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FLIES INFECTED BY ENTOMOPATHOGENIC FUNGI IN AN URBAN FRAGMENT OF SEMIDECIDUOUS FOREST

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Abstract: Entomopathogenic fungi parasitize a wide variety of hosts may be involved in regulating the populations of these arthropods helping maintain stability in tropical forest ecosystems. The genus *Ophiocordyceps* and *Entomophthora* contains several species of entomopathogenic fungi specialized to infect and kill their hosts due to development and the need for transmission by manipulating host behavior. Despite mounting research in the area, works with parasitized flies are scarce. This study aims to describe associations between the occurrence of entomopathogenic fungi and parasitic flies of the family Muscidae and behaviors presented by these flies parasitized in an urban fragment of semideciduous forest in southeastern Brazil. Were recorded two species of entomopathogenic fungi parasitizing flies collected for the first time in this locality, *E. muscae* and O. *dipterigena*. Different from Diptera parasitized by different fungi behaviors were observed. These new records of occurrence, along with data on their hosts, suggest that many species of this group have not yet registered. Therefore, more studies in tropical forests will certainly increase the knowledge about these interactions.

Keywords: *Entomophthora,* fungal diversity, Muscidae, *Ophiocordyceps,* parasite manipulation.

INTRODUCTION

The entomopathogenic fungi parasitizing a wide variety of hosts (SAMSON & EVANS 1982, 1984; KOBAYASI 1941) and may change their behavior in order to favor the dispersion of the manipulator (ANDERSEN *et al.* 2009). There are records of infection of these fungi in eleven insect orders: Hymenoptera, Diptera, Coleoptera, Hemiptera, Lepidoptera, Orthoptera, Isoptera, Blattodea, Odonata, Mantodea and Dermaptera, and other arthropods such as spiders (EVANS 1982). It is believed that these fungi are involved in regulating the populations of these arthropods may help maintain stability in the tropical forest ecosystems (EVANS 1982).

The genus *Ophiocordyceps* and *Entomophthora* contains several species of entomopathogenic fungi specialized to infect and kill their hosts due to a development and transmission necessity (STEENBERG *et al.* 2001; EVANS *et al.* 2011). Some species, such as *Ophiocordyceps unilateralis sensu lato*, are capable to manipulate the host's behavior, causing it to

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abandon the colony and act in detriment to its own to enhance the parasite's fitness (ANDERSEN *et al.* 2009). This behavior, in which genes of the parasite are expressed in the host's phenotype, may be classified as an extended phenotype (DAWKINS 1982).

Due to the high abundance, fungal infections in Formicidae are the most reported and most well known. The infection occurs during foraging when the ants come into contact with the spores that get stuck in their body and penetrate their cuticle. The period of the fungus infection occurs within three to six days after spore adhesion of the body surface ant. Once infected, an individual dies and the fungus produces a fruiting body that grows just behind the head of the parasitized insect. For this structure, the fungus produces spores that are dispersed across the forest floor, where they, infect new hosts (EVANS 1982; EVANS & SAMSON 1982, 1984; PONTOPPIDAN *et al.* 2009).

On the other hand, records the occurrence of infection of entomopathogenic fungi in Diptera are scarce, as well as information about the behavioral changes caused by the fungus and their hosts. Thus, this study describes the occurrence of parasitic associations between entomopathogenic fungi and flies of the family Muscidae and a brief description of their behavior in an urban fragment of Atlantic rainforest in southeastern Brazil.

METHODS AND MATERIALS

Records occurred in 2014 and were held in the Botanical Garden of the Federal University of Juiz de Fora (21 ° 43 '28 "S - 43 ° 16' 47" W), a fragment of Semideciduous Seasonal Forest Montana (VELOSO *et al*. 1991) recently classified by SANTIAGO *et al*. (2014) as expressive richness, diversity and floristic diversity of woody vegetation, with endangered species with predominance of pioneer plant complex, besides the considerable presence of exotic species. The area of 84 hectares of extension is located within the city limits of Juiz de Fora, southeastern state of Minas Gerais, Brazil (Figure 1), 750 m above sea featuring warm subtropical climate with dry winter and wet summer level (Cwa), according to the classification of Köppen (SÁ-JUNIOR 2009).

