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Endoparasite prevalence and recurrence across different age groups of dogs and cats

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Abstract

The apparent prevalence of endoparasite infections across different age groups was calculated from 6,555 dogs and 1,566 cats that had a fecal examination performed upon presentation to the Veterinary Hospital of the University of Pennsylvania between 1997 and 2007. Based on notations from the medical history indicating prior parasite infections, estimates of recurrence were generated for each common group of parasites, including *Trichuris*, *Giardia*, ascarids, hookworms, *Cystoisospora*, and tapeworms. Endoparasitism was predominantly a disease of younger animals, with peak prevalence observed almost uniformly in dogs under 6 months old, with the exception of *Trichuris* with its longer pre-patent period, and in cats less than 18 months old. Furthermore, nearly 50% of dogs under 6 months old with a history of parasites, were diagnosed with at least one species of parasite on subsequent fecal examination. The percentage dropped to 18.4% in animals aged 1 – 4 years, but again increased to 31.5% in animals over 10 years old. There was no reported recurrence of *Giardia* or *Cystoisospora* from canine or feline patients older than 1 year. The recurrence of whipworm rose steadily with age, while hookworm and roundworm recurrence peaked in patients 1 - 4 years old. Findings from the study emphasize the importance of follow up fecal examinations and treatments in patients diagnosed with endoparasites.

Keywords

Endoparasites; canine; feline; Epidemiology

1. Introduction

Standard diagnostic and treatment protocols for companion animal endoparasites can be significantly limited by the poor sensitivity of fecal examination techniques, treatment failure, and importantly, the possibility of re-infection from the same or new environmental sources. Although there is evidence that animals can develop an immune response to the parasitic infections, protection against future challenges does not appear to be absolute. Despite repeated exposure to *Toxocara canis* and the demonstrated presence of antibodies to *Toxocara* surface antigens, adult dogs in one study remained completely susceptible to subsequent oral administration of infective ova (Maizels and Meghji, 1984). Following anthelmintic therapy against *Ancylostoma ceylanicum*, worm burdens in adult dogs challenged by re-infection were

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77% less, but re-infection still occurred (Carroll and Grove, 1985). Patent infections may also be harder to diagnose with the subsequent exposure because of reduced fecal egg counts and attenuated clinical signs (Carroll and Grove, 1986). When mice were experimentally hyperimmunized with *Toxocara* extract, the resistance to subsequent challenge was only 37% (Barriga, 1988).

Little is currently known about the recurrence rates of these and other common companion animal parasites in the field setting. In order to plan adequate parasite control programs, it is crucial for veterinary practitioners to appreciate the chances of their currently parasitized patient testing positive on subsequent fecal examination. The first objective of this study was to characterize the prevalence of *Trichuris*, *Toxocara* and *Toxascaris*, *Ancylostoma*, *Dipylidium* and other tapeworms, *Giardia*, and *Cystoisospora* spp (syn *Isospora*) in different aged dogs and cats since age is a known risk factor for endoparasitism and can influence the development of an immune response. Based on notations in the medical history indicating prior parasite infections, estimates were then generated by age group of the likelihood that an animal tested positive for the same or different parasite species on fecal examination upon presentation to the veterinary teaching hospital at the University of Pennsylvania.

2. Materials and Methods

Between January 1st, 1997 and December 31st, 2007 a total of 6,555 canine patients and 1,566 feline patients presenting to the veterinary teaching hospital of the University of Pennsylvania (VHUP) had a fecal sample examined for evidence of endoparasitism. The fecal samples were examined grossly for the presence of tapeworm proglottids and the zinc sulfate centrifugation method, in some cases supplemented by the formalin-ethyl acetate sedimentation, was then used to prepare slides for microscopic examination (Truant et al., 1981). The species of parasite found was recorded and then classified according to genus, including *Trichuris*, *Toxocara*, *Toxascaris*, *Ancylostoma*, *Dipylidium*, *Taenia*, *Giardia*, and *Cystoisospora*. Other parasites, such as *Toxoplasma*, *Neospora/Hammondia* and *Eucoleus*, were seen so seldom that they did not provide enough data for analysis and they were excluded from the study. Patient date of birth was obtained from the electronic medical records and the age calculated back from the date of fecal examination. Patients were then grouped by year of age with patients under 1 year old further divided into a 0 – 6 months group and 6 months to 1 year group. The apparent prevalence of infections was calculated by dividing the number of animals diagnosed with a parasite on fecal exam by the total number of fecal exams performed for each age group. The prevalence estimates were reported as percentages.

