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Prevalence of zoonotic intestinal helminths in pet dogs and cats in the Belgrade area

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ABSTRACT

The research was conducted in dogs and cats kept as pets on the territory of the city of Belgrade (Serbia), between 2011 and 2014. Its aim was to examine the prevalence of intestinal helminths and to point out their zoonotic potential. Coprological tests were carried out on samples from 528 household pets (421 dogs and 107 cats). The research included specimens from both gender, the dogs were between 2 months and 14 years old and the cats were from 1 month to 15 years old. The diagnosed parasites included: toxocarosis (*Toxocora canis* 16.62% and *Toxocora mystax* 15.88%), ancylostomatidosis (in dogs 4.03%, and in cats 1.87%), trichuriasis (in dogs 4.03%, and in cats 0.93%) and dipilidiosis (in dogs 24.70% and in cats 21.49%). Most of the examined cats and dogs that were found positive for intestinal helminths were 1–8 years old. For the effective planning and conducting of preventive strategies, the most important is to know the epizootiology of intestinal helminths of dogs and cats, including the possibilities of transferring these helminths to people. The priorities include the continued education of pet owners by veterinarians, and also the close cooperation between the veterinary and the human health service.

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1. Introduction

The intestinal parasites are cosmopolitan pathogens, including numerous species with zoonotic potential, which makes the research of this thematic topical in the whole world (Mircean et al. 2010; Kalafalla 2011; Beugnet et al. 2014). Ecological changes due to global warming have resulted in the peaking of wild carnivore populations, and the denser population of stray cats and dogs in city and suburban areas (Traversa et al. 2010). As a result of this, the number of possible infection reservoirs for household pets has increased, which have created the precondition for the continued population upkeep and the spreading of zoonotic helminths (Tsumura et al. 2007; Deplazes et al. 2011). A lot of researchers have been interested in the epidemiology of intestinal helminths of dogs, especially with the aim of promoting public health protection, including research from Greece (Papazahariadou et al. 2007), Spain (Martinez-Carasco et al. 2007), Turkey (Senlik et al. 2006), Italy (Zanzani et al. 2014), Germany (Barutzki and Schaper 2011), Belgium (Vanparijs et al. 1991), the Netherlands (Overqauw and Boersema 1998) and Finland (Pullola et al. 2006). Cats have an important role in the epidemiology of parasitic zoonosis, caused by ancylostomas (Coelho et al. 2011), also with the species such as *Toxocora cati* and *Dipylidium caninum* (Abu-Madi et al. 2010). Research works from around the world conclude that toxocarosis and ancylostomatidosis are the two most represented helminths of cats (Robertson and Thompson 2002; Coati et al. 2003; Funada et al. 2007; Sharif et al. 2010; Petry et al. 2011; Waap et al. 2013; Zanzani et al. 2014).

The research of intestinal helminthosis of dogs in the Belgrade area (Kulišić et al. 1992; Pavlović et al. 1995; Dimitrijević 1996; Pavlović et al. 2003; Dimitrijević et al. 2005; Nikolić et al. 2008; Pavlović et al. 2010; Pavlović et al. 2014) and other cities in Serbia (Lepojev and Marković 1983; Paunović et al. 1993; Stokić-Nikolić et al. 2008; Đurić et al. 2011; Rogožarski et al. 2012) are over 20 years old, and are continually renewed, without research renewals in cats (Dimitrijević et al. 2005; Lažetić et al. 2012). The results show the importance of cats' and dogs' role in contaminating the habitat, and can influence the health of humans and other animals, bringing them near to the possibility of infection.

From the aspect of human and animal health protection, the research of parasitic infections of carnivores is of great importance, considering that cats are the second most represented pets in Belgrade. The city environment supports the breeding of cats and dogs in flats, which results in a very close contact between humans and pets. With the sharing of space, and sometimes even food, the circumstances for the transfer of different zoonoses are created.

This paper represents the results of the research of intestinal helminths of household pets, dogs and cats of different age, and also their zoonotic potential.

2. Material and methods

2.1. The studied area

The research was conducted in cats and dogs kept as household pets on the territory of the city of Belgrade, in the

Table 1. The number of marked and vaccinated dogs and cats in the Belgrade area in the period from 2011 to 2014.

