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To cite this article: I N Lykov *et al* 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **677** 052033

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Sanitary and hygienic aspects of urban environment pollution by dog feces

I N Lykov, O P Pavlova and S A Rudova

Kaluga State University named after K.E. Tsiolkovsky, Kaluga, Russia

Email: linprof47@yandex.ru

Abstract. The aim of the study is to assess the scale of parasitic and microbial soil contamination in residential areas of the city of Kaluga (Russia), including playgrounds and kindergarten areas. The research method involved identifying *Toxocara* eggs and microorganisms in sandpits, lawns, and boulevards. Investigated 210 samples of soil and sand in different areas of the city. It was found that the soil pollution of boulevards with *Toxocara* eggs is 4.9 times higher than that of sandpits and 1.9 times higher than that of lawns. Molds of the genera *Aspergillus*, *Penicillium*, *Mucor*, *Fusarium*, *Cladosporium*, *Candida*, *Alternaria*, and *Rhizopus* were sown most often from the soils of lawns and boulevards. The bacterial microbiota is represented by *Clostridium*, *Enterococcus*, *Enterobacteriaceae*, *Salmonella* and *Micrococcus*. The average number of microorganisms isolated from soil and sand samples varied in the range from 1.5 to 3.0 million CFU in 1 g. To quantitatively estimate the population of domestic animals, a sociological survey was conducted annually for 20 years. A total of 4,700 people over the age of 16 were interviewed.

1. Introduction

Public health risks due to a large number of canine faeces on city streets raise concerns as they may contain microorganisms pathogenic to humans. Urban soils, as well as children's sandpits and playgrounds gradually become accumulation basins for various microorganisms and helminth eggs released together with faeces of domestic animals [1, 2]. *Toxocariasis* is now considered to be the most common human helminthiasis. Dogs are the primary transmitters of *Toxocara canis*. To a lesser extent, this applies to cats that transmit *Toxocara cati*. With the growth of the canine population, city streets, yards and playgrounds are subject to soil contamination with *Toxocara* eggs [3, 4].

Dog faeces may contain various types of microorganisms potentially pathogenic to humans. Notable among such potentially hazardous microorganisms inhabiting urban soils and children's sandpits with animal excrement are gut microbiota, mould fungi and *Clostridia* [5, 6]. Just one gramme of dog faeces contains up to 23 million different microorganisms that can seriously affect human health. Therefore, an increase in the number of domestic animals, leaving their faeces in the soil, children's sandpits and recreation areas poses a serious epidemiological threat. Those children who irregularly follow personal hygiene rules and potentially swallow soil or sand particles during their games (geophagy) [7, 8] are particularly at risk.

2. Research methods

We examined 70 samples of lawn soil, 70 samples of courtyard soil and 70 samples of sandpit sand from different Kaluga districts. The samples were taken from April to October in accordance with the



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requirements of GOST 17.4.4.02-2017 Nature Protection. Soils. Methods for sampling and preparation of soil for chemical, bacteriological, helminthological analysis. The helminthological study was conducted in accordance with the Methodological Guidelines of MUK 4.2.2661-10 Methods of sanitary and parasitological research (approved by the Chief State Sanitary Doctor of the Russian Federation on 23 July 2010).

The microbiological study of soil and sand, as well as the identification of microorganisms, were carried out in accordance with the Methodological Guidelines of MUK 4.2.2661-10 on the sanitary and microbiological study of soil. Mould fungi were grown in the Ploskirev and Sabouraud media. The taxonomic identification of mould fungi was carried out taking into account morphological characteristics of the vegetative mycelium and reproductive structures.

To quantify the domestic animal population in the city, we used a specially developed form (questionnaire) to survey Kaluga residents. For 20 years, 4,700 people over 16 years old were surveyed.

