Nesting of the keyhole wasp *Pachodynerus nasidens* (Latreille, 1812) (Vespidae, Eumeninae) in a nest of a paper wasp (Vespidae, Polistinae)

Gabriel de Castro Jacobs¹, Wellington Donizet Ferreira²,³, Paola Aparecida Moura⁴, Gabriel Teofilo-Guedes⁵, Marcos Magalhães de Souza⁴

¹ Instituto Federal de Educação, Ciência e Tecnologia de Minas Gerais - IFMG, Campus Bambuí, Varginha Farm, Bambuí/Medeiros Highway - Km 05, Bambuí, Minas Gerais, Brazil ² Laboratório de Sistemática e Biologia de Insetos, Departamento de Biologia, Universidade Federal de Lavras - UFLA, Lavras, Minas Gerais, Brazil ³ Universidade do Estado de Minas Gerais - UEMG Campus Dínópolis, Dínópolis, Minas Gerais, Brazil ⁴ Instituto Federal de Educação, Ciência e Tecnologia do Sul de Minas - IFSULDEMINAS, Campus Inconfidentes, Tiradentes Square, 416, Inconfidentes, Minas Gerais, Brazil ⁵ Instituto de Geociências, Universidade Estadual de Campinas - UNICAMP, Zeferino Vaz University City, Barão Geraldo, Campinas, São Paulo, Brazil

Corresponding author: Gabriel de Castro Jacques (gabriel.jacques@ifmg.edu.br)

Academic editor: Michael Ohl | Received 5 August 2022 | Accepted 23 August 2022 | Published 31 October 2022

Citation: Jacobs GC, Donizet Ferreira W, Aparecida Moura P, Teofilo-Guedes G, Magalhães de Souza M (2022) Nesting of the keyhole wasp *Pachodynerus nasidens* (Latreille, 1812) (Vespidae, Eumeninae) in a nest of a paper wasp (Vespidae, Polistinae). Journal of Hymenoptera Research 93: 125–130. https://doi.org/10.3897/jhr.93.91298

Abstract

Potter wasps (Hymenoptera, Vespidae, Eumeninae) adopt different substrates for nesting, including other wasp nests. Nevertheless, such behavior rarely occurs with abandoned nests of the paper wasps (Hymenoptera, Vespidae, Polistinae). In this study, we report the occurrence involving the nesting of a potter wasp on a paper wasp’s nest. Such a record occurred in November 2021 in a segment of a deciduous forest, at Mata Seca State Park, Southeast Brazil. An abandoned Polistinae nest was found, with 14 cells sealed with mud, from which four male *Pachodynerus nasidens* individuals emerged. This record of *P. nasidens* reusing a Polistinae’s nest increases our knowledge of Eumeninae nesting strategies and on possible associations between different groups of vespid wasps.

Keywords

Neotropical wasps, nest abandonment, nesting strategy, social wasp
Introduction

The Vespidae family includes around 5300 species (Piekarski et al. 2018), which present diverse nesting and social behaviors (Iwata 1976; Cowan 1991). Among Neotropical vespids, two taxa stand out in this regard: Eumeninae, with 3404 species (Piekarski et al. 2018), usually builds their nests with mud and are commonly classified as solitary wasps (Hermes et al. 2014); and Polistinae, with 1003 species (Piekarski et al. 2018), uses macerated cellulose for nesting and presents eusocial behavior (Somavilla and Carpenter 2021). Several ecosystem services are attributed to these insects, including floral visiting (Pires et al. 2022) and biological control of agricultural pests (Jacques et al. 2020), which demonstrates their ecological and economic importance (Brock et al. 2021).

Records of other insects reusing nests of Polistinae wasps are scarce (Bakar et al. 2015). For example, Pinto (2005), recorded solitary bee Tetrapedia diversipes Klug, 1810 reusing nests of Polistes, affirming that nests without an envelope were more propitious for reuse. Rau (1928) also reported the reuse of Polistes nests by species of Apoidea: Trypoxylon Latreille, 1796 and Osmia Panzer, 1806. There are also reports of the use of abandoned Polistinae nests by solitary wasps of the subfamily Eumeninae (Rau, 1944), who recorded the reuse of old Polistes nests by Euodynerus foraminatus (de Saussure, 1853) and Paracinstrocerus fulvipes (de Saussure 1856). Here, we add information to this ecological condition, with a report of the occurrence of the species of Eumeninae Pachodynerus nasidens (Latreille, 1812) reusing a Polistinae nest, recorded in a Neotropical seasonal forest, in Southeast Brazil.