Year	Type of record	Animal species	
		Dogs	Cats
2011.	No. of marked animals	16.422	1.648
	No. of vaccinated animals	39.205	3.513
2012.	No. of marked animals	13.797	1.443
	No. of vaccinated animals	39.731	3.161
2013.	No. of marked animals	9.033	1.204
	No. of vaccinated animals	36.800	2.955
2014.	No. of marked animals	7.307	760
	No. of vaccinated animals	28.515	2.186

Source: Ministry of Agriculture and Environmental Protection Republic of Serbia – Veterinary Directorate.

period between 2011 and 2014. Belgrade can be found on the north of Central Serbia, on the Balkan Peninsula and is a part of southeastern Europe. It is situated at the confluence of Sava river into Danube river, whose elevation is 347 m above sea level with the coordinates 44,049'14" north and 20,027'44" south. The territory of the city is divided into 17 city districts, with 1,659,440 citizens on the whole.

The number of marked and vaccinated cats and dogs in the Belgrade territory varies from year to year (Table 1). The owners of cats and dogs are obligated to chip and to register their pets up to 90 days from birth. The variation in the numbers of marked and vaccinated animals is a result of irresponsible owners who do not sign out their pets if their pet died, or they do not register their new pets.

2.2. Material and methods for work

Coprological examinations were executed on samples from 421 dogs and 107 cats, kept as household pets. The faeces were collected 3 days in a row, by the owner. The examined dogs were between 2 months and 14 years old, and the cats were between 1 month and 15 years old. The examined pets were divided into three age groups: specimens younger than 1 year, specimens from 1 year to 8 years old and specimens older than 8 years. With the collection of faeces of cats and dogs, data from the owners were collected about the health status and data

about the dehelminthization (if it was conducted or not; if yes, with which kind of medicament). Some of the dogs and cats were treated with antiparasitic treatment, but the larger number of animals did not receive any kind of treatment.

Macroscopic and microscopic examinations of the collected material were done. For microscopic examination, the method of flotation was used, with the saturated solution of NaCl (with the specific weight of 1200 on the temperature 20°C).

2.3. Statistical analyses

The statistical analysis was done by GraphPad Prism Software program. For determination of the statistical significance between different age categories of dogs and cats which were found positive for intestinal helminthosis, chi square (χ^2) test was used. The results obtained are shown in tables.

3. Results and discussion

In the examined dogs the prevalence of toxocarosis was 16.62% (70/421), that of ancilostomatidosis was 3.80% (16/421), trichuriasis 4.03% (17/421) and dipylidiosis 24.70% (104/421). Based on the results, a statistically very large significance was proved ($P < .001$) in the prevalence of ancylostomatidosis, *D. caninum* and *Trichuris vulpis* compared to the age category of dogs (Table 2). In the examined cats, the prevalence of toxocarosis was 15.88% (17/107), ancylostomatidosis was 1.87% (2/107), trichuriasis was 0.93% (1/107) and dipylidiosis was 21.49% (23/107). A statistically very large significant difference was found ($P < .001$) in the prevalence of *Toxocara mystax* and *D. caninum* compared to the age category of cats (Table 3). The highest prevalence of mixed infections was found with *Toxocara canis* and *D. caninum* – 5.12% (10/195), and it was registered only in the age category between 1 and 8 years ($P < .001$). In dogs older than 8 years, no mixed infections, caused by two species of intestinal parasites, was found (Table 4).

In dogs younger than 1 year, was not found polyparasitism with three species of intestinal parasites. A statistical significant difference ($P < .001$) was established in the prevalence of mixed

Table 2. The prevalence of intestinal helminths in dogs of different ages.

Parasite species	Age category (years)									
	0–1 (n = 207)		1–8 (n = 195)		≥8 (n = 19)		Total (n = 421)		χ^2	P
	No. infected	%	No. infected	%	No. infected	%	No. infected	%		
<i>T. canis</i>	40	19.32	29	14.87	1	5.26	70	16.62	3.29	.19
<i>Ancylostomatidae</i>	0	0	13	16.66	3	15.78	16	3.80	20.03	.00***
<i>T. vulpis</i>	2	0.96	13	6.66	2	10.52	17	4.03	10.58	.00***
<i>D. caninum</i>	0	0	94	48.20	10	52.63	104	24.70	133.8	.00***

*** $P < .001$.

Table 3. The prevalence of intestinal helminths in cats of different ages.

Parasite species	Age category (years)									
	0–1 (n = 42)		1–8 (n = 54)		≥8 (n = 11)		Total (n = 107)		χ^2	P
	No. infected	%	No. infected	%	No. infected	%	No. infected	%		
<i>T. mystax</i>	1	2.38	13	24.07	0	27.27	17	15.88	11.62	.00***
<i>Ancylostomatidae</i>	0	0	2	22.22	0	0	2	1.87	2.00	.37
<i>T. vulpis</i>	0	0	1	1.85	0	0	1	0.93	0.99	.61
<i>D. caninum</i>	0	0	17	31.48	6	54.54	23	21.49	21.81	.00***

*** $P < .001$.

Table 4. The prevalence of mixed infection with two species of intestinal helminths in dogs of different ages.

