

THE INFLUENCE OF CLIMATIC FACTORS ON THE PREVALENCE OF CONTAMINATION OF GREEN AREAS IN BELGRADE BY DOG PARASITES

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Abstract

*The rising population of dogs poses a significant environmental issue in urban settings. Parks and green spaces, which are popular gathering spots and often have children's playgrounds, are frequently polluted by dog feces. These feces can contain zoonotic parasites, with the most hazardous and most common being the eggs of the helminths *Toxocara canis*, *Ancylostomidae* spp., *Echinococcus granulosus*, *Trichuris vulpis* and *Strongyloides stercoralis* and oocysts of the protozoa *Giardia intestinalis*, *Amoeba* spp. and *Cryptosporidium* spp. The growth rate of these parasites depends on the microclimatic conditions prevalent during specific times of the year. Therefore, when studying this pollution and evaluating human infection risks, it's essential to consider bioclimatic conditions to ensure accurate sampling and interpretation. During our twenty-year study of contamination in Belgrade's parks, we used the Uvarovo bioclimatogram to pinpoint the best sampling times and evaluate our findings.*

Keywords: dogs, urban environment pollution, climate condition, epidemiology

1. INTRODUCTION

Dogs represent the largest population of pet animals. In recent decades, in the world and in our country, a constant increase in their number is evident, which represents a serious environmental problem in urban areas. Dog owners let their pets onto green areas - parks, promenades, sand pits and other public areas, which they pollute with their excrement, which, in addition to its unpleasant appearance and smell, represents an epidemiological danger (). Many parasites are transmitted through dogs, so that dogs that have become inseparable companions in people's lives can pose a potential hazard to human health. Dogs may become mechanical and biological vectors as they roll in noxious substances, eat feces and contaminated soil, as well as lick contaminated fur or paws. The most dangerous and at the same time the most frequently found eggs of helminths *Toxocara canis*, *Ancylostomidae* spp., *Echinococcus granulosus*, *Dipylidium caninum*, *Trichuris vulpis* and *Strongyloides stercoralis* and oocysts protozoa *Giardia intestinalis*, *Amoeba* spp. and *Cryptosporidium* sp. (Puccini and Tarsitano, 2003a,b, Tiago et al., 2011, Pavlovic , 2015).

In the close cohabitation of stray dogs and pets that are in the immediate environment of humans, this constant contamination of public surfaces with parasite eggs indicates that the possibility of human infections is constantly present. This has been confirmed by numerous researches in the world and in our country. If it is known that more than 5% of polluted surfaces represent a serious danger to people's health, we are of the opinion that this should not be commented on (Woodruff, 1976, Wong et al. 1999). Correlation between the climate (i.e. the climatogram that shows it) and the occurrence, distribution, abundance, speed of development, etc. of living beings is very strong. In our paper, we present the results of research into the influence of climatic factors on the prevalence of contamination of Belgrade's public areas with dog parasites.

2. MATERIALS AND METHODS

In the period from 1993 to 2023 samples are collected in the period April-September based on the climatic conditions that prevail in the area of Belgrade (using the bioclimatogram method according to Uvarov, which has as a component the temperature and humidity of the soil in average values for the examined area). This indicator is extremely important when evaluating the results, considering that

geohelminths in the soil embryonate (become infectious) under certain conditions of optimum temperature and humidity (Pavlović and Stevanović, 2005, Pavlović et al. 2015).

Each year a total of 64 soil samples collected from 10 parks in the central part of Belgrade were examined using the sedimentation-flotation methods described by Pavlović (2017). At the same time, 64 samples of dog excrement, collected at the same time as the soil samples, were examined from the same locations every year. Feces were examined by sedimentation and flotation methods.

Determination of parasite eggs was performed by morphometric analysis based on the keys given by Eusebi (1981).