The medical records were scanned for notations indicating a prior history of endoparasites. A total of 127 canine cases and 37 feline cases were found. For the majority of cases, parasites were classified into ascarid, hookworm, whipworm, tapeworm, coccidia (all in the genus *Cystoisospora*), and *Giardia*. The remaining cases were listed as ‘unspecified’. It should be noted that some patients had a history of multiple parasites, while others with a history of a single parasite tested positive for multiple species on the subsequent fecal exam. Due to the relatively small sample size, cases were then divided into groups according to age: 0 – 6 months (54 dogs, 12 cats), 6 months – 1 year (16 dogs, 8 cats), 1 – 4 years (26 dogs, 8 cats), 4 – 10 years (24 dogs, 6 cats), and Over 10 years (9 dogs, 3 cats). The age ranges were selected to ensure an adequate distribution of cases across the groups and also matched well with the different patient life stages. Parasite recurrence was calculated for each age group by dividing the number of patients testing positive for a given parasite on fecal exam by the total number of patients with a history of the same parasite. As information was rarely available on the time elapsed and the treatments provided for the prior infection, the impact of these factors on parasite recurrence could not be addressed.

3. Results

3.1. Canine endoparasite prevalence and recurrence

The prevalences of all parasites found in dogs are given in Table 1. With the exception of *Trichuris* and *Dipylidium*, the highest prevalence of canine endoparasitism was observed in patients less than 6 months old (Figure 1). The prevalence of ascarids (89% of which were *Toxocara canis* and the remaining 11% were *Toxascaris leonina* only one of which was seen in a dog over a year of age), *Giardia* sp, and *Cystoisospora* spp declined abruptly in patients over 1 year old, while a more gradual decline was noted for *Ancylostoma caninum* and *Trichuris vulpis*. The prevalence of *Giardia* appears to rise again in patients over 15 years old. *Dipylidium caninum* prevalence remained relatively constant across all age groups of dogs.

Of the 127 canine patients with a history of endoparasites, 68.5% had no parasites on the subsequent fecal exam, 22.0% had 1 parasite, and 9.4% had 2 or more parasites. The age of the animal appears to influence the likelihood of re-infection as demonstrated in Figure 2. Approximately 50% of animals under 6 months with a history of parasites were positive for at least one species on a subsequent fecal exam. The percentage dropped to 18.4% in animals between 1 and 4 years of age before increasing again to 31.5% in animals over 10 years old.

Examining the incidence of re-infection by parasite group (Figure 3), patients who were less than 1 year old with a history of *Giardia* had a 52.4% chance of testing positive on a subsequent fecal. For both *Giardia* and coccidia, there were no instances of recurrence after patients reached 1 year of age. The percentage of cases with whipworm recurrence increased from 0% in animals under 1 year old to about 22% for animals over 4 years old. There were no reported recurrences of *Dipylidium caninum* (the only tapeworm seen in dogs during this time period) in animals with a prior history.

3.2. Feline endoparasite prevalence and recurrence

The prevalences of all parasites found in cats are given in Table 1. Trends in parasite prevalence for cats by age differed from dogs as seen in Figure 4. The highest prevalence of hookworms and tapeworms occurred between the ages of 1 and 5 years, although prevalence for the remaining parasites was still greatest in the 0 - 6 month age group. There were no cases of *Giardia* observed in feline patients over 9 years old. The prevalence of *Cystoisospora* dropped to zero when the patients were between 5 and 9 years old, but steadily increased back to 3.4% when the patients were over 17.