Parasite species	Age category (years)								χ^2	P
	0–1 (n = 207)		1–8 (n = 195)		≥8 (n = 19)		Total (n = 421)			
	No. infected	%	No. infected	%	No. infected	%	No. infected	%		
<i>T. canis</i>	0	0	1	0.51	0	0	1	0.24	1.16	.56
<i>Ancylostomatidae</i>										
<i>T. canis</i>	1	0.48	1	0.51	0	0	2	0.48	0.1	.95
<i>T. vulpis</i>										
<i>T. canis</i>	0	0	10	5.12	0	0	10	2.37	11.87	.00***
<i>D. caninum</i>										
<i>Ancylostomatidae</i>	0	0	1	0.51	0	0	1	24.70	1.16	.56
<i>T. vulpis</i>										
<i>Ancylostomatidae</i>	0	0	1	0.51	0	0	1	0.24	1.16	.56
<i>D. caninum</i>										
<i>T. vulpis</i>	0	0	1	0.51	0	0	1	0.24	1.16	.56
<i>D. caninum</i>										

***P < .001.

Table 5. The prevalence of mixed infection with three species of intestinal helminths in dogs of different ages.

Parasite species	Age category (years)								χ^2	P
	0–1 (n = 42)		1–8 (n = 54)		≥8 (n = 11)		Total (n = 107)			
	No. infected	%	No. infected	%	No. infected	%	No. infected	%		
<i>T. canis</i>	0	0	1	0.51	0	0	1	0.24	1.16	.56
<i>Ancylostomatidae</i>										
<i>D. caninum</i>										
<i>T. canis</i>	0	0	1	0.51	0	0	1	0.24	1.16	.56
<i>T. vulpis</i>										
<i>D. caninum</i>										
<i>Ancylostomatidae</i>	0	0	0	0	2	10.53	2	0.48	42.52	.00***
<i>T. vulpis</i>										
<i>D. caninum</i>										

***P < .001.

Table 6. The prevalence of mixed infection with two species of intestinal helminths in cats of different ages.

Parasite species	Age category (years)								χ^2	P
	0–1 (n = 42)		1–8 (n = 54)		≥8 (n = 11)		Total (n = 107)			
	No. infected	%	No. infected	%	No. infected	%	No. infected	%		
<i>T. mystax</i>	0	0	1	1.85	0	0	1	0.93	0.99	.61
<i>Ancylostomatidae</i>										
<i>T. mystax D. caninum</i>	0	0	3	5.55	2	18.18	5	4.67	6.66	.03*
<i>Ancylostomatidae</i>	0	0	1	1.85	0	0	1	0.93	0.99	.61
<i>D. caninum</i>										
<i>T. vulpis</i>	0	0	1	1.85	0	0	1	0.93	0.99	.61
<i>D. caninum</i>										

*P < .05.

infections with species (ancylostomatidosis – *T. vulpis* – *D. caninum*) in dogs older than 8 years, and it was 10.53% (2/19) (Table 5). In cats younger than 1 year, no mixed infections from two species of intestinal helminths were established. A statistically significant difference ($P < .05$) was established between different age categories of cats with the prevalence of mixed infections with *T. mystax* – *D. caninum*. The highest prevalence of infections with these species was diagnosed in cats between 1 and 8 years old (5.55% – 3/54) and those older than 8 years (18.18% – 2/11) (Table 6).

Parasitic infections usually are clinically significant in puppies; while ascariidosis causes vomitus and diarrhoea (sometimes bowl obstruction), ancylostomas cause clinically significant, acute diarrhoea; *T. vulpis* causes chronic enterocolitis, followed by bloody-mucousy to watery diarrhoea (Sturgess 2000).

All helminthosis diagnosed in the research possess a zoonotic potential. The highest prevalence of toxocarosis was established in dogs younger than 1 year (19.32%) and in cats older than 8 years (27.27%). Ancylostomatidosis was diagnosed with the highest prevalence in samples from animals between 1 and 8 years old (16.66% of dogs and 22.22% of cats).

A wide systematic research of intestinal parasite infections of dogs kept as pets and stray dogs from Belgrade area showed the presence of the following species: *T. canis*, *Toxascaris leonina*, *Ancylostoma caninum*, *Uncinaria stenocephala*, *T. vulpis* and *D. caninum*, whose primary hosts were stray dogs (Kulišić et al. 1992, Pavlović et al. 2010, Pavlović et al. 2014). Pavlović and Kulišić (1994) diagnosed ascariidosis in dogs kept as pets, stray dogs and foxes on the territory of Belgrade, and from this research it can be concluded that by the spreading of the city belt to the natural territories of foxes resulted in a

closer contact between foxes and stray dogs. This has brought on a significant population boost of possible infection reservoirs for household pets.

