







Research Article / Artículo de Investigación

Eumeninae and Zethinae (Hymenoptera: Vespidae) from Conservation Units in the state of Minas Gerais, Brazil

Eumeninae y Zethinae (Hymenoptera: Vespidae) de Unidades de Conservación del estado de Minas Gerais, Brasil

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ZooBank: [urn:lsid:zoobank.org:pub:9299825F-91E6-4F37-9E2C-1A44B9245EAE](https://doi.org/10.35249/rche.50.4.24.07)
<https://doi.org/10.35249/rche.50.4.24.07>

Abstract. Despite the significant biodiversity and ecological importance of solitary and pre-social wasps, the subfamilies Eumeninae and Zethinae are still under-sampled in Minas Gerais state, southeastern Brazil. The aim of this study was to record the occurrence of species of these subfamilies in different Conservation Units (CUs) in the state. The study was conducted in eight CUs in the Cerrado and Atlantic Forest domains and recorded 95 individuals distributed among 31 species of Eumeninae and seven individuals from five Zethinae species. *Alphamenes campanulatus* (Fabricius, 1804), *Pachodynerus argentinus* (de Saussure, 1870) and *Pseudodynerus auratoides* (Bertoni, 1918) (Eumeninae) are recorded for the first time in Minas Gerais state. In turn, *Zethus wagneri* Bohart & Stange, 1965 (Zethinae) is recorded for the first time in Brazil. Our results illustrate the importance of UCs for the conservation of vespid biota and reinforce the need for further studies of these insects.

Key words: Hymenoptera; inventory; wasps.

Resumen. Apesar de la significativa biodiversidad e importancia ecológica de las avispas solitarias y presociales, las subfamilias Eumeninae y Zethinae aún están submuestreadas en el estado de Minas Gerais, sureste de Brasil. El objetivo de este estudio fue registrar la presencia de especies de estas subfamilias en diferentes Unidades de Conservación (UC) en el estado. El estudio se realizó en ocho UC en los dominios Cerrado y Mata Atlántica y registró 95 individuos distribuidos entre 31 especies de Eumeninae y siete individuos de cinco especies de Zethinae. *Alphamenes campanulatus* (Fabricius, 1804), *Pachodynerus argentinus* (de Saussure, 1870) y *Pseudodynerus auratoides* (Bertoni, 1918) (Eumeninae) se registran por primera vez en el estado de Minas Gerais. A su vez, *Zethus wagneri* Bohart & Stange, 1965 (Zethinae) se registra por primera vez en Brasil. Los resultados ilustran la importancia de los UC para la conservación de la biota de véspidos y refuerzan la necesidad de realizar más estudios sobre estos insectos.

Palabras clave: Himenóptero; inventario; avispas.

Received 24 September 2024 / Accepted 22 October 2024 / Published online 30 October 2024
Responsible Editor: José Mondaca E.

Introduction

Biodiversity conservation and ecosystem services have been a key topic in environmental discussions, given their importance in maintaining the balance of natural ecosystems that are home to endemic and threatened species (Bond 2019; Grass *et al.* 2019). In this context, Conservation Units (CUs), whether Sustainable Use or Full Protection, are considered effective tools for protecting biota and natural resources (Salvio 2017). Although they can generate socio-environmental conflicts in their maintenance and implementation, CUs not only expand the area of protection, but also promote connectivity between different habitat fragments, allowing species to move and adapt to anthropogenic pressures and environmental changes (Silva *et al.* 2024).

Regarding biodiversity conservation and management and assessing the endangered status of species, systematic and comprehensive biological surveys are needed. These surveys extend beyond species identification to encompass studies on their interactions, geographical distribution, and conservation status. Based on this data, management and conservation strategies can be developed effectively, aiming not only to protect species and habitats, but also to restore degraded ecosystems, promote long-term sustainability and assist in the implementation of species protection policies (Segan *et al.* 2011; Oliveira *et al.* 2021, 2023).

