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SHORT COMMUNICATION
Prevalence of fecal-borne parasites detected by centrifugal flotation in feline samples from two shelters in upstate New York

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Over a 3.5-year period, fecal samples from 1322 cats from two shelters and affiliated foster homes in upstate New York were processed for parasite detection by both 1.18 spg zinc sulfate and 1.3 spg sugar double centrifugal flotation. In 50.9% of the samples at least one parasite was detected. Overall, 18 different parasites ranging in prevalence from 0.2% to 21% were recovered. The most prevalent parasites of foster and shelter cats in this study were *Cystoisospora* species and *Toxocara cati* (21% prevalence, each). In order of percentage of positive samples, other findings were: *Giardia* species (8.9%), *Aelurostrongylus abstrusus* (6.2%), taeniid eggs (3.9%), *Cryptosporidium* species (3.8%), *Aonchotheca* species (3.7%), *Eucoleus* species (2.3%), *Ancylostoma* species (2.2%), *Cheyletiella* species (2.0%), *Dipylidium caninum* (1.1%), *Otodectes* species, *Toxoplasma*-like oocysts and *Sarcocystis* species (0.8% each), *Demodex* and *Spirometra* species (0.4% each), and *Alaria* species and *Felicola subrostratus* (0.2% each).

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Over a 3.5-year period (August 2006–January 2010), a total of 1629 feline fecal samples from two shelters and affiliated foster homes in Cortland and Tompkins counties in the state of New York were submitted as teaching material for parasite detection to the Community Practice Service (CPS) clinical rotation. Third and fourth year veterinary students at Cornell University's Veterinary College processed these samples as part of a clinical diagnostic parasitology course. These samples corresponded to 1322 individual cats. Of these, 307 samples represented resubmissions, ie, for these cats more than one fecal sample was examined. Shelters housed 1272 of these cats, while the remaining 50 were in foster care. No information on source of cat prior to arrival, age, gender, housing (ie, whether singly or in groups), history of parasite control products used (if any), length animals had been in custody, or signs of disease, is submitted along with the fecal samples, but both apparently-healthy and ill cats can shed parasites in their feces.[1,2] Collected samples were stored at 4°C and processed within 5 days of collection. All samples were processed by both 1.18 spg zinc sulfate and 1.3 spg sugar double centrifugal flotation.[3] Slides were examined under 100× or 400× magnification using bright field microscopy. Parasites were identified based on morphology alone, thus, in many instances identification beyond the genus level may not always be accurate. All samples were processed under the supervision of the principal author; all samples were examined by the principal author.

In just over half the samples (50.9%) at least one parasite was detected. Eighteen different parasites ranging in prevalence from 0.2 to 21% were noted (Table 1). The most prevalent parasites of foster and shelter cats in this study were *Cystoisospora* species and *Toxocara cati* (each had a prevalence of 21%). This trend seems to be consistent with the findings of other surveys (Table 1).[4–23] As individual *Cystoisospora* species are not always recorded on our forms, and mixed infections of *Cystoisospora* species are often present, these infections are grouped in our data. *Giardia* species cysts were detected in 8.9% of all fecal samples. The cat lungworm, *Aelurostrongylus abstrusus*, was present in 6.2% of samples examined. When taken together, the next most prevalent parasites were the capillarids (2.3% of samples contained *Eucoleus* species and 3.7% contained *Aonchotheca* species; mixed infections are common); *Eucoleus*

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Table 1. Parasite prevalence in cats reported in surveys between 1948 and 2009

