Annals of Parasitology 2021, 67(2), 287–294
doi: 10.17420/ap6702.341

Original paper

Parasitic contamination in the soil of public parks from northern Brazil

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ABSTRACT. Public parks are an important source of contamination by parasites due to the high flow of people and animals. We aimed to evaluate the prevalence of intestinal parasites in the soil of public parks from Belém, northern Brazil, as well as compare the degrees of parasitism in squares analyzed, the frequency of parasites found according to parasitological methods and verify the conditions of squares on collection day. This was a cross-sectional analytical study carried out during October 2020. The forty samples from four squares were analyzed by Hoffman, Faust and Baermman modified methods. The results showed that 72.5% of samples were parasitized and 100% of squares were contaminated with intestinal parasites. Moreover, polyparasitism was predominant in contaminated samples and Baermann-Moraes method was the most sensitive in the detection of helminths. *Blastocystis hominis* (47.2%) and hookworms (52.5%) were the most found species. Thus, this study showed parasitic contamination in all of the squares analyzed, which may be associated with poor sanitary from the city of Belém and reinforce the adoption of preventive measures to reduce the parasitic contamination on squares.

Keywords: parasites, soil, environmental pollution, parasite load

Introduction

Intestinal parasitic infections are an important public health problem around the world, mainly in developing regions, and may be associated with inadequate sanitation and unfavorable socio-economic status [1]. Furthermore, lack of knowledge of the population about the transmission mechanism and means of preventing these pathogens contribute to their spread [2]. These diseases can be transmitted through infected water and food or contact with contaminated soil by parasites [3]. Therefore, the morphological characteristics of the microorganism influence its survival, as the cystic wall present in the protozoa and the membrane of helminth eggs, rich in carbohydrates, conferring protection and resistance of these forms to the environment [4].

Thus, factors inherent to the host can favor parasitic infections, such as age, nutrition, immune response, and inadequate habits of personal hygiene [5–7]. Likewise, several environmental determinants contribute to the soil contamination and guarantee the survival of these parasites, including garbage dump in the environment, temperature, humidity, pH, consistency, composition, and texture [6–8].

Among the favorable places for the propagation of parasitic forms in the soil, public parks represent an important source of parasitic infection to humans due to the high flow of people and animals. The risk factors that facilitate this contamination are poor hygiene practices, especially by children, who use these spaces for leisure and the habit of bringing animals to the parks, mainly dogs, which deposit their faeces directly in the environment [9.8].

Several reports demonstrate the parasitic contamination in the soil of public parks [8,10–14]. The most frequently described parasites were helminths (*Ancylostoma* spp., *Toxocara* sp. and *Ascaris lumbricoides*) [8,15] and the protozoans (*Entamoeba* spp. and *Giardia* spp.) [10,13,14]. However, few parasitological analyses were performed in public parks in Northern Brazil [8,14].

Table 1. Prevalence of parasitic contamination, degrees of parasitism in the samples of four public squares, in Belém, Pará, Northern Brazil

Samples	P1 N (%)	P2 N (%)	P3 N (%)	P4 N (%)	Total	P-value	Total P-value
Parasitized	10 (100%)	7 (70%)	7 (70%)	5 (50%)	29 (72.5%)	0.0327[a]	0,0044[b]
Non-parasitized	0 (0%)	3 (30%)	3 (30%)	5 (50%)	11 (27.5%)		
Total	10 (100%)	10 (100%)	10 (100%)	10 (100%)	40 (100%)		

P1: Orla Park, P2: Jaú Park, P3: Espaço Criança Square, P4: Batista Campos Square. [a]Comparison between the samples parasitized and non-parasitized according to the squares analyzed by G-test ($p<0.05$). [b]Comparison between total samples parasitized and non-parasitized by chi-square test ($p<0.05$).

In the city of Belém, northern Brazil, the precarious conditions of the public parks are related to the poor sanitation and the geographic pattern of the city that is cut by rivers and streams, with an extensive area subject to flooding, making these areas suitable for propagation of parasites [16]. Therefore, we evaluated the prevalence of intestinal parasites in the soil of public parks in Belém, Brazil, and we compared the different degrees of parasitism in the squares analyzed, the frequency of parasites found according to the different parasitological methods used in the analysis and checking the conditions of the squares on the day of collection.

