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Short notes

Occurrence of geohelminths in the soil of children's playgrounds and green areas in the city of Wrocław, Poland

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ABSTRACT. Pets, strays, and wild animals that excrete dispersal forms of parasites into the soil may be a threat in urban areas. The aim of the study was to determine the level of contamination with geohelminth eggs in community playgrounds (fenced and unfenced), playgrounds in city parks, and a transect found along the banks of the River Oder. In 74 out of 424 examined soil samples, the presence of geohelminths was confirmed (*Toxocara* spp., Ancylostomatidae and *Trichuris* spp.). The highest prevalence was noted for *Toxocara* spp. roundworms. Both total and mean number of eggs in the examined samples, as well as the general prevalence, proved to be diversified in almost all types of development that were compared. Areas near the river emerged as places most exposed to the appearance of geohelminth eggs; playgrounds in city parks were less likely sites; community playgrounds in the city centre were the least common places.

Keywords: geohelminths, playgrounds, *Toxocara*, Ancylostomatidae, *Trichuris*, Wrocław

Introduction

Since the number of pet animals in cities is steadily increasing, the necessity to monitor threats posed by soil contamination with dispersal forms of parasites remains indisputable. The threat appears to be even more important when one considers a constantly increasing number of stray animals (per 2018 data provided by the Polish Supreme Audit Office). Results of studies that covered various urban agglomerations in Poland and were published during the last decades consentaneously indicate a leading role of dogs and cats in soil contamination with geohelminth eggs, e.g. *Dipylidium caninum* tapeworm [1], particularly roundworms representing the following genera: *Toxocara*, *Toxascaris*, *Ancylostoma*, *Uncinaria* and *Trichuris* [2–8]. During the last twenty years, it has been observed that synanthropisation of wild animals is an increasingly more common phenomenon as the animals penetrate not only the suburbs or city parks but also estate areas in the city centres in order to look for food and/or places to propagate [9–11]. While several years ago the issue with introducing and maintaining zoonotic potential in the city soil pertained mainly to the fox and, to a lesser extent, the beech marten, the list now includes two new invasive species that successfully colonise new areas: the raccoon dog and the raccoon [12]. The reservoir role of epizootic and zoonotic parasitoses of the two mentioned predators has been confirmed a number of times [13,14]. It concerns both helminth species that were confirmed earlier, e.g. *Echinococcus* spp. and *Mesocestoides* spp. tapeworms [15–17], and new taxa, e.g. *Baylisascaris procyonis* roundworms [18,19], parasitic protozoans [20,21], and bacterial micropathogens [22]. Since parasitological tests of the soil in Wroclaw were conducted only twice [5,23] and the data was published 21 and 12 years ago, it is justified to repeat the tests and update the data.

Materials and Methods

Studies on the presence of geohelminth eggs in soil were conducted in 2015–2016 in Wroclaw and involved three types of development. The first type covered city playgrounds (CPs) found in high-density housing estates, namely Ołbin and Nadodrze, where 12 sites were located. In addition, those were divided into fenced city playgrounds (CPFs) and unfenced city playgrounds (CPUNs). Two hundred and sixty-four samples were examined, 132 of which came from fenced and unfenced playgrounds. The second type covered unfenced playgrounds found in four public parks in Wroclaw (PPs): Stabłowicki Park, Wschodni Park, Grabiszyński Park and Kasprowicz Park, where from 16 sites a total of 80 soil samples were collected. Soil samples from all playgrounds were collected from sandpits and their near and distal surroundings. The third type was used for recreation; a 4-km-long transect located along the polder of the River Oder's right bank (OP), located in the Biskupin estate. Its beginning was at the Opatowice Weir and the end was at Zwierzyniecki Bridge. From 12 sites (informal picnic or fishing sites, etc.) 80 soil samples were collected. In total, 424 samples were collected and analysed; they were placed in plastic bags, labelled and transported to the laboratory.

The soil was examined using a method recommended by Mizgajska-Wiktor [24]. Preparations were scanned with a microscope, whereas parasite eggs were identified on the basis of studies by Thienpont et al. [25] and Zajac and Conboy [26].

In order to estimate the level of soil contamination with geohelminth eggs, the following parasitological indices – adapted to parasitological soil testing – were used: prevalence (P) – expressed as percentage and understood as the ratio of numbers of positive samples to the total number of examined samples; mean number of eggs (MNE) – a mean number of eggs found in positive samples; and range (R) – understood as the lowest and highest number of eggs found in a single sample.

In order to estimate the significance of differences in the level of soil contamination with geohelminth eggs between the compared types of development, nonparametric χ^2, Mann-Whitney and Kruskal-Wallis tests were used. The normality of distribution was examined with the Shapiro-Wilk test. Statistical significance of the tests was set at < 0.05. Calculations were performed with the Statistica 13.3 PL package.

