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***Dipylidium caninum*, *Ancylostoma* spp., and *Trichuris* spp. Contamination in Public Parks in Mexico**

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ABSTRACT

Background: Zoonotic parasitoses are a public health problem because they are distributed worldwide. Soil contamination with dog faeces is an important worldwide problem because it facilitates the transmission of zoonotic parasites. It has been reported in different studies that soil contamination by parasites represents a risk factor for the population (mainly children) to acquire parasitic diseases caused by *Dipylidium caninum*, *Ancylostoma* spp., and *Trichuris* spp. Therefore, the objectives of the present study were to analyse soil samples collected from five public parks in the city of Nezahualcoyotl, Mexico for the presence of canine soil-transmitted parasites.

Materials, Methods & Results: A total of 1726 soil samples were obtained from five public parks in Nezahualcoyotl County, Mexico and analysed for *Dipylidium caninum*, *Ancylostoma* spp., and *Trichuris* spp. eggs. Sampling was carried out in summer 2009 with the permission of the Parks and Public Gardens Nezahualcoyotl Office. Samples were evaluated using a flotation method, using microscopic observation for egg identification. The data were analysed with the Kruskal-Wallis test and average mean percentages of contamination between the parks means were compared using the Nemenyi test. There were differences in the degree of contamination among the parks, but the soil characteristics were not correlated with the presence of parasite eggs. Contamination with *Dipylidium caninum* and *Trichuris* spp. were positively correlated ($r = 0.32$, $P < 0.0001$). Overall, there was a substantial frequency of *Ancylostoma* spp. (23.7%) and *Dipylidium caninum* (21.7%), with minor presence of *Trichuris* spp. (15.3%) in the parks.

Discussion: Several studies have shown that the close relationship between resulting from the human-animal bond provides benefits for socialisation, mental health, and even physical well-being. However, owning a pet also allows potential health risks for the human population. Incidence studies of parasites in the soil of public parks provide greater insight regarding their zoonotic potential, and revealed that the soil of public parks is a source of infection and transmission of parasitic diseases. The reports on soil parasites contamination vary depending on where in the world were conducted. Studies in Brazil and Argentina had twice the levels of contamination for *Ancylostoma* spp. eggs and lower levels of *D. caninum*. However, the degree of contamination for *Trichuris* spp. in this report was higher than that observed in public parks in other countries (Croatia, Nigeria, and Brazil). These studies indicate that the risk of acquiring a zoonotic parasitic infection is extremely high, since the soil is highly contaminated with infectious eggs of parasites. The study of the prevalence of parasites in dogs and understanding of the life cycle, epidemiology, and risk factors involved require the establishment of prevention programs for public health reason. Therefore, it is important to implement measures for the collection of excreta in public parks and promote dog deworming programs and hygiene measures to prevent infection in paratenic hosts. The results of this research revealed that the soil of public parks were a source of parasitic zoonoses, because dogs play an important role in the contamination of soils by excreting intestinal parasites through their faeces, constituting a public health problem.

Keywords: soil contamination, parasite eggs, parks, Mexico.

INTRODUCTION

Zoonotic parasitosis are a worldwide health problem [25] due to their high prevalence rates and since they cause high economic losses related to the health in the human population affected [15]. Dogs have played an important role in public health, since they act as reservoirs and transmitters of parasites [10]. The problem is aggravated by the fact that many intestinal parasites diffuse into the environment through faeces in several parasitic stages (larvae and eggs). this is considered a major factor for the transmission of zoonotic parasitoses [3], and is potentiated by the high prevalence of helminth infections in dogs worldwide, which ranges from 67.4 to 100% [2].

Ancylostoma spp., *Dipylidium caninum*, and *Trichuris vulpis* have been detected on city sidewalks of Corrientes, Argentina [14], and *Toxocara canis* on the streets of Mexico City [19], which makes the human population capable to transmit the eggs to other public spaces. Research has been focused on soil contamination with eggs and has revealed that it is a risk factor for the population for parasitic infections [1]. However, most of the studies have focused on *Toxocara canis*, with little attention being paid to other parasites of zoonotic importance. Therefore, the objective of this study was to evaluate soil contamination with eggs of *D. caninum*, *Ancylostoma* spp., and *Trichuris* spp. in public parks in an area with highly dense populations of humans and canines in Nezahualcoyotl, Mexico.

