OCCUPATION OF ABANDONED SOCIAL WASP (VESPIDAE: POLISTINAE) NESTS BY DIFFERENT TAXON OF HYMENOPTERA

OCUPAÇÃO DE NINHOS ABANDONADOS DE VESPAS SOCIAIS (VESPIDAE: POLISTINAE) POR DIFERENTES TAXON DE HYMENOPTERA

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RESUMO

Há alguns registros de artrópodes utilizando ninhos abandonados de vespas sociais (Vespidae: Polistinae), porém estes registros ainda são escassos, e novos dados são necessários para identificar ocupações e relações destes ocupantes com seus parasitas/parasitoides. Portanto, o objetivo deste estudo foi relatar a ocupação de ninhos de vespas sociais abandonados por diferentes Hymenoptera e possíveis associações entre ocupantes e parasitas/parasitoides. Dez ninhos de vespas do gênero *Polistes* foram coletados por meio de busca ativa no *campus* Bambuí do Instituto Federal de Educação, Ciência e Tecnologia de Minas Gerais, em área de Cerrado. Destes, cinco apresentaram emergência de outros Hymenoptera, pertencentes a quatro famílias distintas: Crabronidae (3 spp.): *Trypoxylon* (*Trypargilum*) *aurifrons* Shuckard, *Trypoxylon* (*Trypargilum*) *nitidum* Smith e *Trypoxylon* (*Trypoxylon*) *marginatum* Cameron; Vespidae (Eumeninae): *Pachodynerus nasidens* (Latreille); Chrysididae (Chrysidinae): *Caenochrysis parvula* (Fabricius); e Ichneumonidae: *Photocryptus fumartus* (Hancock). As associações registradas sugerem possíveis interações entre os ocupantes de ninhos abandonados, como Crabronidae e vespas solitárias construtoras de ninhos de lama, e possíveis parasitas e parasitoides: Chrysididae e Ichneumonidae, respectivamente.

PALAVRAS-CHAVE: Crabronidae; Chrysididae; Eumeninae; Ichneumonidae; parasitoide.

ABSTRACT

There are some records of arthropods using abandoned nests of social wasps (Vespidae: Polistinae), but these records are still scarce, and new data are needed to identify occupations and relationships of these occupants with their parasites/parasitoids. However, records of nest reoccupation behaviors are still scarce, and new data are needed to identify new occupations and associations between different occupants. Therefore, the objective of this study was to report the occupation of abandoned social wasp nests by different Hymenoptera and possible associations between occupants and parasites/parasitoids. Ten nests of wasps of the genus *Polistes* were collected through active searching on the Bambuí campus of the Federal Institute of Education, Science, and Technology of Minas Gerais, in Cerrado area. Of these nests, five exhibited emergence of other Hymenoptera, belonging to four distinct families:

Crabronidae (3 spp.): *Trypoxylon* (*Trypargilum*) *aurifrons* Shuckard, *Trypoxylon* (*Trypargilum*) *nitidum* Smith, and *Trypoxylon* (*Trypoxylon*) *marginatum* Cameron; Vespidae (Eumeninae): *Pachodynerus nasidens* (Latreille); Chrysididae (Chrysidinae): *Caenochrysis parvula* (Fabricius); and Ichneumonidae: *Photocryptus fumartus* (Hancock). The recorded associations suggest possible interactions between the occupants of abandoned nests, such as Crabronidae and solitary wasps that build mud nest, and possible parasites and parasitoids: Chrysididae and Ichneumonidae, respectively.
KEYWORDS: Crabronidae; Chrysididae; Eumeninae; Ichneumonidae; parasitoid.

INTRODUCTION

The order Hymenoptera is one of the four insect orders considered megadiverse, with more than 150 thousand described species[1]. Representatives of this order exhibit a wide phenotypic disparity and ecological diversity, resulting in unique importance in biological pest control and various ecosystem services[2,3]. Insects of this order are notable for having an appendicular ovipositor, used for egg deposition in phytophagous and parasitoid species; or modified into stingers used for defense and prey capture, as seen in females of both social and solitary wasps of the Vespidae family[1].