Many studies on the diversity, abundance and behavior of different taxa, including social wasps, have been recently carried out in different CUs in Brazil (Oliveira *et al.* 2021). However, for some groups, such as the solitary and pre-social wasps of the Eumeninae and Zethinae subfamilies (Hymenoptera: Vespidae), there are few inventories. Among the few examples, there is a single inventory in the Amazon (Silveira *et al.* 2008), one in the Caatinga (Barbosa *et al.* 2022), two in the Cerrado (Auko and Silvestre 2013; Grandinete and Noll 2013), one in the Atlantic Forest (Hermes and Köhler 2004) and one in the ecotone between the Atlantic Forest and the Cerrado (Lopes 2020). Auko *et al.* (2017) carried out a study similar to the present one, where they provided data on the occurrence of these vespids in various biomes, such as the Cerrado and Pantanal, in Mato Grosso do Sul. In addition, there are some other more extensive studies that used nest traps to collect different Hymenoptera (Assis and Camilo 1997; Pires *et al.* 2012) that provide some of the few records of Eumeninae for the state of Minas Gerais.

Eumeninae is the most numerous subfamily of Vespidae, with more than 3,700 species and 210 genera recorded worldwide (Perrard *et al.* 2017). The Zethinae has gained prominence due to its phylogenetic position: sometimes included as a tribe, Zethini, within the subfamily Eumeninae (Hermes *et al.* 2014), sometimes as a distinct subfamily, considered a sister group of the eusocial vespids (Bank *et al.* 2017; Piekarski *et al.* 2018). These insects perform important ecosystem services, such as pollination, biological control and trophic regulation (Brock *et al.* 2021).

Therefore, the aim of this study was to record the occurrence of species of Eumeninae and Zethinae in CUs located within Cerrado and Atlantic Forest domains in Minas Gerais state, southeastern Brazil, where information on these taxa is scarce (Lopes 2020; Barbosa *et al.* 2022).

Materials and Methods

For this study, specimens of Eumeninae and Zethinae were collected through active search using entomological nets in several CUs in Minas Gerais state, located in Cerrado and Atlantic Forest areas: Serra da Canastra National Park (PNSC) in 2016 and 2018, Sempre Vivas National Park (PNSV) in 2018 and 2019, Grande Sertão Veredas National Park

(PNGSV) in 2022, in Cerrado; and Rio Doce State Park (PERD), in 2010 and 2011, Ritópolis National Forest (FNR) and Alto Montana Private Natural Heritage Reserve (RPPNAM), in 2015, Serra do Papagaio State Park (PESP), in 2018, Machado River Basin Environmental Protection Area (APARM), in 2018 and 2019, in the Atlantic Forest (Fig. 1).

