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Biodiversity of Endoparasites in Domestic Cats and Dogs from the Sofia city, Bulgaria

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During the period 2019-2021 fecal samples of domestic cats and dogs from the regions of Sofia, Bulgaria, were investigated by the ovoscopical methods of Fulleborn, serial sedimentations and modified technique of Bearman. Most of the registered parasites were nematodes (22% in cats; 23.8% in dogs), followed by protozoa (8% in cats; 9.5% in dogs), and cestodes (4% in cats; 4.8% in dogs). Parasites were found in 30% of the 50 fecal samples obtained from cats: *Aelurostrongylus abstrusus* (10%), *Capillaria aerophila* (2%), *Toxocara cati* (16%), *Dipylidium caninum* (4%), *Cystoisospora* sp. (8%). Parasites were found in 38% of the 21 samples from dogs: *Toxascaris leonina* (9.5%), *Trichuris vulpis* (9.5%), *Uncinaria stenocephala* (14.3%), *D. caninum* (4.8%), *Cystoisospora* sp. (9.5%). Morphometric features of eggs and larvae of the established parasites were described in present materials. Some of data concerning *A. abstrusus* were supplied for the first time in materials from Bulgaria.

Key words: Aelurostrongylus abstrusus, Capillaria aerophila, Toxascaris leonina, Toxocara cati, Trichuris vulpis, Uncinaria stenocephala, Dipylidium caninum, Cystoisospora sp.

Introduction

Carnivores are involved in the emergence and circulation of some viral, bacterial and parasitic infections, in most of the cases, they appear to be the leading factors in the distribution of them [16]. Many of the parasite species, specific to cats and dogs, parasitize other groups of animals, such as herbivores, omnivores, rodents. Examples are endoparasites of *Taenia* spp., *Toxocara* spp., *Hydatigera* spp., *Ancylostoma* spp. and others. Carnivores are hosts for a number of parasites that cause disease also in humans. According to Baneth et al. [1] some of the most important zoonoses transmitted from pets (dogs and cats) to humans in Europe are parasitic in nature, such as toxoplasmosis, leishmaniasis, giardiasis, cystic echinococcosis, alveolar echinococcosis, heartworm disease and toxocarosis. In 2012 alone, 320 people were

diagnosed with cystic echinococcosis in Bulgaria [8], and in the period 2006-2014 our country ranked first in the European Union in the number of confirmed cases of cystic echinococcosis [3]. Large part of the dogs' and cats' owners are unfamiliar with pet parasites and do not know how they are transmitted or what zoonotic risk they pose. Katagiri and Oliveira-Sequeira [9] suggest that low awareness, together with the high percentage of zoonotic parasites in dogs found in their study, show a high risk of infecting people with zoonotic parasites even in developed parts of the world. Children and the elderly are most at risk of infestations with parasites transmitted by carnivores, and protozoa of the genera *Cryptosporidium*, *Giardia* and *Toxoplasma* are particularly dangerous for people with compromised immune systems and pregnant women [15].

In order to succeed in the fight against parasitoses, special attention must be paid to their accurate diagnosis, to develop adequate guidelines for epidemiological studies and to obtain reliable data that enable health services to determine current ways to prevent and control them. In this regard, the aim of the present work was set, namely: to perform diagnostic parasitological studies of domestic cats and dogs by tracking the biodiversity and morphometric features of the established parasites, as well as some aspects of the observed parasitoses.

Materials and Methods

Fecal samples from 50 cats and 21 dogs were investigated for parasites in the period 2019-2021. The samples have been brought to several veterinary practices in Sofia by the animals‘ owners with a complaint of their pets being sick or a desire for preventive testing. Ovoscopical methods of Fulleborn, serial sedimentations and modified technique of Bearman were used to examine the feces in the laboratory [11]. The imaging and measurement of the parasite forms were performed using a Motic Images Plus 3.0 camera connected to an Amplival microscope, with accompanying software. The helminth eggs, larvae and protozoan oocysts were identified morphologically according to the descriptions of Thienpont et al. [18] and Foreyt [4].

Results

Parasite diversity

The biodiversity of the found parasites are pointed out in **Table 1**. Eight parasite taxa were diagnosed: *Aelurostrongylus abstrusus, Capillaria aerophila*, *Toxascaris leonina*, *Toxocara cati*, *Trichuris vulpis*, *Uncinaria stenocephala*, *Dipylidium caninum*, and *Cystoisospora* spp. Nematodes were most commonly found both in cats and dogs, followed by protozoa and cestodes. Single infections were more common. Co-infections were found in three cats, they were: *T. cati* + *Cystoisospora* sp.; *T. cati* + *A. abstrusus*; *T. cati* + *C. aerophila* + *Cystoisospora* sp. Two dogs were co-infected, both of them with *T. leonina* and *U. stenocephala*.