Materials and Methods

Study area

This is a cross-sectional analytical study carried out in soil samples in Belém, northern Brazil, a territorial extension of 1,059,466 km², an estimated population of 1,499,641 inhabitants in 2020 and 236 public parks registered [17,18]. The public parks were selected by convenience, based on observation of child circulation and the presence of kids toys. The locations were Orla Park – P1 (1°28’20”S 48°30’ 07”W), Jaú Park – P2 (1°25’07”S 48°28’48”W), Espaço Criança Square – P3 (1°26’19”S 48°28’31” W) and Batista Campos Square – P4 (1°26’19”S 48° 28’31”W).

Collection, processing, and sample analysis

We first evaluated the squares on the day of collection about the conservation of the space, presence of waste, circulation of people and animals, and conditions of the playground. A total of 40 samples (10 samples per square) were collected during October 2020. The collection area was established in two quadrants with a total area of 9m² around the toys in each square. In each vertex and center of each quadrant was removed 90g of material [19].

The samples were stored in sterile plastic bags identified as (P1, P2, P3, and P4), the sample number, and the time of collection, being

Table 2. Degree of parasitism in the samples of public squares, in Belém, Pará, Northern Brazil

Samples	P1 N (%)	P2 N (%)	P3 N (%)	P4 N (%)	Total	P-value	Total P-value
Monoparasitism	0 (0%)	1 (14.3%)	2 (28.6%)	1 (20%)	4 (13.7%)	0.2070[a]	0.0233[b]
Biparasitism	4 (40%)	1 (14.3%)	1 (14.3%)	3 (60%)	9 (31.1%)		
Polyparasitism	6 (60%)	5 (71.4%)	4 (57.1%)	1 (20%)	16 (55.2%)		
Total	10 (100%)	7 (100%)	7 (100%)	5 (100%)	29 (100%)		

P1: Orla Park, P2: Jaú Park, P3: Espaço Criança Square, P4: Batista Campos Square. [a]Comparison between the different degrees of parasitism in the samples according to the squares analyzed by G-test ($p<0.05$). [b]Comparison between the total number of samples presenting the different degrees of parasitism by Chi-square test ($p<0.05$).

Table 3. Prevalence of parasitic contamination through three parasitological methods performed in the samples of four public squares, in Belém, Pará, Northern Brazil

Samples	Baermann N (%)	Faust N (%)	Hoffman N (%)	P-value
Parasitized	21 (52.5%)	16 (40%)	14 (35%)	0.2645[a]
Non-parasitized	19 (47.5%)	24 (60%)	26 (65%)	
Total	40 (100%)	40 (100%)	40 (100%)	

[a]Comparison between parasitized and non-parasitized samples in relation to the different parasitological methods used by G-test ($p<0.05$)

immediately transported in a refrigerated thermal box at 4ºC to the Laboratory of Parasitology of the Centro Universitário Metropolitano da Amazônia (UNIFAMAZ).

The material was divided and processed using three different methods: 50g of sand for Hoffman, Pons and Janer method [20], 35g for Faust method [21] and 5g for Baermann-Moraes method [22] as

Table 4. Prevalence of parasites, by species, through three parasitological methods performed in the samples of four squares, in Belém, Pará, Northern Brazil

Species	Baermann	Faust	Hoffman	Total	P-value	Total P-value
Protozoan						
Blastocystis hominis	3 (25%)	9 (60%)	5 (50%)	17 (46%)	0.1774[a,c]	0.0397[a,g]
Endolimax nana	4 (33.3%)	4 (26.6%)	1 (10%)	9 (24.3%)		
Entamoeba coli	2 (16.7%)	0 (0%)	0 (0%)	2 (5.4%)		
Iodamoeba butschlii	0 (0%)	1 (6.7%)	1 (10%)	2 (5.4%)		
Giardia lamblia	2 (16.7%)	1 (6.7%)	3 (30%)	6 (16.2%)		
Toxoplasma gondii	1 (8.3%)	0 (0%)	0 (0%)	1 (2.7%)		
Total	12 (100%)	15 (100%)	10 (100%)	37 (100%)	0.5984[b,d]	
Helminths						
Ascaris lumbricoides	2 (8.3%)	0 (0%)	3 (25%)	5 (12.8%)	0.7024[a,e]	
Hookworms	14 (58.4%)	2 (66.7%)	5 (41.6%)	21 (53.9%)		
Toxocara canis	1 (4.1%)	0 (0%)	1 (8.4%)	2 (5.1%)		
Strongyloides stercoralis	5 (20.9%)	1 (33.3%)	3 (25%)	9 (23.1%)		
Trichuris trichura	2 (8.3%)	0 (0%)	0 (0%)	2 (5.1%)		
Total	24 (100%)	3 (100%)	12 (100%)	39 (100%)	0.0002[b,f]	