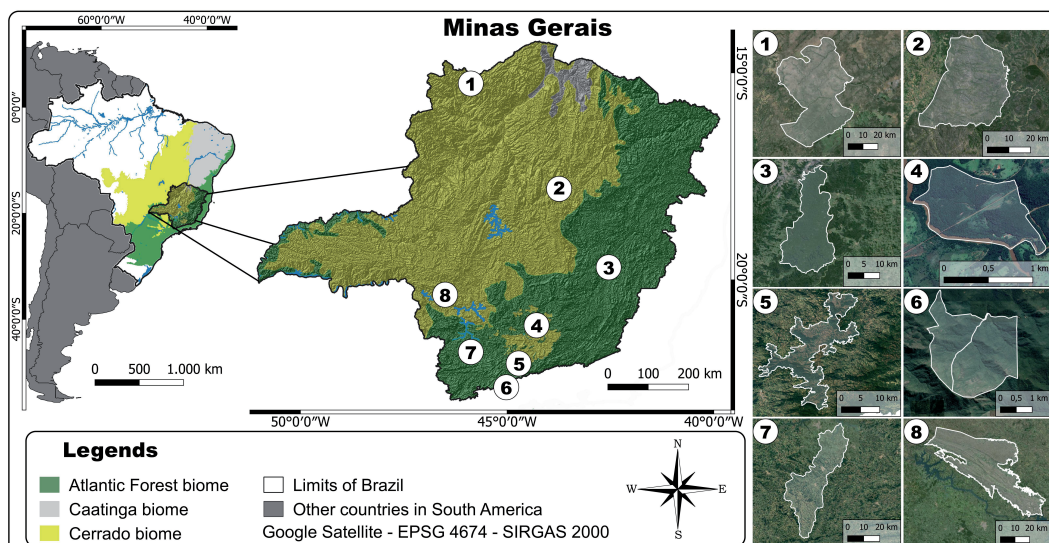


Figure 1. Location of the sampling areas. 1. Grande Sertão Veredas National Park. 2. Sempre Vivas National Park. 3. Rio Doce State Park. 4. Ritópolis National Forest. 5. Serra do Papagaio State Park. 6. Alto Montana Private Natural Heritage Reserve. 7. Machado River Basin Environmental Protection Area. 8. Serra da Canastra National Park. / **Figura 1.** Ubicación de las áreas de muestreo. 1. Parque Nacional Grande Sertão Veredas. 2. Parque Nacional Sempre Vivas. 3. Parque Estatal Río Doce. 4. Bosque Nacional Ritópolis. 5. Parque Estatal Serra do Papagaio. 6. Reserva Privada del Patrimonio Natural Alto Montaña. 7. Área de Protección Ambiental de la Cuenca del Río Machado. 8. Parque Nacional Serra da Canastra.

The collected specimens were fixed in ethanol, dried and mounted on entomological pins. All specimens are deposited at the Entomological Collection of the Federal University of Lavras (CEUFLA), Lavras, Brazil. Identification was performed by Prof. Dr. Marcel Gustavo Hermes, from the Federal University of Lavras (UFLA) using specific keys and comparison with specimens previously deposited at CEUFLA.

Results and Discussion

A total of 102 individuals from 36 species of solitary and pre-social wasps were collected, including 95 individuals from 31 species of Eumeninae and seven individuals from five species of Zethinae (Tab. 1).

Table 1. Solitary wasp species (Eumeninae / Zethinae) in different Conservation Units in Minas Gerais state. APARM = Machado River Basin Environmental Protection Area; PNGSV = Grande Sertão Veredas National Park; PNSV = Sempre Vivas National Park; PNSC = Serra da Canastra National Park; PERD = Rio Doce State Park; PESP = Serra do Papagaio State Park; FNR = Ritópolis National Forest; RPPNAM = Alto Montana Private Natural Heritage Reserve. / **Tabla 1.** Especies de avispas solitarias (Eumeninae/Zethinae) en diferentes Unidades de Conservación del estado de Minas Gerais. APARM = Área de Protección Ambiental de la Cuenca del Río Machado; PNGSV = Parque Nacional Grande Sertão Veredas; PNSV = Parque Nacional Semper Vivas; PNSC = Parque Nacional de la Sierra de Canastra; PERD = Parque Estatal Río Doce; PESP = Parque Estatal Serra do Papagaio; FNR = Bosque Nacional Ritópolis; RPPNAM = Reserva Patrimonial Natural Privada Alto Montana.