Results

Four hundred and twenty-four soil samples were examined and geohelminth eggs were confirmed in 74 of them. The mean number of eggs per sample was 1.8, whereas the general prevalence was 17.5%. Eggs belonging to three parasitic helminth taxa were isolated: *Toxocara* spp., Ancylostomatidae and *Trichuris* spp. The highest prevalence was noted for eggs of *Toxocara* roundworms; the prevalence of hookworms from the Ancylostomatidae family was lower by almost a half, and the prevalence of *Trichuris* spp. was the lowest (Table 1).

The total number (without a division into taxa) and mean number of eggs (MNE) in the examined samples, as well as general prevalence (P), proved to be diverse almost in all compared types of development. The observed differences regarded a general division of city playgrounds (CPs),

Table 1. The occurrence of geohelminth eggs in children's playgrounds and green areas in the city of Wrocław, Poland

Site of study	*Toxocara* spp. %; MNE (R)	Ancylostomatidae %; MNE; (R)	*Trichuris* spp. %; MNE (R)	Total %; MNE; (R)
Fenced city playgrounds	4.5; 1.3 (1-3)	1.5; 1.5 (1-2)	–	5.3; 1.6 (1-3)
Unfenced city playgrounds	6.8; 1.2 (1-2)	3.8; 1.4 (1-2)	–	9.1; 1.5 (1-3)
City playgrounds (total)	8.7; 1.3 (1-3)	3.8; 1.3 (1-2)	–	10.6; 1.5 (1-3)
Public parks	18.8; 1.8 (1-5)	6.3; 1.4 (1-2)	–	25.0; 1.7 (1-5)
Polder of the Oder River	18.8; 2.0 (1-4)	7.5; 1.5 (1-4)	11.3; 1.7 (1-4)	32.5; 2.1 (1-4)
Total	12.5; 1.6 (1-5)	5.0; 1.4 (1-4)	2.1; 1.7 (1-4)	17.5; 1.8 (1-5)

% - prevalence; MNE - mean number of eggs found in positive samples; R - range playgrounds found in public parks (PPs), and the transect along the Oder polder (OP) (P: χ^2=24.32; df=2; p<0.001; MNE: Kruskal-Wallis test: H=4.39; p=0.111), and the specification including fenced city playgrounds (CPFs) and unfenced city playgrounds (CPUFs) (P: χ^2=2.55; df=1; p=0.109; MNE: Mann-Whitney test: Z=-0.41; p=0.679). The highest values of both indices were confirmed in samples from sites found along the OP and in PPs, whereas the lowest ones came from CPs sites. Taking into account the CPs division into fenced and unfenced CPs, a higher level of contamination was confirmed in CPUNs soil, whereas the mean number of eggs in samples was slightly higher in the soil from fenced playgrounds (Table 1).

The presence of *Toxocara* roundworms was most often confirmed in samples from the OP and PPs, whereas it was less common in soil samples collected from CPs (P: χ^2=9.18, df=2, p=0.010; MNE: Kruskal-Wallis test H=7.22, p=0.027). A similar result was also obtained in case when CPs were divided into fenced and unfenced – the prevalence in CPUFs was higher than in CPFs (χ^2=1.19, df=1, p=0.275). In that case, MNE turned out to be slightly higher in samples collected from CPFs (Mann-Whitney test: Z=0.04, p=0.965).

A general pattern of prevalence and distribution of index values for Ancylostomatidae hookworm eggs were similar to the ones observed for *Toxocara* spp. The highest prevalence and mean number of eggs in a sample were also confirmed in samples from the Oder polder; these were lower in playgrounds situated in public parks, and the lowest in community playgrounds found in the high-density sprawl (P: χ^2=2.149, df=2, p=0.341; MNE: Kruskal-Wallis test: H=0.38, p=0.826). Taking into account the division into fenced and unfenced playgrounds, the prevalence in the latter turned out to be higher by over a half (χ^2=3.99, df=1, p=0.045), whereas slightly higher MNE values were confirmed in the soil of fenced playgrounds (Mann-Whitney test: Z=0.49, p=0.623).

The presence of eggs belonging to the *Trichuris* spp. roundworm genus was confirmed only in samples taken from the Oder polder.