[a]Values obtained through the G-test ($p < 0.05$). [b]Values obtained through the chi-square test ($p < 0,05$). [c]Comparison between protozoans species. [d]Comparison between the methods and the total number of protozoans. [e]Comparison between helminths species. [f]Comparison between the methods and the total number of helminths. [g]Comparison between all species of parasites detected in the samples.

Table 5. Conditions of the squares assessed on the day of collection

Squares	Conservation of squares	Conservation of squares toys	Presence of garbage	Circulation of people	Circulation of animals
P1	Good	Good	Present	Absence	Present
P2	Poor	Poor	Present	Present	Present
P3	Good	Good	Present	Absence	Absence
P4	Good	Poor	Absence	Present	Present

P1: Orla Park, P2: Jaú Park, P3: Espaço Criança Square, P4: Batista Campos Square. Conservation of the squares: Good: presents an appropriate structure; Poor: poorly preserved structure. Conservation of toys: Good: well preserved and suitable for the public; Bad: broken or unviable toys for use. Presence of garbage: Present: accumulation of garbage in the territory of the square. Absent: no accumulation of garbage in the square. Circulation of people and animals: Present: square had movement of animals and/or people; Absent: place without movement of animals and/or people.

previously described with modifications. At the end of the methods, two slides were prepared from each sample with Lugol 5% (Newprov®) and analyzed under Eclipse E100 (Nikon®) optical microscope in the 10x and 40x objectives. Double-observer was used as internal quality control to validate the results.

Statistical analysis

Data analysis was performed in the Bioestat software, version 5.23 [23]. Chi-square test and the G-test was used to evaluate the number of parasitized samples, the degrees of parasitism (monoparasitism, biparasitism, and polyparasitism) in the total sample and in each square, the prevalence of parasitic contamination and species of parasites according to parasitological methods used. Differences were considered statistically significant when $p<0.05$. To analyze the conditions of the squares was performed a descriptive statistic.

Results

A total of 72.5% (29/40) of the samples were significantly parasitized ($p=0.0044$) and P1 had the highest prevalence of parasites with 100% (10/10) of contamination among the squares ($p=0.0327$), as shown in Table 1.

Polyparasitism was predominant in 55.2% (16/29) of the parasitized samples ($p=0.0233$). However, no significant difference was observed between squares ($p=0.2070$) (Table 2). When comparing parasitological methods, the modified Baermann-Moraes method detected a great number of parasites 52.5% (21/40), however, the difference between parasitological methods was not significant ($p=0.2645$) (Table 3).

Considering all the parasitological methods, the most prevalent protozoan parasite was *Blastocystis hominis* 46% (17/37), followed by *Endolimax nana* 24.3% (9/37). The predominant helminths were hookworms 53.9% (21/39) and *Strongyloides stercoralis* 23.1% (9/39). Faust's method was the most effective in detecting protozoa, but there was no significant difference between the methods ($p=0.5984$) and Baermann's method was significantly more sensitive in detecting helminths ($p=0.0002$) (Table 4).

Regarding the conditions of the squares on the day of collection, 75% (3/4) were in good condition, 50% (2/4) had a good conservation of the toys and there was a presence of people. Nevertheless, the majority (75%) contained waste disposal and circulation of animals in the recreation space, including P1, the square significantly contaminated compared to the other investigated sites, as described in Table 5.

Discussion

The public squares can be an important source of infection by enteroparasites [8,11–13]. In the present study, all squares presented parasitic contamination and 72.5% of the samples were parasitized, indicating a potential risk to the health of the population.