Region	Year	*N*	Source of animals	Percent parasite prevalence (%)														Notes	Method (spg of solution, if given)	Reference
				Cystoisospora species	*Cryptosporidium* species	*Giardia* species	*Sarcocystis* species	*Toxoplasma* species-like	*Aelurostrongylus* species	*Toxascaris leonina*	*Toxocara cati*	Hookworms	'Capillarids'	*Ollulanus tricuspis*	*Dipylidium* species	Taeniids	*Alaria* species			
Northeast																				
NY	2006–2009	1322	(SH)(F)	21.0	3.8	8.9	0.8	0.8	6.2	——	21.0	2.2	3.7 Ap 2.3 Ea	——	1.1	3.9	0.2	*Spirometra* also detected (0.4%)	ZS (1.18) and S (1.3); CF	Present study
NY	2001	263	(SH)(O), <1 year old	——	3.8	7.2	——	1.1	——	——	32.7	——	——	——	——	——	——		ZS (1.18) and S (1.3); CF	Spain 2001[4]
NY	1971	132	(SH)	——	——	——	——	——	——	——	75.0	——	——	——	——	13.0	——		Necropsy	Styles 1971[5]
PA	2009	1566	(H)	37.0 Cf; 1.2 Cr	——	2.3	——	——	——	0.1	7.5	0.5	——	0.1	0.8	0.3	——		Proglottids, ZS (?); CF; sometimes EAS	Gates and Nolan 2009[6]
CT	2003	450	(ST)(O)	——	——	——	——	0.7	0.2	——	39.8	0.4	——	——	4.7	——	——		Ovassay; ZS; SF	Rembiesa 2003[7]
NJ	1970	757	(ST)	36.0	——	2.5	——	——	*	——	*	*	*Ea	*	*	*	*	(*) other recovered nematodes and trematodes	ZS (1.2) SF, PAF sedimentation; necropsy	Burrows 1970[8]
NJ	1967	1480	(ST)	——	——	——	——	——	1.1	——	36.2	34.2	9.0	0.2	0.1	5.3	——	*Trichuris* 0.2%	ZS (1.2); F	Lillis 1967[9]
NJ	1955	300	(ST)	——	——	——	——	——	——	10.0	42.0	19.0	——	——	32.3	14.3	——		Necropsy; NaCl (1.25); CF	Mann 1955[10]
NJ	1952	100	(V)	7.0*	——	——	——	——	——	5.0	50.0	17.0	——	——	19.0	8.0	——	*'Coccidia'	Necropsy; NaCl (1.25) CF	Mann 1952[11]
Midwest																				
IA	1983*	60	(SH)(O)	——	——	——	——	——	——	——	——	——	18.3 A.p	——	——	——	——	* *Aonchotheca* survey	Necropsy	Greeve 1983[12]
IA	1978	11,995	(O)	——	——	——	——	——	——	*	*	1.7	——	——	——	——	——	(*) 3.2% '*Ascarids*'	'Fecal examination'	Lightner 1978[13]
IL	1977	217	(R)(SH)(O)	23.0 Cf; 24.0 Cr	——	——	——	1.0	——	32.0	6.0	9.0	4.0	——	——	——	——		S (?); F	Guterbock 1977[14]
IL	1948	51	(SH)	——	——	——	——	——	——	——	37.3	5.9	——	——	39.2	3.9	——	*Trichinella* 21.6%	Necropsy	Cross 1948[15]
IL KY	1971	100	(LD)	——	——	——	——	——	——	12.0	26.0	45.0	——	——	14.0	16.0	——	*Physaloptera* species 5%, *Amphimerus pseudofelineus* 1%	Necropsy	Power 1971[16]
MI	1953	147	(UK), 6-12 wks old	89.0	——	5.0	——	——	——	1.0	67.0	8.0	1.4 Ea	——	1.0	0.5	——	*Trichomonas* 1%; *Physaloptera* 1%	Necropsy	Hitchcock 1953[17]
MO	1978	1294	(O)	67.0	——	——	——	——	——	——	——	6.4	2.6*	——	*	*	——	(*) 24.4% '*Ascarids*'; 5.2% 'tapeworm'. 'Capillarids' or *Trichuris* species	MS (1.25); (unspecified method)	Visco 1978[18]
OH	1976	1000	(SH)	94.0	——	——	0.2	1.0	——	——	25.0	9.6	1.3	——	*	*	——	(*) 0.5% 'tapeworm'	S (1.15); CF	Christie 1976[19]
WI	1980	23	(SH)	——	——	——	——	——	——	13	43.5	4.4	——	——	21.7	21.7	——		Necropsy	Amin 1980[20]
West																				
CA	2007	344	(SH)	52.0	4.7	9.9	——	——	——	——	19.0	1.0	——	——	2.0	2.0	——	*Strongyloides stercoralis* 1%	ZS (?); CF; DIF and EIA *Cryptosporidium* and *Giardia*	Mekaru 2007[2]