3. Results and discussion

The survey results show a trend towards increasing the number of families with domestic animals. Moreover, most families prefer to have mainly cats and dogs. Over the past 20 years, the number of cats and dogs in families has increased by 15,111 and 16,596 individuals, respectively. At the same time, the number of cats in 2020 was 148,111 individuals, and dogs – 97,096 individuals (figure 1).

The number of homeless animals before 2019 decreased and amounted to no more than 0.5% of the total number of domestic cats and dogs. But in 2020 the number of homeless dogs increased to 0.7%. This may be due to rumours regarding the possibility of being infected with the SARS-CoV-2 virus (COVID-19) from dogs.

Dog owners walk their dogs several times a day in such places as streets, squares, lawns and boulevards. During walks, dogs annually leave on city lawns from 5 to 8 kg of faeces and from 18 to 21 litres of urine per 1 resident.

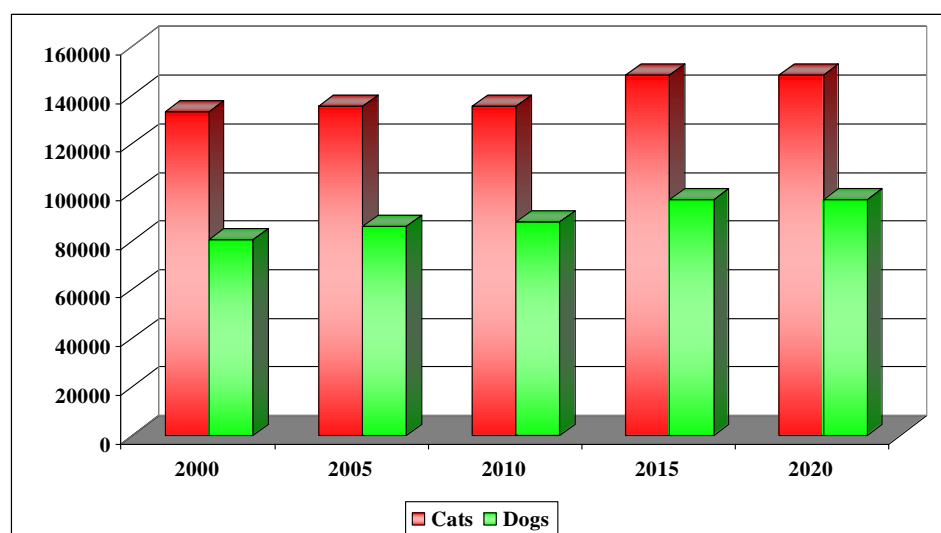


Figure 1. Dynamics of the number of cats and dogs in the city of Kaluga.

The most intensive parasitic contamination of soils and sand is recorded in areas of high population density, including playgrounds and kindergartens. Most often, *Toxocara* eggs were present in the soils of boulevards and lawns (figure 2).

In general, the probability of soil and sand contamination with *Toxocara* eggs in the areas under study was significantly higher in April-May and September-October. This is probably due to colder and wetter weather at this time of year, which can contribute to the survival of *Toxocara* eggs. In summer,

such factors as exposure to sunlight, drying of soil and sand are an important reason for reducing parasitic contamination.