Until the present moment, this is the first analysis carried out in the city of Belém to detect parasites in the soil of public squares and agrees with previously reported studies in northern Brazil using the Hoffman or Faust method. In Redenção city, state of Pará, 60% (15/25) of samples was contaminated from 80% (4/5) of the parks [8]. Already the state of Rondônia recorded a high prevalence of parasites in the soil with 100% (16/16) positivity in two public parks [14], corroborating with our results.

In contrast to our findings, several parasitological analyses performed by different methods in Southern Brazil presented low contamination rates. In public squares of Curitiba, in the Paraná state were observed a prevalence of 36% (124/345) of parasitized samples [24]. Likewise, in parks of Laguna dos Patos, Rio Grande do Sul were detected 8.3% (10/120) of positivity [25]. These results may be associated with greater sewage (65.1% coverage) and garbage collection (94.1% of houses) in the Southern Brazil when compared with the Northern Brazil (22.6% and 78%, respectively), which reinforces the relationship between parasitic diseases and precarious conditions of sanitation of the population [26].

In this study, the Orla Park was significantly contaminated in comparison with other squares analyzed, and may be related to the poor sanitary found in this square, including the accumulation of waste and the circulation of animals. However, no information described in the literature about the frequency of garbage collection or people flow in these places.

According to the Brazilian Institute of Geography and Statistics, in 2019, Belém occupied the 5th position between municipalities with the highest absolute number of houses in subnormal clusters, indicating the presence of poor housing and infrastructure, urban and land irregularity, and low-income population [18]. These characteristics can be observed in the district of Jurunas, where the Orla Park is located, which has one of the highest rates of flooding points, an outflow of water difficulties, and inadequate disposal of soil waste, contributing to the propagation of several parasites [27].

In our study, polyparasitism was predominant, suggesting a high parasitic load in the soil, due to the squares being open spaces for the community and with the high animal flow, which allows the contamination by parasites. These may present several transmission mechanisms to the human host and morphological characteristics that ensure their survival for a prolonged period in the soil [4,28].

Regarding parasitological methods, the Faust method detected more protozoans in soil samples in this study, although no statistical difference was observed between the methods. This finding corroborates with the aim of this method, which is to find cysts and oocysts of protozoa [4]. On the other hand, the Baermann method was the most effective in the research of helminths, reinforcing the purpose of the technique that is the detection of larvae of *S. stercoralis* and hookworms [4], which correspond to the helminths most commonly detected in this investigation.

These results corroborated with other analyses conducted in Brazil, in which these two species of helminths were found in public squares. In the Northeast Brazil, in Maceio, Alagoas had an occurrence of positive samples for hookworm species 40.5% (28/69) and *S. stercoralis* 58% (40/69) [29]. In Southern Brazil, Bento Gonçalves, Rio Grande do Sul, the percentage of hookworms was 19.2% (10/52) and *S. stercoralis* 7.7% (4/52) [30]. Likewise, 40.3% (50/124) of hookworms and 6.4% (8/124) *S. stercoralis* [24] were found in the squares of Curitiba, which was similar to our data that showed the prevalence of 52.5% of hookworms, followed by 22.5% *S. stercoralis*, regardless of the sample size is different.

Moreover, no agreement on the sample number that should be collected or a standardized methodology for collecting soil samples from public parks in the literature. There are researches analyzing from 3 to 8 samples per square [10,11,15,19,24]. Several authors considered the ends of the square [14], cardinal points [11], or established quadrants and collection points [10,19,24], which was the method selected in this study.

The choice of our collection method was based on the size of the recreation space and the way that the toys were arranged in this area. Considering the results found, the method was considered adequate, because there was significant contamination in all squares, through parasitological methods. However, it is necessary to expand the number of squares analyzed to obtain a panorama of contamination in the different neighborhoods of the municipality.

The presence of *S. stercoralis* and hookworms indicates possible pathways for faecal and transcutaneous contamination from the samples, because transmission of these parasites can occur through ingestion of contaminated food and water or penetration by the L3 filariaid larva. The maturation of the larva up to its infecting stage is facilitated by environmental factors such as oxygenation, temperature, and humidity. In the case of hookworms, the larva has a double cuticle which gives greater resistance to this microorganism, while *S. stercoralis* has a thin cuticle, making it more sensitive to the environment [4].

