Research Article / Artículo de Investigación

Contribution on the eating habits and new records of *Mirothrips arbiter* Cavalleri, Souza, Prezoto & Mound, 2013 (Thysanoptera: Phlaeothripidae) in *Polistes* Latreille, 1802 (Hymenoptera: Vespidae) wasp nests

Contribución sobre los hábitos alimenticios y nuevos registros de *Mirothrips arbiter* Cavalleri, Souza, Prezoto y Mound, 2013 (Thysanoptera: Phlaeothripidae) en nidos de avispas *Polistes* Latreille, 1802 (Hymenoptera: Vespidae)

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Abstract. New host wasps attacked by *Mirothrips arbiter* (Thysanoptera: Phlaeothripidae) are recorded and their possible feeding on fungi and mites in colonies of *Polistes melanosoma* and *Polistes ferreri* is evaluated. No predation events on mites or fungal ingestion were observed, indicating that these thrips only use wasp eggs as food. Thrips do not parasitize wasps' bodies, they only live at the expense of their colonies, where they find food and shelter. However, as these insects feed on the immature stages of the wasps, it is possible that they cause or accelerate colony decline. Given this, we can say that the ecological relationship between thrips and social wasps is that of social parasitism, that is, thrips are parasites of wasps colonies, they depend directly on them for their survival and cause damage to them. From our findings, the number of host wasp species of this thrips rose to five, all belonging to the Polistinae subfamily.

Key words: Atlantic Forest; Ecological interactions; Polistinae; thrips.

Resumen. Se registran nuevas avispas hospedantes atacadas por *Mirothrips arbiter* (Thysanoptera: Phlaeothripidae) y se evalúa su posible alimentación de hongos y ácaros en colonias de *Polistes melanosoma* y *Polistes ferreri*. No se observó ningún evento de depredación sobre ácaros o ingesta de hongos, lo que indica que estos trips sólo usan los huevos de las avispas como alimento. Los trips no parasitan el cuerpo de las avispas, solamente viven a expensas de sus colonias, donde encuentran alimento y refugio. Sin embargo, como estos insectos se alimentan de las etapas inmaduras de las avispas, es posible que provoquen o aceleren el declive de las colonias. Ante esto, podemos decir que la relación ecológica entre los trips y las avispas sociales es de parasitismo social, o sea, los trips son parásitos de las colonias de avispas, dependen directamente de ellas para su supervivencia y les causan daños. A partir de nuestros hallazgos, el número de especies de avispas hospedantes de este trips se elevó a cinco, todas pertenecientes a la subfamilia Polistinae.

Palabras clave: Bosque Atlántico; interacciones ecológicas; Polistinae; thrips.

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Introduction

Wasps of the subfamily Polistinae (Hymenoptera: Vespidae) are commonly called "paper wasps" because they use plant material to build their nests, which can have a wide variety of shapes (Wenzel 1998). Some genera, such as *Polistes* Latreille, 1802 and *Mischocyttarus* Saussure, 1853, generally build relatively small, exposed-comb nests, and are attached to a substrate by a pedicel (Richards 1978). The nests of these wasps can host other organisms that are looking for shelter and/or food, such as fungi, mites and other insects (Jeanne 1979). Although some of these species can live as tenants without harm to the colony, others can parasitize or prey on the offspring, compromising the development of the colony and even leading to the abandonment or death of the nest (Carpenter and Marques 2001; Soares *et al*. 2006).

