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Zoonotic parasite frequency in homebound and feral dogs in Texcoco, State of Mexico, Mexico

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ABSTRACT

Objective: To describe and compare the frequency in which different parasites infect homebound and feral dogs, in the localities of the municipality of Texcoco, State of Mexico, Mexico.

Design/Methodology/Approach: In order to determine the presence of ectoparasites and gastrointestinal parasites, a sampling was carried out from August 2019 to July 2020, in localities of Texcoco, State of Mexico, Mexico. A total of 500 samplings of faeces from homebound and feral dogs were gathered.

Results: The general parasitosis samples had a 39% frequency (95% IC: 34.8-43.34%). Out of 325 samples obtained from homebound dogs, 134 (41.2%) tested positive (95% IC: 36.0-46.6%). Meanwhile, 175 samples were taken from feral dogs and 61 samples (34.8%) had at least one egg (95% IC: 28.1-42.1%). More than one type of parasite was found in 110 samples. The presence of parasites reached 48.8% in females (95% IC: 43.3-54.4%), while the percentage in males reached 66.4% (95% IC: 59.5-72.80%).

Study Limitations/Implications: The main limitation of this cross-sectional study is that data was gathered during a certain period (neutering/spaying campaigns). Therefore, the results may vary, if the same population is analyzed in another period.

Findings/Conclusions: The *Ancylostoma* sp. + *Toxocara* sp. association had the highest Relative Risk and Cross-Product Ratio in 5-60-month-old homebound male dogs. Regarding the age group, 0-4-month-old animals had the highest parasitosis frequencies.

New studies on this subject must be carried out to achieve a more exhaustive evaluation of the health status of homebound dogs, focusing on issues such as vaccination status, the interval between de-worming treatments, and the presence of parasites. Feral and semi-homebound dogs must also be included in the studies.

Keywords: Zoonosis, dogs, public health, epidemiology.

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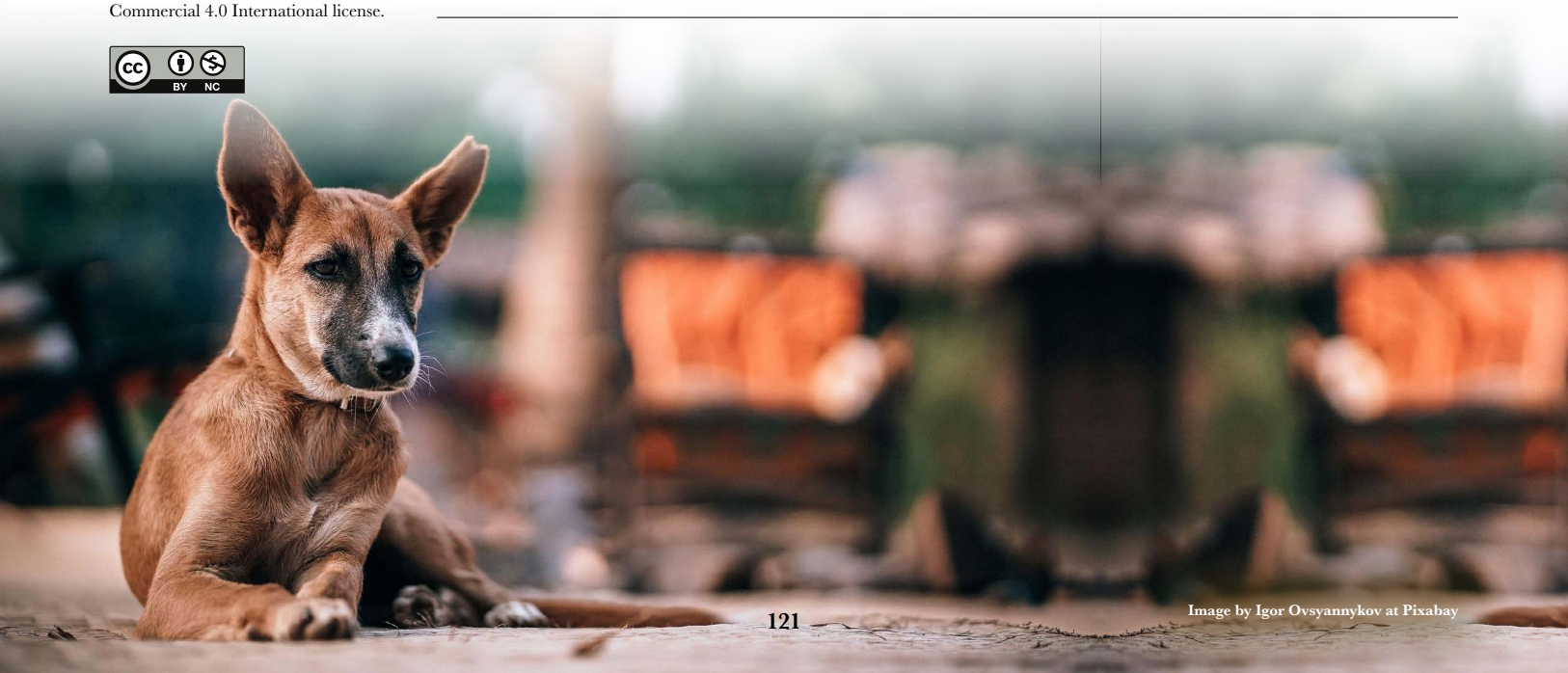