In the Neotropical region, solitary wasps that nest in cavities belong to the families Ampulicidade, Crabronidae, Pemphredonidae, Psenidae, Sphecidae, Pompilidae, and Vespidae. Most of these wasps use mud to build their nests and/or utilize pre-existing natural cavities in dead wood, pithy or hollow plant stems, twigs, and man-made holes in different substrates[4-6]. Hence, pre-existing cavities may be a limiting resource for this species due to this particular feature.

Social wasps in the Neotropical region belong to the Polistinae subfamily and build their nests from plant fibers[4]. They are divided into two groups based on their behavior and nest structure: independent nest-founding wasps and swarm-founding wasps[7]. Independent nest-founding wasps, from the Polistini and Mischocyttarini tribes, form colonies with fewer individuals and build smaller nests with exposed combs attached to a surface by a peduncle[7]. Swarm-founding species, from the Epiponini tribe, build large nests, most of which are protected by an envelope, and exhibit a well-defined social organization[6,7].

These nests are very resistant[8] and provide protection against harsh weather and predators[9,10]. Therefore, when abandoned, they are often occupied by other insects or arthropods, such as ants[11], spiders[12], termites[13], bees[14], and solitary wasps[15]. However, new studies are needed to identify additional occupants and associations between residents, as

some of them exhibit parasitic and parasitoid behaviors.

Therefore, the aim of this study was to report the occupation of abandoned social wasp nests by different Hymenoptera in an anthropized area in the Cerrado.

METHODOLOGY

The study was conducted at the Bambuí campus of the Federal Institute of Education, Science, and Technology of Minas Gerais, Brazil, Cerrado area (20°02'22.64"S 46°00'19.40"W). The campus encompasses a total area of 328.76 hectares and approximately 40,000 square meters of buildings[16]. The anthropized region of the campus, characterized by a predominance of buildings, also includes green areas and agricultural crops.

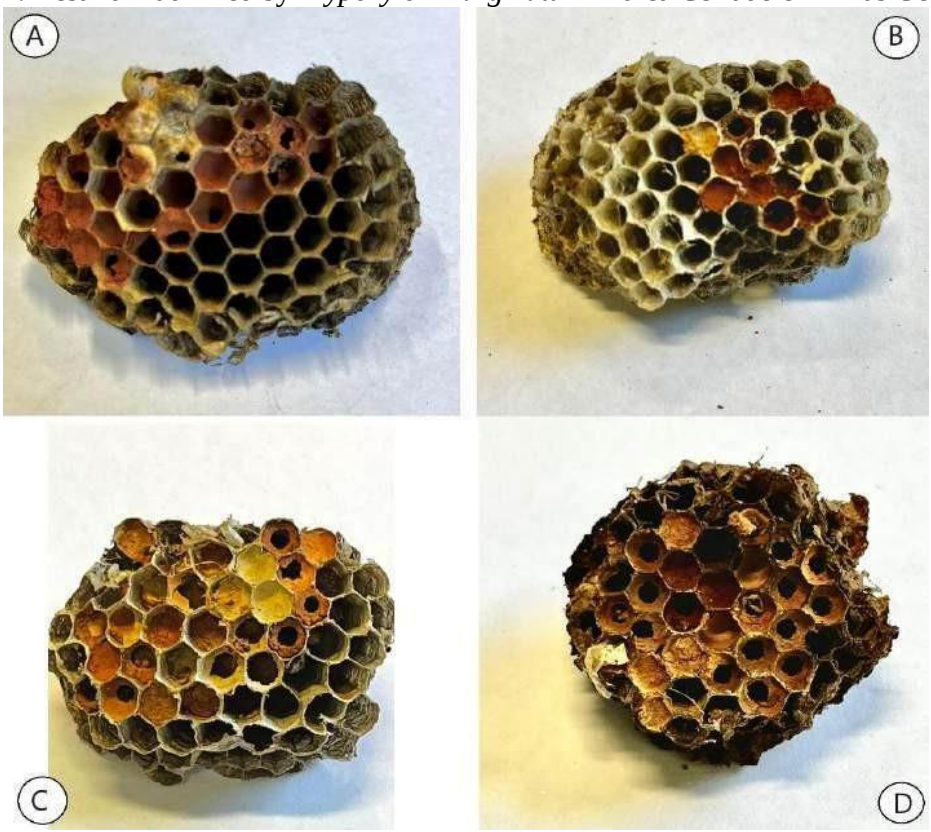
The nests were collected on March 9, 2023, from 8 am to 12 pm, through active searching in the buildings of the educational institution. Abandoned nests of social wasps containing mud-filled cells were collected and placed in plastic containers covered with fabric to ensure ventilation. These containers were kept in a B.O.D. type incubator at 25 °C and 70% relative humidity[15]. The total number of cells and mud-filled cells were recorded, and the nests were monitored daily for 45 days to observe the emergence of other insects, which were subsequently sacrificed and preserved in 70% alcohol.