Subfamily	Species	APARM	PNGSV	PNSV	PNSC	PERD	PESP	FNR	RPPNAM
	<i>Alphamenes campanulatus</i> (Fabricius, 1804)	0	2	1	0	0	0	0	0
	<i>Alphamenes insignis</i> (Fox, 1899)	0	0	0	0	0	0	5	0
	<i>Alphamenes</i> sp.	0	2	0	0	1	0	0	0
	<i>Ancistrocerus</i> sp.	0	0	0	0	0	2	0	1
	<i>Hypalastoroides</i> sp.	0	0	0	1	0	0	1	0
	<i>Minixi tricoloratum</i> (Zavattari, 1911)	0	0	0	0	0	0	2	0
	<i>Monobia</i> sp.	0	0	0	1	0	0	0	0
	<i>Montezumia azurescens</i> (Spinola, 1851)	0	4	0	0	0	0	0	0
	<i>Montezumia infernalis</i> (Spinola, 1851)	3	0	1	0	0	0	0	0
	<i>Montezumia nigriceps</i> (Spinola, 1841)	0	0	0	0	1	0	0	0
	<i>Montezumia petiolata</i> de Saussure, 1855	4	0	0	0	0	0	0	0
	<i>Omicron gondwanianum</i> Giordani Soika, 1978	1	0	0	0	0	0	0	2
	<i>Omicron</i> sp. 1	0	0	0	0	0	0	2	1
	<i>Omicron</i> sp. 2	0	0	0	0	0	0	1	1
Eumeninae	<i>Omicron tegulare</i> (Fox, 1899)	0	1	3	0	0	1	1	0
	<i>Omicron tuberculatum</i> (Fox, 1899)	2	0	0	0	0	0	1	0
	<i>Omicron vexatum</i> Giordani Soika, 1978	0	0	0	0	0	0	0	1
	<i>Pachodynerus argentinus</i> (de Saussure, 1870)	0	0	0	4	0	0	1	0
	<i>Pachodynerus brachygaster</i> (de Saussure, 1853)	0	1	0	0	0	0	0	0
	<i>Pachodynerus brevithorax</i> (de Saussure, 1853)	1	0	0	1	0	0	0	0
	<i>Pachodynerus guadulpensis</i> (de Saussure, 1853)	1	0	0	1	1	0	0	0
	<i>Pachymenes ater</i> de Saussure, 1852	12	0	0	0	0	3	4	1
	<i>Pachymenes ghilianii</i> (Spinola, 1851)	0	0	0	0	0	0	1	0
	<i>Pachymenes olympicus</i> (Zavattari, 1912)	0	0	0	0	1	0	0	0
	<i>Pachymenes picturatus</i> (Fox, 1899)	2	0	0	0	0	0	0	3
	<i>Parancistrocerus</i> sp.	0	0	0	0	0	0	0	1
	<i>Pirhosigma superficiale</i> (Fox, 1899)	1	0	0	0	0	0	0	0
	<i>Pseudodynerus auratoides</i> (Bertoni, 1918)	1	0	0	0	0	0	0	0
	<i>Stenonartonia apicipennis</i> (Fox, 1902)	1	0	1	0	0	0	0	0
	<i>Stenosigma allegrum</i> (Zavattari, 1912)	0	0	0	0	0	0	0	1

Eumeninae	<i>Zeta argillaceum</i> (Linnaeus, 1758)	1	1	0	0	0	0	6	0
	<i>Zethus productus</i> Fox, 1899	0	0	0	0	0	0	1	0
	<i>Zethus smithii</i> de Saussure, 1855	1	0	0	0	0	0	0	0
Zethinae	<i>Zethus</i> sp. 1	1	0	0	0	0	1	0	0
	<i>Zethus</i> sp. 2	0	0	1	0	0	0	0	0
	<i>Zethus wagneri</i> Bohart & Stange, 1965	0	0	0	0	2	0	0	0
Species richness	Eumeninae	12	6	4	5	4	3	11	9
Abundance	Eumeninae	30	11	6	8	4	6	25	12
Species richness	Zethinae	2	0	1	0	1	1	1	0
Abundance	Zethinae	1	0	1	0	2	1	1	0

Although Eumeninae is the largest subfamily of Vespidae in terms of number of species (Perrard *et al.* 2017), in Minas Gerais the known diversity of these wasps and also of the Zethinae subfamily is still low. Considering the large territorial extension of the state and its heterogeneous habitats, the sampling of these groups is very low compared to the Polistinae subfamily (Vespidae) (Lopes 2020; Barbosa *et al.* 2022; Hermes and Somavilla 2024). Our results add three more records for the state, three of which are Eumeninae: *Alphamenes campanulatus* (Fabricius, 1804), *Pachodynerus argentinus* (de Saussure, 1870) and *Pseudodynerus auratoides* (Bertoni, 1918). These results increase the number of species of these taxa for the state.

Alphamenes campanulatus was recorded in the Cerrado of the Grande Sertão Veredas National Park (PNGSV) and the Sempre Vivas National Park (PNSV). These CUs are considered essential for the conservation of invertebrate biota in the state (Drummond *et al.* 2005), harboring a high diversity of different insect taxa, with endangered species and new records for Brazil (Silva *et al.* 2022; Oliveira *et al.* 2023), including social wasps (Souza *et al.* 2020; Francisco *et al.* 2023). This species also occurs in Mato Grosso do Sul (Grandinete and Noll 2013) Amazonas, Pará, Bahia, Goiás and São Paulo (Hermes and Somavilla 2024).