Clinical symptoms of the disease with concomitant detection of parasites in the feces were observed in 18% of the cats and 28.6% of the dogs. The main clinical symptoms that have led the owners to bring their pets for examination have been cough and diarrhea. Cough was observed in all cats infected with *A. abstrusus*, two

infected with *T. cati* and one with *C. aerophila*. Animals infected with *Cystoisospora* spp., *T. vulpis*, *U. stenocephala*, and some with *T. cati* had diarrhea. Diarrhea was particularly severe, with content of blood in feces, in two dogs - one of them with *Cystoisospora* sp. infection and other one with *T. vulpis* infection, as well as one cat with triple infection by *T. cati*, *C. aerophila*, and *Cystoisospora* sp.

Morphometric data

Morphometric characteristics of the detected parasites are presented in **Fig. 1** and **Table 2**. Here, we also provide some more morphometric data for *A. abstrusus* first stage larvae (L1) in the present materials: Body fusiform, 337.99 – 402.65 (av. 372.25) μm long and 15.18 – 21.00 (av. 17.41) μm maximal wide. Oesophagus with two dilatations – elongate, at the anterior and bulbous at the posterior end (**Fig. 2a**), 134.51 – 160.72 (av. 152.53) μm long and 7 – 10.51 (av. 8.77) μm maximal wide. Tail end of the body spirally curved, 5.08 – 7.38 (av. 6.13) μm long, with a small spike on the dorsal side (**Fig. 2b**). Distance between posterior body end and anus 31.96 – 52.19 (av. 37.53) μm.

Discussion

As can be seen from **Table 1** prevalence of infections with nematodes, cestodes and protozoa, as well as the overall prevalence of parasite infections was similar in cats and dogs. There were differences in the species composition of parasites in cats and dogs, most of which were due to host specificity (*A. abstrusus*, *T. vulpis*, *U. stenocephala*).

Targeted studies in Bulgaria and Europe, as well as reports of clinical cases provide data on the parasitofauna of domestic cats in our country [2, 6, 7, 14, 17, 19, 20]. Stoichev et al. [17] have found seven helminth species in cats from different villages in the country, and 3 of them were found in the present study (*D. caninum, T. cati* and *A. abstrusus*). Infestation of domestic cats in Bulgaria with helminthes of genera *Capillaria, Toxocara* and *Dipylidium* was reported in the international study by Rehbein et al. [14] with the values of the prevalence of infection were much higher than those found by us (4.3%, 53.2%, and 27.7% respectively). A higher prevalence of infection with *T. cati* (23.78%) and *D. caninum* (5.59%) has been also found in cats from the region of Stara Zagora [7]. The lungworm *A. abstrusus* has been established in cats of different categories from the regions of Sofia and Stara Zagora [2, 6, 20]. According to Giannelli et al. [6] the prevalence of cats' lungworm infections in Europe varied between the sampled sites, with the highest were recorded in Bulgaria (35.8%) where *A. abstrusus*, *Troglostrongylus brevior*, and *Eucoleus aerophilus* were found species. The name of the last mentioned species is synonymous with *C. aerophila* which we found in the present study.

The parasites we have identified in dogs are among the most prevalent parasitic agents in these animals from Bulgaria according to different scientists during the last two decades [7]. The prevalence of the registered infections in a comparative aspect is shown in **Table 3**. Our results about *T. vulpis, U. stenocephala, D. caninum* and *Cystoisospora* sp. are relatively close to those obtained in a study of dogs from shelters and owners from the regions of Sofia and Stara Zagora, which could be explained by the same studied region [13] and category of the dogs [7]. The present results differ to a greater extent from those of Georgieva et al. [5] and Kirkova et al. [10]. This could

be due to the fact that the first study covered only non-dewormed stray dogs [5], and the second studied a much larger number of animals of different categories from all over Bulgaria [10]. According to Iliev et al. [7] overall prevalence of infections with parasites in dogs from the region of Stara Zagora was 47.49%, by about 10% higher than established by us in this study.

The analysis of the morphometric data with respect to the identified parasitic species showed the following: The length and width of L1 of *A. abstrusus* measured by us correspond to those reported by Thienpont et al. [18]: 360-400 / 15-20 μm. The minimum and maximum length of the larvae established by us falls within the range indicated in materials from the region of Stara Zagora, Bulgaria: 234.9-417.6 μm [6] and the average length we have obtained is slightly higher than those pointed out in materials from the regions of Stara Zagora (350.8 μm) [6] and Lisbon, Portugal (350 μm) [12]. As can be seen from **Table 2** the egg sizes of the helminths we found generally correspond to those given by Thienpont et al. [18] and Foreyt [4]. Within the exceptions that are observed, the values we found are closer to the lower ones indicated by Thienpont et al. [18] and Foreyt [4]. Metric values for *D. caninum* egg packets are lower than those reported in the literature. Diversity in the metric features observed in the analysis most likely due to the peculiarities of the separate parasite populations from different parts of the world.