The emerged insects were identified to the family level using the identification key available in Melo and Molin[1] and then forwarded to taxonomists specialized in each family or subfamily. The Eumeninae were identified by Dr. Wellington Donizet Ferreira from the State University of Minas Gerais (UEMG); Chrysididae by Dr. Daercio Adam de Araújo Lucena from the São Paulo State University "Júlio de Mesquita Filho" (UNESP); Ichneumonidae by Dr. Bernado F. Santos from the Center for Integrative Biodiversity Discovery, Museum für Naturkunde, Berlin, Germany; and Crabronidae by Dr. David Barros Muniz from the Federal University of Maranhão (UFMA), using the work developed by Richards[17]. To determine the Polistinae genus responsible for building the nests, we used the dichotomous key of Barbosa, Maciel, and Prezoto[18]. Eumeninae species identification was conducted using the key developed by Willink and Roig-Alsina[19].

RESULTS AND DISCUSSION

Ten nests were collected, all of the gymnodomous stelocytic type, with a pedicel and without a protective envelope[18] (Figure 1), identified as belonging to the genus *Polistes* Latreille.

Figure 1. Figure 1. Nests of Polistes sp. containing mud-filled cells. A. Nest 1 are mud-filled by *Trypoxylon aurifrons*; B. Nest 2 mud-filled by *T. aurifrons*; C. Nest 5 mud-filled by *Pachodynerus nasidens*; D. Nest 10 mud-filled by *Trypoxylon marginatum* in area Cerrado of Minas Gerais.



The nests had an average of 84.5 total cells and 20.2 mud-filled cells. Five nests had the emergence of other Hymenoptera, from four families and seven species: *Trypoxylon* (*Trypargilum*) *aurifrons* Shuckard, *Trypoxylon* (*Trypargilum*) *nitidum* Smith, and *Trypoxylon* (*Trypoxylon*) *marginatum* Cameron (Crabronidae: Crabroninae) (Figure 2); *Pachodynerus nasidens* (Latreille) (Vespidae: Eumeninae); *Caenochrysis parvula* (Fabricius) (Chrysididae: Chrysidinae) (Figure 3); and *Photocryptus fumartus* (Hancock) (Ichneumonidae: Cryptinae) (Table 1).

Figure 2. Images of the three *Trypoxylon* species that emerged from the nests of *Polistes* sp. (Vespidae: Polistinae). A. Frontal view of the male head of *Trypoxylon aurifrons*; B. Lateral view of the male of *T. aurifrons*; C. Frontal view of the male head of *Trypoxylon nitidum*; D. Lateral view of the male of *T. nitidum*; E. Frontal view of the male head of *Trypoxylon marginatum*; F. Lateral view of the male of *T. marginatum*. Scale equals A. 0,5 mm; B. 1 mm; C. 0,5 mm; D. 1 mm; E. 0,5 mm; F. 1 mm.

