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INTESTINAL PARASITIC INFECTIONS OF STRAY DOGS ON THE CARIBBEAN ISLAND OF ST. MAARTEN/ST. MARTIN

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ABSTRACT

The island of St. Maarten/St. Martin has a big stray dog population, with many roaming and non-sterilised owned dogs. Faecal samples from 111 dogs, including 70 puppies and 41 adult dogs, underwent coprological examination including flotation. Collection occurred from July through September of 2022. The infection rate of 92.8 % was higher than that reported in the previous Caribbean studies. The species found were *Cystoisospora* spp., *Giardia intestinalis*, species from the family Ancylostomatidae, *Toxocara canis*, *Trichuris vulpis*, and *Dipylidium caninum*. Ancylostomatidae family had the highest prevalence at 75.7 %. The high *T. canis* (42.3 %) and *D. caninum* (13.5 %) rates were attributed to the young age of the sample population in this study. Conversely, the low *T. vulpis* (10 %) rate was attributed to its long prepatency period, as eggs only shed from older puppies and dogs. *Cystoisospora* spp. were the most prevalent protozoan parasite at 10.8 %. The total coinfection rate was 45.9 %, with the most being 5 different species. It was determined that the parasite burden on the island is high and is likely to benefit from animal welfare interventions.

Key words: coccidiosis; giardiasis; helminthiasis; St. Maarten/St. Martin; stray dogs; zoonosis

INTRODUCTION

The high stray dog population on St. Maarten/St. Martin is an enduring problem many residents felt was exacerbated by the Category 5 hurricane Irma in 2017 and the economic impact of the COVID-19 pandemics causing more pet abandonment. The reduced or nil veterinary care that stray dogs receive, together with the low sterilisation rate and a high roaming status of owned animals in the Caribbean provides a hospitable situation for parasites to thrive. However, there is a lack of previous parasitological research throughout the Caribbean [5]. Nematodes of the family Ancylostomatidae, and species *Toxocara canis* have complex life cycles and potential zoonotic transmission. The migrating hookworm larvae can cause cutaneous larva migrans, whilst migrating *T. canis* larvae can affect organs, muscles, and the central nervous system, causing visceral, neural, or ocular larva migrans syndromes in humans [2, 13, 16]. These nematodes along with *Trichuris vulpis*, or "whipworms", and the cestode *Dipylidium caninum* can cause serious gastrointestinal disease in their canine hosts. Whilst most infections are asymptomatic, heavy infections can lead to damage of intestinal mucosa, anaemia, ill-thrift, ileus, and in some cases death. Severe perianal pruritus is common in human and canine *D. caninum* infections. The protozoan *Cystoisospora* species (spp.) and zoonotic *Giardia intestinalis* can cause enterocyte damage with an acute course or chronic malabsorption and debilitation [2, 13]. Co-infections of gastrointestinal parasites are common and can complicate the aetiology of certain clinical signs and produce potentially fatal synergistic effects [2, 12]. All these parasites can be identified via distinctive eggs, oocysts, or trophozoites in the faeces of infected dogs.

As there is no information published on these clinically important parasites on St. Maarten, and very little is available in the Caribbean in general, this study aimed to provide novel data to lessen the knowledge gap, and reference material to improve the parasitic burden of the island's canine and human population.

MATERIALS AND METHODS

Study area and sample collection

Faecal samples were collected immediately post-defecation or by faecal loop and placed in clean plastic bags and refrigerated for a maximum of 4 hours until examination to ensure minimal morphological deterioration of diagnostic stages [17]. Stray and free-roaming dogs without identifiers were sampled. Any dogs given antiparasitic medications within the preceding 6 months, as confirmed by the island's animal welfare bodies or community caretakers, were eliminated as subjects. Altogether 111 sampled dogs met these criteria, including 61 individual dogs, and 50 dogs found with littermates: 13 litters ranging from 2–7 puppies, 70 puppies (< 1 year old) and 41 adult dogs. In total, the age ranged from 3 weeks to 7 years of age, with an average age of 51 weeks. The location and general state of the animals was noted including approximate age, general nutritional status, and observable pathologies. The analysis was conducted at the Island Vet veterinary clinic, Cay Bay, St. Maarten.