Discussion

In Wroclaw, when compared to other Polish urban agglomerations, there were only two studies assessing the level of soil contamination with geohelminth eggs conducted. The first one was performed at a rather special time for the city, after the flood at the end of 1990s [23], whereas the second one was conducted nine years later [5]. Considering the general level of soil contamination with geohelminth eggs, the authors' results obtained in the studies (17.5%) are similar to the results obtained in 1999 and 2008 (17% and 20%, respectively). The composition of the confirmed taxa was also similar. Compared with the studies conducted in 1999 and 2008, roundworm eggs representing the following genera were also confirmed: *Toxocara*, *Ancylostoma* and/or *Uncinaria*, and *Trichuris*. Apart from the above mentioned, Mizgajska [23] also confirmed eggs of *Ascaris* sp. and *Capillaria* spp. A significantly higher participation of *Toxocara* eggs in positive samples therefore appears to be an unsettling difference. While the studies of Mizgajska [23] and Perec-Matysiak et al. [5] showed the presence of eggs of that roundworm in 6% and 3.2% of samples respectively, in the authors' studies, conducted in 2015–2016, the presence increased to 12.5%. The reasons behind this situation might be multiple. On one hand, it seems that dog and cat owners' awareness with regard to deworming is growing. Consequently, soil contamination with eggs of this parasite should either decrease or remain at the same level. On the other hand, an increasing number of stray animals, as well as the colonisation and synurbisation of Wroclaw by foxes and racoon dogs may bring about the completely opposite trend.

The distribution of results with regard to development types where samples were collected, does not hold any great surprises. The level to which playgrounds situated in public parks were contaminated with parasites' eggs proved to be considerably higher than at other sites found at the estates in the city centre. This is most certainly associated with the scale and frequency of dog owners visiting both types of development, and their accessibility for stray and wild animals. In both cases, parks will be used much more often and, consequently, they will be more often subject to the environmental effects of animal defecation. The results of the comparison regarding contamination with geohelminth eggs in fenced and unfenced playground are also not surprising. Despite the fact that various types of fences might constitute effective barriers for canines, the percentage of positive samples in the soil of fenced playgrounds turned out to be almost two times lower, both in general and with regard to representatives of

Toxocara and Ancylostomatidae.

Having compared the results of the authors' study – which focused on community playgrounds (10.3%), sandpits and their surroundings, to be precise – with results of other authors, it seems that the ones from Wroclaw are moderately high. Considerably higher values might be found in the study of Grygierczyk et al. [3], who confirmed *Toxocara* spp. eggs in 47.4% of soil samples collected from playgrounds in Katowice, and Sadowska et al. [8], who observed the presence of geohelminth eggs in 40.9–42.9% of samples collected from sandpits and playgrounds in Szczecin. Furthermore, Petryszak and Nosal [27] reported 30% of soil samples from Bytom that contained *Toxocara* spp. eggs. Results similar to the authors' might be also found in papers of Rokicki et al. [1] as well as Ronkiewicz and Karczewska [4] that reported a 13–14% soil contamination of sandpits in Gdańsk and Lębork. Significantly lower values come from the paper of Jarosz [2] which found *Toxocara* spp. eggs only in 4.5% of soil samples from playgrounds in Elbląg, and Błaszkowska et al. [28] who examined sand from playgrounds as well as sandpits and confirmed the presence of geohelminth eggs in 7.7% and 1.4% of samples, respectively. The same authors also compared results from fenced and unfenced playgrounds. Their results (fenced playgrounds – 6.8%; unfenced playgrounds – 8.3%) correspond well with the results in the presented study (5.3% and 9.1%, respectively). Moreover, results from foreign counties are also similar or higher than the ones obtained by the authors. Papajova et al. [29] reported a quite wide-ranging (5.6–33.3%) percentage of positive samples taken from sandpits of chosen cities and villages in Slovakia, 23.2%; Kleine et al. [30] and Otero et al. [31] reported the level of sandpit contamination at 23.2% and 85.7% in Hannover (Germany) and Lisbon (Portugal) respectively. Finally, Vanhee et al. [32] confirmed the presence of *Toxocara* eggs in 14% of samples collected from sandpits in two cities in the north of Belgium.

As it stems from the above comparisons, playgrounds located in estates are the most common sites of such environmental studies, and the obtained results are more or less repeatable. Equally interesting is an examination of the area that is both used as a recreation site and offers attractive conditions for pets and wild animals. The analysed polder of the Oder is such a place in the authors' study: it is a meadow with clusters of bushes and trees that have various densities. The area is divided up by a network of passageways that connect various fishing sites and informal picnic areas, what makes it an ideal and commonly used place by local residents who are dog owners. Due to the semi-natural character of this terrain, which borders a high-end residential area located further away from the city centre, foxes, martens, and, in the recent years, racoon dogs and probably racoons have penetrated it eagerly and systematically. The conditions and accessibility for wild fauna explain the highest rates of contamination, both in general and regarding particular taxa, as reported here.

The presented results indicate the need for continuing such studies because, in spite of expectations, the indices for soil contamination with parasitic eggs have not fallen. Furthermore, it is legitimate to examine recreational areas, which may be accessed by wild animals colonising the cities, apart from routinely monitoring community or park playgrounds. This regards invasive species in particular – such as racoon dogs and racoons – which might transfer new and zoonotic parasite species into cities.

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