During our research, we monitored the climatic conditions in Belgrade (data were obtained annually from the Republic Hydrometeorological Service of Serbia and cumulatively for the period 1991-2021 from the website <https://en.climate-data.org/europe/serbia/belgrade/belgrade-1046/>)

3. RESULTS

In the period 1993-1999, based on the performed examinations, the presence of parasite eggs was established in 65.90% and polyparasitism in 54.61% of the examined samples. In a period of 2000-2009 years, the presence of parasite eggs was found in 45.90% and polyparasitism in 44.32% of the examined samples (Pavlovic et al.2000, 2009,2010). The average contamination of parks in period 2010-2019 amounted to 39.06%, and in 2020-2022 it will drop to 26.68% (Pavlovic et al.2019, Pavlovic, 2023). In table 1 we presented biodiversity and prevalence of parasitic fauna of green areas of Belgrade in the period 1993-2022.

Parasites species	Examined period			
	1993-1999	2000- 2009	2010-2019	2020-2022
<i>Toxocara canis</i>	65,90	42,82	31.63	30.29
<i>Dipylidium caninum</i>	49,62	37,19	29.90	32,50
<i>Ancylostomidae</i> sp.	46,96	31,70	38,36	40.15
<i>Trichuris vulpis</i>	14,92	7,31	16.32	21.25
<i>Taenia</i> spp.	7,19	4,19	4.28	6.25
<i>Toxascaris leonina</i>	6,81	2,43	5.1	6.97
<i>Strongylouides stercoralis</i>	0	0	4.00	5.78
<i>Isospora</i> sp.	1.21	2.22	2.32	9.36
<i>Giardia intestinalis</i>	0.11	4,01	9.37	23.5
<i>Amoeba</i> spp. (<i>hystolitica</i>)	0.02	1.11	7.92	11.06
<i>Cryptosporidium</i> sp.	0.01	1.02	2.12	3.37

Table 1. Biodiversity and prevalence of parasitic fauna of green areas of Belgrade in the period 1993-2022

4. DISCUSSION

The majority of helminth eggs found on public surfaces are from the group of geohelminths - parasites whose development takes place in the soil, so that the thrown eggs only become infectious for animals and humans in the external environment. All over the world, the eggs of *T. canis* and *Ancylostomida*

sp are the most numerous. - parasites with the greatest zoonotic potential (Pavlović et al. 2000; Matter and Daniels 2000; Rinaldi et al. 2006; Poglayen and Marchesi 2006).

The degree of infection of public spaces with geohelminths depends on the number of parasite eggs per kg of soil, and the speed of parasite development on the microclimatic conditions prevailing in certain parts of the year (Jardine et al. 2003; Eguía-Aguilar et al. 2005; Pavlović 2006, Tiago et al. 2011). Thus, when studying this type of pollution and assessing the risk of human infections, we must be guided by the knowledge of bioclimatic conditions so that taking samples and interpreting the results are in accordance with the actual situation on the ground (Puccini and Tarsitano, 2003a,b, Cringoli et al. 2005). ; Pavlović and Terzin 2012, Pavlović et al. 2012, 2014).

The correlation between the climate (that is, the climatogram that shows it) and the appearance, distribution, number, and rapid development of living beings is very strong. If data on the vital optimum, development and generations of living beings during the year are included in the climatogram, it is then a bioclimatogram. Bioclimatograms are useful for showing, explaining or forecasting the occurrence or absence of a species in increased or decreased abundance (Stanković 1962). Therefore, there is a strong correlation of microclimate conditions with the dynamics of biological phenomena, and therefore also a mutual correlation of biological phenomena that take place in those conditions (Stanković 1962; Jovičić 2011; Pavlović et al. 2012). of the park areas of Belgrade were guided by a bio-climatogram according to Uvarovo in order to determine the optimal time of taking samples for inspection and evaluation of the obtained results (Stanković 1962; Pavlović et al. 2015).

Based on previous research, a change in parasitofauna was observed, which was caused by the influence of climate changes in Belgrade during the last decades. The prevalence of certain parasitic species is significantly lower, and at the same time, species of parasites that were not previously present in this area have appeared. This trend has had its upward trend in the last few years, when drastic climate changes occurred - with mild winters, very hot summers, a large amount of atmospheric precipitation, etc. (table 2). This was reflected in the biodiversity, prevalence and incidence of the parasitic fauna of the green areas of Belgrade in the period from 1993, when these continuous investigations began until today (Pavlović et al. 2015).