Faecal analysis

Flotation was conducted according to Dryden et al. [3] using 1–2 g of fresh faeces that were mixed with 10 ml of a commercially prepared Sheather's sugar solution of specific gravity 1.27. The mixture was strained to remove larger debris and centrifuged at 1200 rpm for 5 minutes. More Sheather's solution was added until a small meniscus formed, and a coverslip was placed in contact with the flotation fluid. After 10 minutes the coverslip was transferred to a microscope slide and examined. The parasitic load was estimated according to the number of eggs/oocysts seen, and categorised as nil, low (≤ 5), moderate (6–19), and heavy (> 20). These eggs/oocysts-per-gram limits agree with those reported by Dryden et al. [3], taking into account the smaller sample size.

Ethical approval

The study was conducted on St. Maarten, a semi-autonomous country of the Netherlands with no specific regulation of animal research. Dogs found on St. Martin, an administrative region of France, were brought to the Island Vet for veterinary care and faecal samples were taken for this research incidentally. All dogs were treated with respect and no sedation, stress, or pain was imposed for the purpose of this research. Efforts were made to rehome the strays and treat the parasitic infections found. No consent was required as the dogs were not client-owned.

RESULTS AND DISCUSSION

An overall intestinal parasitic prevalence of 92.8 % was found. The species were members of the family Ancylostomatidae, namely *Toxocara canis*, *Trichuris vulpis*, *Dipylidium caninum,* and *Cystoisospora* spp. and *Giardia intestinalis.* The infection rates and severity of infection are shown in Fig.1.

The infection rate was higher than that found during the previous research in the region. A Grenada study found endoparasites in 88.5 % of stray dogs, whilst 80 % was found among owned dogs in the tropical region of Yucatán Peninsula in Mexico, and 7 % in Costa Rica [11, 14, 18]. In our study, the most common were Ancylostomatidae

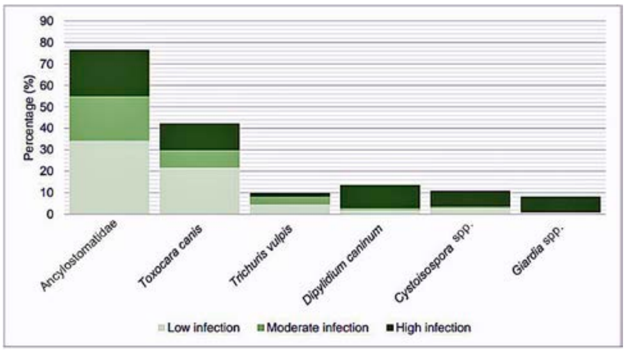

Fig. 1. Parasites found – species and cumulative percentages of low, moderate, and high infection rates

spp. at 75.7 %. Other studies identified *Ancylostoma* spp. as the predominant endoparasite, with 75 %, 73.8 %, and 73 % of dogs testing positive in the Costa Rica, Mexico, and Grenada studies, respectively [11, 14, 18]. In the studies with lower overall prevalence of endoparasites, *Ancylostoma* spp. were still found to have the highest relative infection rate. For example, in Venezuela there was a 35.5 % endoparasite infection rate, with 21.7 % testing positive for *Ancylostoma* spp., more than double the next most-common parasite [10].

