

## Research Article / Artículo de Investigación

**New records of two-winged flies (Diptera: Brachycera) in social wasp colonies (Hymenoptera: Vespidae) from the Atlantic Forest biome in the state of Minas Gerais, Brazil**

Nuevos registros de moscas de dos alas (Diptera: Brachycera) en colonias de avispas sociales (Hymenoptera: Vespidae) del bioma de la Mata Atlántica en el estado de Minas Gerais, Brasil

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**Abstract.** Nine new associations between dipterans and social wasp colonies are reported, providing information for understanding the ecological relationships between species in addition to new geographic distributions. The records took place between 2016 and 2018, in urban and secondary forest fragments in the cities of Cataguases, Goianá, Juiz de Fora, Muriaé, and Viçosa, all inserted in the Atlantic Forest biome in the state of Minas Gerais, Brazil. Understanding the ecological relationships between groups of insects provides subsidies for studies of ecology, biology, and behavior of the organisms involved in order to develop conservation strategies not only for the organisms but also for the areas where they occur.

**Key word:** Facultative host; host relationships; Neotropical region; parasitic dipterans; Polistinae.

**Resumen.** Se reportan nueve nuevas asociaciones entre dípteros y colonias de avispas sociales, brindando información para comprender las relaciones ecológicas entre las especies, además de nuevas distribuciones geográficas. Los registros ocurrieron entre 2016 y 2018, en fragmentos de bosques urbanos y secundarios en las ciudades de Cataguases, Goianá, Juiz de Fora, Muriaé y Viçosa, todos ellos insertos en el bioma de Mata Atlántica en el estado de Minas Gerais, Brasil. Comprender las relaciones ecológicas entre grupos de insectos proporciona subsidios para estudios de ecología, biología y comportamiento de los organismos involucrados con el fin de desarrollar estrategias de conservación no solo para los organismos, sino que también para las áreas donde se encuentran.

**Palabras clave:** Hospedador facultativo; relaciones de hospedantes; región neotropical; dípteros parásitos; Polistinae.

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## Introduction

Social wasps, commonly referred to as “paper wasps”, are predatory insects that possess important ecological attributes. The most prominent and crucial role of social wasps is their ability to capture insects for food, thereby functioning as vital biological agents in the ecosystem natural, agricultural and urban. Additionally, they also contribute as pollinators, further enhancing their importance in maintaining the balance of the natural environment (Wenzel 1998; Prezoto *et al.* 2019).

There are several organisms, especially insects, that are associated with social wasps, since their colonies have a high concentration of resources such as meconium, fungi, organic matter, prey and potential hosts, such as larvae, pupae and adults, in addition to providing shelter (Barbosa *et al.* 2021). In particular, insects of the order Diptera have already been registered in colonies of *Mischocyttarus cassununga* (R. von Ihering, 1903) (Soares *et al.* 2006), and in *Polybia* spp. (Lutz *et al.* 2013; Somavilla *et al.* 2015; Gudin 2023).

Diptera include flies and mosquitoes, with a total of about 160,000 species described in the world (Evenhuis & Pape 2022; Whitmore *et al.* 2021). In Brazil, there are about 11,800 species (Rafael *et al.* 2022). Diptera has a wide variety of eating habits, and maybe parasites, parasitoids, predators, hematophagous, herbivores, frugivores, nectivores or detritivores (Marshall & Kirk-Spriggs 2017). This paper reports nine new associations between dipterans and social wasp colonies, providing information to improve knowledge of the ecological relationships between species in addition to new geographic distributions.

## Material and Methods

Eighty-eight social wasp colonies and nests were collected between 2016 and 2018, in urban and secondary forest fragments in the cities of Cataguases, Goianá, Juiz de Fora, Muriaé and Viçosa, all inserted in the Atlantic Forest biome in the state of Minas Gerais, Brazil. All colonies were inspected, stored in plastic containers covered with voile fabric and kept in the laboratory, in particular due to its size, the nest of *Agelaia vicina* (de Saussure, 1854) was stored in a plastic bag. The adults, when necessary, were removed with tweezers and the nests were kept and monitored for 30 days at room temperature (+/- 28 °C) and 70% relative humidity.

To confirm the studied species, the key proposed by Richards (1978) was used for social wasps and Brown *et al.* (2009) key for Diptera, both groups had their confirmations with specialists. The social wasps are deposited in the Laboratório de Ecologia Comportamental e Bioacústica of Universidade Federal de Juiz de Fora and the dipterans in the Invertebrates Collection of Instituto Nacional de Pesquisas da Amazônia, Brazil.