Of the 37 feline patients with a history of endoparasites, 70.3% had no parasites, 27.0% had 1 parasite, and 2.7% had 2 parasites on the subsequent fecal exam. For patients under 1 year, there was no reported recurrence of ascarids (98% of which were *Toxocara cati* and 2% *Toxascaris leonina*), *Ancylostoma*, or tapeworms (75% *Dipylidium* and 25% *Taenia*). However, 5 out of the 6 patients with a history of *Giardia* and 1 out the 3 patients with a history of *Cystoisospora* were diagnosed with parasites of the same genus. In patients 1 – 4 years old, ascarid recurrence was 40%. No parasite recurrence was observed in the 9 patients over 4 years old.

4. Discussion

The findings reported above on the recurrence of parasites, as well as, the well known variations in sensitivity of different fecal examination techniques (Zajac, et al. 2002) emphasize the importance of conducting routine and repeat fecal examinations, even in the well cared for pet population. Overall, 41.5% of patients with a history of parasites were positive for at least one species on the subsequent fecal examination. The percentages varied by age with the highest seen in patients under 6 months, followed by patients greater than 10 years old. One possible explanation for the age association with parasite recurrence is that the immune system of very young dogs is unable to generate long term immunity to the parasites during development, while the immune system of older animals may begin to lose anamnestic responses against previously seen parasites (Day, 2007; Muirhead et al., 2008). Another explanation is the changing use of preventative medications with age. Based on unpublished data from the same VHUP patient population, chemoprophylactic use was significantly lower in patients under 6 months than any other age group. Chemoprophylactic use also declined steadily after patients reached 9 years old. If owners are less willing to engage in preventative practices for the very young and very old patients, this may put the animals at greater risk of parasite infections. There is also the possibility that given the small number of animals with recurrence of parasites, that the trends we see may just be due to chance.

There was distinct variation in parasite recurrence, based on the individual species of parasite, which was also at odds with the age prevalence estimates. The 4 species of *Cystoisospora* in cats and *Giardia* in dogs were the only situations where the prevalence in older animals was slightly higher than the 1- 5 age group. However, no patients over the age of 1 with a history of coccidia or *Giardia* were found to have the parasites on the subsequent fecal exam, although this result should be interpreted with caution given the small numbers of cases. This suggests that immunity to coccidia and *Giardia* may be life-long in companion animals, but when exposed for the first time, older animals may be more likely to develop patent infections easily detectable on fecal examination. Had an antigen test for *Giardia* been used, we would have seen either the same number or slightly more cases, depending on the test kit used, given that the majority of these were clinical cases (Cirak and Bauer, 2004; Geurden, et al., 2008), however, the slight increase in sensitivity would not have changed the age distribution we found. The results on age prevalence for *Giardia* are not entirely consistent with the literature, where other studies have found the individual prevalence of *Giardia* to be highest in dogs greater than 6 months (Hamnes et al., 2007). Even though prevalence increased slightly with age in the VHUP patients, the highest prevalence was still reported in patients less than 6 months.

Ascarids and hookworms are predominantly parasites of neonatal animals (Visco et al., 1977), so it was not surprising to find that recurrence decreased in patients over 4 years old. Visco, et al. (1977) found the prevalence of whipworm infections increased with age, while tapeworm infections remained sporadic across all age groups. The epidemiology of whipworms may have changed over the last 30 years as the prevalence of whipworms declined in our patients over 1 year old. However, this decline may have been due to client awareness of this parasite and the use of an appropriate monthly chemotherapy. Whipworm recurrence, however, did increase with age.

Despite the lack of information on what prior anthelmintic and preventative treatments the patients received, the contribution of product failure to parasite recurrence cannot be ruled out. For example, the efficacy of the pyrantel pamoate and ivermectin combination against *Toxocara canis*, *Toxascaris leonina*, *Ancylostoma caninum*, and *Uncinaria stenocephala* was estimated to be 90.1, 99.2, 98.5, and 98.7%, respectively (Clark et al., 1992). Although selamectin, the active ingredient in Revolution®, is not labeled for treating hookworms or roundworms in dogs, the efficacy against *Toxocara* has been reported as high as 97.6% depending on product administration (McTier et al., 2000). A percentage of the cases of ascarid and hookworm recurrence may therefore be attributable to the known less than 100% product efficacy, and some are probably due to accidental under dosing, but some may be due to resistance of the parasite. The same holds true for *Cystoisospora* and *Giardia* infections in dogs (Buehl et al., 2006; Payne et al., 2002). It is worth noting that dogs with previous *Toxocara* exposure have the same susceptibility for patent infections as naïve patients when later re-exposed, while those given milbemycin for treatment had significantly increased resistance to patent infections at a later time (Fahrion et al., 2008).