MATERIALS AND METHODS

Sample collection was conducted from May to June 2009 with permission from the Office of Public Parks and Gardens of Nezahualcoyotl County

(Mexico). Five parks in Nezahualcoyotl, with an average surface area of 34.52 m², were selected as sampling sites. Two samples were collected every 100 m² [22] for a total of 1726 soil samples (Table 1).

Soil samples were characterised according to USDA classification [26], and soil pH was measured using a potentiometer (Table 1), and 1 kg of soil was collected from a depth of at least 10 cm from the soil surface.

All samples were tested for *Dipylidium caninum*, *Ancylostoma* spp., and *Trichuris* spp. using the flotation method [27]. Samples were pulverised and screened to remove large solid matter. Each sample (20 g) was placed in an Erlenmeyer flask and mixed with 50 mL 5% NaOH for 1 h to separate the eggs from the soil. Samples were then stirred for 20 min and placed in 50 mL conical tubes, which were centrifuged for 3 min at 280 g. The supernatants were removed and the pellets were washed three times with distilled water. After the third wash, the pellets were re-suspended in saturated sodium nitrate (NaNO₃) with a specific gravity of 1.30 and centrifuged again at 280 g for 3 min. The tubes were transferred to a rack and filled with a saturated solution of sodium nitrate. A small amount of the mixture was then placed onto a slide for 30 min to allow the eggs to adhere before subsequent microscopic observation.

The percentage of parasites was not normally distributed, therefore, a Kruskal-Wallis test was used to analyse the data [7] and a Nemenyi test was used to compare the percentages of contamination between the parks [5]. A simple correlation analyses was performed between soil characteristics and degree of contamination, and also between parasite contaminations [7].

Table 1. Soil characteristics of samples collected from the parks studied in Nezahualcoyotl, Mexico.

Soil characteristic	Park				
	Pueblo	Rey Neza	Camellón	Alameda	Esperanza
Samples (N)	126	360	300	620	320
pH	8.85	8.98	9.54	8.26	7.38
Organic matter, %	0.15	1.61	8.77	5.4	2.0
Sand, %	72.8	68.8	70.8	74.8	72.8
Silt, %	2.0	4.0	10.0	4.0	12.0
Clay, %	25.2	27.2	19.2	21.2	15.2
Electric conductivity, Mmhos/cm	55	55	60	20	15

RESULTS

Table 2 shows the degree of contamination for each parasite studied, illustrating the large variation between parks and the differences among the three parasites studied. Soil from “Pueblo” Park was found to have the lowest parasitic contamination (14.5%), while “Camellón” Park had the highest contamination

(26.1%). No soil characteristics were associated with the degree of parasitic contamination.

When comparing the relative differences between parasites, *Ancylostoma* spp. was the greatest contaminant (23.7%), followed closely by *Dipylidium caninum* (21.7%), and then *Trichuris* spp. (15.3%). However, only contamination by *Dipylidium caninum* and *Trichuris* spp. showed a positive correlation ($r = 0.32, P < 0.0001$).

Table 2. Contamination by different parasites in the soil from parks in Nezahualcoyotl, Mexico.

Park	Parasites		
	<i>Dipylidium caninum</i>	<i>Ancylostoma</i> spp.	<i>Trichuris</i> spp.
Pueblo	10.76 ^b	17.30 ^{bc}	15.57 ^{ab}
Rey Neza	28.33 ^a	9.44 ^c	23.88 ^a
Camellón	31.33 ^a	34.67 ^a	12.33 ^b
Alameda	20.64 ^{ab}	31.29 ^a	11.29 ^b
Esperanza	17.81 ^{ab}	26.25 ^{ab}	13.43 ^b
Coefficient of variation (%)	90.29	78.37	95.89
Kruskal-Wallis Test			
Chi-square	25.09	51.71	8.47
Degree of freedom	4	4	4
<i>P</i> > Chi-square	< 0.0001	< 0.0001	0.07

^{ab}Means with the same letter are not significantly different (Nemenyi, $P < 0.05$).