Conclusion

The parasite species found in domestic cats and dogs in the study were usual for these animals. In general, the prevalence of parasite infections was lower than this found in other studies from Bulgaria, especially when in them stray animals have been covered. In some cases the infestation of the animals was accompanied by a clinical manifestation of the disease. It should be borne in mind that some of the parasites found, such as *C. aerophila*, *T. cati, U. stenocephala* and *D. caninum*, have zoonotic potential.

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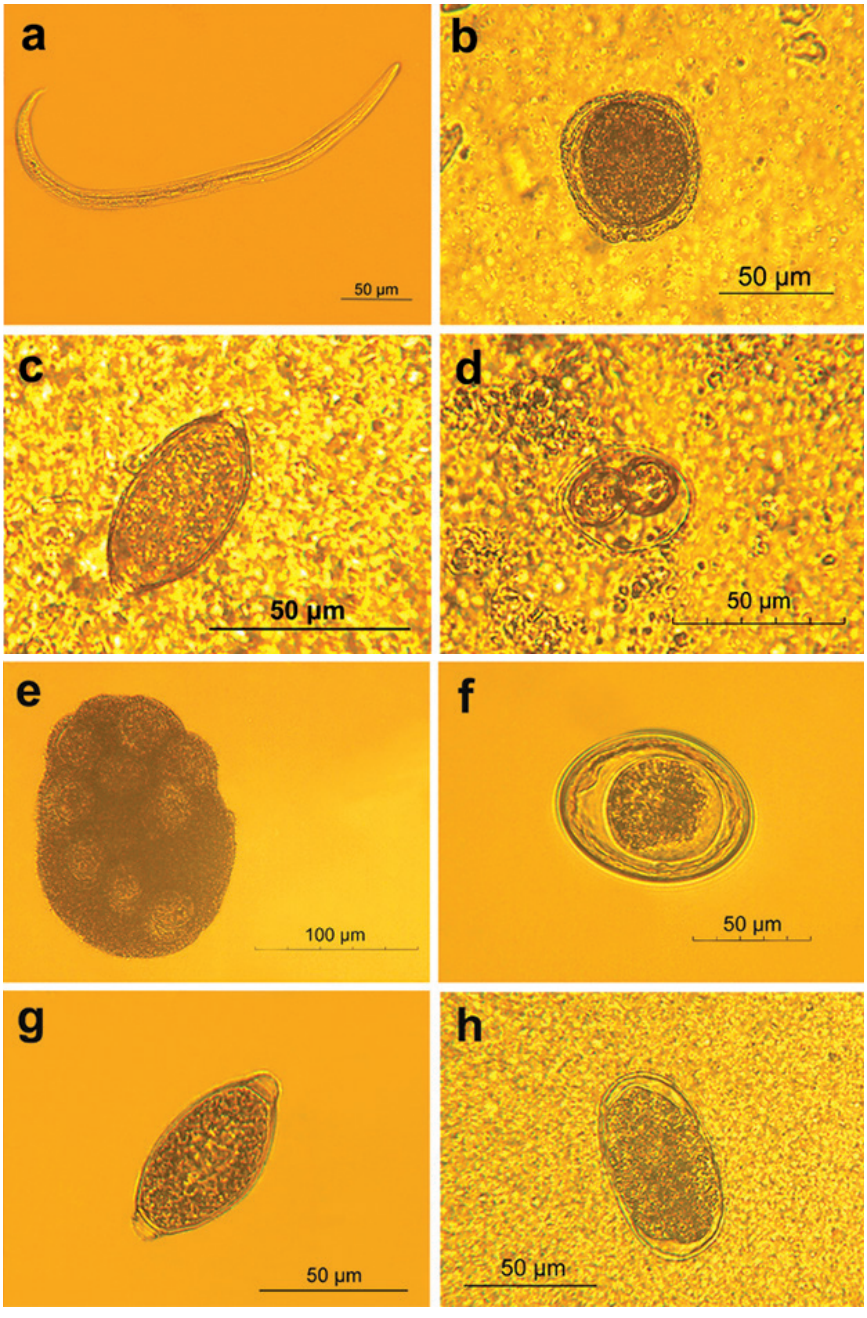

Fig. 1. Parasites detected in domestic cats (a-d) and dogs (e-h) from the Sofia city, Bulgaria, 2019-2021. **a)** *Aelurostrongylus abstrusus* larva first stage. **b)** *Toxocara cati* egg. **c)** *Capillaria aerophila* egg. **d)** *Cystoisospora* sp. oocyst. **e)** *Dipylidium caninum* egg packet. **f)** *Toxascaris leonina.*egg. **g)** *Trichuris vulpis* egg. **h)** *Uncinaria stenocephala* egg. Original pictures.