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INTRODUCTION

There are about 700 million dogs living in the world, 75% of which live in the streets (Anderson and Shwiff, 2015). In Mexico, there are approximately 16 million dogs and 10 million of them are stray dogs. In Mexico City, there are about 5 million dogs and 3 million of them are stray dogs. Each year, more than 100 thousand dogs fall into this condition. There are no records about the health of these dogs (Acevedo-Ramírez and Peralta-Abarca, 2010).

The inappropriate management of this dog population is a serious public health and animal welfare issue (Martínez-Barbosa *et al.*, 2008). Dog populations are constantly exposed to pathogens (mostly zoonotic) that cause diseases (particularly, parasitosis) (Acevedo Ramírez and Peralta Abarca, 2010; Kisiel *et al.*, 2016).

Giardiasis, dipilidiosis, toxocariosis, and ancylotomiasis are some of the parasitic zoonoses that dogs share with humans. Toxocariosis and ancylotomiasis manifest as visceral/ocular and cutaneous *Larvae migrans*, respectively (Macpherson, 2013; Rodríguez-Caballero *et al.*, 2017). The most vulnerable population are children and teenagers (6-16 years old) (Walsh, 2012; Cociancic *et al.*, 2018).

The objective of this study is to describe and compare the frequency in which different parasites infect homebound and feral dogs, in localities of Texcoco, State of Mexico.

MATERIALS AND METHODS

The work was carried out from August 2019 to July 2020, in Texcoco, State of Mexico, Mexico (latitude: 19° 30′42"′N; longitude: 98° 52' 58" W; at 2257 m.a.s.l.). Temperature fluctuates from 6 to 16 °C. The region has an annual rainfall of 500-1,200 mm. A total of 500 samples of faeces were collected from 325 homebound and 175 feral dogs, who were neutered or spayed during the neutering/spaying campaigns carried out by the regional Centros de Bienestar Animal. While the animals were under general anesthesia, a 10 g sample of faeces was taken directly from their rectum, using latex gloves. The samples were then preserved in 4% formalin or 70% alcohol. All the samples were cooled and sent to the Laboratorio de Diagnóstico Parasitológico, Facultad de Medicina Veterinaria y Zootecnia, Universidad Nacional Autónoma de México, where a fecal flotation study was carried out. The samples were divided into three groups:

A) Dogs with and without owner (homebound and feral dogs);
B) Age groups, divided as follows: 1st, 0-4 months; 2nd, 5-8 months; 3rd, 9-12 months; 4th, 13-60 months; 5th, older than 60 months; and
C) Sex.