Methods

We made this observation on November 30th, 2021, at the beginning of the rainy season, in the Mata Seca State Park, an Integral Protection Conservation Unit, situated in the municipalities of Manga and Itacarambi, the northern part of the State of Minas Gerais, Brazil (14°52'0"S, 43°59'58"W). This region houses deciduous forest remnants, the phytophysiognomy of the Atlantic Rainforest Domain. More than 50% of arboreous species are deciduous, characterized by the intensive loss of leaves in response to the two defined seasons of the year: rainy (spring/summer) and dry (fall/winter) (Belém et al. 2021).

We carried out the photographic record in the field, with a digital camera Nikon 60x Optical Zoom Wide. The nest was collected and stored in a glass recipient topped with a net, allowing gas exchange with the external environment and avoiding escape by the insects which would emerge from the occupied cells. Nest observations were performed daily until the imagoes emerged, at the Zoology Laboratory, in the Federal Institute of Education, Science, and Technology of South Minas Gerais – IFSUL-DEMINAS, Campus Inconfidentes.

To identify the genus of Polistinae that would have produced the nest, we adopted the dichotomous key of Barbosa et al. (2021) and compared the nest with others stored
in the IFSULDEMINAS entomological collection. The nest length and diameter were measured, in addition to the dimensions of the collected specimens, using a pachymeter, 0.2 mm precise. The number and relative position of both empty and sealed cells were also registered. To identify the individuals that emerged from the occupied reused cells, a stereoscopic microscope Leica S8 APO was used and the dichotomous key of Carpenter and Garcete-Barrett (2002 [2003]) at the genus level, and the dichotomic criteria presented by Willink and Roig-Alsina (1998), at the specific level, were employed.

Results

We found one Polistinae nest, built on the plant species *Quiabentia zehntneri* (Britton & Rose) Britton & Rose (Cactaceae). This nest is of the gymnodomous type (Richards and Richards 1951; Barbosa et al. 2021), without a protection envelope, 154.2 mm in length (pedicel to the basis), and 40 mm in width. It contained a total of 223 counted cells, 14 of which were sealed with mud, indicating the probable presence of solitary wasps (Fig. 1). Four of the sealed cells belonged to the medium portion of the nest, and the other 10 cells, to the superior portion, 20 mm from the pedicel.

Two weeks after the field collection, on December 14th, 2021, four male individuals of *Pachodynerus nasidens* (Latreille, 1812) emerged from the cells at the nest medium portion. These cells were situated around 60 mm above the basis, with an average diameter of 6.2 mm. *P. nasidens* sealed the cells’ entrance and underlaid their bottom, having emerged one adult individual for each cell.

Individuals emerging from these cells presented average measurements of 7.395 mm in body length, 2.68 mm in mesosoma width, and 3.485 mm in T2 width. These male individuals presented average dimensions, relatively smaller than those presented by *P. nasidens* females deposited in the Entomological Collection of Federal University of Lavras (CEUFLA) (9.03 mm in body length, 3.78 mm in mesosoma width, 3.485 mm in T2 width). The other 10 sealed cells presented an average diameter of 5.74 mm; we did not observe emergence from them until May 1st, 2022.

Discussion

Nests completely built by *P. nasidens* are rare. This species commonly acts as an inquiline, in cavities made by humans (House et al. 2020) or in abandoned nests of other hymenopterans (Freeman and Jayasingh 1975; Matthews and González 2004). *P. nasidens* also build mud structures in the ground and fixed to plants (Carpenter 1986). The use of abandoned cavities in cells of a Polistinae nest seems to be one more case of the species’ plasticity in nesting behavior.

*Pachodynerus nasidens* nesting peaks occur in months of higher temperature and humidity throughout the year (House et al. 2020). The ideal temperature for egg development ranges from 26 to 31 °C (Jayasing and Taffe 1982), while higher humidity
ensures the availability of water and mud for nest building (Freeman and Jayasingh 1975), explaining our record in the hot and humid season.