There were several limitations to the data used in this study. Since the majority of patients were referred from other practices, there were no records of how long ago the previous parasite infection was diagnosed, what treatments were attempted, and what steps the owners took to prevent the pet from becoming re-infected. Parasite recurrence may be higher than documented in this study because even though zinc sulfate centrifugation is among the best fecal examination techniques for diagnosing parasites, its sensitivity is not absolute. For example, if the patient was re-examined during the parasite's pre-patent period, recurrence of the parasite may have been missed. Regardless of the shortcomings in the study, it is clear that any patient with a history or clinical signs of parasitism should have multiple fecal exams run to ensure the best chances of accurately diagnosing and controlling endoparasites. This study also indicates that routine fecal examinations are still indicated in older pets, even in those that have previously been successfully treated for parasites.

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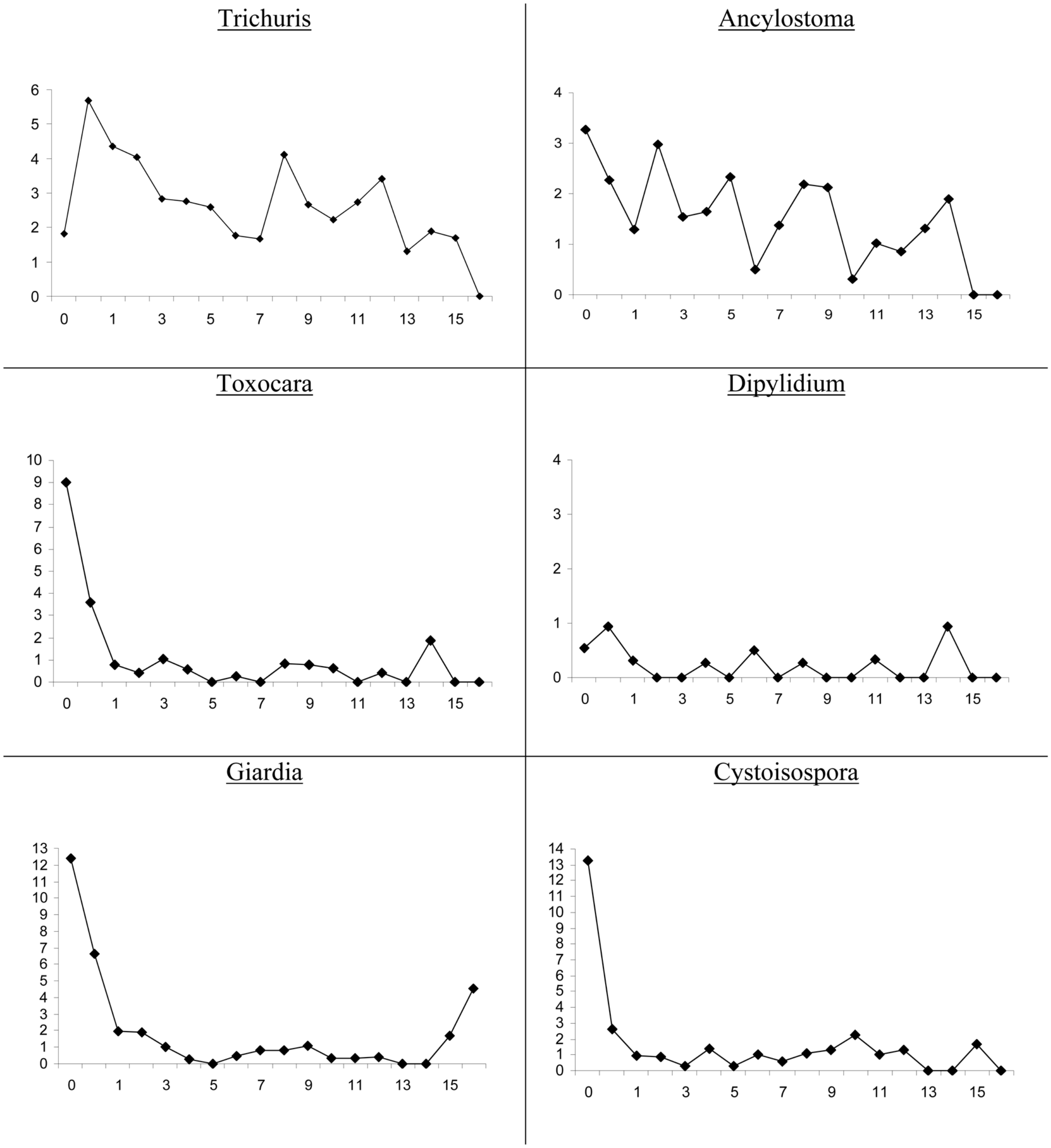