Conversely, the second most common parasite found in this study was *T. canis* at 42.3 %, which is considerably higher than in other studies, with ≤ 6.2 % infection rates found in the Costa Rica, Mexico, and Grenada [11, 14, 18]. *T. canis* is noted to have data from only five islands since the 2000's, and most data referenced are from historical studies [5]. The high population density of St. Maarten is also likely a contributing factor. As previous research has found, incidence of *T. canis* infections increase in urban areas [5]. A study by Schwartz et al. [15] found infections that were highly age dependent: 50 % infection at 2 weeks, increasing to 70 % by 12 weeks, and ultimately 0 % after 40 weeks. High free-roaming and stray dog populations throughout the Caribbean increases risk of environmental contamination, infection, and re-infection, although the general trend being the dogs are older with a reduced risk of *T. canis* infection [5]. Only 9.9 % of the dogs sampled were under 6 months of age in Tiwari et al. [18], and 70.8 % of the dogs were older than 2 years in Rodríguez-Vivas et al. [11]. This was in stark contrast to this St. Maarten study, where 61.3 % of the dogs were under 6 months old. This large disparity in the ages of the subjects could explain the large difference between values obtained in this study and those of the previous research.

The same reasoning can be applied to the relatively low infection rate of *T. vulpis* of 10 %, which ranged between 15.7 % in Grenada and 73 % in Costa Rica in the supporting literature where sampled dogs were older [11, 14, 18]. As the prepatency period for *T. vulpis* is at least 9 weeks and generally around 3 months [2, 19], this indicates that infection rates on St. Maarten may appear low as any whipworms present had not matured enough to shed detectable eggs.

The *D. caninum* infection rate was 13.5 %. In the previous research, the rates were highly variable, with two studies in the same Cuban city finding 0 % and 16.3 % infection rates [7, 9]. This could be due to the sporadic nature of flea infestations and the rapid infection of dogs living in proximity. There is a contradiction between the high *D. caninum* infection rates reported in this study and the high stray dog population density of St. Maarten. A meta-analysis conducted by Rousseau et al. [12] found a strong correlation between population density and infection, with greater rates (1.3–13.1 %) found in less-developed areas, whilst urban areas had lower rates (0.7–5.7 %). It has been indicated that immunity to *D. caninum* infection increases with age as shown in studies where grooming mothers of infected puppies were ingesting infected fleas but were free of infection themselves [4]. Thus, the high infection rate on St. Maarten could once again be explained by the young age of strays.

The predominant protozoa found were *Cystoisospora* spp. in 10.8 % of St. Maarten dogs. It was present in 91.7 % of the sampled puppies under 3 months of age. This is corroborated by a study in Venezuela, that found prevalence to be significantly increased in young puppies [10]. Although coccidiosis is known as a disease with high morbidity and low mortality, it should be noted that 50 % of the affected dogs on St. Maarten showed severe clinical signs, with 25 % having profuse yellow diarrhoea with blood and poor body conditions. *G. intestinalis* were detected in 8.1 % of dogs. A study in Costa Rica found a comparable rate of 8.6 %, however these cases were confirmed by direct immunofluorescent assay [14]. Conventional PCR was used to find a 19.6 % infection rate in Jamaica, exclusively of the zoonotic assemblage A [6]. This suggests that infection of *G. intestinalis* should be considered a potential concern for human transmission in the Caribbean. *G. intestinalis* predominantly affected the puppies and young dogs of St. Maarten, which is supported by a meta-analysis of giardiasis severity factors [1].

On St. Maarten, the rate of coinfection was far higher than in other studies as 45.9 % had multiple parasitic species: 29.7 % with two, 11.7 % with three, 3.6 % with four, and 0.9 % with five. In the Costa Rica study, only 26.7 % of the dogs had two parasites, and 5 % had three, while in the Mexico study the coinfection rate was 24.4 % [11, 14]. There is a potential for a synergistic effect between parasites which can result in a worse clinical picture [2, 12]. There were high infection rates within litters, with genera *Giardia* and *Cystoisospora* having a 100 % infection rate among five affected litters. Ancylostomatidae family had an average infection rate of 88.5 % among nine affected litters. This high value can be attributed to the lactogenic transmission route that *A. caninum* can take from mother to her puppies. *D. caninum* had an infection rate of 73.8 % in three affected litters, likely due to the flea and lice ectoparasites serving as an intermediate host necessary for transmission being ingested by several of the puppies. The *T. canis* infection rate was 71 % among ten affected litters. The transplacental infection rate can reach 77–100 % when hypobiotic larvae undergo hormonal reactivation during pregnancy [8], and some may have become infected via lactogenic or environmental transmission [2].