All the information about the animals —including the contact information of the owner or person in charge of the dog and the result of each analysis— was recorded and stored in a Microsoft Excel 2007™ database. Subsequently, the information was analyzed using the EpiInfo 7™ software. Frequencies with a 95% confidence interval (95% IC) were obtained. Relative Risks (RR) and Cross-Product Ratio (RPC) were calculated. A Fisher's exact test

was carried out using the *Ancylostoma* sp. + *Toxocara* sp. association in each age and sex group, level of ownership, and the frequency of each group.

RESULTS AND DISCUSSION

The overall level for the frequencies that tested positive for parasites was 39% (95% IC: 34.8-43.34%). Out of the 325 homebound dog samples, 134 samples (41.2%) had at least one parasite egg (95% IC: 36.0-46.6%). Meanwhile, out of the 175 samples from feral dogs, 61 samples (34.8%) had parasite eggs (95% IC: 28.1-42.1%). Table 1 shows the frequency of the parasitosis.

Regarding mixed infections, the results were the following: ninety-nine samples had two types of parasites; seven samples had three types of parasites; and one sample showed five types of parasites (Table 2).

Three-hundred and nine samples were taken from female dogs. There was at least one parasite in 151 samples (48.8%) (95% IC: 43.3-54.4%). Out of the 191 samples taken from male dogs, 127 samples (66.4%) tested positive (95% IC: 59.5- 72.80%). Table 3 shows the frequency of the various parasites.

The *Ancylostoma* sp. + *Toxocara* sp. association obtained the highest RR and RPC in 5-60-month-old homebound male dogs (Table 4). The *Ancylostoma* sp. and *Toxocara* sp. parasites also had the highest association frequency and were found in La Purificación Tepetitla, San Juan Tezontla, and El Xolache (Table 5).

Zoonotic gastrointestinal parasites were detected in homebound and feral dogs in several localities of Texcoco, State of Mexico. Eggs of *Toxocara* sp. (13.6%) and *Ancylostoma* sp. (14.8%) were the most frequently found parasites. These results match the findings of Eguía-Aguilar *et al.* (2005), who recorded 13.33% of *Toxocara* sp. and 62.5% of *Ancylostoma* sp. in Mexico City. Meanwhile, Ponce-Macotela *et al.* (2005) recorded 10-18% of *Toxacara canis* and 22-65% of *Ancylostoma caninum* in the same city.

The larvae of *Ancylostoma* sp. can survive in the environment for several months and can penetrate human epidermis by direct contact. Consequently, they have a great zoonotic importance. Likewise, this disease has been associated with *Uncinaria* sp., which was also found in homebound dogs in this study. Meanwhile, *Toxocara* sp. is one of the most common dog parasites. It is mostly found among males, especially those younger than 36 months old (Overgaauw and van Knapen, 2013). Its impact on dogs of that age range was also detected in this study.

Toxocara sp. can spread to humans through accidental ingestion of embryonated eggs, soil and water, or contaminated vegetables. It can survive for months and even years in optimal conditions (Mizgajska-Wiktor *et al.*, 2017). Unfortunately, if it is not addressed, this disease is particularly frequent among children from low-income populations, both in the tropic and the subtropic regions (*e.g.*, Mexico), as well as in industrialized countries (Macpherson, 2013). There are other routes of infection; for instance, a person may eat meat from paratenic hosts (poultry, pigs, and ruminants) infected with larvae, particularly if the meat is not well done (Cociancic *et al.*, 2018).

The presence of the *Ancylostoma* sp. + *Toxocara* sp. association in the animal samples gathered in human populations is a potential public health risk, as a consequence of the

Table 1. Frequency of zoonotic parasites in homebound and feral dogs in Texcoco, State of Mexico, Mexico.

Result	Domiciliated n=325			Nondomiciliated n=175		
	Frequency	%	CI 95%	Frequency	%	CI 95%
Ctenocephalides sp.	47	14.4	11.0-18.7	77	44	36.5-51.6
Ancylostoma sp.	39	12.0	8.9-15.9	35	20	14.3-26.7
Toxocara sp.	23	7.0	4.7-10.4	45	25.7	19.4-32.8
Cystoisospora sp.	2	0.6	0.1-2.2	5	2.8	0.9-6.5
Dipylidium caninum	0	0.0	0	3	1.71	0.3-4.9
Uncinaria sp.	2	0.6	0.1-2.2	0	0.0	0

IC 95%: 95% Confidence Interval.

