CS
e-ISSN: 2177-5133
www.ufpi.br/comunicata

Comunicata Scientiae 5(3): 349-355, 2014

Original Article

The housefly *Musca domestica* L. (Diptera: Muscidae) as a paratenic host in the city of Bom Jesus - Piauí, Brazil

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Abstract

The common housefly *Musca domestica* L. (Diptera: Muscidae) is of great importance to public health because it is a mechanical vector of pathogens, and acts as an agricultural blight affecting the productivity of chicken and cattle farming. In Bom Jesus, Piauí, Brazil, the proliferation of this vector was intensified with the absence of regulated slaughterhouses and environmental changes caused by disorder and rapid agricultural expansion. In order to isolate eggs and cysts/oocysts of enteric parasites in adults of *M. domestica*, this study used the "jug-trap" method from October 2008 to October 2009 to capture the flies. In the ecological analysis was used the Concentration of Relative Dominance (CRD) as well the Bodenheimer's Constancy. In 96 collections, 1180 specimens of *M. domestica* were captured, from which five morphospecies of protozoans (*Entamoeba histolytica/dispar/ moshkovskii*, *Entamoeba coli*, *Iodamoeba butschlii*, *Cystoisospora* sp., and *Giardia* sp.) and five morphospecies of helminths (Ascarids, *Trichuris* sp., *Hymenolepis nana* and *Enterobius vermicularis*) were isolated. The role of the housefly as a potential mechanical transporter of potentially pathogenic enteric parasite to humans in environments from Piauí city, Brazil, is confirmed.

Key-words: mechanic vector, parasitology, pathogens, public health

A mosca doméstica *Musca domestica* L. (Diptera: Muscidae) como hospedeiro paratênico na cidade de Bom Jesus - Piauí, Brasil

Resumo

Musca domestica é uma espécie de grande importância para a saúde pública por ser vetor mecânico de patógenos e uma praga agrícola quando afeta a produtividade de granjas e gado. No município de Bom Jesus-PI, a proliferação de vetores desta natureza foi intensificada pela ausência de matadouros públicos e pelas alterações ambientais decorrentes da ocupação desordenada. No intuito de verificar o transporte de ovos e cistos por parte destes vetores, utilizou-se o método "jug-trap". Em 96 coletas foi possível capturar 1180 espécimes de *Musca domestica*, das quais foram isoladas cinco morfoespécies de protozoários: *Entamoeba histolytica/dispar/ moshkovskii*, *Entamoeba coli*, *Iodamoeba butschlii*, *Cystoisospora* sp., and *Giardia* sp. e cinco morfoespécies de helmintos: Ascarídeos, *Trichuris* sp., *Hymenolepis nana* e *Enterobius vermicularis*. Estes resultados demonstram que a proliferação deste vetor constitui um grave problema de saúde pública no município, sendo sugerido o papel da mosca doméstica como um vetor de organismos patogênicos para as populações das cidades do Piauí.

Palavras-chave: saúde pública, parasitologia, patógenos, vetor mecânico

Received: 07 April 2013
Accepted: 20 August 2013

Introduction

A paratenic or transportation host is the one in which the parasite does not develop, but instead remains in the egg or cyst/oocyst until ingested by a definitive host (Neves et al., 2005). The common housefly, *Musca domestica* Linnaeus, 1758 (Diptera: Muscidae), is the responsible for the transportation of several enteropathogenic microorganisms (e.g., bacterias, virus, protozoo, helminths), and can acts as an intermediate host of several endoparasites, such as helminths *Habronema* in horses and *Raillietina* in birds. Furthermore, the larvae of *M. domestica* are etiological agents of intestinal myiasis. Other genera belonging to Brachycera (Cyclorrapha) clade such as *Cochliomyia*, *Chrysomyia*, *Phaenicia* and *Sarcophaga*, besides being pathogens transporters, cause myiasis (Barriga, 2002).