There were incidental findings where dogs served as neither the final nor the intermediate host. *Hymenolepis diminuta*, the rat tapeworm was found where the dog acts as a side host. This is more common around high rodent populations where dogs ingest insect intermediate hosts [2, 13]. Lizard and rat pinworm eggs of the order Oxyurida were found in several dogs. Through personal observation, there were seen many living and dead rats, and it was common to see a dog with one of the local iguanas in its jaws. Other species included Ascaridida nematodes, mites, and various other arthropods.

CONCLUSIONS

This study provided novel data on the parasitic burden of stray and free-roaming dogs on the St. Maarten/St. Martin Island for the reduction of the prevalent knowledge gap of modern parasitic studies in the Caribbean. The usual bias towards abandoned, stray, and free-roaming dogs being older does not hold true on St. Maarten, as most dogs were very young. As such, the canine population inevitably had a higher parasitic burden at 92.8 % and a coinfection rate of 45.9 %, resulting in reduced quality of life for many animals, and likely a higher incidence of environmental contamination and zoonotic transmission to humans. The zoonotic giardiasis, ancylostomiasis, toxocariasis, dipylidiasis should be taken as a real and present threat to the public health of St. Maarten's human population, as their etiological agents are present in high numbers. The health and welfare of the island's dogs should be considered an area which needs improvement.

Conflict of interest

The authors have no potential conflict of interest pertaining to this submission to Folia Veterinaria.

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REFERENCES

1. **Bouzid, M., Halai, K., Jeffreys, D., Hunter, P. R., 2015:** The prevalence of *Giardia* infection in dogs and cats, a systematic review and meta-analysis of prevalence studies from stool samples. *Vet. Parasitol.*, 207, 3–4, 181–202. DOI: 10.1016/j.vetpar.2014.12.011.
2. **Deplazes, P., Eckert, J., Mathis, A., Von Samson-Himmelstjerna, G., Zahner, H., 2016:** *Parasitology in Veterinary Medicine*. Wageningen Academic Publishers, Wageningen. 653 pp. DOI: 10.3920/978-90-8686-274-0.
3. **Dryden, M. W., Payne, P. A., Ridley, R., Smith, V., 2005:** Comparison of common faecal flotation techniques for the recovery of parasite eggs and oocysts. *Vet. Ther.*, 6, 1, 15–28.
4. **East, M. L., Kurze, C., Wilhelm, K., Benhaiem, S., Hofer, H., 2013:** Factors influencing Dipylidium sp. infection in a free-ranging social carnivore, the spotted hyena (*Crocuta crocuta*). *Int. J. Parasitol. Parasites Wildl.*, 2, 257–265. DOI: 10.1016/j.ijppaw.2013.09.003.
5. **Ketzis, J. K., Lucio-Forster, A., 2020:** *Toxocara canis* and *Toxocara cati* in domestic dogs and cats in the United States, Mexico, Central America and the Caribbean: A review. *Adv. Parasitol.,* 109, 655–714. DOI: 10.1016/bs.apar.2020.01.027.