(*continued on next page*)

Table 1 (*continued*)

Region	Year	*N*	Source of animals	Percent parasite prevalence (%)												Notes	Method (spp of solution, if given)	Reference
				Cystoisospora species	*Cryptosporidium* species	*Giardia* species	*Sarcocystis* species	*Toxoplasma* species-like	*Aelurostrongylus* species	*Toxascaris leonina*	*Toxocara cati*	Hookworms	Capillarids'	*Ollulanus tricuspis*	*Dipylidium* species	Taeniids	*Alaria* species			
CO	2000	206	(SH)(O)	—	5.4	2.4	—	—	—	—	3.9	—	—	—	—	—	—		ZS (?); CF	Hill 2000[1]
UT	1977	100	(ST)	10.0	—	—	—	—	—	—	43.0	—	—	—	1.0	10.0	—	*Physaloptera* species 2%	Necropsy examination; S; F	Sawyer 1977[21]
South																				
MS	2006	250	(SH)(O)	—	—	13.3	—	—	—	—	—	—	—	—	—	—	—	* *Giardia* study	S (1.13); CF and IFA	Vasilopulos 2006[22]
TN	1956	12	(SH)(ST)	—	—	—	—	—	—	*	*	34.0	—	—	8.0	17.0	—	(*) 50% '*Ascarids*'	Necropsy	Ciordia 1956[23]

(*) = notes in note column (——) = parasite not reported. SH = shelter cats; F = foster cats; H = veterinary hospital patients; ST = stray cats; O = owned cats; R = research cats; V = 'various'; LD = 'local dealer'; U = 'unknown'. *Cf* = *Cystoisospora felis*; Cr = *Cystoisospora rivolta*-like; Ap = *Aonchotheca putorii*; Ea = *Eucoleus aerophilus*. ZS = $ZnSO_4$; S = sugar/sucrose; CF = centrifugal flotation; EAS = ethyl acetate sedimentation; SF = standing flotation; PAF = phenol–alcohol–formaldehyde; F = unspecified flotation; MS = $MgSO_4$; DIF = direct immunofluorescence; EIA = enzyme immunoassay; IFA = indirect fluorescent antibody.

aerophilus can cause coughing and wheezing due to bronchiolar disease and *Aonchotheca putorii* has been reported as a cause of gastritis in cats in Europe.[24] The remaining parasites were each found in less than 4% of samples: taeniids (3.9%), *Cryptosporidium* species (3.8%), *Ancylostoma* species (2.2%), *Cheyletiella* species (2.0%), *Dipylidium caninum* (1.1%), *Otodectes* species, *Toxoplasma gondii*, and *Sarcocystis* species (0.8% each), *Demodex* and *Spirometra* species (0.4% each), and *Alaria* species and *Felicola subrostratus* (0.2% each). Oocysts of size and shape consistent with *T gondii* were recorded as '*T gondii*', although by microscopic examination alone, they cannot be differentiated from *Hammondia* or *Besnotia* species. While the techniques used in this study cannot determine *Giardia* species assemblages or *Cryptosporidium* species, the authors believe *Giardia intestinalis* assemblage F and *Cryptosporidium felis* are most likely; neither of which are considered to be a major source of zoonotic infections.[25–27]

Prevalence determination based solely on fecal examination is likely to underestimate the true prevalence of infection in the population. Animals may have non-patent or latent infections that cannot be detected by the methods employed here, or animals may have been treated with anti-parasitic drugs prior to sample submission. In addition, tapeworm infections are more readily diagnosed by observing segments (as was sometimes the case with these samples) rather than by egg recovery in fecal flotation. Likewise, fecal flotation is not the method of choice for detection of fluke infections or ectoparasite infestations. Detection of larvae can be accomplished by the methods used here, as evidenced by the recovery of *A abstrusus* larvae in 6.2% of samples; however, Baermann sedimentations of all samples may have increased our ability to detect infections with this parasite.