Fungi were also identified by Prof. Harry Evans, CABI and João Paulo Machado de Araujo of Pennsylvania State University, based on morphological analysis of fruiting bodies and identification of the hosts present.

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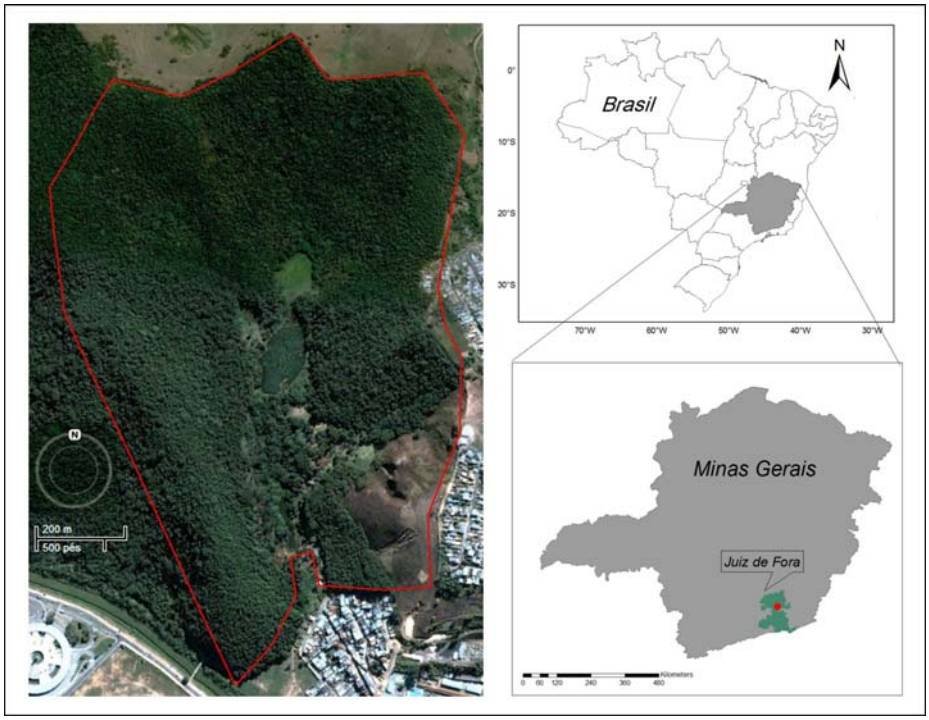

Figure 1: Location of the Botanical Garden of the Federal University of Juiz de Fora, Brazil.

RESULTS AND DISCUSSION

Two species of entomopathogenic fungi were collected for the first time in this locality, *Entomophthora muscae* (Cohn) Fresen. (Figure 2a and 2b) and *Ophiocordyceps dipterigena* (Berk. & Broome) G.H. Sung, J.M. Sung, Hywel-Jones & Spatafora (Figure 2c and 2d) with host on adult of Diptera (Muscidae).

Due to the effect of partial decomposition caused by the fungus, the identification of Diptera were only possible family level (Muscidae) for the individual parasitized by *Ophiocordyceps dipterigena* and gender (*Musca* sp) for the individual parasitized by *Entomophthora muscae*.

In this study, fungal species showed distinct forms as the manipulation of the setting behavior where *E. muscae* seems to control the fly in looking for a vine leaf, and with his legs cling, favoring for development the fungus. It was observed that the fungus monopolize the entire surface of the fly between the membranes including the abdominal segments, mesossomal and sclerites (Figure 2a and 2b). The species *O. dipterigena* seems manipulate the insect to land on a sheet without the need to hold her where, after the death of the fly, the fruiting body emerges, extrapolated the body of the fly, getting out of the inside through the head (Figure 2c and 2d).

As data on these parasitic associations are still rare, especially in anthropogenic areas (TRAVIS *et al.* 1993; LASTRA *et al.* 2006; SUNG *et al.* 2007), these new records of occurrence, along with data on their hosts, suggest that many species of this group have not yet registered. Therefore, more studies in tropical forests will certainly increase the knowledge about these interactions.

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Figure 2: Flies infected by entomopathogenic fungi found in the Botanical Garden of the Federal University of Juiz de Fora: A and B - Fly parasitized by *Entomophthora muscae*; C and D - Fly parasitized by *Ophiocordyceps dipterigena*.

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