Table 2. Multiparasite infections in homebound and feral dogs in Texcoco, State of Mexico, Mexico.

	Frequency
2 parasites	
Ctenocephalides + *Toxocara*	40
Ancylostoma + *Ctenocephalides*	27
Ancylostoma + *Toxocara*	13
Ancylostoma + *Cystoisospora*	3
Ancylostoma + *Dipylidium*	3
Dipylidium + *Ctenocephalides*	3
Cystoisospora + *Ctenocephalides*	2
Cystoisospora + *Toxocara*	2
Dipylidium + *Toxocara*	2
Ancylostoma + *Uncinaria*	1
Cystoisospora + *Dipylidium*	1
Ctenocephalides + *Uncinaria*	1
Toxocara + *Uncinaria*	1
3 parasites	
Ancylostoma + *Cystoisospora* + *Dipylidium*	1
Ancylostoma + *Cystoisospora* + *Ctenocephalides*	1
Cystoisospora + *Dipylidium* + *Ctenocephalides*	1
Cystoisospora + *Dipylidium* + *Toxocara*	1
Dipylidium + *Ctenocephalides* + *Toxocara*	2
Ctenocephalides + *Toxocara* + *Uncinaria*	1
4 parasites	
Ancylostoma + *Cystoisospora* + *Dipylidium* + *Ctenocephalides*	1
Ancylostoma + *Cystoisospora* + *Dipylidium* + *Toxocara*	1
Cystoisospora + *Dipylidium* + *Ctenocephalides* + *Toxocara*	1
5 parasites	
Ancylostoma + *Cystoisospora* + *Dipylidium* + *Ctenocephalides* + *Toxocara*	1

Table 3. Frequency of zoonotic parasites in female and male dogs in Texcoco, State of Mexico, Mexico.

Parásito	Hembras (n=309)	Machos (n=191)	RPC IC 95%	Prueba exacta de Fischer's
	Frecuencia % IC 95 %	Frecuencia % IC 95 %		
Ctenocephalides sp.	63 20.4 16-25.2	61 31.94 25.4-39.1	1.57 0.76-3.23	p>0.05
Ancylostoma sp.	48 15.5 12-20.0	26 13.61 9.1-19.3	0.34 0.04-2.7	p>0.05
Toxocara sp.	33 10.7 7.7-15	35 18.32 13.1-24.6	0.88 0.24-3.22	p>0.05
Cystoisospora sp.	4 1.3 0.5-3.2	3 1.57 0.3-4.5	-	p>0.05
Dipylidium caninum	2 0.6 0.2-2.3	1 0.52 0.01-2.8	-	-
Uncinaria sp.	1 0.3 0.1-1.8	1 0.52 0.01-2.8	-	p>0.05

RPC: Cross-Product Ratio; IC 95%: 95% Confidence Interval.

Table 4. *Ancylostoma* sp. + *Toxocara* sp. association frequency divided by age, sex, and level of ownership of dogs in Texcoco, State of Mexico, Mexico.

	Association *Ancylostoma* sp. + *Toxocara* sp.				
Age group (months)	**RR**	**CI 95%**	**OR**	**CI 95%**	**Fischer's Exact Test**
0 - 4	0.89	(0.49-1.60)	0.79	(0.22-2.8)	P>0.05
5 - 8	1.24	(0.92-1.67)	**3.29**	(0.9-12.03)	**P<0.05**
9 -12	1.06	(0.87-1.28)	**2.8**	(0.23-33.87)	P>0.05
13 - 60	1.08	(0.95-1.22)	**6.95**	(0.92-52.02)	**P<0.05**
More than 60	0.95	(0.91-1.00)	0	(0)	P>0.05
Sex					
Male	1.2	(0.92-1.57)	**2.27**	(0.89-5.75)	**P<0.05**
Female	0.99	(0.89-1.10)	0.96	(0.35-2.64)	P>0.05
Domiciliated					
Yes	1.11	(0.96-1.27)	**2.87**	(1.06-7.8)	**P<0.05**
No	0.91	(0.75-1.10)	0.67	(0.27-1.66)	P>0.05

RR: Relative Risk; RPC: Cross-Product Ratio; IC 95%: 95% Confidence Interval.