Pseudodynerus auratoides have only been recorded in the Machado River Basin Environmental Protection Area (APARM), located in southern Minas Gerais, home to a rich fauna of social vespids (Oliveira *et al.* 2021), Odonata (Guedes *et al.* 2022) and butterflies (Vieira *et al.* 2020). However, this area is threatened by various anthropogenic pressures. This species also occurs in the states of Paraná and Rio Grande do Sul, besides been recorded in Paraguay (Hermes *et al.* 2005; Hermes and Melo 2008).

Pachodynerus argentinus has been recorded in the Serra da Canastra National Park (PNSC) and the Ritópolis National Forest (FNR), and occurs in the states of Goiás, Mato Grosso, São Paulo, Paraná, Santa Catarina and Rio Grande do Sul (Hermes and Somavilla 2024). The PNSC, the second largest CU in the state, is part of the Cerrado biome, in transition with the Atlantic Forest, is a priority conservation area (Drummond *et al.* 2005), with the presence of endemic and endangered species (Bruno 2013; Vilela *et al.* 2023), and a high diversity of arthropods, including other vespids, such as social wasps (Vicente *et al.* 2020).

In turn, the FNR is the smallest CU in Minas Gerais state, located in its central-southern region and covering only 89.5 ha of Cerrado and Atlantic Forest remnants. This area has proved to be an important refuge for the biota of the Campos das Vertentes, especially for social wasps (Oliveira *et al.* 2021). In addition to the unprecedented record of *P. argentinus* for the state of Minas Gerais, *Alphamenes insignis* (Fox, 1899) and *Minixi tricoloratum* (Zavattari, 1911) were recorded only in this CU, and constitute the second record of these species for the state, previously recorded in the western portion of Minas Gerais (Oliveira *et al.* 2019). *Alphamenes insignis* also occurs in the states of Bahia and Espírito Santo (Hermes and

Somavilla 2024), Mato Grosso do Sul (Grandinete and Noll 2013; Oliveira *et al.* 2019) and Paraguay (Oliveira *et al.* 2019), while *M. tricoloratum* has been recorded in Mato Grosso, São Paulo and Rio Grande do Sul (Hermes and Somavilla 2024) and Argentina (Oliveira *et al.* 2019). Thus, the records of restricted and rare species in this CU reinforce its importance for maintaining the biota in a region that has few CUs (Oliveira *et al.* 2023).

Zethus wagneri Bohart & Stange, 1965 (Fig. 2) represents a new record for Brazil, collected in the Rio Doce State Park (PERD) (Hermes and Somavilla 2024). This CU is also home to one of the richest Social Vespid faunas in the country (Souza *et al.* 2012; Oliveira *et al.* 2021). An additional specimen had already been collected in the same UC in 2000 and is deposited in the Centro de Coleções Taxonômicas da Universidade Federal de Minas Gerais, Belo Horizonte, State of Minas Gerais (CCT-UFGM), Brazil. These data added to the new record can be explained by the fact that this CU is home to the largest conserved and continuous area of Atlantic Forest in Minas Gerais, formed by semi-deciduous and ombrophilous forest. In addition, this is one of the most important remnants in Brazil (Ribeiro *et al.* 2009), which highlights the need to carry out inventories of Eumeninae and Zethinae in this CU.