The nesting preference of *P. nasidens* is for cavities with openings of 6 to 9 mm in diameter (Bequaert 1948; Oliveira-Nascimento and Garófalo 2014), which explains the use of Polistinae cells, which have 6.2 mm in average diameter. The exclusive emergence of male individuals, smaller than females from the same collection, may be related to the cell size of the Polistinae nest, which may be too small for females’ development. In this species, feminine eggs are usually elongated in comparison with masculine ones. Additionally, female immatures develop more slowly and need more food, consequently needing a bigger physical space for development (Jayasingh 1980; Jayasingh and Taffe 1982).

The nest herein described probably belonged to *Polistes versicolor* (Olivier, 1791). According to the dichotomous key presented by Barbosa et al. (2021), we conclude that this nest was produced by *Polistes* social wasp genus. Close to the abandoned nest, we found nests of *P. versicolor*, including one being built on Q. zehntneri.

![Figure 1. Polistinae’s abandoned nest A with sealed cells occupied B by juveniles of the *Pachodynerus nasidens* solitary species (Vespidae, Eumeninae).](image)
Nesting of the keyhole wasp *Pachodynerus nasidens* in a nest of paper wasp

(Moura et al. 2022). In another study (Jacques et al. in press) the Polistinae diversity on social wasps from the Mata Seca State Park is presented, in which only nests of this species of the genus *Polistes* genus were found.

**Acknowledgements**

To IFMG – Campus Bambuí and IFSULDEMINAS – Campus Inconfidentes for logistics. To JLV, manager of the Mata Seca State Park – MG for field support. To the field team composed of interns of IFMG and IFSULDEMINAS. To ICMBio for providing the field collection license. To Prof Dr. Marcel Hermes, curator of the Entomological Collection of Federal University of Lavras (CEUFLA), for providing infrastructure, literature, and help in determining the Eumeninae species. WDF and GTGS are funded by CNPq (141168/2018-8) (132617/2020-0).

**References**

Bakar NAA, Baracchi D, Turillazzi S (2015) Reuse of old nests by the European paper wasp *Polistes dominula* (Hymenoptera Vespidae). Redia 48: 21–24.

Barbosa BC, Maciel TT, Prezoto F (2021) Nesting Habits of Neotropical Social Wasps. In: Prezoto F, Nascimento FS, Barbosa BC, Somavilla A (Eds) Neotropical Social Wasps. Springer, Cham, 85–98. https://doi.org/10.1007/978-3-030-53510-0_5

Belém RA, Oliveira CV, Veloso M (2021) Os fatores edáficos e antropogênicos e suas correlações com as fitofisionomias do Parque Estadual da Mata Seca, Manga/MG. Revista Cerrados 19: 298–328. https://doi.org/10.46551/rc24482692202113%20

Bequaert JC (1948) The genus *Pachodynerus* (Hymenoptera, Vespidae) in the Antilles. Psyche 55: 105–112. https://doi.org/10.1155/1948/59321

Brock RE, Cini A, Sumner S (2021) Ecosystem services provided by aculeate wasps. Biological Reviews 96: 1645–1675. https://doi.org/10.1111/brv.12719

Carpenter JM (1986) The genus *Pachodynerus* in North America (Hymenoptera: Vespidae: Eumeninae). Proceedings of the Entomological Society of Washington 88: 572–577.

Carpenter JM, Garcete-Barrett BR (2002 [2003]) A key to the Neotropical genera of Eumeninae (Hymenoptera: Vespidae). Boletín del Museo Nacional de Historia Natural del Paraguay 14: 52–73.

Cowan DP (1991) The solitary and presocial Vespidae. In: Ross KG, Matthews RW (Eds) The social biology of wasps. London: Cornell University Press, Ithaca, 33–73. https://doi.org/10.7591/9781501718670-005

Freeman BE, Jayasingh DB (1975) Population dynamics of *Pachodynerus nasidens* (Latr.) in Jamaica (Hymenoptera: Eumenidae). Oikos 26: 86–91. https://doi.org/10.2307/3543282

Hermes MG, Melo GAR, Carpenter JM (2014) The higher-level phylogenetic relationships of the Eumeninae (Insecta, Hymenoptera, Vespidae), with emphasis on *Eumenes* sensu lato. Cladistics 30: 453–484. https://doi.org/10.1111/cla.12059
House A, Ring JG, Shaw PP (2020) Inventive nesting behavior in the keyhole wasp *Pachodynerus nasidens* Latreille (Hymenoptera: Vespidae) in Australia, and the risk to aviation safety. PLoS ONE: e0242063. https://doi.org/10.1371/journal.pone.0242063

Iwata K (1976) Comparative Ethology of Hymenoptera. Amerind Publish, New Delhi, 535 pp.