## Results and Discussion

From the total, Diptera individuals emerged from 13 colonies belonging to 11 species of social wasps. Of these, eight species from four dipteran families were identified (Tab. 1, Fig. 1). The Phoridae family were the group with the most records, present in seven species of social wasps, of independent (*Mischocyttarus* Saussure, 1853 and *Polistes* Latreille, 1802) and swarming foundation (*Agelaia* Lepeletier, 1836, *Apoica* Lepeletier, 1836 and *Polybia* Lepeletier, 1836), with abandoned and active nests. *Megaselia scalaris* (Loew, 1866) (Figs. 1A, B), recorded for the first time in Minas Gerais, was found in five species of social wasps, all records of new associations, with emphasis on a new host genus (Tab. 1).

*Megaselia scalaris* (Loew, 1866) is a cosmopolitan species, capable of exploring different types of resources in the environment, where they can be detritivores, predators, parasitoids or facultative parasites (Disney 2008). There are records of *M. scalaris* in colonies of various

social Hymenoptera such as *Apis mellifera* Linnaeus, 1758 (Santini 1998), army ants (Disney & Berghoff 2005), and in social wasps: *Leipomeles dorsata* (Fabricius, 1804) (Disney 1994), *Polybia jurinei* Saussure, 1854 and *Mischocyttarus cassununga* (R. von Ihering, 1903) (Somavilla *et al.* 2015), in addition to records on insects from other orders (see a small review at El-Hawagry *et al.* 2021). Due to the great behavioral and feeding plasticity of *M. scalaris* and the great diversity of resources available in the colony, it was not possible to determine what role it played in social wasp colonies, however, very likely *M. scalaris* acted as a parasitoid of larvae and pupae and as detritivore. A second species of *Megaselia* was registered in a colony of *Apoica pallens* (Fabricius, 1804). An individual of Metopininae was recorded in a colony of *Mischocyttarus drewseni* de Saussure, 1857, however, as it is a male in poor condition, it was not possible to carry out a generic identification.

The Stratiomyidae family were represented by two species, each in a wasp species. Both records are the first occurrences for the social wasp species. *Hermetia illucens* (Linnaeus, 1758) in colonies of social bees, with or without stingers, has been documented in North America (Riley & Howard 1889; Auth *et al.* 2021, both in the United States of America), South America (Copello 1926, Argentina) and, more recently, in Southeast Asia (Ivorra *et al.* 2020, Malaysia). Some other records point to the presence of *Hermetia* larvae in bee nests, however, there is no indication of which species (Borgmeier 1930; Rau 1933; Nogueira-Neto 1997; Devanesan *et al.* 2003). *Hermetia illucens* larvae develop in a wide variety of organic matter, mostly at some stage of decomposition, from manure and meat to fruits, vegetables, wood, as well as fungi and bacteria (Tomberlin *et al.* 2002; Gobbi 2012; Soares *et al.* 2020), so that the records of *Hermetia* in bee colonies are attributed to the poor maintenance conditions of the colonies themselves, many of which have already been damaged by some other cause. Although the species is present in social insect colonies, none of the species has been reported as an obligate host so far and the immatures of *H. illucens* likely take advantage of the damaged and abandoned state of the colony (Ivorra *et al.* 2020).