Figure 1.
Age prevalence curves for canine endoparasites. The x-axis represents Age in years and the y-axis represents the percentage of infected patients. Note: The scale of the y-axis changes depending on the parasite prevalence.

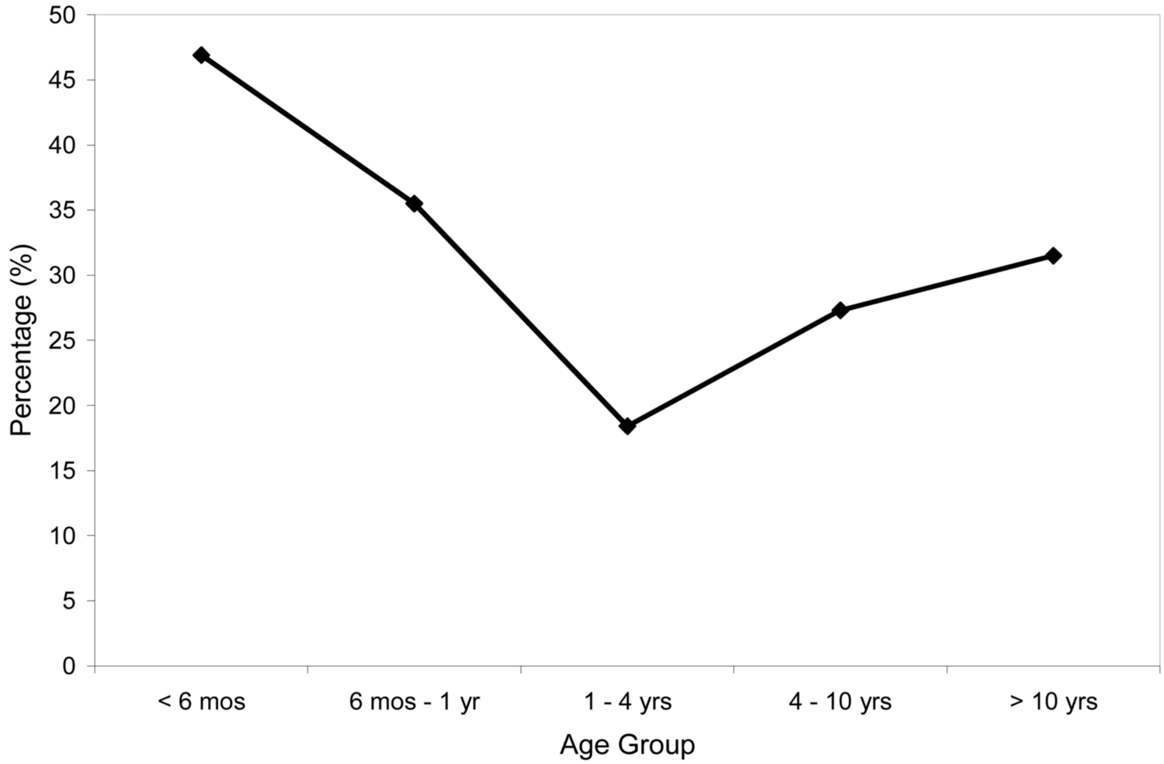

Figure 2.
Percentage of cases with a history of parasites that had either the same or a different parasite on repeat fecal exam.

