

Article

Contamination by Eggs of Nematodes (*Nematoda*) of Public Health Concern in Tropical Beaches

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Abstract: Public spaces such as beaches develop an important role in the welfare of the human population in Brazil, where leisure and safety spaces are increasingly scant. Knowledge about the possible role of contaminated sand of beaches on the health of animals and humans is pivotal to determine risk areas and preventing future cases. Therefore, the aim of this study was to assess the presence of eggs of nematodes of public health interest on tropical beaches. Soil samplings ($n = 42$) from 10 different beaches located in the Metropolitan region of Recife, Northeastern Brazil, were analyzed through the FLOTAC technique. In 80% (8/10) of beaches, eggs of nematodes were detected. In particular, if we consider each individual sample ($n = 42$) a positivity rate of 90.4% (38/42) was observed. Eggs belonging to the families Ascarididae (47.6%; 20/42), Ancylostomatidae (26.1%; 11/42), and Trichuridae (11.9%; 5/42) were detected. Based on these data, it is necessary to implement preventive measures and educational actions for the population in order to mitigate the potential risk of exposition to parasites of zoonotic importance. Additionally, the FLOTAC technique has been shown to be a reliable technique for assessing soil contamination by nematode eggs.

Keywords: Ascarididae; Ancylostomatidae; feces; animals; humans; beaches



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1. Introduction

Public spaces everywhere, such as parks and beaches, have played an important role in the welfare of the human population. These areas have been used for several purposes, such as sports practice, meetings, and rest, promoting a pivotal social aspect in the life of humans. In general, an intense movement of people and their pets (e.g., dogs and cats) has been observed in these areas that frequently present a ground contaminated by eggs of helminths of medical and veterinary concern [1].

The contamination of the soil on beaches and in parks has been extensively studied [2], but over the last few years, little attention has been given to this sanitary threat that has increased [3]. It is important to note that the increase in soil contamination by eggs of helminths is related to the rise in the human population and their pets, especially in urban areas [4]. Undoubtedly, in developing countries, this kind of environmental contamination has become a public health matter due to several reasons, including health education, the absence of basic sanitation, and animal welfare [2].

For instance, in Brazil, at the beginning of the current century, several studies were conducted on squares and beaches. These researches have demonstrated contamination of the soil varying from 4.69% in Pernambuco [5] to 40% in São Paulo [6]. More recently, a similar study carried out in the state of Paraíba revealed that 96.4% of soil samples collected from squares were contaminated with eggs of nematodes, including *Ancylostoma*

spp. (Dubini, 1834) (28.6%), *Trichuris* spp. (Morgani, 1740) (21.4%), and *Strongyloides* spp. (Normand, 1876) (46.4%) [7].

Overall, parasites belonging to the genera *Ancylostoma*, *Toxocara* (Wilder, 1950), *Trichuris*, *Ascaris* (Linnaeus, 1758), and *Strongyloides* are those more frequently detected [8,9]. It is important to note that some of them are parasites of dogs, cats, and also humans, and in some cases, the sharing of these pathogens among different mammal species has been considered a common event. Most of these parasite species spend part of their life cycle on the soil, which is considered an important source of accidental infection of animals, including human beings [10]. Indeed, the role of contamination of the soil on the health of animals and humans is indisputable. However, even with all knowledge acquired over the last decades, the lack of education and the absence of basic sanitation in many Brazilian regions contribute to the persistence of this issue, exposing the animal and human population to the risk of parasitic infections.

It is also important to note that public spaces such as beaches have developed an important role in the welfare of the human population in Brazil, where leisure and safety spaces are increasingly scant. In this context, knowledge about the possible role of contaminated sand of beaches on the health of animals and humans is pivotal to determining risk areas and preventing future cases of parasitic infections. Therefore, the aim of this study was to assess the presence of eggs of nematodes of public health interest in tropical beaches in Northeastern Brazil.

2. Material and Methods

2.1. Study Area

The study was conducted in the Metropolitan Region of Recife (MRR) (8°3'15" S and 34°52'53" W), state of Pernambuco, Northeastern Brazil. This area is characterized by a hot and humid tropical climate (As) with an average annual temperature of around 27 °C and rainfall of 2000 mm/year, unevenly distributed in dry and rainy periods. Climatic information was obtained from the Pernambuco Water and Climate Agency (Agência Pernambucana de Águas e Clima, APAC, Recife, Brazil). Approximately 3,975,411 people live in the MRR, and only 46.6% of this population has access to basic sanitation and treated water [10].