The direct relationship between fly density and disease transmission has already been demonstrated by many researchers, and is often associated with food poisoning that can be easily identified in urban environments (Rey, 2001; Graczyk et al., 2001; Ferreira & Andrade, 2005). The proliferation of *M. domestica* is a public health problem because of its performance as a potential vector of more than 50 different pathogens that threaten to be drastically increased in the future (Greenberg, 1971; Bicho et al., 2005). Furthermore, this insect is able to fly up to three kilometers in 24 hours, being attracted by various odors, feeding and defecating constantly, sometimes every five minutes, which contributes to its importance as a vector (Neves et al., 2005).

North & Bell (1990) showed that the number of flies increased with continuous city expansion towards the countryside; i.e., the increase of pathogens transmitted by these vectors is directly related with the centers of animal farming (Bicho et al., 2005).

The city of Bom Jesus, Piauí in northeastern Brazil has experienced agricultural expansion over the past 15 years that has contributed to the reorganization of its rural-urban space. The urban space follows this expansion process via increase of the urban perimeter, the built area, and the urban soil valorization (Araujo, 2006). These changes and the arrival of “gaúchos” to the city widened the volume and the variety of products and services offered within the city (Araújo, 2006). This has generated an increase in the food sector of Bom Jesus, particularly in chicken and beef cattle farming. However, the city lacks regulated slaughterhouses, and as a result animals are slaughtered without the health recommendations of the authorities. This, along with the inadequate handling of animal feces, has created a permanent population of flies. This fact motivated us to determine if *M. domestica* transports cysts/oocysts and eggs of human parasites that can potentially aggravate the conditions of pathogens transmission within the city.

Material and Methods

Area of study:

The municipality of Bom Jesus (Figure 1) is located in the coordinates 9°04’28” S and 44°21’31” W, 277 m above sea level in a region of Cerrado and arboreal Caatinga. Its climate is semiarid tropical hot with rainfall average of 944.4 mm (CEPRO, 2012).

The study was done at the Professora Cinobelina Elvas Campus (PCEC), Piauí Federal University – UFPI, five km from downtown, where there are caprine, swine and bird farmings operations.

Traps:

To the adults specimens sample, a modified “jug-trap” method was used (Burg & Axtell ,1984; Lysyk & Axtell, 1986), using an empty and transparent 2 L PET plastic soda bottle. Four small holes were made at five cm from the bottom of the bottle, and part of the top was removed and placed in an inverted manner to form a funnel.

The flies were attracted by placing 100 g banana and sugar in chicken excrement in the bottom of the trap. The traps were installed during the morning (07:00) and were active for 11 hours, protected from sun and rain near from caprine, swine and bird farming operations. This routine was repeated twice a week, summing 96 collections from October 2008 to October 2009. At each of the three sample points, eight meters away from each other, a trap was placed in each of the three vertical strata: directly on soil, one meter above the soil, and two meters above the soil, for a total of nine traps.

The sampling of the captured flies was made in the Laboratório de Zoologia- PCEC at the end of each week. After every collection, traps were removed and exchanged for new ones containing the same amount of bait. In the laboratory, insects were transferred to the test tubes and frozen.