Dogs and cats have an important role in the contamination of their habitat, which results in a risk to infect other animals and humans. In the addition to this is the research of parasitofauna of dogs and cats on the territory of the city of Belgrade, which were conducted by Kulišić et al. (1992), Pavlović et al. (1995), Pavlović et al. (2010), Pavlović et al. (2014) when they proved that the open green habitats (such as parks, playgrounds and sandboxes) were contaminated with ascaris, ancylostomatids, the nematode *T. vulpis*, cestodes and coccidia.

In earlier research works from the territory of Belgrade (Dimitrijević et al. 2005; Lažetić et al. 2012) established in dogs and cats kept as pets, the highest prevalence of infection was with ascaridids and the cestode *D. caninum*. This finding is in line with our results, which show that this tendency continued, which can present danger and potential risks to the health of people.

The results are very important for the fact that children are the most exposed ones to infection with *T. canis*, whose eggs can be found on the fur of pup, with which the children are playing (Aydenizöz-Özkayhana et al. 2008). As a result of migration of ascaris larvae to the eye, ocular larva migrans develops, which is an additional danger for children.

The clinical symptoms manifest as vision problems, chronic endofoalmitis with different stadiums, the detachment of the retina, occurrence of strabismus, glaucoma and even blindness (Stanojević-Paović 2001; Kranjčić-Zec et al. 2003; Elaine et al. 2011). The migration of *T. canis* larvae in other tissues and organs (liver, lungs, brain) leads to formation of visceral larva migrans (VLM), which also represents a health hazard (Kranjčić-Zec et al. 2003). In Serbia, there is a great risk from the occurrence of this zoonosis, considering the high prevalence of toxocarosis in dogs, and the high degree of soil contamination with the eggs of *T. canis* (Kulišić et al. 1992; Pavlović et al. 1995; Pavlović et al. 2010; Pavlović et al. 2014). In the last years, a few hundreds of cases were proved in children, while in older people the illness is rarely diagnosed. This is why patients with eosinophilia, migrating lung infiltrations and positive serological analysis on *T. canis* were considered doubtful cases for human toxocarosis (Považan et al. 2011; Colovic-Calovski et al. 2014).

Besides echinococcosis, in the process of educating the public about parasitic zoonoses, which can have direct consequences on human health, special attention must be directed to the toxocarosis of dogs. Despite the availability of effective antihelminthics for cats and dogs, in Europe there are big endemic parts, where echinococcosis and toxocarosis of people still persist (Deplazes et al. 2011).

A. caninum constitutes an important zoonosis, as the larvae can invade human skin (cutaneous larva migrans (CLM)), resulting in itchy, serpiginous skin eruptions, usually found on the hands and legs (Wojnarowicz 2007).

Passing, but typical lesions for CLM can be caused also with the nematode *Strongyloides stercoralis* (Ganesh and Cruz 2011).

The largest number of dogs (6.66%) and cats (1.58%) infected with *T. vulpis* were between 1 and 8 years old. This finding is in line with the data from literature, considering

that *T. vulpis* is dominantly a dog parasite, and can be found rarely in cats (Shapiro 2009; Traversa 2011). It is proved that *T. vulpis* causes VLM in people (Masuda et al. 1987; Márquez-Navarro et al. 2012). Because of the zoonotic potential of this species and the dogs as the infection source, the most important thing to do is to make a correct diagnosis, so as to stop the spreading of the infection or reinfection.

The cestode *D. caninum* was diagnosed with the highest prevalence in dogs (52.63%) and in cats (54.54%) older than 8 years. Dipylidiosis can occur in dogs and cats, if they are infected with fleas (Đurić et al. 2011; Lažetić et al. 2012). Children can get infected similarly to dogs, if they accidentally ingest a flea with a cysticercoid. Because of this, cestode can be a danger for the human population (Tsumura et al. 2007). This is why it is important to treat cats and dogs, besides regular dehelminthization, with antiektoparasitics.

4. Conclusion

Considering the zoonotic potential of the diagnosed parasites, the results are very important for veterinary and human medicine. Also they are of importance for the improvement of controlling the parasitic infections of carnivores. Veterinarians are obliged to educate the owners about the parasites which can be found in carnivores, about their zoonotic risks, to accent the importance of coprological examinations and to suggest the appropriate therapy, because only through responsibly protecting the health of their pets, can the owners protect their own health.

Disclosure statement

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