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Arachnids Infected by arthropod-pathogenic Fungi in an urban fragment of Atlantic Forest in southern Brazil.

Aracnídeos infectados por fungos artrópodes-patogênicos em fragmento urbano de Mata Atlântica no sul do Brasil.

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Abstract Two genera of entomopathogenic fungi were found on different arachnids in the countryside of the state of Rio Grande do Sul, Brazil. The genus *Ophiocordyceps* was found on two species of Theraphosideae, presenting its fruiting body on the dead host. Harvestmen of the genus *Acanthogonyleptes* were infected with fungi of the genus *Torrubiella*. The discovery of arthropod-pathogenic fungi in Santa Maria highlights the importance of urban fragments as potential refuges of biodiversity.

Keywords: fungal diversity, *Ophiocordyceps*, *Torrubiella*, parasite manipulation.

Resumo Dois gêneros de fungos entomopatogênicos foram encontrados em diferentes aracnídeos no interior do estado do Rio Grande do Sul, Brasil. O gênero *Ophiocordyceps* foi encontrado em duas espécies de Theraphosideae, apresentando corpo de frutificação nos hospedeiros mortos. Opiliões do gênero *Acanthogonyleptes* estavam infectados com fungos do gênero *Torrubiella*. A descoberta de fungos artrópodes patogênicos no município de Santa Maria evidencia a importância de fragmentos urbanas como potencias refúgios da biodiversidade.

Palavras-chaves: diversidade de fungos, manipulação parasítica, *Ophiocordyceps*, *Torrubiella*.

Introduction

Arthropod-pathogenic fungi parasitize a wide variety of hosts (Evans 1982; Evans e Samson 1984), being able to modify the behavior of the hosts, thus improving the fitness of the parasite (Andersen et al. 2009). It is believed that these fungi are involved in regulating populations of arthropods, helping to maintain the stability of tropical forest ecosystems (Evans, 1982).

The genera *Ophiocordyceps* Petch (1931) and *Torrubiella* Boud (1885) are the most well-known arthropod-pathogenic organisms, including over 240 species of fungi specialized in infecting and killing their hosts (Sung et al. 2007; Johnson et al. 2009). In particular, the genus *Torrubiella* is designed to parasite *Cordyceps* and similar genera that do not produce

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stromatic clavae (Boudier 1885; Petch 1923; Andersen et al. 2009).

The relationship between these fungi and Formicidae is well documented due to the high abundance of this group in the environment (Evans et al. 2011; Barbosa et al. 2015). Infection occurs during foraging, when arthropods come into contact with the spores, which become trapped on their bodies and penetrate their cuticles. The period of fungal infection occurs within a few days after the adhesion of spores to the animal's body surface. Once infected, the individual dies and the fungus produces a fruiting body that grows between the segments of the parasitized arthropod's body. Through this structure, the spores are produced and dispersed throughout the forest floor, where they will infect new hosts (Evans 1982; Pontoppidan et al. 2009).

On the other hand, occurrence records of infection of arthropod-pathogenic fungi on arachnids are scarce, as is information about behavioral modification caused by fungi. This study describes the occurrence of parasitic associations between arthropod-pathogenic fungi and arachnids, in an Atlantic Forest fragment in southern Brazil.

Recordings were made in September 2013, by random sampling in Morro do Link (-29.669004, -53.801748), municipality of Santa Maria, in the central region of the state of Rio Grande do Sul. The site is the result of the regressive erosion of the southern edge of the plateau, situated in the urban region of the city, in a basalt quarry that has been inactive since the mid-1990s. The cluster of hills, in which Morro do Link is found, reaches a maximum altitude of 459 meters, and is covered by fragments of the Deciduous Seasonal Forest with a humid subtropical climate, no defined dry season, but with invariably more humid winters (Heldwein et al. 2009) (Figure 1).

Two species of arthropod-pathogenic fungi were found on three specimens of the harvestmen genus *Acanthogonyleptes* Mello-Leitão, 1922 (Gonyleptidae), four spiders of the genus *Grammostola* Simon, 1892 (Theraphosidae) and one of the species *Pterinopelma vitiosum* (Keyserling, 1891) (Theraphosidae).

The specimens of *Acanthogonyleptes* were infected by the fungus *Torrubiella* cf. *aranicida* Boudier 1885, which is known mainly for attacking adult or immature spiders, there being few records of its biological relationship with harvestmen (Bischoff e Whith, 2004). The infected *Acanthogonyleptes* individuals were males and females, with a size range of 5 to 7 centimeters (Figure 2). Due to the level of decomposition performed by the fungus on the hosts, we could not identify the harvestmen to the species level. Only one infected *Acanthogonyleptes* specimen had an evident fruiting body, and this split open its exoskeleton at various points along its length (Figure 2A).

