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Canine tungiasis: High prevalence in a tourist region in Bahia state, Brazil

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ABSTRACT

Tungiasis is a parasitic skin disease neglected by authorities, health professionals, and the general population. Its occurrence is significantly associated with poverty. A cross-sectional study was conducted to describe the prevalence of tungiasis, associated clinical signs and risk factors of the canine population at a tourist site in the city of Ilhéus, Bahia (northeast Brazil). All village households were visited and dogs inspected after authorization by owners. A semi-structured questionnaire was administered. Of the 114 dogs included in the study, 71 (62.3%) were infested; all of them had lesions on their pads. An ectopic lesion on the nose was observed in one dog (1.4%). The number of manipulated lesions outnumbered the number of vital and avital lesions with an average of 88.3%. Edema (95.8%) and hyperkeratosis (85.9%) were the most prevalent clinical signs. Behavioral disorders such as excessive licking (6/71; 8.5%), disobedience (1/71; 1.4%) and prostration (2/71; 2.8%) were reported. In the multi-variate analysis, semi-restricted condition of the dogs (adjusted OR = 8.58; 95% CI = 2.47–29.76) and the presence of sand on the compound (adjusted OR = 14.23, 95% CI = 2.88–70.28) were significantly associated with infestation. We concluded that, infestation with *Tunga* spp. is highly endemic in the canine population of the village. The low level of restrictions on dogs and the presence of sand in areas most frequented by the animals are perpetuating factors of infestation in the community, subject to integrated and multidisciplinary intervention measures.

1. Introduction

Tungiasis is a parasitic skin disease of humans and animals caused by the penetration and hypertrophy of the *Tunga* flea into the skin of its host (Heukelbach et al., 2001; Viestel and Silva, 2012). Both males and females are hematophagous, but only the females penetrates into the skin after copulation and fertilization; bacterial superinfection of lesions is common (Heukelbach et al., 2001; Feldmeier et al., 2002). Dogs, cats, pigs and rodents are important reservoirs hosts (Heukelbach et al., 2004).

The disease is endemic in several regions of Latin America, the Caribbean and sub-Sahara Africa, from Sierra Leone to Madagascar (Heukelbach et al., 2001; Feldmeier et al., 2002). In these places, infestation occurs mainly in rural areas, fishing communities, indigenous communities and urban settlements of low socioeconomic level (Heukelbach et al., 2001; Ariza et al., 2007; Calheiros et al., 2007; Bonfim et al., 2010), which reflects the association of tungiasis with poverty (Heukelbach et al., 2003; Heukelbach, 2005). In fact, tungiasis is endemic in disadvantaged urban areas, rural communities and fishing villages throughout Brazil (Heukelbach

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et al., 2003; Carvalho et al., 2012), constituting a major public health problem in these locations (Heukelbach, 2005).

Previous animal studies including Brazilian dogs demonstrated high prevalences in communities in the states of Rio Grande do Norte, Ceará and Rio de Janeiro, where 46.7%, 67% and 61% of dogs were infested, respectively (De Carvalho et al., 2003; Heukelbach et al., 2004; Bonfim et al., 2010). In some studies, infestation on pads, periungual region, interdigital region, nose, tail and testicles was reported, accompanied by pain, limited mobility, prostration, weight loss, and behavioral changes such as excessive licking in the pelvic and thoracic limbs and disobeying commands (Silva et al., 2001; Viestel and Silva, 2012).

In Brazil, studies that showed high percentage of infestation in dogs in poor communities indicated the presence of animals on the compound as an important risk factor for human infestation. Lack of basic infrastructure, inadequate hygiene habits, low educational level and the presence of domestic animals have been associated with human tungiasis (Muehlen et al., 2006). However, in Brazil, there are no systematic studies available detecting risk factors for canine infestation.