6. **Lee, M. F., Cadogan, P., Eytle, S., Copeland, S., Walochnik, J., Lindo, J. F., 2017:** Molecular epidemiology and multilocus sequence analysis of potentially zoonotic *Giardia* spp. from humans and dogs in Jamaica. *Parasitol. Res*., 116, 1, 409–414. DOI: 10.1007/s00436-016-5304-y.
7. **Merlo, R. H., Núñez, F. A., Durán, L. P., 2007:** Potencial zoonótico de las infecciones por helmintos intestinales en perros callejeros de Ciudad de La Habana (Zoonotic potential of intestinal helminth infections in stray dogs from City of Havana) (In Spanish). *Rev. Cubana Med. Trop*., 593, 234–240.
8. **Mirza, A., Rathore, M. H., 2012:** Toxocariasis, hydatid disease of the lung, strongyloidiasis, and pulmonary paragonimiasis. In **Kendig** and **Chernick's**: *Disorders of the Respiratory Tract in Children*. Elsevier, 552–563. DOI: 10.1016/B978-1-4377-1984-0.00036-X.
9. **Puebla, L. E., Nunez, F. A., Rivero, L. R., Hernandez, Y. R., Garcia, I. S., Milan, I. A., 2015:** Prevalence of intestinal parasites in dogs from municipality la Lisa, Havana, Cuba. *J. Vet. Sci. Technol*., 6, 5. DOI: 10.4172/2157-7579.1000250.
10. **Ramírez-Barrios, R. A., Barboza-Mena, G., Muñoz, J., Angulo-Cubillán, F., Hernández, E., González, F., Escalona, F., 2004:** Prevalence of intestinal parasites in dogs under veterinary care in Maracaibo, Venezuela. *Vet. Parasitol*., 121, 1–2, 11–20. DOI: 10.1016/j.vetpar.2004.02.024.
11. **Rodríguez-Vivas, R. I., Gutierrez-Ruiz, E., Bolio-González, M. E., Ruiz-Piña, H., Ortega-Pacheco, A., Reyes-Novelo, E., et al., 2011:** An epidemiological study of intestinal parasites of dogs from Yucatan, Mexico, and their risk to public health. *Vector Borne Zoonotic Dis*., 11, 8, 1141–1144. DOI: 10.1089/vbz.2010.0232.
12. **Rousseau, J., Castro, A., Novo, T., Maia, C., 2022:** *Dipylidium caninum* in the twenty-first century: Epidemiological studies and reported cases in companion animals and humans. *Parasit. Vect.*, 15, 1, 131. DOI: 10.1186/s13071-022-05243-5.
13. **Saari, S., Nareaho, A., Nikander, S., 2019:** *Canine Parasites and Parasitic Diseases*. Academic Press, 269 pp.
14. **Scorza, A. V., Duncan, C., Miles, L., Lappin, M. R., 2011:** Prevalence of selected zoonotic and vector-borne agents in dogs and cats in Costa Rica. *Vet. Parasitol*., 183, 1–2, 178–183. DOI: 10.1016/j.vetpar.2011.06.025.
15. **Schwartz, R., Bidaisee, S., Fields, P. J., Macpherson, M. L. A., Macpherson, C. N. L., 2022:** The epidemiology and control of *Toxocara canis* in puppies. In *Parasite Epidemiol. Control.* 8, 1, e00232. DOI 10.1016/j.parepi.2021.e00232.
16. **Strube, C., Janecek, E., Heuer, L., 2013:** Die Toxokarose des Hundes – wichtige Aspekte für die tierärztliche Praxis (Toxocarosis in dogs – important aspects for the veterinary practice) (In German). *Tierarztl Prax Ausg. K. Kleintiere Heimtiere*, 41, 03, 181–189. DOI: 10.1055/s-0038-1623704.
17. **Smith, H. V., Mank, T. G., 2011:** *Diagnosis of Human Giardiasis*. In **Luján, H. D., Svärd, S.** (Ed.). Giardia, 1st edn., Springer, Vienna, 353–377. DOI: 10.1007/978-3-7091-0198-8.
18. **Tiwari, K., Carloni, J., Thomas, D., Allie, C. D., Chikweto, A., Hegamin-Younger, C., Sharma, R. N., 2016:** Prevalence of gastrointestinal parasites in stray dogs (*Canis familiaris*) from Grenada, West Indies. *J. Anim. Res.,* 6, 1, 1. DOI: 10.5958/2277-940x.2016.00001.2.
19. **Traversa, D., 2011:** Are we paying too much attention to cardio-pulmonary nematodes and neglecting old-fashioned worms like *Trichuris vulpis*? *Parasit. Vect.*, 4, 1, 32. DOI: 10.1186/1756-3305-4-32.

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