Table 5. *Ancylostoma* sp. + *Toxocara* sp. association frequency of dogs in the main localities of Texcoco, State of Mexico, Mexico.

Place	*Ancylostoma* spp.	*Toxocara* spp.	Relative Risks	Odds ratio
	Frequency % CI 95%	Frequency % CI 95%	RR IC95%	OR IC95%
Boyeros	1 1.4% 0.03-7.3	4 5.9% 1.6-14.3	0.80 0.65-.099	-
Centro	4 5.4% 1.4-13.2	2 2.9% 0.3-10.2	0.95 0.89-1.01	-
ISSSTE	6 8.1% 3.03-16.8	2 2.9% 0.3-10.2	0.33 0.06-1.65	-
La Purificación Tepetitla	7 9.5% 3.8-18.5	8 11.8% 5.2-21.8	1.58 0.83-3.03	**7.35** 1.26-42.6
San Juan Tezontla	7 9.5% 3.8-18.5	4 5.9% 1.6-14.4	1.5 0.73-3.04	**4.5** 0.33-60.1
San Simón	3 4.1% 0.8-11.3	1 1.5% 0.04-7.9	0.9 0.73-1.1	-
Tequexquinahuac	4 23.53% 9.56-27.26	1 7.14% 1.27-31.47	1.1 0.73-1.84	**3.25** 1.16-64.6
UACh	12 16.2% 8.6-26.6	6 8.8% 3.3-18.2	1.02 0.65-1.59	1.11 0.17-6.97
Xolache	5 6.8% 2.2-15.0	18 26.5% 16.5-38.5	1.29 0.62-3.67	**2.33** 0.35-15.1

F: absolute frequency; CI95%: Confidence Interval 95%. RR: Relative Risk; RPC: Cross-Product Ratio.

close coexistence between homebound dogs and humans. This risk is particularly high among children, who are the most vulnerable to parasitic infections.

In this study, the *Ancylostoma* sp. + *Toxocara* sp. association had a >2 Cross-Product Ratio in the 2, 3, and 4 groups (5-60-month-old) of homebound male dogs. This situation suggests a lack of preventive medicine among this population stratum, which increases the risk of the owners' families to get parasites (Rinaldi *et al.*, 2008; Šlapeta *et al.*, 2015). Cases of interaction between stray animals (mainly cats and dogs) and humans in urban districts, parks, cattle-raising areas, and even in preschool playgrounds have been reported. Therefore, we suggest determining the risk and the exposition factors based on the knowledge about the natural history of the disease.

New studies must be carried out to achieve a more exhaustive evaluation of the health status of homebound dogs, focusing on issues such as vaccination status, the interval between de-worming treatments, and the presence of parasites. Feral, free-roaming, and

homebound dogs must also be included in the last two population groups, as well as those dogs that are part of the trap-neuter-return programs (CER). The studies must include tests for intermediate and paratenic species (Kwan Nigel *et al.*, 2019). The use of geographic information systems can be useful to manage this type of dog population, allowing preventive medicine interventions aimed particularly at preventing and controlling zoonotic infections (Rinaldi *et al.*, 2008; Šlapeta *et al.*, 2015; Taetzsch *et al.*, 2018).

CONCLUSIONS

New studies must be carried out to achieve a more exhaustive evaluation of the health status of homebound dogs, focusing on issues such as vaccination status, the interval between de-worming treatments, and the presence of parasites. Feral and semi-homebound dogs must also be included in the last two. A surgical neutering/spaying campaign must be carried out, along with an anti-rabies vaccination campaign and other preventive medicine interventions aimed particularly at preventing and controlling zoonotic parasite infections.

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