The lack of clinical and epidemiological data and the lack of health programs including tungiasis demonstrate the neglect of this disease by public authorities, health professionals, researchers and the affected populations (Heukelbach et al., 2001; Ariza et al., 2007; Carvalho et al., 2012). In addition, the non-recognition of the disease as a zoonotic disease interferes significantly integrated control measures (Carvalho et al., 2012).

The city of Ilhéus, Bahia, along the northern stretch of the Cocoa Coast, has the ideal conditions for the development of premature *Tunga* stages. There are numerous villages with inadequate sanitation which shelter dog populations with low level of restriction and inadequate health management, such as the coastal village of Juerana. We investigated the occurrence of tungiasis in the canine population of this community and identified risk factors associated with infestation.

2. Material and methods

2.1. Ethical considerations

This study was approved by the Ethical Review Board for Animals of the State University of Santa Cruz (protocol number 06/2013). Oral consent for the clinical examination and the administration of questionnaires was obtained from dog owners.

2.2. Study area

The study was conducted in a coastal rural community called Village of Juerana, originally a fishing village, of Aritaguá district in the city of Ilhéus, Bahia (Soub, 2013). The village is located in the tourist corridor of the Cocoa Coast. It is on the left bank of the Almada River and 700 yards inland from the Atlantic Ocean (Fig. 1). There are 104 households and a population of approximately 368 inhabitants living in poor socioeconomic conditions. The housing profile is horizontal, presenting masonry, mud, wood, recyclable material and unfinished masonry houses. Many of the older houses have non-concrete floors and the seven streets that cross cross Juerana are made of dirt, sand and mud. There is no sewage system. Garbage is left in inappropriate places, and collected once or twice a week by the municipality of Ilhéus. The dog population corresponds to 27.1% of the human population, with a 1:3.7 dog to human ratio and 92% of them are semi-restricted (Harvey et al., 2013). Tourists and residents usually visit the bars and restaurants and go swimming in the Almada River. Parasitic infections in dogs and humans are frequent in this population, according to some residents and preliminary studies (Santos et al., 2011).

2.3. Study population and study design

In August 2013, a cross-sectional study was conducted, consisting of clinical examination of the canine population and application of a semi-structured questionnaire to dog owners. All 104 households were visited to record the total number of local dogs.

2.4. Clinical examination

All dogs were inspected, regardless of gender and age, without using chemical restraint and after authorization from the owner.

During the inspection, the animals were restrained mechanically and the entire animal body surface was examined thoroughly in order to detect embedded *Tunga* parasites. The diagnosis of tungiasis was made by clinical inspection of the lesions according to the criteria of Eisele et al. (2003): *Tunga* spp. in *statu penetrandi* or a red-brown spot with a diameter between 1 and 2 mm (stage I); presence of a white-yellowish halo with a diameter of 3–10 mm, with a central black dot (stage II); maximum hypertrophy of the halo with the presence of hyperkeratosis and peeling skin around the lesion (stage III); presence of a dark-brownish crust with a dead parasite, with or without surrounding necrosis (stage IV); residual circular scarring (stage V). Stages I, II and III were considered vital lesions, the stage IV and V was considered dead lesion. Manipulated lesions by the dog or owner, which leaves a crater-like sore in the skin, were also annotated. The locations and the number of lesions were noted, as well as dermatological and behavioral changes observed and reported by the owners.

2.5. Collection of epidemiological data

A semi-structured questionnaire was applied to dog owners to identify possible risk factors for infestation. The variables assessed included: sex, age, level of restriction, type of peridomiciliar floor, peridomiciliar hygiene, contact with other dogs and beach and river access.

2.6. Data analysis

Data were compiled, checked for entry errors and analyzed using Epi Info™ software (version 7.2.0.1) – Centers for Disease Control and Prevention – CDC, Atlanta, USA. Pearson's Chi-square test and Fisher's exact test were used to determine differences between proportions. To identify risk factors for the occurrence of tungiasis and its association with exposure variables, bivariate analysis and logistic regression were performed to calculate odds ratios and adjusted odds ratios (OR). The program BIOSTAT 5.0 was used to determine the colinearity between pair of variables through the Spearman's rank correlations coefficient.