Jayasingh DB (1980) A new hypothesis on cell provisioning in solitary wasps. Biological Journal of the Linnean Society 13: 167–170. https://doi.org/10.1111/j.1095-8312.1980.tb00079.x

Jayasingh DB, Taffe CA (1982) The biology of the eumenid mud-wasp *Pachodynerus nasidens* in trap-nests. Ecological Entomology 7: 283–289. https://doi.org/10.1111/j.1365-2311.1982.tb00668.x

Jacques GC, Oliveira DC, Souza MM, Silveira LCP (2020) The use of *Polistes versicolor* (Olivier, 1971) in the control of *Ascia monuste orseis* (Godart, 1819) in kale cultivation. Revista Agroambiental 11: 96–106. https://doi.org/10.18406/2316-1817v11n420191395

Matthews RW, González JM (2004) Nesting biology of *Zeta argillaceum* (Hymenoptera: Vespidae: Eumeninae) in Southern Florida, U.S. Florida Entomologist 87: 37–40. https://doi.org/10.1653/0015-4040(2004)087[0037:NBOZAH]2.0.CO;2

Moura AP, Jacques GC, Teófilo-Guedes GS, Souza MM (2022) *Polistes versicolor* (Olivier, 1791) nesting in deciduous forest, Northern Minas Gerais State, Brazil (Vespidae, Polistinae). Sociobiology 69: 1–5. https://doi.org/10.13102/sociobiology.v69i2.7691

Oliveira-Nascimento AL, Garófalo CA (2014) Trap-nesting solitary wasps (Hymenoptera: Acalyptera) in an insular landscape: Mortality rates for immature wasps, parasitism, and sex ratios. Sociobiology 61: 207–217 https://doi.org/10.13102/sociobiology.v61i2.207-217

Rau P (1928) Field studies in the behavior of the nonsocial wasps. Transactions of the Academy of Science of Saint Louis 25: 319–489.

Rau P (1944) The use of old *Polistes* nests by *Odynerus foraminatus* and *Ancistrocerus fulvipes* for nesting purposes. Canadian Entomologist 76: 129. https://doi.org/10.4039/Ent76129-6

Piekarski PK, Carpenter JM, Lemmon AR, Lemmon EM, Sharanowski B (2018) Phylogenomic evidence overthrows current conceptions of social evolution in wasps (Vespidae). Molecular Biology and Evolution 35: 2097–2109. https://doi.org/10.1093/molbev/msy124

Pinto NPO (2005) Estudo de caso: a reutilização de células de ninho abandonado de *Polistes (Aphanilopterus) simillimus* Zikan, 1951 (Hymenoptera: Vespidae, Polistinae) por *Tetrapedia* (Tetrapedia) *diversipes* Klug, 1810 (Hymenoptera: Apidae, Apinae). Revista de Etiologia 7: 67–74.

Pires EP, Faria LDB, Monteiro AB, Domingos DQ, Mansanares ME, Hermes MG (2022) Insect sociality plays a major role in a highly complex flower-visiting network in the neotropical savanna. Apidologie 53: 1–16. https://doi.org/10.1007/s13592-022-00923-8

Richards OW, Richards MJ (1951) Observations on the social wasps of South America (Hymenoptera, Vespidae). Transactions of the Entomological Society of London 102: 1–169. https://doi.org/10.1111/j.1365-2311.1951.tb01241.x

Somavilla A, Carpenter JM (2021) Key to the Genera of Social Wasps (Polistinae) Occurring in Neotropics. In: Prezoto F, Nascimento FS, Barbosa, BC, Somavilla A (Eds) Neotropical Social Wasps. Springer, Cham, 327–336. https://doi.org/10.1007/978-3-030-53510-0_18

Willink A, Roig-Alsina A (1998) Revision del genero *Pachodynerus* Saussure (Hymenoptera: Vespidae, Eumeninae). Contributions of the American Entomological Institute 30: 1–117.