DISCUSSION

The close relationship between humans and animals provides benefits, including socialisation, improved mental health, and even physical well-being. However, with these benefits come potential health risks for the human population that are associated with owning a pet [16]. Studies of parasites in the soils of parks may provide more information about infections with zoonotic potential in the environment [9]. It has been shown that the soil in public parks may be a source of infection, and that domesticated and stray dogs play an important role in soil contamination by excreting intestinal parasites in their faeces [6,16]. The contamination of urban public spaces with parasitic dog faeces constitutes a public health problem mainly in children, which is most likely due to the close contact that children have with soil in public parks [17, 23].

From the estimated 500 million dogs worldwide, 400 million are believed to be stray dogs [20], and higher numbers of stray dogs are observed in

developing countries, where they freely roam in public spaces, increasing the risk of infection [18]. The particular problem of the study area (Nezahualcoyotl) is relevant because it has 824 public parks and an approximate dog population of 79,000, with high rates of parasites indicating that a large proportion of dog owners do not adhere to the proper deworming programs for their canine pets [20].

Unlike what was observed in this study, a lower prevalence was detected for *Trichuris* spp. (6.06%), *Dipylidium caninum*, (0.31%) and *Ancylostoma* spp. (0.41%) from 1944 soil samples obtained from urban areas in the province of Neuquén, Argentina, [23]. Although the level of contamination was low, the researchers recognise these intestinal parasites as zoonotic agents. In contrast, Maikai *et al.* [11] conducted a similar study in Kaduna, Nigeria, and reported a higher incidence of *Dipylidium caninum* eggs (26.3%) and lower levels of *Ancylostoma* spp. (9.0%) and *Trichuris* spp. when compared with this study.

A higher of presence of *Ancylostoma* spp. contamination was observed in a study of sidewalks in Argentina (41.2%) than was detected in this study [14]. This was higher when compared to the presence of *Trichuris* spp. (4-7%) and *D. caninum* (0.3%). A study of the contamination of public parks in Croatia [24] also found a lower presence of *Trichuris* spp. (10-17%), when compared to the levels reported for parks from Brazil (6.17%) [12]. It is interesting to note that contamination by *Ancylostoma* spp. (80.1%) in Brazil [12] was much higher than the results in this study. Another Brazilian study [17] reported a contamination by *Ancylostoma* of 85% [17], which coincided with the results of Cringoli *et al.* [4], who indicated that this parasitosis represents a significant risk to public health.

In another study in the province of Cordoba, Spain [13], the prevalence of gastrointestinal parasites in dogs was studied using soil samples from parks and public gardens. The reported incidence rate was 13.2 % for *Dipylidium caninum* and 1.66 % for *Trichuris* spp., which are lower levels than those observed in Nezahualcoyotl, Mexico. The distribution and extent of soil contamination by parasites are influenced by climate, as well as geographical, cultural, and economic factors [3].

Saori *et al.* [21] concluded that the risk of infection by zoonotic parasitoses is extremely high because the soil is highly contaminated by the eggs of infectious parasites. It is important the study of the prevalence of parasites in dogs, as well as understanding of the epidemiology of these parasites and the risk factors in order to establish prevention programs [3,16]. Therefore, it is important to implement measures for the collection of excreta in public parks and promote dog deworming programs and hygiene measures to prevent infection of humans, especially children.

CONCLUSION

The soil from the studied parks may present a potential source of parasitic eggs infestation for *Dipylidium caninum*, *Ancylostoma* spp., and *Trichuris* spp. with zoonotic potential. The soils from public parks are a source of infection of zoonotic parasites because dogs play an important role in the contamination of soils by excreting intestinal parasites through their faeces. This constitutes a public health problem.

Declaration of interest. The authors declare no conflict of interest.

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