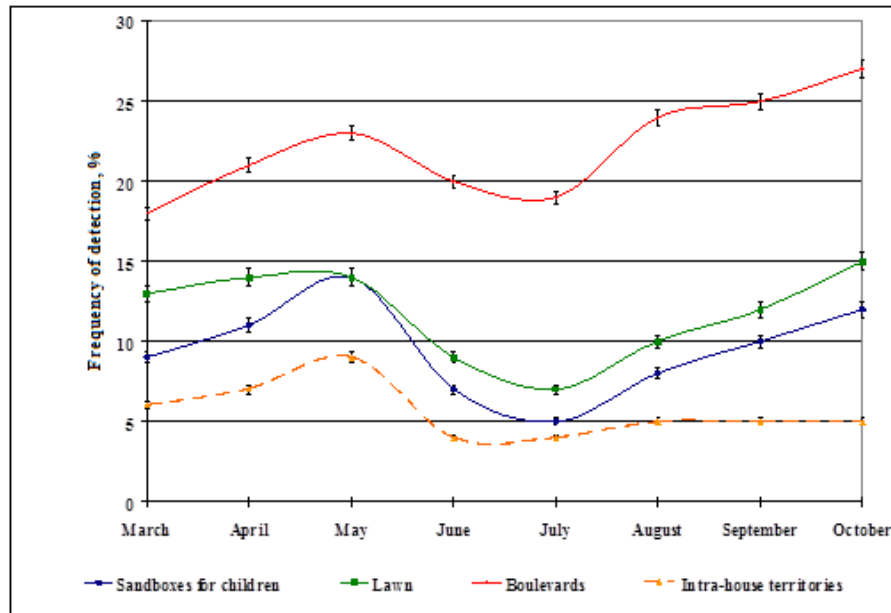


Figure 2. Frequency of detection (%) of contamination of soil and children's sandpits with *Toxocara* eggs.

Thus, the soil of residential areas and the sand of children's playgrounds pose a risk of infection of city residents with *Toxocara* eggs. This is evidenced by the fact that in the structure of helminthiases, toxocariasis ranks third in terms of prevalence among Kaluga's residents. The incidence of this invasion increases on an annual basis (figure 3).

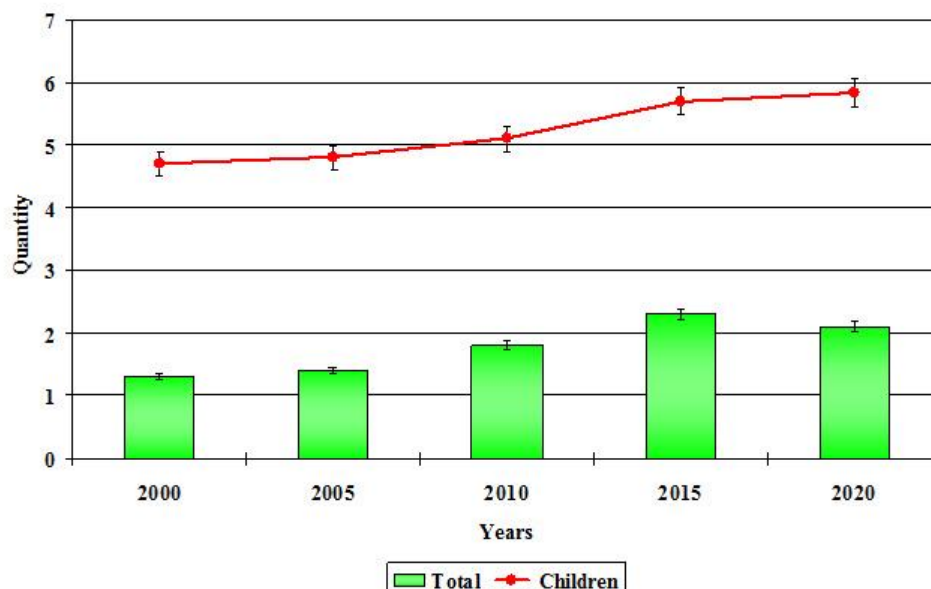


Figure 3. Prevalence of toxocariasis in Kaluga per 100,000 people Quantity.

A large number of various types of microorganisms are present in the samples of lawn soil from courtyards and in the samples from sandpits. Mould fungi obtained from the soil samples are represented by such species as *Aspergillus*, *Penicillium*, *Mucor*, *Fusarium*, *Cladosporium*, *Candida*, *Alternaria* and *Rhizopus*. During the entire observation period, moulds of the *Aspergillus* and *Penicillium* species were most often plated from the soils of lawns and boulevards (figure 4).