The methods used here are considered by many, including the authors, to be the gold standard for routine fecal diagnostic testing for parasites.[28–31] The results obtained are generally within the range of those previously reported in other surveys (Table 1). There appears to be only one other survey[19] reporting the prevalence of *Sarcocystis* species in cats; our prevalence was four times greater than that reported by Christie et al.[19] The prevalence of *T gondii*-like oocysts in fecal samples in our study (0.8%), falls in the range of what is to be expected; it is believed at any point in time only about 1% of cats are shedding oocysts of this type. This is reflected by the data from other surveys as well (Table 1).

With regards to helminth infections, only two other surveys have reported *Aelurostrongylus* species prevalence in fecal samples[7,9]; these studies found a prevalence of 0.2% and 1.1%. The 6.2% prevalence found in our survey is quite a bit higher, even though, as mentioned above, this is still expected to be an underestimate of the true prevalence. It may be that the previous studies used standing flotation procedures, which are known to generally have poorer parasite recoveries,[30,31] or the discrepancy may be due to seasonal or geographical differences. *Toxascaris leonina* was not reported in any of the three surveys conducted in New York State (including

this one). The highest prevalence of *T cati*, hookworms, capillarids, *Dipylidium* species and taeniids has been reported in surveys that have included necropsy examinations, as would be expected (Table 1). This survey is the only survey reporting the prevalence of *Spirometra* (0.4%) and *Alaria* species (0.2%).

Many of the parasites detected in these cats are acquired through predation, (eg, *Cystoisospora*, *Toxoplasma*, *Toxocara*, *Ancylostoma*, *Aelurostrongylus*, *Taenia* species, etc). Cats of any age with access to prey species can be infected, including owned cats that have access to the outdoors and those in homes that have the potential for visits from mice, vole or other transport hosts. The findings of this study support the recommendation that all pets, even those under regular veterinary care, should have at least one annual fecal examination and should be placed on year-round prevention for internal and external parasites.