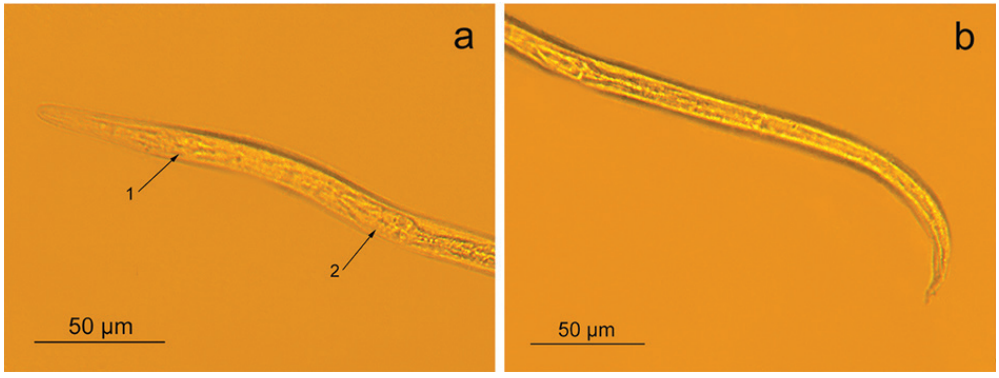

Fig. 2. *Aelurostrongylus abstrusus* first stage larvae detected in domestic cats. **a)** Anterior end. 1 – elongate dilatation of oesophagus. 2 – bulbous dilatation of oesophagus. **b)** Posterior end. Original pictures.

Table 1. Prevalence of parasite infections in domestic cats (n=50) and dogs (n=21) from the Sofia city, Bulgaria, 2019-2021.

	Cats	**Dogs**
Aelurostrongylus abstrusus	10 %	0
Capillaria aerophila	2 %	0
Toxascaris leonina	0	9.5 %
Toxocara cati	16 %	0
Trichuris vulpis	0	9.5 %
Uncinaria stenocephala	0	14.3 %
Nematodes	22 %	23.8 %
Dipylidium caninum	4 %	4.8 %
Cestodes	4 %	4.8 %
Cystoisospora sp.	8 %	9.5 %
Protozoa	8 %	9.5 %
Overall parasites	30 %	38 %
Single infections	24 %	28.6 %
Co-infections	6 %	9.5 %

Table 2. Metric data (in µm) on parasites from domestic cats and dogs from different sources

Parasite	Host	Length				Width			
		Thienpont et al. (2003)	Foreyt (2017)	Present data		Thienpont et al. (2003)	Foreyt (2017)	Present data	
				min-max	average			min-max	average
Capillaria aerophila eggs	cat	60-65	60	55.63-62.07	57.83	29-30	30	25.98-29.87	27.78
Toxascaris leonina eggs	dog	85	80	73.58-85.68	78.34	75	70	61.55-77.22	64.65
Toxocara cati eggs	cat	75	75	59.89-70.69	67.52	65	65	50.08–63.31	56.07
Trichuris vulpis eggs	dog	70-90	75	70.78-76.81	74.2	32-41	40	35.83-36.77	36.12
Uncinaria stenocephala eggs	dog	63-80	74	69.2-76.66	72.88	32-50	45	42.23-46.56	43.92
Dipylidium caninum egg packet	dog	200	200	157.5-183.5	169.3	120	150	94.37-25.42	114.28
Cystoisospora sp. oocysts	cat	–	13-42	38.79-40.66	39.77	–	10-31	30.95- 4.45	32.3
Cystoisospora sp. oocysts	dog	–	13-36	23.06-23.54	23.32	–	10-30	21.58-22.23	21.8

Table 3. Prevalence (%) of some parasite infections in domestic dogs from Bulgaria

Sources	Regions	Category of dogs	Parasite species				
			T.l.	**Tr. sp.**	**U. s.**	**D. c.**	**Cyst. sp.**
Georgieva et al., 1999	Stara Zagora	Stray	30	60	60	50	10%
Kirkova et al., 2013	Various regions of Bulgaria	Client-owned; From shelters	1	24.15	37.8*	0.3	1**
Radev et al., 2016	Sofia	Stray; From shelters	–	12.5	1	5.0	7,5
Iliev et al., 2017	Stara Zagora	Client-owned	–	10.42	–	1.93	–
Present data	Sofia	Client-owned	9.5	9.5	14.3	4.8	9.5

T.l. – Toxascaris leonina; Tr. sp. – *Trichuris* sp.; *U. s. – Uncinaria stenocephala*; *D. c. – Dipylidium caninum; Cyst.* sp. – *Cystoisospora* sp.; *hookworms; **Coccidia