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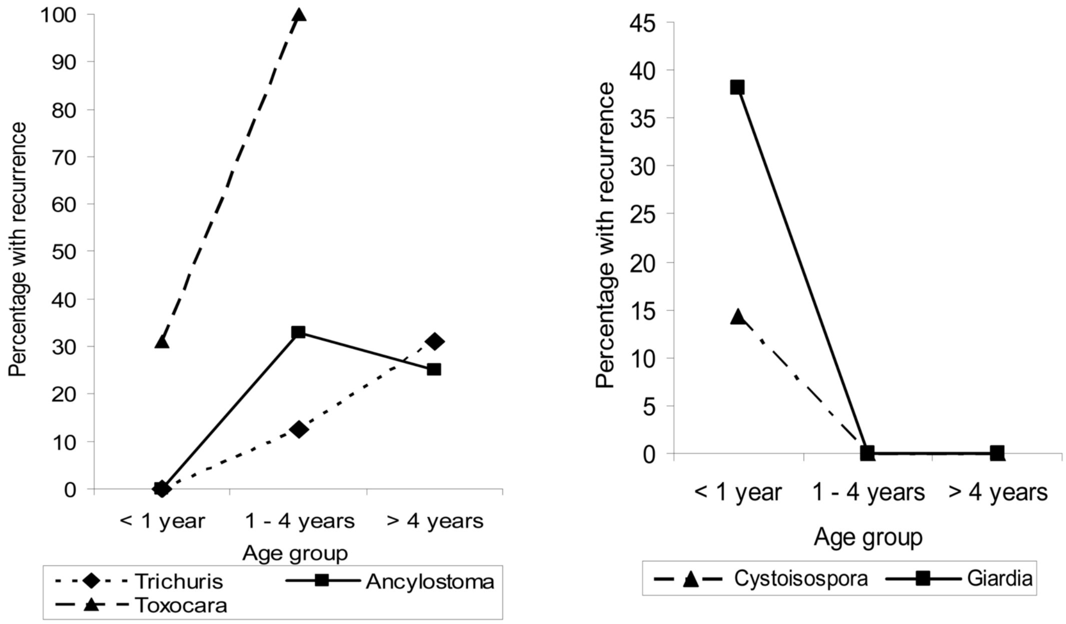

Figure 3.
Percentage of canine patients with recurrence of the same parasite by age group.