Several organisms can prey on social wasps, such as ants, birds and parasotoid wasps (Maciel *et al.* 2016; Detoni *et al.* 2021; Barbosa and Somavilla 2022), however, one of the most curious cases of predation by immature wasps is the thrips *Mirothrips arbiter* Cavalleri, Souza, Prezoto & Mound, 2013 (Thysanoptera: Phlaeothripidae), which is known only from active and abandoned nests of *Mischocyttarus socialis* (de Saussure, 1854) [= *M. atramentarius (*Saussure, 1854)], *Mischocyttarus cassununga* (R. von Ihering, 1903) and *Polistes versicolor* (Olivier, 1792) in Atlantic Forests of southeastern Brazil (Cavalleri *et al.* 2013). In Brazil, adults of *M. arbiter* measure less than 2 mm in length and their entire life cycle are completed inside the nests. Both larvae and adults of these thrips were observed sucking the contents of wasp eggs with their biting-sucking mouthparts (Cavalleri *et al.* 2013). Other species of the thrips, *Mirothrips* are likely to be mite predators on dead branches and abandoned galls. Some genera related to this group may be facultative predators of small arthropods, but maintain a primarily phytophagous diet (*e.g*., *Haplothrips* Amyot & Serville, 1843), while others feed on fungal hyphae (*e.g*., *Karnyothrips* Watson, 1923) (Mound and Marullo 1996; Cavalleri *et al.* 2016).

Although predation of wasp eggs by *M. arbiter* has been observed, these thrips may have other sources of food within the nests. The colonies with thrips collected by Cavalleri *et al.* (2013) also contained fungi and detritivorous mites (pers. obs.), including in inactive nests. However, no observations or experiments were carried out in order to detect possible interactions between the organisms. In the present study, we recorded new species of wasps attacked by *M. arbiter*, in addition to evaluating their possible feeding on fungi and mites in colonies of *Polistes melanosoma* de Saussure, 1853 and *Polistes ferreri* de Saussure, 1853.

Material and Methods

Two colonies of social wasps infested with *M. arbiter* were recorded in March 2016 in the Botanical Garden of the Federal University of Juiz de Fora (21°43'28" S - 43°16'47" W, 750 m.a.s.l), Montane Seasonal Semideciduous Forest remnant in the Zona da Mata region of Minas Gerais State. These colonies infested by thrips belonged to two distinct species of wasps: one of *P. melanosoma* in the decline phase and the other of *P. ferreri* in the post-emergence phase. Both social wasps' species are distributed only in South America, mainly in south-central Brazil, Paraguay and northeastern Argentina. The colonies and thrips were taken to the Laboratory of Behavioral Ecology and Bioacoustics of the Federal University of Juiz de Fora for tests and observations, using the colony maintenance methodology of De Souza *et al*. (2021).

To evaluate the feeding habit of *M. arbiter*, arena tests were carried out in 90 mm diameter Petri dishes, wrapped in plastic film. For this, three experiments were carried out: five adult individuals of *M. arbiter* x three mites collected from the colony (T1), five adult individuals of *M. arbiter* x fungi from the colony (T2) and five adult individuals of

M. arbiter x six *P. ferreri* eggs (T3). The thrips and organisms were used only once in the experiment and were placed centrally in the arena. The experiments were observed for one hour, *ad libitum*, and each one had three repetitions. Due to not having enough eggs, no test was performed with *P. melanosoma*.

The thrips were mounted on microscope slides and their identity confirmed using the key available at Cavalleri *et al.* (2016), for the social wasps were identified to species using the keys of Richards (1978). Vouchers specimens are deposited in the entomological reference collection of the Federal University of Rio Grande, Rio Grande, Brazil.

Results and Discussion

The collected *P. melanosoma* colony (Figs. A, C) had 28 cells, five eggs, three adults and no wasp pupae. In it, 47 adults, 27 larvae and eggs of *M. arbiter* were recorded (Figs. E, F). The *P. ferreri* colony (Figs. B, D) had 93 cells, 23 eggs, 11 adults and 14 pupae. In this colony, 63 adults, 35 larvae and eggs of *M. arbiter* were recorded. Adult thrips were recorded walking throughout the nest structure. Eggs, larvae and pupae were observed only at the inner base of the cells, close to the meconium. We did not observe any type of parental care of *M. arbiter* in relation to its offspring or antagonistic interaction between the other organisms inside the nest.