3. Results

Of the 104 households visited, 57 (54.8%) had dogs, totaling 114 animals; 71 of the dogs (62.3%; 95% CI: 52.7–71.2) were infested by *Tunga* spp.

Of these, 37 (52.1%) were female, 55 (77.5%) were over one year old, 67 (94.4%) were kept in semi-restricted regimen, 70 (98.6%) had contact with other animals, 44 (62%) had access to the inside of the tutor's home. None of the dogs had veterinary supervision.

All infested dogs had lesions on their pads (Fig. 2). The acute and chronic clinical signs identified and associated with tungiasis are summarized in Table 1. Vital, avital and manipulated lesions were observed in 85.9% (61/71) 78.8% (56/71) and 94.3% (67/71) of

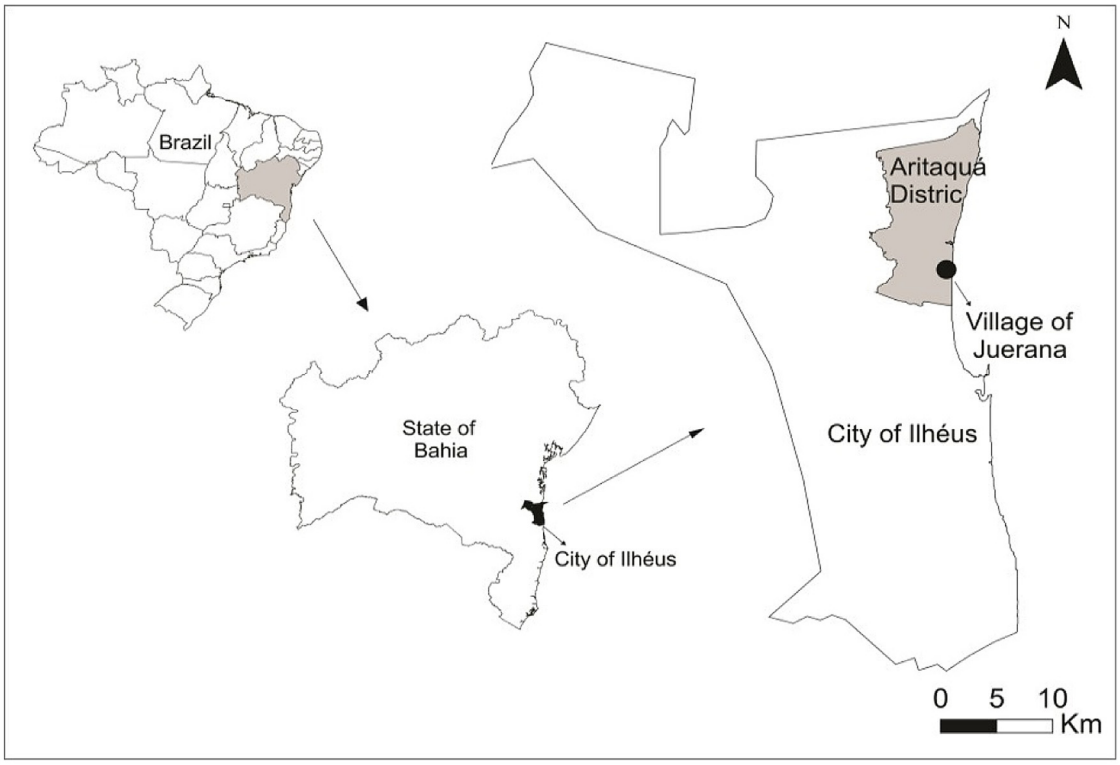

Fig. 1. Location of the city of Ilhéus, Bahia, Brazil.

Table 1
Acute and chronic clinical signs/pathologies associated with tungiasis identified in the infested dog population (n = 71) of Village of Juerana, Ilhéus, Bahia, Brazil in August 2013.