The fungus of the species *Ophiocordyceps caloceroides* (Berk. e MA Curtis) GH Sung, JM Sung, Hywel-Jones e Spatafora was found on spiders of the genus *Grammostola* (Figure 3A) and of the species *Pterinopelma vitiosum* Pocock 1901 (Figure 3B), both belonging to the infraorder Mygalomorphae. Due to taxonomic difficulties regarding the genus *Grammostola* and the level of decomposition of the individual, identification to species level was not viable.

It was observed that, after the death of the individuals, the fungi developed and the fruiting bodies exited the bodies of the spiders, breaking through the cephalothorax and segments of the legs. Mycelium was identified around the bodies of the individuals. In this stage of development, fungi produce spores (asexual) that are not actively released, but produce a mucilage that sticks to other surfaces with which they come into contact.

Due to the terrestrial habit shared by all parasitized species, which forage close to the ground and hide under stones or logs of trees, it is remarkable that these species of arthropod-pathogenic fungi are able to propagate their genetic material widely in the study area. Entomopathogenic fungi can play an important role in the control of arthropod populations (Andersen et al. 2012). Evans et al. (2011) observed a high diversity of entomopathogenic fungi in ants in tropical regions, estimating that dozens or even hundreds of species remain to be described.

The records of arthropod-pathogenic fungi in urban fragments highlight the importance of these areas as a reserve of species and a potential for the discovery of new species of pathogenic fungi. That said, more studies in urban fragments may contribute to the elucidation of the value of impacted fragments on sensitive groups because of their specialization as hosts.

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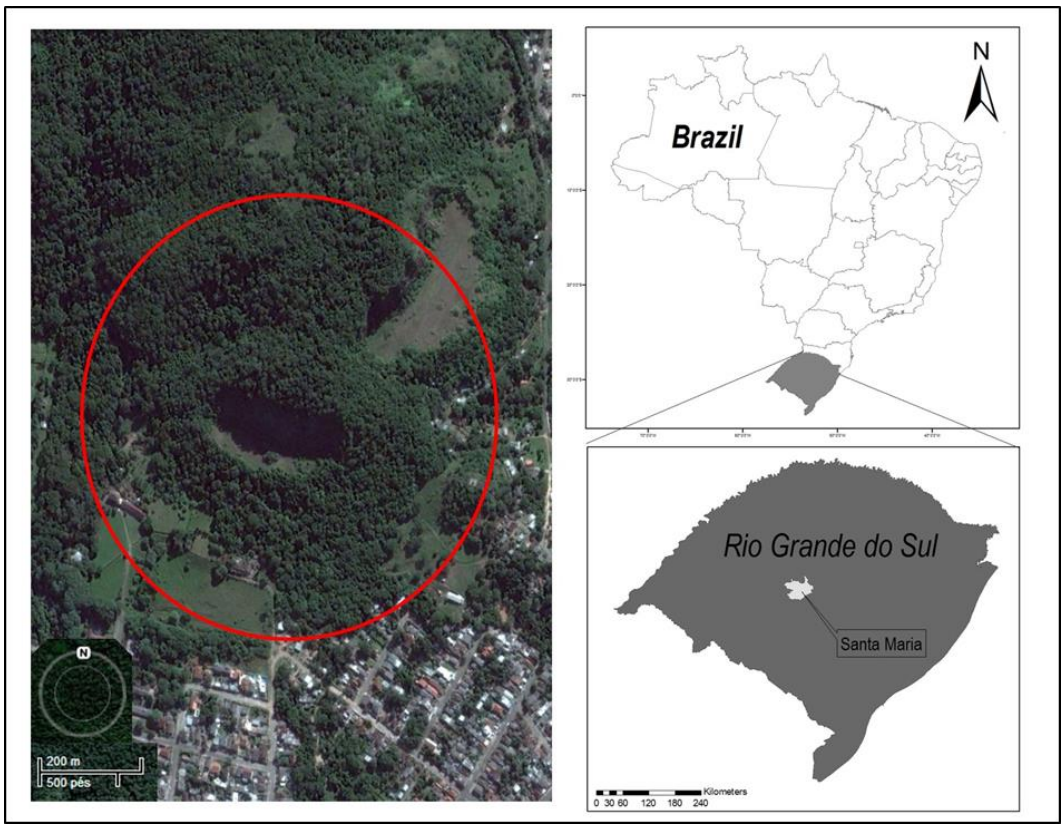

Figure 1. Record area of species of arachnids Infected by arthropod-pathogenic fungi in urban fragment (Morro do Link) in the municipality of Santa Maria, central Rio Grande do Sul.

Figure 2. Harvestmen of the genus *Acanthogonyleptes* infected by *Torrubiella cf. aranicida* (A and B); *Ophiocordyceps caloceroides* infected by *Grammostola* sp (C) and *Pterinopelma vitiosum* (D), in the municipality of Santa Maria, state of Rio Grande do Sul, Brazil.

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