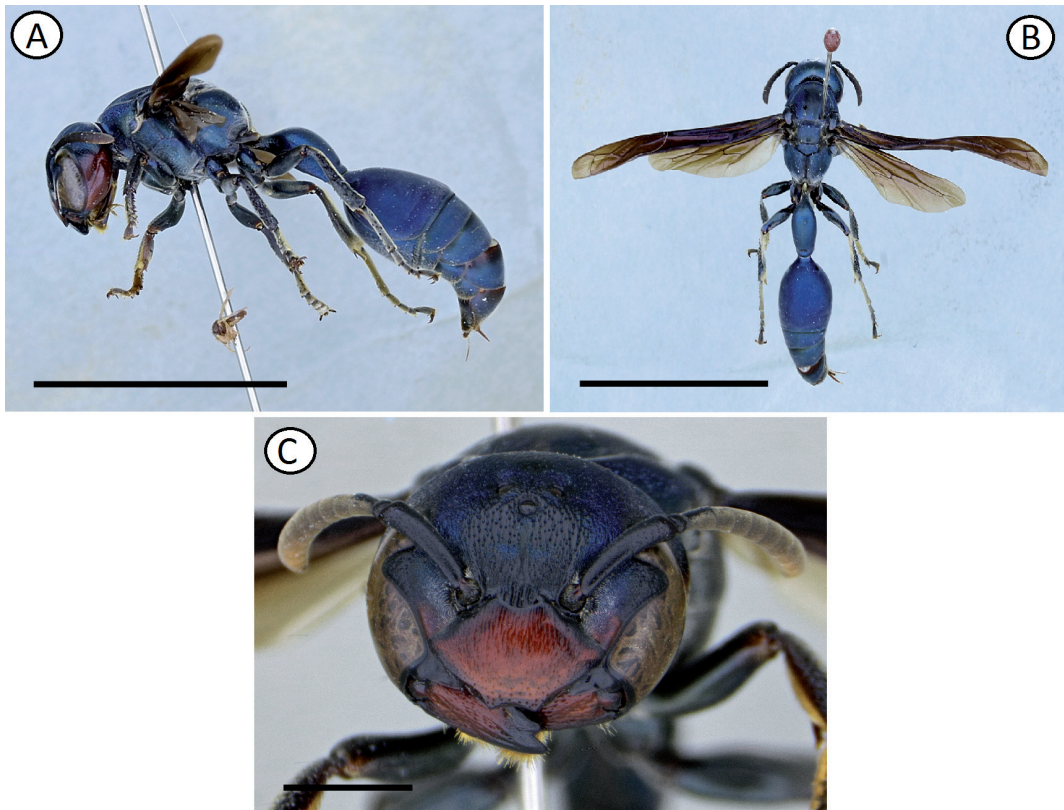


Figure 2. *Zethus wagneri* collected in the Rio Doce State Park (PERD). **A.** Lateral view. **B.** Dorsal view. **C.** Head frontal view. Escalas: A-B = 10 mm; C = 2 mm. / **Figura 2.** *Zethus wagneri* coleccionado en el Parque Estatal Río Doce (PERD). **A.** Vista lateral. **B.** Vista dorsal. **C.** Vista frontal de la cabeza. Scale bars: A-B = 10 mm; C = 2 mm.

Alphamenes campanulatus and *P. argentinus* occur across various states and biomes in Brazil; however, this record is significant in addressing the knowledge gap regarding their presence in the state of Minas Gerais. In contrast, *P. auratoides* is primarily distributed within the Atlantic Forest, predominantly in southern Brazil, where the climate is milder.

This study confirms that its range also extends into southeastern Brazil, reaching the transitional zone with the Cerrado. *Zethus wagneri* had previously been documented only along the Paraguay-Argentina border (Bohart and Stange 1965), within the Atlantic Forest, specifically in the Semideciduous Seasonal Forest. This new record from Brazil extends the known distribution of the species, now including a different phytophysiognomy of the Atlantic Forest—the Ombrophilous Forest. These findings enhance the understanding of the distribution patterns of these species and provide essential baseline data for future assessments of their extinction risk.

Conclusion

Our study presents new records of Eumeninae and Zethinae for Minas Gerais state, as well as a new occurrence for Brazil: *Zethus wagneri* (Zethinae). This reinforces the need for new studies on these insects, in order to develop strategies for their preservation, biodiversity management and assessment of their conservation status, as well as highlighting the importance of Conservation Units for the conservation of the vespid biota.

Acknowledgments

To Leonardo Dutra Barbosa for sorting the specimens for identification. MGH thanks CNPq (Process 306882/2021-3). We thank Rogério B. Lopes for confirming the occurrence of a second specimen of *Z. wagneri* in Brazil.

Author Contributions

MMS: Conceptualization, investigation, writing - original draft. **FGAC:** Investigation, writing - original draft. **GCSO:** Investigation, writing - original draft. **TPG:** Investigation, writing - original draft. **MGH:** Supervision, writing - review & editing. **GCJ:** Writing - original draft, writing - review & editing, visualization.

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