Crabronidae was the family with the largest number of emerged Hymenoptera, with four *T. aurifrons* in nest 1 (Figure 1A) and four in nest 2 (Figure 1B); two *T. nitidum* in nest 9, and four *T. marginatum* in nest 10 (Figure 1D). Species of *Trypoxylon* Latreille use mud to build their nests, which can be built in pre- existing cavities or reused nests[20-22], with greater frequency in the hot and rainy season[21], explaining the abundance and richness of these insects in this work. The nesting biology of *T. aurifrons* and *T. nitidum* was studied using trap-nests[20,22], while there is limited literature on *T. marginatum*, first recorded in Brazil in 2014[23]. There are few records of *Trypoxylon* nesting in social wasp nests[24], one of which is of *T. nitidum* in abandoned nests of *Polistes lanio* (Fabricius) and *P. versicolor*[22].

Table 1. Abandoned social wasp nest: total number of cells, number of mud-filled cells, number of specimens emerged, names of the emerged species, and family of emerged Hymenoptera.

Nest	Total cells	Cells with mud	Emerged Hymenoptera		
			Quantity	**Species**	**Family**
1	108	31 (28%)	4	*Trypoxylon aurifrons*	Crabronidae
			3	*Caenochrysis parvula*	Chrysididae
			1	*Photocryptus fumatus*	Ichneumonidae
2	125	12 (9,6%)	4	*Trypoxylon aurifrons*	Crabronidae
3	170	13 (7,6%)		-	
4	140	24 (17,1%)		-	
5	90	35 (38,8%)	3	*Pachodynerus nasidens*	Eumeninae
6	46	25 (54,3%)		-	
7	10	7 (70%)		-	
8	42	8 (19%)		-	
9	50	17 (34%)	2	*Trypoxylon nitidum*	Crabronidae
10	64	30 (46%)	4	*Trypoxylon marginatum*	Crabronidae

Another solitary wasp that emerged was *P. nasidens* (Vespidae: Eumeninae), from nest 5 (Figure 1C), with three individuals. This species typically utilizes pre-existing cavities to build its nests, including human structures[25] and abandoned nests of other Hymenoptera[26]. These cavities have openings ranging 6 to 9 mm[27], which explains their use of *Polistes* cells, which have an average diameter of 6.2 mm[15]. Apart from this report, there are only two other reports of Eumeninae nesting in Polistinae nests documented[15,28].

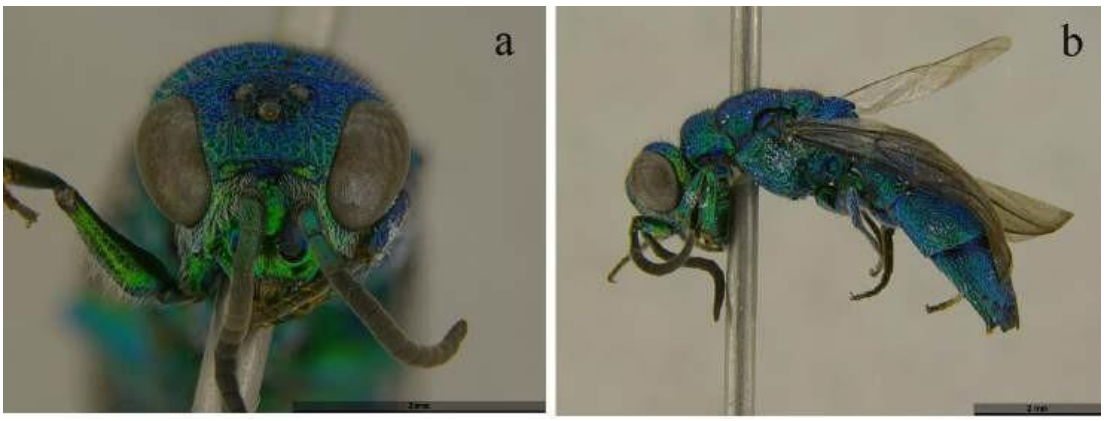
A factor that may explain the reuse of *Polistes* sp. nests by solitary wasps is the limited availability of pre-existing cavities in the environment. According to Moorman et al. (1999)[29], the number of cavities increases with the age of trees, regardless of the physiognomy and structure of the vegetation. Undisturbed forests typically harbor more standing dead trees, which are potential sources of cavities for animals, compared to disturbed forests[30]. The study area is anthropized, and the reoccupation of *Polistes* sp. nests by these solitary wasp species may be a way to cope with the low number of naturally

available cavities in the area.