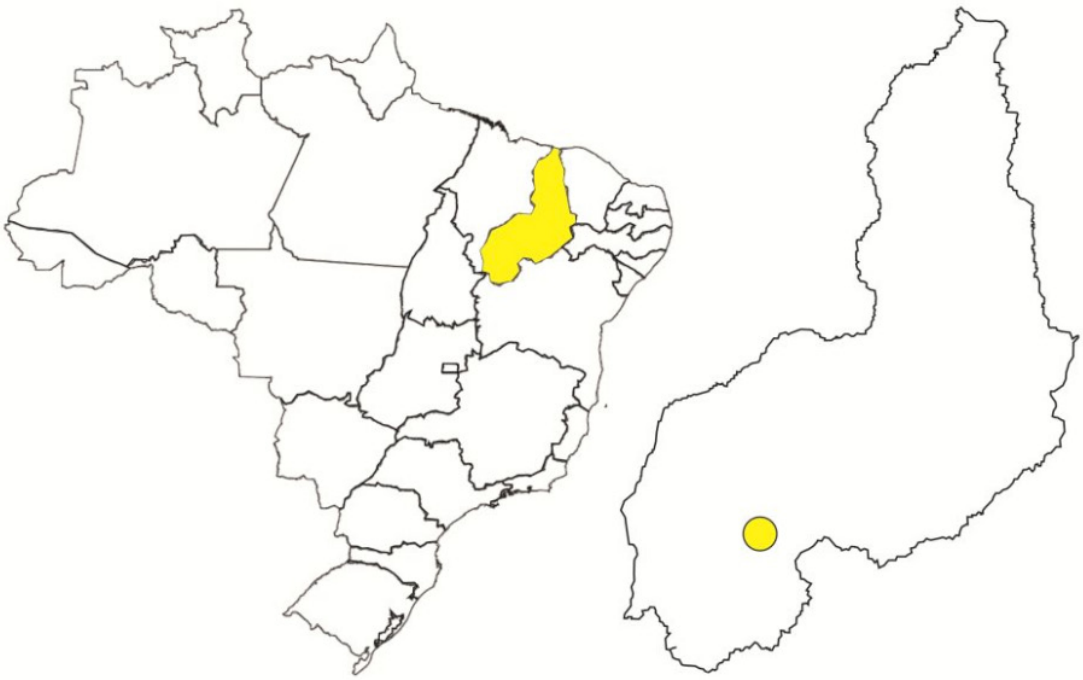

Figure 1. Left, Brazil with the State of Piauí (in yellow). At right, the State of Piauí and the position of the city of Bom Jesus (yellow circle) where the sample was made.

Cysts/oocysts and eggs isolation

To recover protozoan (as cysts/oocysts) and helminth (as eggs), 10 mL of sterile distilled water was added to each test tube containing 10 flies, and the test tube was then shaken. The obtained solution was centrifuged at 10,000 rpm in a refrigerate centrifuge HERMLE® 65390 xg, for 60 sec, and the supernatant was discarded. The sediment was removed with Pasteur pipette and put on a slide with Lugol's iodine stain and coverslip and observed with objective lens of 10x and 40x to confirm the taxonomic structures of the egg or cyst/oocyst (Vallada, 2004). The positive sediments and the flies are deposited in Coleção de História Natural da Universidade Federal do Piauí – UFPI/CAFS.

Ecological Approach

The ecological aspects of the parasitic community was determined by its components and its infra-communities (Esch et al., 1990). The parasitic infra-communities were classified into central species (present in more than 2/3 of hosts), secondary species (present in 2/3 of hosts) and satellite species (present in less than 2/3 of hosts) (Busch & Holmes, 1986).

The protozoan and helminth concentration per centrifuged test tube and its Concentration of Relative Dominance (CRD) of individuals per protozoan and helminth species were calculated according to Silveira-Neto et al. (1976). That is,

$$CRD = (i / t) \times 100$$

where i is the sum of individuals of one species and t is the sum of sampled individuals. The Bodenheimer´s Constancy (1955) (Apud Silveira-Neto et al. (1976)) of protozoans and helminths was determined by

$$C = (p.100)/N$$

where p is the number of cysts/oocysts and eggs per flies containing the species, and N is the total number of the sample. The presence per transported species was considered: Constant > 50%; Accessory 25 to 50%; and Rare < 25%.

Results and Discussion

Between October of 2008 and 2009, 1180 specimens of *M. domestica* were examined in groups of 10 flies per test tube. From these specimens, five morphospecies of protozoans and five morphospecies of helminths were isolated. Larvae of Nemathyhelminthes were also present but their identification was not possible at the genus level.

The average abundance of flies transporting parasites was 40%, of which 44.2% were classified as Protista and 55.8% as Helminths. The CRD pointed to a higher concentration of Ascarids' eggs in 100% of positive samples, followed by cysts of *Giardia* sp. with 92.04% of positive samples (Figure 2).