2.2. Soil Samplings and Laboratorial Procedures

Soil samplings ($n = 42$) were performed on the beaches and encompassed an area of approximately 38.14 km of the seafront. Briefly, samplings were carried out at 42 points from 5 a.m. to 7 a.m. For each collection point, an area of 100 m² was delimited and the soil was collected of five sub-points (four on the corners and one in the center). The collection was carried out in a superficial layer up to 5 cm deep with 100 g at each point, totaling 500 g of soil. In some areas of sampling was observed the presence of sewage discharge on the beach, as well as the presence of domestic animals (Figure 1).



Figure 1. Areas of sampling with sewage discharge on the beaches. (A–D): sewage discharge.

Each sample was individually standardized according to Ramos [11]. Briefly, they were homogenized, sieved (149 μ m), and 300 g weighed. Afterwards, the sample was placed in a plastic box and 900 mL of distilled water was added. The material was homogenized for 30 s, then left to rest for one minute, and the supernatant was separated in two sieves of 149 μ m and 38 μ m, respectively. Finally, the sieve of 38 μ m, where eggs of nematodes were retained, was washed with 50 mL of distilled water and the material analyzed through the FLOTAC technique [12].

2.3. Data Analyses and Map Construction

All data were firstly described by descriptive statistics and the relative and absolute frequencies were obtained. Afterwards, the distribution of parasites was performed using choropleth maps with color intensity levels, using the Quantum Geographic Information System (QGIS 3.16, Hannover, Germany).

3. Results

Soil samples from 10 different beaches were analyzed, and nematode eggs were detected in 80% (8/10) of them. In particular, if we consider each individual sample ($n = 42$), a positivity rate of 90.4% (38/42) was observed. Eggs belonging to the families Ascarididae (47.6%; 20/42), Ancylostomatidae (26.1%; 11/42), and Trichuridae (11.9%; 5/42) were detected (Table 1).

Table 1. Positivity for eggs of nematodes in the sand of beaches located in the Metropolitan Region of Recife.

Beach	Municipality	Collection Points (N)	Overall Positivity (%; n/N)	Family of Nematodes (%; n/N)
Pau Amarelo	Paulista	3	100% (3/3)	Ancylostomatidae (100%; 3/3) Ascarididae (100%; 3/3)
Janga	Paulista	9	100% (9/9)	Ancylostomatidae (88.8%; 8/9) Ascarididae (100%; 9/9) Thichuridae (77.8%; 7/9)
Rio Doce	Olinda	3	100% (3/3)	Thichuridae (100%; 3/3)
Casa Caiada	Olinda	6	100% (6/6)	Ancylostomatidae (100%; 6/6) Ascarididae (100%; 6/6) Thichuridae (83.3%; 5/6)
Bairro Novo	Olinda	3	100% (3/3)	Ancylostomatidae (100%; 3/3) Ascarididae (100%; 3/3)
Carmo	Olinda	2	0 (0/2)	-
Milagres	Olinda	3	100% (3/3)	Ascarididae (100%; 3/3)
Pina	Recife	2	0 (0/2)	-
Boa Viagem	Recife	5	100% (5/5)	Ancylostomatidae (100%; 5/5) Ascarididae (100%; 5/5)
Piedade	Jaboatão dos Guararapes	6	100% (6/6)	Ancylostomatidae (100%; 6/6) Ascarididae (100%; 6/6)

It is important to note that the higher diversity of eggs of nematodes was observed in Janga and Casa Caiada beaches (three distinct families), followed by Pau Amarelo, Bairro Novo, and Boa Viagem beaches (two distinct families), and finally Rio Doce and Milagres beaches with only one family of nematodes. No eggs of nematodes were retrieved in Carmo and Pina beaches. The graphical distribution of eggs of nematodes on the shore of Metropolitan Region of Recife is represented on Figure 2.