Clinical signs/pathology	Dogs		
	n	n (%)	95% IC
Acute			
Edema	68	95.8	88.14–99,12
Linear erosive	11	15.5	8.00–26.03
Inflammation	6	8.5	3.16–17.49
Abscess/suppuration	4	5.6	1.56–13.80
Lameness	3	4.2	0.88–11.86
Chronic			
Hyperkeratosis	61	85.9	75.62–93.03
Residual sign of lesion[a]	56	78.8	67.56–87.66

[a] Residual lesions (stages IV and V) according Eisele et al. (2003).

the dogs, respectively. One dog had the maximum number of 52 vital lesions.

Behavioral disorders such as excessive licking, disobeying commands and prostration were reported in 6/71 (8.5%) 1/71 (1.4%) and 2/71 (2.8%) infected dogs, respectively. Weight loss was reported in 31/71 (43.7%) dogs.

Fifty (70.4%) dog owners sporadically removed the *Tunga* fleas from their infested animals. The instruments used to remove the parasites included: needles, pins, thorns (from either a lemon tree, orange tree or gravatá plant), or pliers. There were many different methods of removal: a) pierce the neosomic flea and let the dog be responsible for removal; b) pierce the neosomic flea and apply kerosene, organophosphate spray or gas; c) pierce, squeeze the neosomic flea, remove and place the eggs in alcohol and burn them; d) pierce and remove the entire neosomic flea and burn it; e) pierce and remove the neosomic flea and put it in the trash, in the woods, in the toilet or bury it in the backyard. To remove the bag the dog owners detach the bag from the skin with the material used to pierce it or they pull out the flea with pliers. Some dog owners used more than one method. Eighteen just pierce the neosomic flea and eleven tutors remove the flea and discard it in the woods. Two owners (2.8%) treated lesions giving the oral tablets Nitenpyram (Capstar®) for their dogs.

Among the assessed variables in bivariate analysis (Table 2), in the multi-variate analysis, the condition of semi-restriction and the presence of sand on the compound (Fig. 3) were associated significantly with infestation (Table 3). There was no collinearity between the variables ($\rho = 0.17$).

4. Discussion

This study shows that tungiasis is highly endemic in dogs of an area frequented by tourists in the state of Bahia. Dogs, as other domestic animals, are important reservoirs for the perpetuation of human tungiasis (Heukelbach et al., 2003; Mutebi et al., 2015). Rural communities, similar to our study area, typically shelter large populations of dogs, have a low socioeconomic status and poor environmental health conditions (Magnabosco, 2006). Such conditions make these communities potential places for the development and maintenance of parasitic infections and infestations and become hotspots of zoonotic diseases.

In March 2012, a previous descriptive study of the canine population of the Village of Juerana showed a dog to human ratio of 1:3.7 (Harvey et al., 2013). In this paper, considering the same human population of that time with the recent number of dogs found (114) in the 104 surveyed households, this ratio would be 1:3.2, reaffirming the high number of dogs on the site, perpetuating the risk of infestation for people living and visiting that community. According to the association of local residents, there was no significant variation in the number of local residents in the period between the two studies.

The tungiasis prevalence found in this study (62.3%) was higher than in other Brazilian and African studies, such as by De Carvalho