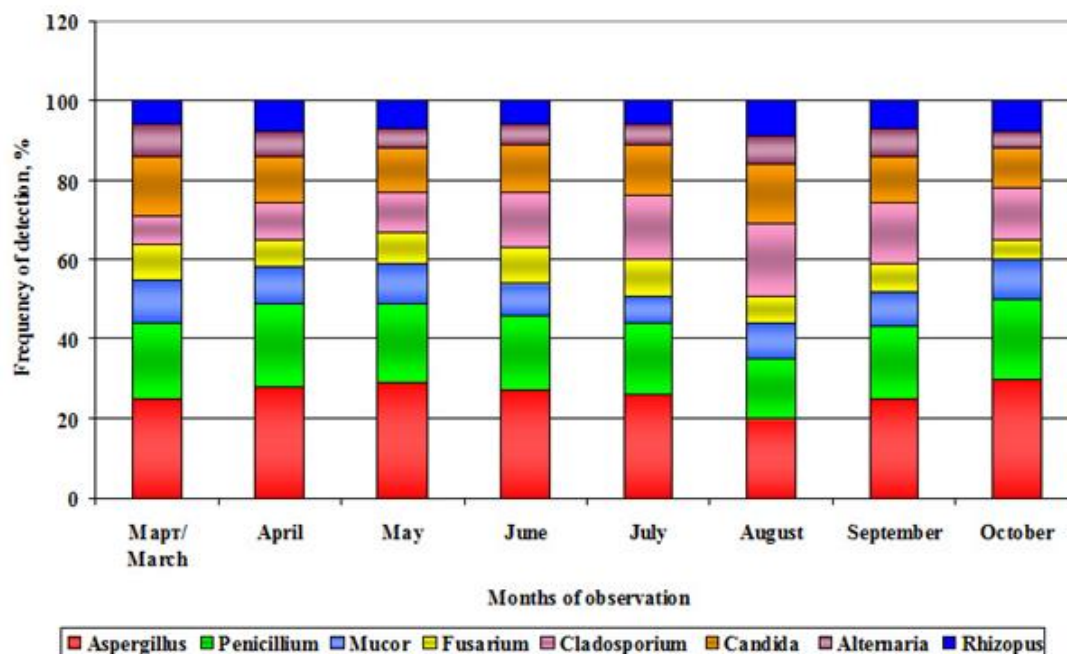


Figure 4. Mould fungi in the soil and sandpits of the city.

In summer, the number of *Cladosporium* increased. These microorganisms are also present in the microbiome of dog excrement. The sand samples most often contained moulds of the *Penicillium*, *Fusarium*, *Aspergillus* and *Alternaria* species in an amount of 10,000 to 23,000 CFU/g. The soil and sand samples are subject to different degrees of bacterial contamination. In each season of the year, they were dominated by *Clostridium*, *Enterococcus* and *Enterobacteriaceae* (figure 5).

All the soil samples taken from courtyards contained *E. coli*. The quantitative analysis shows that the coli index is from 15 to 20. As for the category of contamination and the degree of epidemic threats, the courtyard soils are classified as moderately hazardous and hazardous.

The sand taken from the children's sandpits under study was dominated by *Clostridium* and *Enterococcus*. Representatives of the *Enterobacteriaceae* and *Micrococcus* species were present in 25% of the sandpits, and *Escherichia coli* in 7% of the sandpits (coli index from 2 to 5). Pathogenic bacteria of the *Salmonella* species were present in 3 children's sandpits.

Of the total amount of *Clostridium*, 62% of the sandpits identified *Clostridium perfringens*, and 38% – *Clostridium perfringens* and *Clostridium difficile*. These microorganisms are often found in animal excrement. Therefore, their detection in children's sandpits represents a serious risk. Pathogens are spread from unclean hands and as a result of geophagy.

The average amount of microorganisms obtained from the soil samples ranged from 1.5 to 3.0 mln. CFU/g. The total microbial count of sand in children's sandpits ranged from 1.5 to 2.0 mln. CFU/g.