References

1. Hill SL, Cheney JM, Taton-Allen GF, Reif JS, Bruns C, Lappin MR. Prevalence of enteric zoonotic organisms in cats. *J Am Vet Med Assoc* 2000; **216**: 687–92.
2. Mekaru SR, Marks SL, Felley LJ, Chouicha N, Kass PH. Comparison of direct immunofluorescence, immunoassays, and fecal flotation for detection of *Cryptosporidium* spp and *Giardia* spp in naturally exposed cats in 4 Northern California animal shelters. *J Vet Intern Med* 2007; **21**: 959–65.
3. Bowman DD. Diagnostic parasitology. In: Bowman DD, Georgi's parasitology for veterinarians. 9th edn. St Louis: Elsevier, 2009: 295–371.
4. Spain CV, Scarlett JM, Wade SE, McDonough P. Prevalence of enteric zoonotic agents in cats less than 1 year old in Central New York State. *J Vet Intern Med* 2001; **15**: 33–8.
5. Styles TJ, Evans DS. Intestinal parasites of dogs and cats in Schenectady County. *NYS J Med* 1971; **71**: 2755–7.
6. Gates MC, Nolan TJ. Endoparasite prevalence and recurrence across different age groups of dogs and cats. *Vet Parasitol* 2009; **166**: 153–8.
7. Rembiesa C, Richardson DJ. Helminth parasites of the house cat, *Felis catus*, in Connecticut, USA. *Comp Parasitol* 2003; **70**: 115–9.
8. Burrows RB, Hunt GR. Intestinal protozoan infections in cats. *J Am Vet Med Assoc* 1970; **157**: 2065–7.
9. Lillis WG. Helminth survey of dogs and cats in New Jersey. *J Parasitol* 1967; **53**: 1082–4.
10. Mann PH. Additional information pertaining to the incidence of heartworms and intestinal helminths in stray cats and dogs in Bergen County, northern New Jersey. *J Parasitol* 1955; **41**: 637.
11. Mann PH, Fratta I. The incidence of coccidia, heartworms, and intestinal helminths in dogs and cats in northern New Jersey. *J Parasitol* 1952; **38**: 496–7.
12. Greeve JH, Kung FY. *Capillaria putorii* in domestic cats in Iowa. *J Am Vet Med Assoc* 1983; **182**: 511–3.
13. Lightner L, Christensen BM, Beran GW. Epidemiologic findings on canine and feline intestinal nematode infections from records of the Iowa State University Veterinary Clinic. *J Am Vet Med Assoc* 1978; **172**: 564–7.
14. Guterbock WM, Levine ND. Coccidia and intestinal nematodes of east central Illinois cats. *J Am Vet Med Assoc* 1977; **170**: 1411–3.
15. Cross SX, Allen RW. Incidence of intestinal helminths and trichinae in dogs and cats in Chicago. *N Am Vet* 1948; **29**: 27–30.
16. Power LA. Helminths of cats from the midwest with a report of *Ancylostoma caninum* in this host. *J Parasitol* 1971; **57**: 610.
17. Hitchcock DJ. Incidence of gastro-intestinal parasites in some Michigan kittens. *N Am Vet* 1953; **34**: 428–9.
18. Visco RJ, Corwin RM, Selby LA. Effect of age and sex on the prevalence of intestinal parasitism in cats. *J Am Vet Med Assoc* 1978; **172**: 797–800.
19. Christie E, Dubey JP, Pappas PW. Prevalence of *Sarcocystis* infection and other intestinal parasitisms in cats from a humane shelter in Ohio. *J Am Vet Med Assoc* 1976; **168**: 421–2.
20. Amin OM. Helminth and arthropod parasites of some domestic animals in Wisconsin. *T Wisc Acad Sci* 1980; **68**: 106–10.
21. Sawyer TW, Cowgill LM, Andersen FL. Helminth parasites of cats and dogs from central Utah. *Great Basin Nat* 1976; **36**: 471–4.
22. Vasilopulos RJ, Mackin AJ, Rickard LG, Pharr GT, Huston CL. Prevalence and factors associated with fecal shedding of *Giardia* spp in domestic cats. *J Am Anim Hosp Assoc* 2006; **42**: 424–9.
23. Ciordia H, Jones AW. The incidence of intestinal helminths in dogs and cats in Knoxville, Tennessee. *J Am Vet Med Assoc* 1956; **128**: 139.
24. Bowman DD, Hendrix CM, Lindsay DS, Barr SC. The nematodes, Adenophorea. Feline clinical parasitology. Ames, IA: Iowa State University Press, 2002: 338–54.
25. Ballweber LR, Xiao LH, Bowman DD, Kahn G, Cama VA. Giardiasis in dogs and cats: update on epidemiology and public health significance. *Trends Parasitol* 2010; **26**: 180–9.
26. Bowman DD, Lucio-Forster A. Cryptosporidiosis and giardiasis in dogs and cats: veterinary and public health importance. *Exp Parasitol* 2010; **124**: 121–7.
27. Lucio-Forster A, Griffiths JK, Cama VA, Xiao LH, Bowman DD. Minimal zoonotic risk of cryptosporidiosis from pet dogs and cats. *Trends Parasitol* 2010; **26**: 174–9.
28. Blagburn BL, Butler JM. Optimize intestinal parasite detection with centrifugal fecal flotation. *Vet Med* 2006; **101**: 455–63.
29. Blagburn BL. Why fecal centrifugation is better. *Vet Med* 2008; (Suppl S): 8–9.
30. Dryden MW, Payne PA, Ridley R, Smith V. Comparison of common fecal flotation techniques for the recovery of parasite eggs and oocysts. *Vet Ther* 2005; **6**: 15–28.
31. Zajac AM, Johnson J, King SE. Evaluation of the importance of centrifugation as a component of zinc sulfate fecal flotation examinations. *J Am Anim Hosp Assoc* 2002; **38**: 221–4.