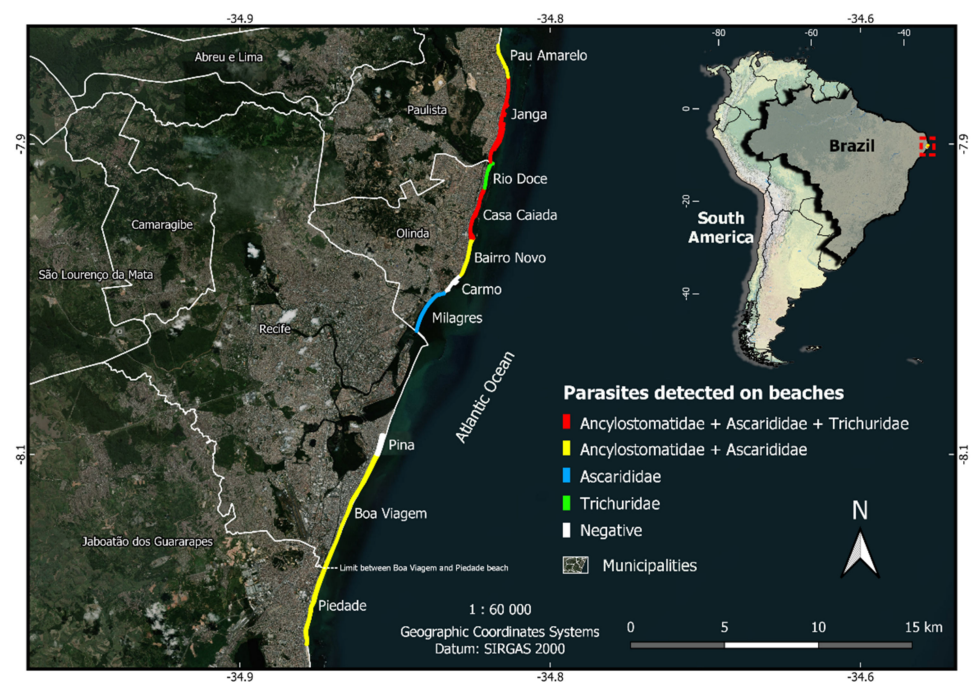


Figure 2. Graphical distribution of nematode families on the shore of Metropolitan Region of Recife.

4. Discussion

This study revealed that eggs of nematodes of medical and veterinary concern are present in sand of the shore of the Metropolitan Region of Recife, with some areas presenting a high risk of exposition for the animal and human population.

Overall, the eggs of nematodes were detected in 80% (8/10) of beaches and in 90.4% (38/42) of soil samples. This high positivity has been a trend observed in other public spaces throughout Brazil. For instance, in the municipality of Sousa, in the state of Paraíba, Helminth eggs were detected in 90% of the analyzed soil samples of public squares [4], whereas 96.4% of positivity was recorded in public squares from João Pessoa, Paraíba [2].

It is important to note that all families of parasites herein detected have been frequently observed in previous studies, where in most cases, the predominance of Ancylostomatidae eggs has been reported [1,4,13]. In comparison, in the present study, Ascarididae eggs predominated. These eggs may have as their source of contamination sewage and waste discharges, as well as feces of animals (e.g., dogs, cats, and human beings) excreted directly on the sand. It is known that Ascarididae eggs are very resistant in the environment. In general, they have a layer formed by chitin, proteins, and lipids, which may resist adverse environmental conditions [14].

Regardless of the family retrieved, both of them (e.g., Ascarididae or Ancylostomatidae) may comprise species of zoonotic concern causative agents of Larva Migrans syndrome, as well as other infections of medical and veterinary importance [1]. The high frequency of eggs of nematodes reported in this study represents an important finding from an epidemiological perspective. The study area presents suitable environmental conditions for the establishment and development of these nematodes on the soil. In addition, the regulations regarding the access of animals to beaches are nonexistent or poorly supervised, allowing the unrestricted access of stray animals in these places. Unfortunately, the lack of basic sanitation with the deposition of sanitary sewage on beaches (see Figure 1) and also poor hygiene behavior of the population are still common practice in these areas and contributes to the retrieval of these parasites.

Although less frequent eggs of the Trichuridae family were also detected, parasites belonging to this group have been already observed in previous studies [4,15], and it seems that eggs are very resistant and remain viable in hot and humid soil for months [16]. Despite

the differences in the data observed in different surveys performed worldwide, it is the consensus that parasites with zoonotic potential are frequently present.

However, in this study, two beaches (Carmo and Pina) scored negatively. This was an unexpected finding, especially because the area presents the same features and hygienic conditions of the other beaches assessed. However, it is important to note that at Pina beach, the soil is turned as a process of cleaning twice a day. This event will facilitate the contact of deep layers of soil with the sun, reducing the survival of eggs of helminths. In addition, it is signposted as a Protected Area of Natural Preservation that probably inhibits the movement of people and the presence of domestic animals, and consequently the deposition of organic matter.

It is believed that the hygienic conditions of each beach and the population density observed in these areas may influence the results herein obtained. In addition, it is important to highlight that due to the advance of the sea, some beaches present a process called “fat-tening” of the sand strip, in which clayey soil is added, modifying the natural composition of the shore, which may influence the presence and survival of eggs of nematodes.

Data herein presented confirms that the FLOTAC technique should be considered a reliable technique to assess the soil contamination by eggs of nematodes. Recently, the applicability of this technique in the assessment of this kind of sample has been validated in a study where FLOTAC presented a better performance than the spontaneous sedimentation technique (SST) and centrifugal flotation technique (CFT) [11].

Based on these data, it is necessary to implement preventive measures and educational actions for the population in order to mitigate the potential risk of exposition to parasites of zoonotic importance. In addition, the main issue of this study (soil contamination) needs to be worked through a “One Health” approach, to establish the equilibrium among human, animals, and environmental conditions.

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