B. hominis was the protozoan most frequent (47.2%) in soil samples, which may be a reflection of the high prevalence of this microorganism in the population of Pará [31]. Other studies reported the prevalence of protozoans in the soil of public squares, among them *Balantidium coli, Entamoeba coli*, *Giardia lamblia*, and *Toxoplasma gondii* [10,14,32], and the last three also detected with a lower percentage in our study.

The cystic forms released in the host's stool are responsible for *B. hominis* infection. The species is considered an important indicator of environmental contamination and can be defined as a commensal protozoan or pathogenic in the human intestine, with various clinical manifestations [33].

In addition, *E. nana* was the second predominant protozoan in the samples (25%), corroborating with a study carried out on the sand in the beaches of Paraíba, João Pessoa, in which 28.1% (13/76) of this species was found [34]. This amoeba parasite on the human intestine is non-pathogenic but may indicate oral fecal contamination. Furthermore, it can survive in feces for two weeks at room temperatures and to 2 months at lower temperatures, facilitating its spread [35].

In summary, our results showed for the first time that the public squares of Belém were affected by enteroparasites, which may be justified by the contamination of these places by faecal material and poor sanitation. Furthermore, all parasitological methods detected parasites, however Baermann method was the most sensitive for helminths. Thus, it is necessary to take preventive and educational measures to prevent the spread of parasites in the squares.

Acknowledgements

The authors are grateful to the Centro Universitário Metropolitano da Amazônia for the financial support. In particular, to the Joiciane Jéssica Pantoja Ramos and Roseclea Souza Teixeira professionals who assisted during the laboratory activities.

References

[1] Souza M.A.A., Almeida C.P., Amorim R.F. 2017. As (Las) parasitoses intestinais por prevalência de geohelmintos representam sérios problemas de saúde pública. *Salud(i)Ciencia* 22: 318-323 (in Portuguese).

[2] Nunes M.O., Matos-Rocha T.J. 2019. Fatores condicionantes para a ocorrência de parasitoses entéricas de adolescentes. *Journal of Health and Biological Sciences* 7: 265-270 (in Portuguese with summary in English). doi:10.12662/2317-3076jhbs.v7i3.2244.

[3] Cociancic P., Torrusio S.E., Zonta M.L., Navone G.T. 2020. Risk factors for intestinal parasitoses among children and youth of Buenos Aires, Argentina. *One Health* 9: 1-5. https://doi.org/10.1016/j.onehlt.2019.100116

[4] Neves D.P. 2016. Parasitologia Humana. Editora Atheneu. São Paulo (in Portuguese).

[5] Ely L.S., Engroff P., Lopes G.T., Werlang M., Gomes I., Carli G.A. 2011. Prevalência de enteroparasitas em idosos. *Revista Brasileira de Geriatria e Gerontologia [online]* 4: 637-646 (in Portuguese with summary in English). http://dx.doi.org/10.1590/S180998230110004000004

[6] Chieffi P.P. 2015. Helmintoses e alterações ambientais e climáticas. *Arquivos Médicos dos Hospitais e da Faculdade de Ciências Médicas da Santa Casa de São Paulo* 60: 27-31270 (in Portuguese).

[7] Ribeiro V.M.F., Faino A.L., Peruquerri R.C., Souza S.F., Medeiros L.S., Karaccas Y., Santos F.G.A. 2017. Avaliação de cal virgem na inativação de ovos de nematóides (*Strongyloides* sp.) parasitos de pacas (*Cuniculus paca*.) criados em cativeiros. *Arquivo Brasileiro de Medicina Veterinária e Zootecnia* 69: 989-996 270 (in Portuguese with summary in English). http://dx.doi.org/10.1590/1678-4162-9282

[8] Rocha M.J., Weber D.M., Costa J.P. 2019. Prevalência de larvas migrans em solo de parques públicos da cidade de Redenção, estado do Pará, Brasil. *Revista Pan-Amazônica de Saúde* 10: 1-8 (in Portuguese with summary in English). http://dx.doi.org/10.5123/s2176-6223201901607