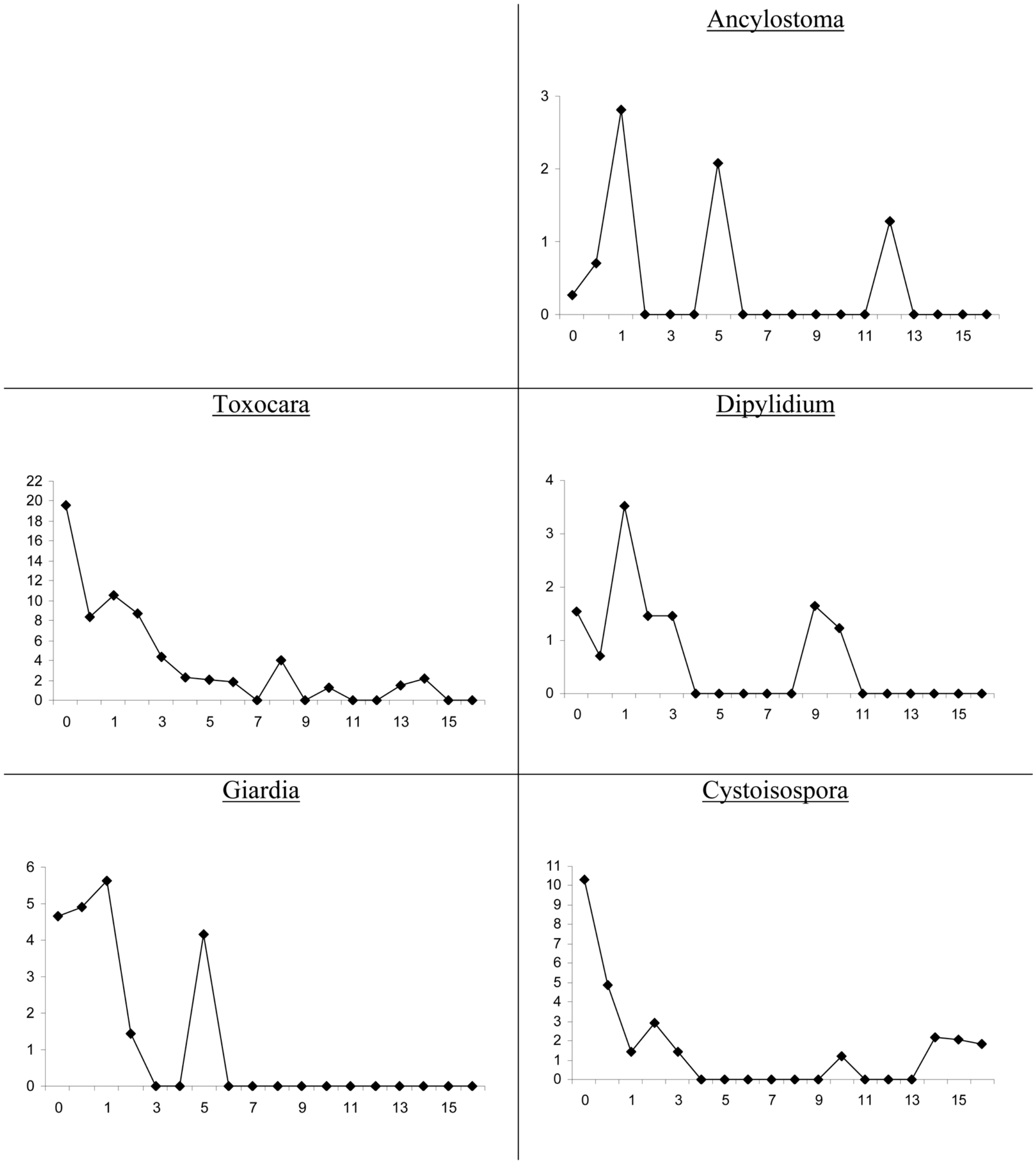

Figure 4.
Age prevalence curves for feline endoparasites. The x-axis represents Age in years and the y-axis represents the percentage of infected patients. Note: The scale of the y-axis changes depending on the parasite prevalence.

Table 1

Prevalence of parasites seen at VHUP between 1997 and 2006.

Dogs N = 6555		Cats N = 1566	
Parasite	**Number diagnosed (%)**	**Parasite**	**Number diagnosed (%)**
Trichuris vulpis	195 (3.0)	*Toxocara cati*	117 (7.5)
Ancylostoma caninum	121 (1.8)	*Toxascaris leonina*	2 (0.1)
Toxocara canis	131 (2.0)	*Ancylostoma tubaeforme*	8 (0.5)
Toxascaris leonina	13 (0.2)	*Ollulanus tricuspis*	2 (0.1)
Strongyloides stercoralis	13 (0.2)	*Dipylidium caninum*	12 (0.8)
Filaroides osleri	2 (0.03)	*Taenia taeniaeformis*	4 (0.3)
Eucoleus böhmi	1 (0.02)	*Cystoisospora felis*	43 (3.7)
Dipylidium caninum	19 (0.3)	*Cystoisospora rivolta* –like	19 (1.2)
Cystoisospora canis	80 (1.2)	*Giardia*	36 (2.3)
Cystoisospora ohioensis –like	129 (2.0)	*Toxoplasma gondii*	1 (0.06)
Neospora / Hammondia spp.	7 (0.1)		
Sarcocystis spp.	5 (0.08)		
Giardia	216 (3.3)		