	January	February	March	April	May	June	July	August	September	October	November	December
Avg. Temperature °C	0.8 °C	2.6 °C	7.5 °C	13.1 °C	17.9 °C	21.7 °C	23.7 °C	23.8 °C	18.7 °C	13.3 °C	8 °C	2.3 °C
(°F)	(33.4) °F	(36.7) °F	(45.4) °F	(55.5) °F	(64.2) °F	(71) °F	(74.7) °F	(74.9) °F	(65.6) °F	(55.9) °F	(46.5) °F	(36.2) °F
Min. Temperature °C	-2.4 °C	-1.2 °C	2.6 °C	8 °C	12.7 °C	16.6 °C	18.6 °C	18.7 °C	14.2 °C	9.3 °C	4.8 °C	-0.5 °C
(°F)	(27.6) °F	(29.8) °F	(36.7) °F	(46.3) °F	(54.8) °F	(61.8) °F	(65.5) °F	(65.7) °F	(57.6) °F	(48.8) °F	(40.6) °F	(31.1) °F
Max. Temperature °C	4.4 °C	6.8 °C	12.4 °C	18 °C	22.7 °C	26.4 °C	28.6 °C	28.8 °C	23.3 °C	17.9 °C	12.1 °C	5.6 °C
(°F)	(40) °F	(44.2) °F	(54.4) °F	(64.5) °F	(72.9) °F	(79.4) °F	(83.4) °F	(83.8) °F	(74) °F	(64.2) °F	(53.7) °F	(42) °F
Precipitation / Rainfall	48	47	55	62	71	77	70	53	56	50	51	56
mm (in)	(1)	(1)	(2)	(2)	(2)	(3)	(2)	(2)	(2)	(1)	(2)	(2)
Humidity(%)	80%	76%	69%	64%	64%	63%	59%	58%	65%	71%	76%	81%
Rainy days (d)	7	7	7	8	9	8	7	6	6	6	6	8
avg. Sun hours (hours)	4.8	5.6	7.9	9.8	10.9	11.4	11.7	11.0	8.9	7.3	6.0	4.5

Table 2. 1991 - 2021 Min. Temperature °C (°F), Max. Temperature °C (°F), Precipitation / Rainfall mm (in), Humidity, Rainy days (<https://en.climate-data.org/europe/serbia/belgrade/belgrade-1046/>)

Changes in the microclimate, which in the last decades had a significantly greater temperature oscillation (increase in average temperature and air humidity), are particularly favorable for the development of certain geohelminths (Pavlovic 2015).

Looking from an epidemiological point of view, the dominant type of parasite is *T. canis* and *Ancylostomidae* sp. parasite whose embryonic development in eggs takes place in the soil and which is

directly dependent on the prevailing microclimate. At a temperature of 25 degrees, the eggs embryonate in 7-12 days, and at a temperature of 25 degrees in 5 days (Dubinski, 1998; Pavlović et al. 2010). Eggs are inactivated at a temperature higher than 37 degrees, before the formation of larvae. At a temperature of 50 degrees, they are inactivated in 5 hours and at a temperature of 55 degrees in 1 hour (Pavlović 2015). Direct sunlight inactivates them very quickly. The effects of these climatic changes on the prevalence of *T.canis* and *Ancylostomidae* sp. are shown in Table 3.

Helminth species	Examined period			
	1993 -1999	2000 - 2009	2010-2019	2020-2022
<i>Toxocara canis</i>	65,90	42,82	31.63	30.29
<i>Ancylostomidae</i> sp.	46,96	31,70	38,36	40.15

Table 3. Prevalence of *T.canis* and *Ancylostomidae* sp. in period 1993-2012

5. CONCLUSIONS

After two decades of research, we have concluded that there has been a shift in the parasitic fauna in Belgrade due to recent climate changes. We observed a significant variation in the prevalence of certain parasites and the emergence of species that were not previously found in this area. This trend has intensified in recent years due to more extreme climate changes, including milder winters, extremely hot summers, and increased rainfall. Additionally, the decline in cleanliness of city parks and streets, coupled with irresponsible pet owners not cleaning up after their dogs, has exacerbated the epidemiological aspect of this issue.

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