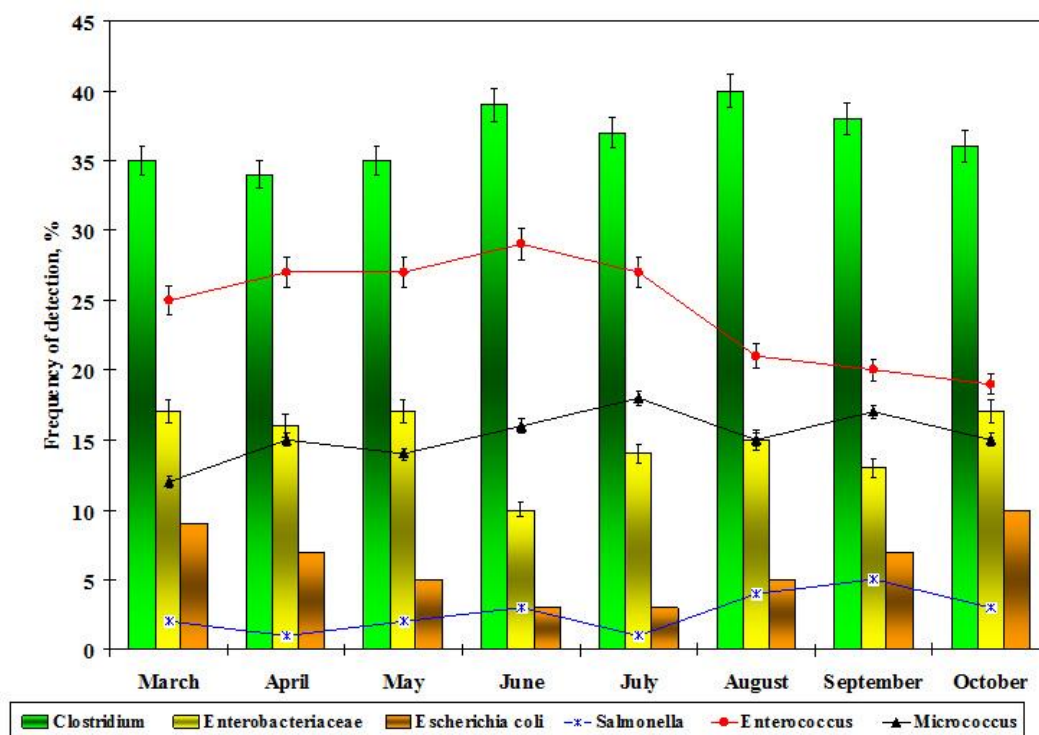


Figure 5. Bacterial contamination of the soil and sandpits of the city.

4. Conclusions

Over the past 20 years, the city of Kaluga has seen an increase in the number of cats (by 15,111 individuals) and dogs (by 16,596 individuals) that annually leave 5 to 8 kg of faeces and 18 to 21 litres of urine per 1 resident during their walks.

A large number of dogs in Kaluga, non-compliance with dog keeping rules, uncontrolled dog walking and low dehelminthisation result in contaminating recreation areas with *Toxocara canis* eggs.

The frequency of detection of *Toxocara* eggs in boulevard soils is 4.9 times higher than in sandpits and 1.9 times higher than in lawn soils.

The sand samples contained mould fungi of the *Penicillium*, *Fusarium*, *Aspergillus* and *Alternaria* species in an amount of 10,000 to 23,000 CFU/g.

In each season of the year, the soil and sand samples were dominated by *Clostridium*, *Enterococcus* and *Enterobacteriaceae*. The coli index of the courtyard soils ranged from 15 to 20, which classifies the soils as moderately hazardous and hazardous.

The amount of microorganisms obtained from the soil samples ranged from 1.5 to 3.0 mln. CFU/g. The total microbial count of sand in children's sandpits ranged from 1.5 to 2.0 mln. CFU/g.

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