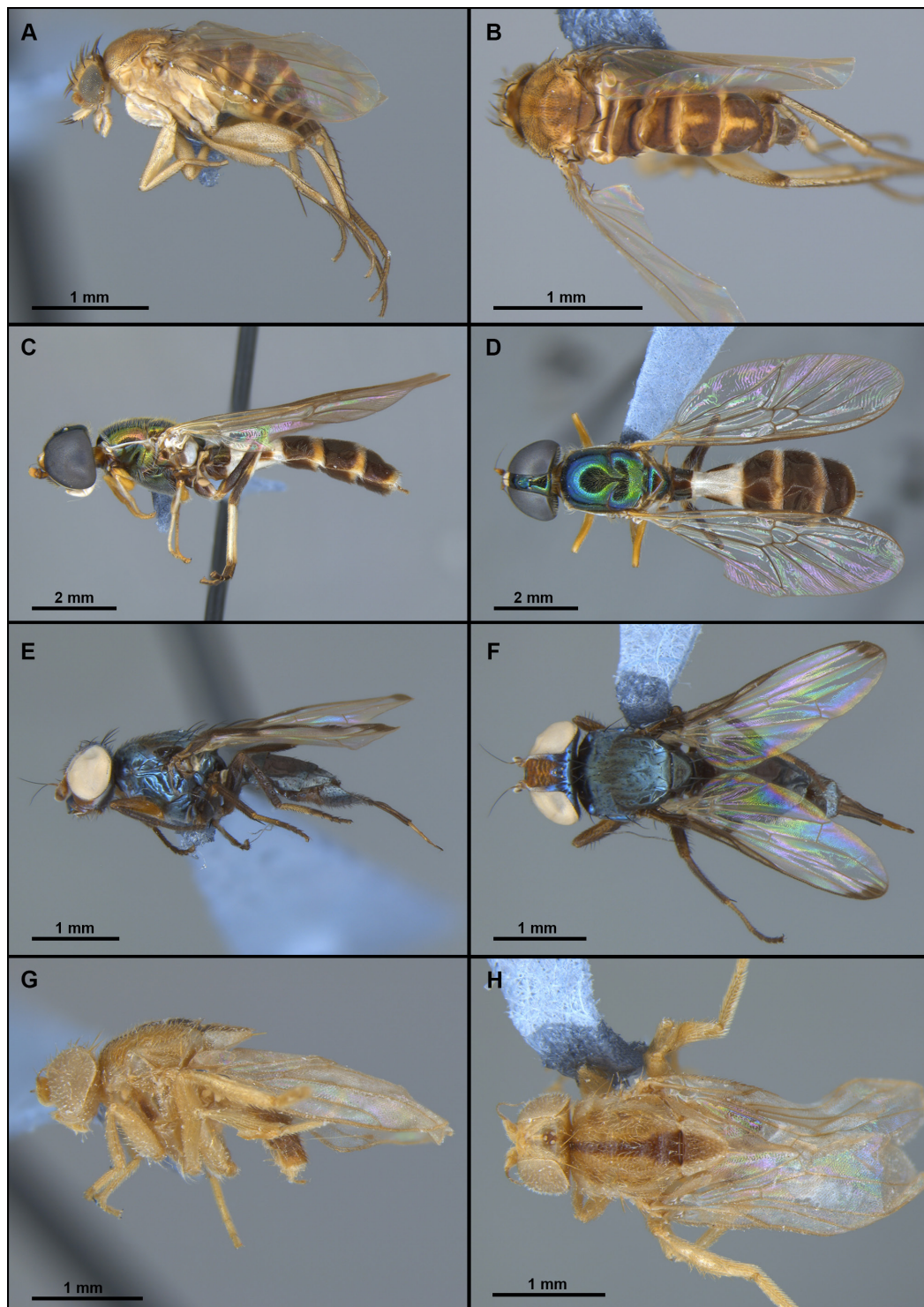
The present record corroborates this hypothesis since it occurred in a nest of *A. vicina* in the phase of abandonment, which was nested inside a termite mound. In this phase, only newly emerged adults remain in the colony, which causes a lack of maintenance and a consequent deterioration of the nest with the subsequent decomposition of the combs and the immature ones dying. Thus, it is believed that the immatures of *H. illucens* were, likewise, attracted to the colony by the decomposing material, rather than being a parasitoid of immature wasps. This is the first record of *H. illucens* in wasp nests.

In addition to the records of *Hermetia* (*H. illucens* and *H. fenestrata* de Meijere, 1904), only *Sargus flavilatus* James, 1973 has been reported infesting social Hymenoptera (Genaro 1996, as *Sargus lateralis* Macquart, 1834), in colonies of *Mischocyttarus cubensis* (de Saussure, 1854), collected in Cuba. Here we also report the registration of *Sargus fasciatus* Fabricius, 1805 (Figs. 1C, D) in a newly abandoned nest of *Polistes simillimus* Zikán, 1950. Immatures of *Sargus* Fabricius, 1798 are also associated with decaying organic matter (McFadden 1967) and, quite possibly, in the same way as commenting above to *H. illucens*, *Sargus* larvae can thus taking advantage of the colony's deteriorating condition.

Only one species of Ulidiidae has been recorded, *Acrosticta apicalis* (Williston, 1896) (Figs. 1E, F), registered for the first time for Brazil. It was found only in an abandoned nest of *Mischocyttarus cassununga* (R. von Ihering, 1903), an independent foundation wasp. Nothing is known about the biology of this species, but Lipsanini species with known biology are mostly associated with monocots (cereals and palms), living in tissues damaged by other insects and young inflorescences, with some genera such as *Euxesta* Loew, 1868 being important pests of cereals such as maize (Kameneva & Korneyev 2010). It is possible that *A. apicalis* was feeding on decomposing organic matter present inside the nest.