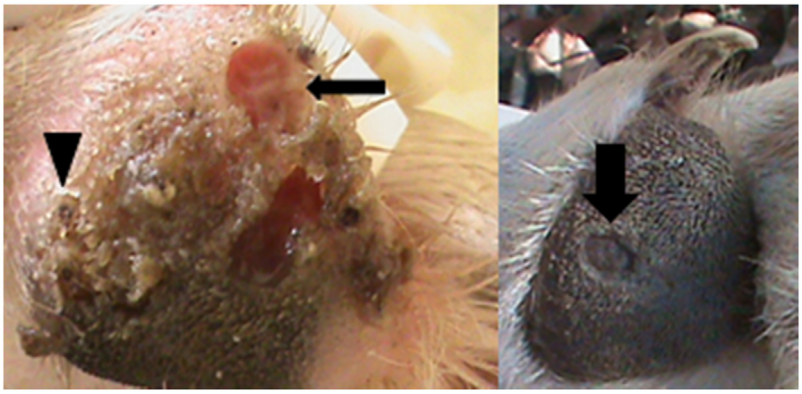

Fig. 2. Presence of vital lesions (arrow tip), manipulated lesions (thin arrow), avital lesions (thick arrow) and edema in a pad of a dog from Village of Juerana. Agosto/2013.

Table 2
Bivariate analysis of factors associated with tungiasis in dogs from Village of Juerana, tourist area of Ilhéus, Bahia, Brazil – August 2013.

Variable		N	n (%) Infested	p-value	OR	95% CI
Access to the beach	Yes	54	36 (66.6)	0.46	1.42	0.66–3.06
	No	60	35 (58.3)			
Access to the river	Yes	60	40 (66.6)	0.40	1.48	0.69–3.17
	No	54	31 (57.4)			
Contact with other animals	Yes	111	70 (6.1)	0.65	3.41	0.30–38.83
	No	3	1 (33.3)			
Age	<1 year	27	16 (59.2)	0.88	1.18	0.48–2.81
	>1 year	87	55 (63.2)			
Peridomiciliary hygiene	Good	35	14 (40)	0.002	3.88	1.68–8.96
	Bad	79	57 (72.1)			
Level of restriction	Restricted	19	4 (21)	0.0001	8.97	2.74–29.43
	Semi-restricted	95	67 (70.5)			
Sex	Male	55	34 (61.8)	0.92	1.03	0.48–2.21
	Female	59	37 (62.7)			
Peridomiciliary floor	Sand	99	69 (69.7)	0.00009	14.95	3,17–70.38
	Cement/grass	15	2 (13.3)			

et al. (2003) in dogs from a poor community of Araruama/RJ, Brazil (61%), by Bonfim et al. (2010) in dogs from a slum in Natal/RN, Brazil (46.7%), and by Mutebi et al. (2015) in dogs from five endemic villages of the District of Bugiri in Uganda (7.1%). However, it was lower than that observed by Heukelbach et al. (2004) in dogs from a slum in Fortaleza/CE, Brazil (67%). Similar to Village of Juerana, these communities had substandard infrastructure, poor environmental and health conditions, below average education and income and there were numerous dogs roaming around the streets. The prevalence observed by De Carvalho et al. (2003) of 61%, did not differ much from the finding in our study (62.3%); both studies included a similar number of dogs (123 and 114, respectively). In the study of Bonfim et al. (2010), the number of inspected dogs was not mentioned, neither the level of restriction of these animals and the number of households who raised the dogs. The low percentage of infested dogs found by Mutebi et al. (2015), was possibly due to production of a large number of pigs in the study villages, where of the 514 inspected pigs (23.5%) were infested, while of the 282 inspected dogs, only 20 (7.1%) were infested. These numbers suggest a preference of *Tunga* fleas to pigs. In fact, according to Linardi (2000), pigs are important reservoirs of this ectoparasite in rural areas. In the study of Heukelbach et al. (2004), the area had a large number of dogs roaming on the streets without any restriction, increasing exposure to the parasite. In the same study, a fishing village had a lower prevalence than the slum (30.9%). The high prevalence rates in dogs in these communities reaffirm the occurrence and importance of infestation in areas with low human development indicators in Brazil and worldwide.

Fig. 3. Peridomicile of a residence from Village of Juerana. Note the sandy soil and the presence of infected dogs coexisting with barefooted children.