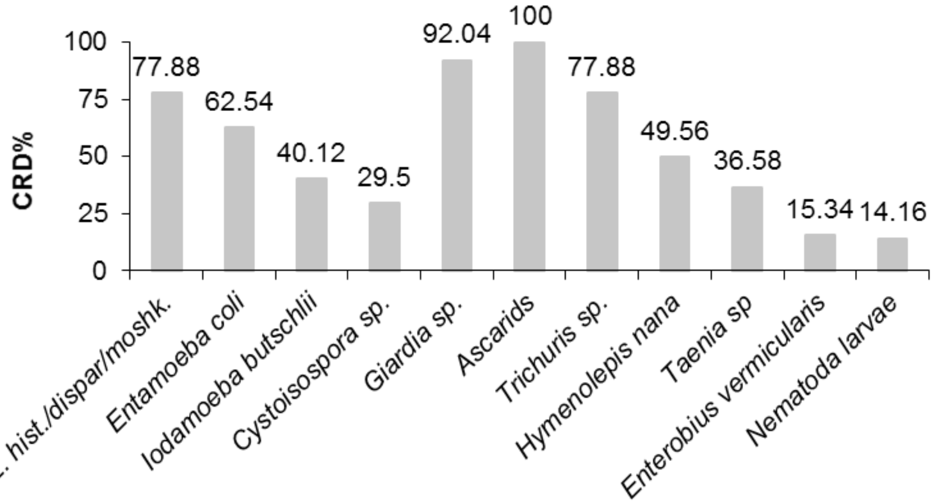

Figure 2. Concentration of Relative Dominance (CRD%) of parasites carried by *Musca domestica*

When the CRD of the organisms transported by *M. domestica* was evaluated the parasites found are those related to the condition of public sanitation (De Carli et al., 1989; Ludwig et al., 1999). The non-existence of public policies based on vector control contributes to the aggravation of the public health of the population, where infectious and parasitic diseases are the main cause of city hospital admissions (Datasus, 2011). In addition only 0.4% of the 20,513 inhabitants of Bom Jesus have access to a drainage system. In general, interventions to use vector control are executed in a punctual form in time and space only as an answer to public pressure. The elaboration of new techniques that aim the control these Diptera is crucial to modify the present situation and use the public resources for emergency purposes.

When we compare the results in this study to the frequencies of occurrence found by other authors in southern and southeast of Brazil (Castro et al., 2004; Marquez et al., 2005), it suggests that *Giardia* sp. and Ascarids are parasitic organisms of major occurrence in stool surveys also in Bom Jesus (Northeast of Brazil) and these condition of central organisms to *Giardia* sp. and Ascarids correspond to their own biological cycle that commonly are excreted in the feces, hundreds of millions of cysts per day and three thousand eggs respectively (Rey, 2001). These high densities of infectious forms in the feces favor mechanical dissemination by Muscoid Diptera.

Ascarids, *Trichuris* sp., *Entamoeba histolytica/dispar/moshkovskii* and *Giardia* sp. were considered constant, that is, occurring in more than 50% of the samples. *Taenia* sp, *Hymenolepis nana*, *Entamoeba coli* and *Iodamoeba butschlii* were considered accessory, that is, occurring in 25 – 50% of the samples. And *Cystoisospora* sp., and *Enterobius vermicularis* were classified as rare, that is, occurring in less than 25% of the samples (Table 1).

Cystoisospora sp. is a human coccidian parasite related to fecal transmission (Frenkel et al., 2003). This coccidian is exclusively related to the human species and remain viable in humid and fresh environments (CDC, 2010). In this specific case, the city of Bom Jesus presents records of temperature and low humidity that vary between 30 and 44 °C and 10 and 20% RH (Agritempo, 2010), that could suggests difficulties for the viability of *Cystoisospora* sp. being any more than an rare species in the samples of Bom Jesus.

