-risk animals (i.e., outdoor cats and clinically ill cats, especially those with diarrhea). Given our

findings of lower prevalence in cats > 2 y of age, diagnostic testing is warranted (as opposed to blanket therapy) for parasites in adult feline veterinary patients. Finally, as this study was retrospective and does not describe prevalence in the general "healthy" cat population, a current cross-sectional study of free-ranging and client-owned cats in Saskatchewan (using powerful molecular and immunological approaches to identification of parasite stages shed in feces), and comparative studies from cats across all of the Canadian provinces are warranted.

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