Throughout the year, the Village of Juerana receives tourists from diverse places who enjoy the bars and restaurants scattered throughout the village, especially on the banks on the Rio Almada. In this context, the risk factors identified by us and others, such as high number of semi-restricted infested dogs (94.4%), the lack of paved streets, poor hygiene and below average socioeconomic conditions as observed by Harvey et al. (2013), put the residents as well as the tourists at risk of disease. Many national and international tourists are infested while traveling to and within Brazil. For example, Veraldi and Valsechi (2007) reported infestations by *Tunga* spp. in seven Italian tourists who returned from Brazil. Palicelli et al. (2016) reported the infestation in an Italian tourist who returned from Jericoacoara Beach in Ceará. In fact, tungiasis is the most common parasitic skin disease acquired by international tourists visiting the Brazilian northeast region. A study on international travelers boarding at the airport of Fortaleza/CE showed that 12 of

Table 3
Multi-variate analysis of factors associated with tungiasis in dogs from Village of Juerana, tourist area of Ilhéus, Bahia, Brazil – August 2013.

Variable		N	n (%) Infested	p-value	Adjusted OR	95% CI
Level of restriction	Restricted	19	4 (21)	0.0007	8.58	2.47–29.76
	Semi-restricted	95	67 (70.5)			
Peridomiciliary floor	Sand	99	69 (69.7)	0.001	14.23	2.88–70.28
	Cement/grass	15	2 (13.3)			

372 (3.2%) had acquired tungiasis during their visit to Brazil, with an increased risk of infestation for those who had been staying for four or more weeks in the country (Heukelbach et al., 2007).

Few studies reported the location of the lesions and clinical/behavioral changes in infested dogs. In our study, all positive animals had lesions on their pads, corroborating previous findings of Mutebi et al. (2016) from five endemic rural villages in Uganda. However, these authors observed edema and lameness in 15% and 20% of the evaluated dogs, respectively, differing from the finding of our study, with edema and lameness in 95.8% and 4.2% of infected dogs. In this study, edema were observed during the inspection, while the lameness was reported by owners. In contrast, Viestel and Silva (2012) did not report any clinical signs or behavioral changes in an infested dog attended in at veterinary hospital connected to a university of Rio de Janeiro, Brazil.

The methods used for removal of lesions by the dog owners denote at best a lack of knowledge about tungiasis and at worst negligent or inadequate treatment of their dogs. According to Viestel and Silva (2012) the surgical removal of the parasites, under aseptic conditions, with the use of sterile needles and subsequent disinfection with povidone iodine and Fipronil spray applied for seven consecutive days is the method used. Furthermore, the owners are not only posing their dogs at risk but also endangering their population and the tourists. The act of just piercing the bag, for example, contributes to the spread and maintenance of the parasite eggs around the compound and inside the houses, to which 62% of infected dogs had access.

Some residents reported that prior to our study some dogs had died due to infestation by *Tunga* spp. According to these reports, these animals supplemented their diet by straying around and looking for food in other village sites, because of the difficulty of the residents to provide adequate food for their dogs. The restriction of the diet caused by difficulty walking – in addition to the inflamed lesions caused by infestation – resulted in depletion and consequently malnutrition, dehydration, and death.

Most owners still treat the infestation without seeking the help of veterinarians, but the advice of workers at agriculture supply stores, as reported several times during this study. In addition, several owners and health professionals do not perceive tungiasis as a disease, but rather as a nuisance (Heukelbach et al., 2003; Carvalho et al., 2012). This neglect and/or lack of information makes the subject more complex, because many attitudes and practices of dog owners may do more harm than good, consequently with negative outcome also for the population.

5. Conclusions

Canine tungiasis is highly enzootic in the study area. There is an evident need for implementation of integrated actions to control tungiasis, including specialists from different areas, such as public health managers, public health professionals, veterinarians and primary health care workers. The low level of restrictions on dogs and the presence of sand in the environment are factors that should be a focus for the control of enzootic diseases in the community.

Control measures should also consider chemical control of the environment (as a short-term emergency measure), the improvement of local infrastructure, and health education programs for the control of tungiasis and promotion of public health.

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