From our experiments, the predation relationship of *M. arbiter* on *P. ferreri* eggs was confirmed, where 83% of the eggs offered were preyed upon and no mites or fungi were consumed. More importantly, we did not observe any predation events on mites or fungi, suggesting that these thrips only use wasp eggs as food.

It was not observed any attack of social wasps against *M. arbiter*, however, they occasionally showed the warning behavior, characterized by the opening of the wings, contraction of the abdomen and active patrolling by the nest, as also observed by Cavalleri *et al.* (2013). Although thrips are small, they are known to be frequent prey for wasps of the genus *Polistes* in Australia (Lefort *et al.* 2020). Social insects present a complex mechanism of cuticular hydrocarbons that act as a chemical identity between colony members (Howard *et al*. 1982; Dani 2006; Blomquist and Bagnères 2010), however, studies with bee ectoparasites have shown that the mite *Varroa destructor* Anderson & Trueman, 2000, for example, can mimic bee cuticular hydrocarbons and go unnoticed by them (Le Conte *et al*. 2016). Little is known about the biology and behavior of these thrips within colonies of social wasps, but it is believed that *M. arbiter* also use the strategy of chemical masks that make them invisible or barely tolerable, since even with warning signs, social wasps do not drive them out of their colonies. It is worth noting that all associations between wasps and *M. arbiter* involve independently founded species of Polistinae, that is, small colonies, without protective envelope, founded by a single female or a small group of them. As they do not have a protective envelope, the access of thrips to nest cells is easier when compared to swarming species, which have closed nests. The number of wasps present in the colony can also be a determining factor, since while independent species maintain one or a few dozen individuals, in swarming species they can contain hundreds or thousands (Wenzel 1998; Barbosa *et al.* 2021).

As observed by Cavalleri *et al.* (2013), *M. arbiter* was not found in vegetation or other structures around the colonies, which suggests that these insects live and depend exclusively on their association with social wasp colonies. In addition to the wealth of resources available in social wasp colonies, thrips also rely on the protection provided by the physical structure of the nests against natural enemies and unfavorable environmental conditions.

Interspecific ecological relationships are those that occur between different species and can be harmonic, when one or both individuals involved benefit and there is no harm to any of the species, or disharmonious, when one of those involved is harmed. In parasitism, a disharmonious ecological relationship, one of the species behaves as a parasite and the other

as a host, the latter being essential for the survival of the parasite (Odum 1986; Svenning *et al*. 2014).

For birds, parasites are known that pass the immature stage in the physical structure of the nests and, when adults, parasitize the bodies of the birds (Tripet and Richner 1997, 1999). Thrips, on the other hand, do not parasitize wasps' bodies, but their colonies, where they find food and shelter. However, as thrips feed on the immature stages of social wasps, it is possible that they cause or accelerate colony decline. Given this, we can say that the ecological relationship between thrips and social wasps is that of social parasitism, that is, thrips are parasites of social wasps colonies, they depend directly on them for their survival and cause damage to them.