**Table 1.** List of two-winged flies' species (Brachycera) associated with social wasps (Polistinae) in urban and secondary forest fragments in Minas Gerais, Brazil. Caption: ■ – New host species; ▲ – New host genus; ● – First record for the state of Minas Gerais; ★ – First record for Brazil; M – Male; F – Female. / Lista de espécies de moscas de dos alas (Brachycera) asociadas con avispas sociales (Polistinae) en fragmentos de bosques secundarios y urbanos en Minas Gerais, Brasil. Leyenda: ■ – Nueva especie huésped; ▲ – Nuevo género huésped; ● – Primer registro para el estado de Minas Gerais; ★ – Primer registro para Brasil; M - Macho; F – Hembra.

Family	Species	Host Species	Activity	N° of specimens	Environment	Region of Brazil
Phoridae	<i>Megascelia scalaris</i> (Loew, 1866) ●	<i>Mischocyttarus lheringi</i> Zikán, 1935 ■	Active	1	University Campus	Juiz de Fora/MG
		<i>Mischocyttarus socialis</i> (de Saussure, 1854) ■	Active	1	Urban fragment	Juiz de Fora/MG
	<i>Megascelia sp.</i>	<i>Polistes similimus</i> Zikán, 1948 ▲	Active	2 F/3 M 1 M	Rural area	Juiz de Fora/MG
		<i>Polybia fastidiosuscula</i> de Saussure, 1854 ■	Abandoned	4 F/2 M	Urban fragment	Juiz de Fora/MG
	<i>Metopiniinae sp.</i>	<i>Polybia platycephala</i> Richards, 1978 ■	Active	17	Urban fragment	Juiz de Fora/MG
		<i>Apoica pallens</i> (Fabricius, 1804) ■ ▲	Active	16	Secondary forest	Cataguases/MG
Stratiomyidae	<i>Hermeta illucens</i> (Linnaeus, 1758)	<i>Mischocyttarus drewseni</i> de Saussure, 1857 ■ ▲	Active	1 M	Urban fragment	Juiz de Fora/MG
		<i>Agelaia vicina</i> (de Saussure, 1854) ■	Abandoned	32	Rural area	Goiandá/MG
	<i>Sargus fasciatus</i> Fabricius, 1805	<i>Polistes similimus</i> Zikán, 1950 ■	Abandoned	1 F	University Campus	Viçosa/MG
Ulidiidae	<i>Acrosticta apicalis</i> (Williston, 1896) ★	<i>Mischocyttarus cassununga</i> (R. von Ihering, 1903)	Abandoned	1 F	Secondary forest	Muriae/MG
Cecidomyiidae	<i>Cecidomyiidae sp.</i>	<i>Polybia fastidiosuscula</i> de Saussure, 1854	Abandoned	39	Urban fragment	Juiz de Fora/MG
Chloropidae	<i>Pseudogaurax aff. longilineatus</i> Sabrosky, 1949 ●	<i>Polistes melanosoma</i> de Saussure, 1853	Abandoned	1 F	Urban fragment	Muriae/MG



**Figure 1.** Specimens of two-winged flies (Brachycera) recorded in social wasp colonies (Polistinae). A-B. *Megaselia scalaris*. C-D. *Sargus fasciatus*. E-F. *Acrosticta apicalis*. G-H. *Pseudogaurax aff. longilineatus*. / Ejemplares de moscas de dos alas (Brachycera) registrados en colonias de avispas sociales (Polistinae). A-B. *Megaselia scalaris*. C-D. *Sargus fasciatus*. E-F. *Acrosticta apicalis*. G-H. *Pseudogaurax aff. longilineatus*.

Chloropidae were also represented by only one species. *Pseudogaurax aff. longilineatus* Sabrosky, 1949 (Figs. 1G, H), the first time recorded for the state of Minas Gerais, obtained from an abandoned nest of *Polistes melanosoma* de Saussure, 1853. *Pseudogaurax* Malloch, 1915 is a poorly studied genus, which still needs a recent revision, and what is known about the feeding behavior is that it contains species with larvae that prey on eggs and larvae, attacking mainly spider ovisacs, Mantodea oothecae and Megaloptera egg mass, and ant larvae (Sabrosky 1989; González *et al.* 2016; Melo & Wheeler 2009). A recently abandoned social wasp nest still has eggs, larvae and pupae, however, the adults no longer protect and care for the nest. In particular, independent foundation wasps, such as *Polistes*, do not have a protective envelope, that is, the comb and cells are exposed. Thus, egg predators like *P. aff. longilineatus*, has free and easy access to eggs abandoned in the colony, which could potentially explain the presence of this species of fly.

Understanding the ecological relationships between groups of insects provides subsidies for studies of ecology, biology, and behavior of the organisms involved in order to develop conservation strategies not only for the organisms but also for the areas where they occur.

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