[9] Ferreira A., Alho A.M., Otero D., Gomes L., Nijsse R., Overgaauw P.A.M., Carvalho L.M. 2017. Urban dog park as sources of canine parasites: contamination kates and pet owner behaviours in Lisboa, Portugal. *Journal of Environmental and Public Health* 2017: 1-7. doi:10.1155/2017/5984086

[10] Marinho R.F., Sá L.C.E.F., Castro N., Gurgel-Gonçalves R., Maldonade I.R., Machado E.R. 2017. High frequency of *Ascaris lumbricoides* in public playgrounds in central Brazil. *Revista de Patologia Tropical* 46: 209-214. doi:10.5216/rpt.v46i2.47544

[11] Berenji F., Movahedi Rudy A.G., Fata A., Tavassoli M., Mousavi Bazaz M., Saleni Sangani G. 2015. Soil contamination with *Toxocara* spp. eggs in public parks of Mashhad and Khat, North East of Iran. *Iranian Journal of Parasitology* 10: 286-289.

[12] Nooraldeen K. 2015. Contamination of public

squares and parks with parasites in Erbil city, Iraq. *Annals of Agricultural and Environmental Medicine* 22: 418-420. doi:10.5604/12321966.1167705

[13] Nazaro O.O., Amorim M.R., Silva A.M. 2016. Pesquisa de helmintos e protozoários de carácter zoonótico no solo de praças públicas no município de Patos, PB. *Temas em Saúde* 16: 130-146 (in Portuguese with summary in English).

[14] Rosa N.B., Maas A., Freitas V.M., Santos A.G., Santos S., Marson R.F., Gasparotto P.H.G., Sobral F.O.S.2018. Análise parasitológica e microbiológica de áreas de recreação no interior do estado de Rondônia. *Brazilian Journal of Surgery and Clinical Research* 23: 26-30 (in Portuguese with summary in English).

[15] Monteiro N.M.C., Gonçalves C.A., Rodrigues A.A., Oliveira R.C., Lima J.A.S., Avelar J.B., Castro A.M., Rezende H.H.A. 2018. Ocorrência de potenciais agentes causadores de *Larvas migrans* em parques públicos em Aparecida de Goiânia, Goiás, Brasil. *Revista de Biologia Neotropical* 15: 72-77 (in Portuguese with summary in English). doi:10.5216/rbn.v15i2.51493

[16] Campos W.S., Miranda S.B.A., Dias G.F.M., Costa J.A. 2020. Uso da ferramenta SIG aplicado a alagamentos: estudo de caso na cidade de Belém (PA). *Revista Desarrollo Local Sostenible* 13: 114-136 (in Portuguese with summary in English).

[17] Prefeitura Municipal de Belém. 2012. Anuário Estatístico de Belém - 2012: Urbanismo. http://www.belem.pa.gov.br/transparencia/wp-content/uploads/2017/06/2_03_Urbanismo.pdf

[18] Instituto Brasileiro de Geografia e Estatística. 2020. Aglomerados subnormais 2019: Classificação preliminar e informações de saúde para o enfrentamento à COVID-19. https://biblioteca.ibge.gov.br/visualizacao/livros/liv101717_ notas_tecnicas.pdf

[19] Maciel J.S., Esteves R.G., Souza M.A.A. 2016. Prevalência de helmintos em areias de praças públicas no município de São Mateus, Espírito Santo, Brasil. *Natureza Online* 14: 15-22 (in Portuguese with summary in English).

[20] Hoffman W.A., Pons J.A., Janer J.L. 1934. The sedimentation-concentration method in schistosomiasis mansoni. *Journal of Public Health* 9: 281-298.

[21] Faust E.C., D'Antoni J.S., Odom V., Miller M.J., Peres C., Sawitz W., Thomen, J.T., Tobie J., Walker, J.H. 1938. A critical study of clinical laboratory technics for the diagnosis of protozoan cysts and helminth eggs in feces. 1 - Preliminary communication. *The American Journal of Tropical Medicine* 18: 169-183. https://doi.org/10.4269/ajtmh.1938.s1-18.169

[22] Baermann G. 1917. A simple method for finding anchylostomum (nematode) larvae in soil samples. *Welteureden Batavia Geneesk Tijschr Ned Ind*. 57: 131-137.