The structure and composition of social wasp nests are likely to be attractive to both Eumeninae and Crabronidae, as they provide cells of ideal size, whose cavity diameter is compatible with their body size[22,15,31,32]. These wasps typically need to use mud only to cover the external opening of the cell, which may offer energy savings, considering that solitary wasps spend most of their lifespan building and provisioning nests[30]. Additionally, the hydrophobic composition of the nest helps protect against rain[33], while the protective pedicel repels ants[8]. Another factor is how easily a solitary wasp can locate an abandoned *Polistes* nest with sufficient cells for reproduction, as the time spent searching for such substrate likely influences the number of cells it can provide[22].

However, this type of substrate is presumably also easily found by nest parasites. Furthermore, Wcislo (1996)[34] observed that grouping trap-nests in bundles facilitated their discovery by parasites. Therefore, these nests do not appear to be very efficient against attacks by parasites and parasitoids, as observed in nest 1, from which three parasitic individuals of the species *C. parvula* (Chrysididae: Chrysidinae) (Figure 3) and one parasitoid, *P. fumartus* (Ichneumonidae), emerged.

Figure 3. *Caenochrysis parvula* (Chrysididae: Chrysidinae) emerging from nest 1 of *Polistes* sp. (Vespidae: Polistinae) reused by *Trypoxylon aurifrons*. A. Frontal view of the head of *C. parvula*; B. Lateral view of the habitus of *Caenochrysis parvula*; Scale equals 2mm.



Insects of the subfamily Chrysidinae are parasites of bee and wasp larvae that build nests or, more frequently, act as kleptoparasites by consuming provisions in the nests of the hosts[35]. *Caenochrysis parvula* is a species widely distributed in the Neotropics and particularly

abundant in Brazil[36], with records parasitizing hosts of the genus *Trypoxylon* (Crabronidae)[37]. Another species in this subfamily, *Chrysis lincea* Fabricius, has been documented parasitizing *P. nasidens*[25].

Regarding Ichneumonidae, most species are parasitoids of immature stages of holometabolous insects[38]. The genus *Photocryptus* Viereck, which comprises ten known species, parasitizes exclusively aculeata wasp species in nests constructed from clay or containing mud[39,40]. Females of this parasitoid use their ovipositor as a drill to penetrate the clay of the nests and deposit their eggs in the host[41]. *Photocryptus fumartus* is a parasitoid of solitary wasps that building mud nests, such as Eumeninae and Sphecidae[39]. Additionally, *Trypoxylon* (*Trypargilum*) *albitarse* Fabricius and *T. nitidum* have been documented as hosts of *Photocryptus testaceus*[39], and *T. nitidum* as a host of *Photocryptus concinnus*[40], indicating a close relationship between *Photocryptus* and *Trypoxylon* species.

Therefore, it is likely that *C. parvula* and *P. fumartus* are parasitizing hymenopterans that are reusing the nests of social wasps, possibly Crabronidae or Eumeninae. Although both natural enemies emerged from nest 1, from which Crabronidae emerged, it cannot be definitively stated that these are the hosts of these parasites/parasitoids, as previously reported instances that Chrysididae and Ichneumonidae also attack species of Eumeninae.

CONCLUSIONS

The occupation of abandoned Polistinae nests by different Hymenoptera is likely to be frequent, particularly in anthropized environments, as a social wasp nest represents an alternative for a limited resource in nature: numerous pre-existing cavities, which save the occupant the effort of building parts of its own nests.

We emphasize that greater sampling effort is necessary to obtain new records. Additionally, futher studies are needed to investigate possible interactions between different occupants and to understand the relationships among Hymenoptera, particularly regarding potencial parasitism/kleptoparasitism and parasitoidism interactions.

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