Table 1. Distribution of parasitic organisms according to their constancy per sample

Isolated organism	Prevalence (%)	Status
Entamoeba histolytica/dispar/ moshkovskii	55	Constant
Entamoeba coli	44	Accessory
Iodamoeba butschlii	28	Accessory
Cystoisospora sp.	21	Rare
Giardia sp.	66	Constant
Ascarids	72	Constant
Trichuris sp.	55	Constant
Hymenolepis nana	35	Accessory
Taenia sp	26	Accessory
Enterobius vermicularis	11	Rare

Constant occurs in more than 50% of the samples. *Accessory* occurs between 25 and 50% of the samples. *Rare*occurs in less than 25% of the samples.

The aggregation pattern and parasitic dispersion has already been studied for the purpose of understanding the population dynamic in relation to the host (Anderson & May, 1978; May & Anderson, 1978; Zuben, 1997). However, studies related to aggregation of organisms transported mechanically by Muscoid Diptera are few, and in this study we evaluate the frequency that the transported organism aggregated with other organisms in the same sample, i.e., simultaneous occurrence of different parasites in the same kind of host (Table 2).

Table 2. Distribution of organisms according to their affiliation with other organisms.

Isolated organism	Status
Entamoeba histolytica/dispar/ moshkovskii	Secondary
Entamoeba coli	Sattelite
Iodamoeba butschlii	Sattelite
Cystoisospora sp.	Sattelite
Giardia sp.	Central
Ascarids	Central
Trichuris sp.	Secondary
Hymenolepis nana	Sattelite
Taenia sp	Sattelite
Enterobius vermicularis	Sattelite

Central species – present in more than 2/3 of samples; Secondary species – present in 2/3 of samples; Satellite species – present in less than 2/3 of sample

The parasites *E. histolytica/dispar/ moshkovskii* and *T. trichiura* were classified as secondary. The former, despite infecting 500 million people in the world, in Brazilian northeast presents an occurrence of 10%, what is less than the 25.2% of its occurrence in the north of the country (Silva et al., 2005; Dourado et al., 2006). Trichuriasis occurrence in Brazil has high prevalence in Amazonas and coast (29.6%), although in Northeast, Alagoas and Sergipe are the states with higher prevalence, reporting 71% and 80%, respectively (Rey, 2001), in Bom Jesus it was find in 2/3 of the sample, confirming their secondary character in relation to parasitic biocenosis.

The protozoans *E. coli* e *I. butschlii* are human commensals, and in spite of not being pathogenic, are indicators of human fecal contamination. The condition of satellites correspond to the fact that they present as cysts/oocysts and trophozoits, and are more vulnerable to environment variations (Neves et al., 2005). Another species classified as satellite was *Cystoisospora* sp., also a protozoan, and does not survive in hot environments with low humidity (CDC, 2010).

Two Cestoda were classified of satellites (*H. nana*, *Taenia* sp), this class corresponds to worms that are excreted in the feces in the proglottids form, and its eggs are only present when these structures rupture (Rey, 2001; Vallada, 2004).

The only Nematoda classified as a satellite was *E. vermicularis* that, due to its specific biological cycle in the human species and to the fact that it usually ruptures and adheres to the perianal and perineal regions of its hosts, presents low densities in the stool (<5%). The Grahan method and swabbing in the anal and perianal regions are recommended for research of these parasites (De Carli & Tasca, 2001; Vallada, 2004; Cimerman & Cimerman, 2005). So, that being said, we believe that transportation of this parasite by flies could not be different from rare (<25%).

The population growth as a result of the agricultural expansion and the disordered urban centers unleashed environmental and spatial changes that were unrestrained by the city, due to the lack of planning and of resources to meet most emergent needs of the population. This situation offered favorable conditions for the development of *M. domestica* that has a biological cycle associated with garbage, animal excrement, and human feces. In doing so, these Muscoid Diptera have become important transporters of protozoan and helminth cysts/oocysts and eggs that are pathogenic to humans.

Conclusions

The role of the housefly as a mechanical transporter of potentially pathogenic enteric parasite to humans in environments from Bom Jesus, a Piauí city, Brazil, is confirmed in this study.

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