[23] Ayres M., Ayres M.Jr., Ayres D.L., Santos A.S. 2007. BioEstat 5.0: Aplicações estatísticas nas áreas das ciências biomédicas. Instituto Mamirauá. Belém.

[24] Sprenger L.K., Green K.T., Molento M.B. 2014. Geohelminth contamination of public areas and epidemiological risk factors in Curitiba, Brazil. *Brazilian Journal of Veterinary Parasitology* 23: 69-73. http://dx.doi.org/10.1590/S1984-29612014009

[25] Leon I.F., Strohmann A.L., Islabão C.L., Jeske S., Vilela MM. 2019. Geohelminths in the soil of the Laguna dos Patos in Rio Grande do Sul state, Brazil. *Brazilian Journal of Biology* 80: 839-843. http://dx.doi.org/10.1590/1519-6984.222590

[26] Associação Brasileira de Engenharia Sanitária e Ambiental. 2015. Situação do saneamento básico no Brasil. http://abes-dn.org.br/pdf/Situacao.pdf

[27] Guimarães R.J.P.S., Rabelo T., Catete C.P., Alves P.P.A., Silva R.C. 2017. Georreferenciamento dos pontos de alagamento em Belém (PA). https://www.tratamentodeagua.com.br/wpcontent/uploads /2018/03/IX-103.pdf

[28] Bernardes V.H.F., Pereira W.L.A., Benigno R.N.M., Moura L.G.S., Queiroz D.K.S., Aguirra L.R.V.M., Rolin Filho S.T. 2015. Ocorrência de parasitas de importância zoonótica: *Ancylostoma spp.* e *Toxocara spp.,* em cães da região metropolitana de Belém, Pará. *Acta Veterinaria Brasilica.* 9: 239-242 (in Portuguese with summary in English).

[29] Oliveira A.T.G., Silva A.P.PS., Farias C.S., Alves M.S., Silveira L.LD., Farias J.A.C. 2011. Contaminação de ambientes arenosos por helmintos em praças públicas da cidade de Maceió-AL. *Revista Brasileira de Semente* 6: 21-29 (in Portuguese with summary in English).

[30] Gonçalves G.V., Paludo C.A. 2018. Ocorrência de parasitos zoonóticos no solo de parques públicos da cidade de Bento Gonçalves, Rio Grande do Sul. *Revista UNINGÁ.* 55: 72-80 (in Portuguese with summary in English).

[31] Borges J.D., Alarcón R.S.R., Amato Neto V., Gakiya E. 2009. Parasitoses intestinais de indígenas da comunidade de Mapuera (Oriximiná, Estado do Pará, Brasil): elevada prevalência de *Blastocystis hominis* e encontro de *Cryptosporidium sp* e *Cyclopora cayetanensis. Revista da Sociedade Brasileira de Medicina Tropical* 42: 348-350 (in Portuguese with summary in English). https://doi.org/10.1590/S0037-86822009000300022

[32] Spósito J.D., Voil B.M. 2012. Avaliação da contaminação ambiental por parasitas potenciais causadores de zoonoses em espaços públicos de lazer em Apucarana, Paraná, Brasil. *Revista Saúde e Pesquisa* 5: 332-337 (in Portuguese with summary in English).

[33] Parija S.C., Jeremiah S.S. 2013. *Blastocystis*:

Taxonomy, biology and virulence. *Tropical Parasitology* 3: 17-25. doi:10.4103/2229-5070.113894

[34] Oliveira Filho A.A., Fernandes H.M.B., Alcântara N.D.F., Assis T.J.C.F., Freitas F.I.S. 2011. Frequência de enteroparasitas nas areias das praias da Paraíba. *Journal of Biology & Pharmacy and Agricultural Management* 6: 108-113 (in Portuguese with summary in English).

[35] Poulsen C.S., Stensvold C.R. 2016. Systematic review of *Endolimax nana*: a less well studied intestinal ameba. *Tropical Parasitology* 6: 8-29. https://doi.org/10.4103/2229-5070.175077

Received 25 February 2021
Accepted 13 April 2021