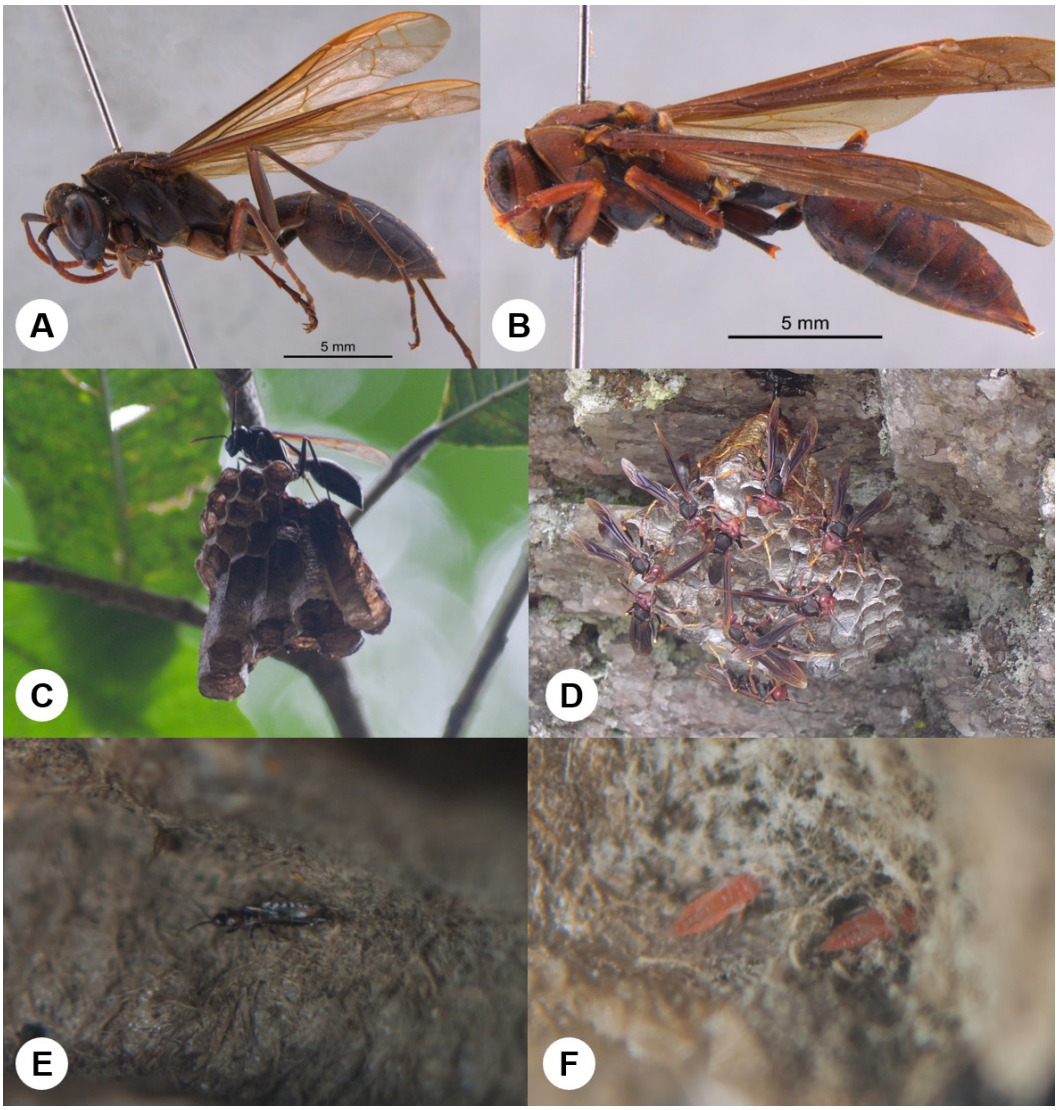

Figure 1. A. Specimen of *Polistes melanosoma*. **B.** Specimen of *Polistes ferreri*. **C.** Colony of *Polistes melanosoma*. **D.** Colony of *Polistes ferreri*. **E.** Female of *Mirothrips arbiter* in nest of *P. melanosoma*. **F.** Pupae of *M. arbiter* at the bottom of a cell near the meconium of *P. melanosoma*. / **A.** Ejemplar de *Polistes melanosoma*. **B.** Ejemplar de *Polistes ferreri*. **C.** Colonia de *P. melanosoma*. **D.** Colonia de *P. ferreri*. **E.** Hembra de *Mirothrips arbiter* en nido de *P. melanosoma*. **F.** Pupas de *M. arbiter* en el fondo de una celda cerca del meconio de *P. melanosoma*.

From our findings, the number of host wasp species of this thrips rose to five, all belonging to independently founded species of Polistinae. In the study area, at least seven species of *Polistes* and nine of *Mischocyttarus* are found (Barbosa *et al.* 2016, 2020), all with similar nest structures and potential hosts of *M. arbiter*. In addition to investigating the nests of these species, field studies will be able to assess the impact of thrips on colony decline over time.

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