Apidologie (2024) 55:21

https://doi.org/10.1007/s13592-024-01063-x

Scientific note

Scientific note on a Neotropical wasp preying on stingless bees

Samuel Boff[1], and Alexandre Somavilla[2]

[1] Institute of Evolutionary Ecology and Conservation Genomics, Ulm University, Ulm, Germany
[2] Coordenação de Biodiversidade, Instituto Nacional de Pesquisas da Amazônia, Manaus, Amazonas, Brazil

Received 13 November 2023 – Revised 23 January 2024 – Accepted 16 February 2024

Abstract – The antagonistic interaction between wasps and bees has long driven the attention of beekeepers and evolutionary entomologists. In the most classic reported interaction, *Vespa velutina* may invade the nest of honeybees and kill many of workers. Although this interaction has been registered to Asian honeybees, which was shown how to defend the nests, little or no attention has been given to similar interactions in the Neotropical region. Here, we report for the first time an antagonistic interaction between the wasp *Polybia ignobilis* and the stingless bees, *Tetragonisca angustula*. The wasp of this species was recorded killing and chewing guard bees near at the nest entrance of the stingless bee. Although our report is limited to answer evolutionary aspects of this interaction, it raises questions which may help to understand in the future the reasons this behavior evolved.

***Tetragonisca angustula* / *Polybia ignobilis* / agonistic interactions / Brazil**

1. INTRODUCTION

Social wasps (Vespidae: Polistinae) exhibit fascinating predation habits that play a crucial role in their ecosystem. These wasps are omnivorous, preying on a wide range of organisms, such as insects and spiders, and drinking nectar from flowers (Sühs et al. 2009; Somavilla et al. 2016; Prezoto et al. 2019). Wasps are generally highly efficient hunters, using their powerful stingers to paralyze or kill their prey. Once a wasp captures its prey, it brings it back to the nest to feed the developing larvae, contributing to brood survival. This predation behavior not only ensures the wasps' sustenance but also helps control pest populations in their habitat, for example, when performing predation of lepidopteran larvae species recognized as agricultural pests (Prezoto et al. 1994; Bichara Filho et al. 2010; Jeon et al. 2019). The foraging behavior of wasps highlights their ecological significance as both predators and, when they visit flowers, as pollinators (Vieira and Shepherd 1999; Sühs et al. 2009; Prezoto et al. 2019; Elisei et al. 2021).

Polybia ignobilis (Haliday 1836), a species commonly found in South America, ranging from Panama to South Brazil and Argentina (Carpenter and Marques 2001), is a social wasp well-known for its aggressive hunting and stinging behavior (Richards 1978). These wasps construct nests that are protected by envelopes and are typically situated in cavities on the ground or in tree hollows (Richards 1978). In a comprehensive study conducted by Gomes et al. (2007), they observed *P. ignobilis* foraging and preying on insects of the Diptera order found on pig carcass. Once captured and killed, these preys are reduced to a formless mass and subsequently distributed to nourish the brood (Gomes et al. 2007).

Corresponding author: S. Boff, samboff@gmail.com
Manuscript editor: James Nieh

The stingless bees, *Tetragonisca angustula* (Latreille 1811) (Apidae: Meliponini), are eusocial bees with wide distribution in the Neotropical region (Nogueira Neto 1970). The society of this species is divided in castes: queen, workers, and guards (Baudier et al. 2019). Some of the guards stand in the nest entrance while others hover in front of the nest in a stable position, both to protect the nest against the attack from natural enemies (Kärcher and Ratnieks 2009). The presence of guards at the nest entrance may suggest successive clashes with natural enemies. For instance, they are known to defend the nest from the attack by the cleptobiotic *Lestrimelitta limao* (Apidae: Meliponini) by biting legs and wings of the cleptobiotic. According to Wittmann et al. (1990), the cephalic volatiles of *L. limao* have a kairomonal effect on *T. angustula* workers, as they trigger their defense behavior. It is worth mentioning that guards are also keen to recognize non-nestmates and defend the nest against drifting (Jones et al. 2012).

Despite the defensive behavior of *T. angustula*, we do not know how this species would defend their nests against natural enemies of bigger size known to be efficient wasp predators. We already know, in similar case, that the Asian hornet *Vespa velutina* can quickly strike and decapitate honey bees; however, outside the natural region of distribution, these bees did not yet develop efficient strategies for nest defense (Arca et al. 2014).

In this study, we present preliminary observations of attacks by the wasp *P. ignobilis* on the eusocial stingless bees, *T. angustula* at the nest entrance.

Figure 1. A *P. ignobilis* females handling a guard of stingless bee, *T. angustula*, after preying on it at the bee nest entrance (Photo: SB).

2. MATERIAL AND METHODS

The observations were performed in a stingless bee nest placed at a beekeeping station, in the city of Itu, São Paulo, Brazil (23° 16′ S, 47° 15′ W). The beekeeping stations were about 14 m^2 large with the presence of five nests *of T. angustula* and nests of several other wild bee species, such *Centris* (Apidae: Centridini), *Xylocopa* (Apidae: Xylocopini), and *Euglossa* (Apidae: Euglossini) species. The attacks by *P. ignobilis* always occurred on individuals from the same nest (Supplementary Figure S1), which was positioned in the corner of the bee station approximately 85, 245, 420, and 480 cm away from the other nests.

Occasional observations ($n = 14$) started when the wasp(s) were observed flying near the nest or already standing in the proximity of the nest and lasted until the wasp(s) dispersed. The records took place between 12:00 and 17:00 on 30th September and on 1st, 2nd, and 9th October 2023 on sunny days.

3. RESULTS

During the preying attacks, the workers of *P. ignobilis* interrupted its flight by landing in nearby vegetation circa of 1.5 m from the nest entrance, or in the lateral of the *T. angustula* nest or directly on the wooden beam from which the nest was suspended only a few centimeters (~30 cm) from the nest entrance. In 85% ($n = 12$) of our observations, a single wasp was observed attempting to attack the bees. Only at two occasions, two wasps were simultaneously preying on bees. Before the attacks, it seemed that the wasps observed the behavior of the guard bees while hovering at the nest entrance. The wasp moved close to the nest entrance attempting to prey the bees while it was flying close to the nest entrance. Alternatively, the wasp started approaching the bees on foot walking on the hive wall. Following the latter, the wasps hub their antennae with the first two pairs of legs before moving towards the guard bees. The guard bees on the other hand flew in the direction of the wasp seeming to

Figure 2. A guard of *T. angustula* biting the left wing of a female of *P. ignobilis* near the stingless bee nest entrance (Photo: SB).

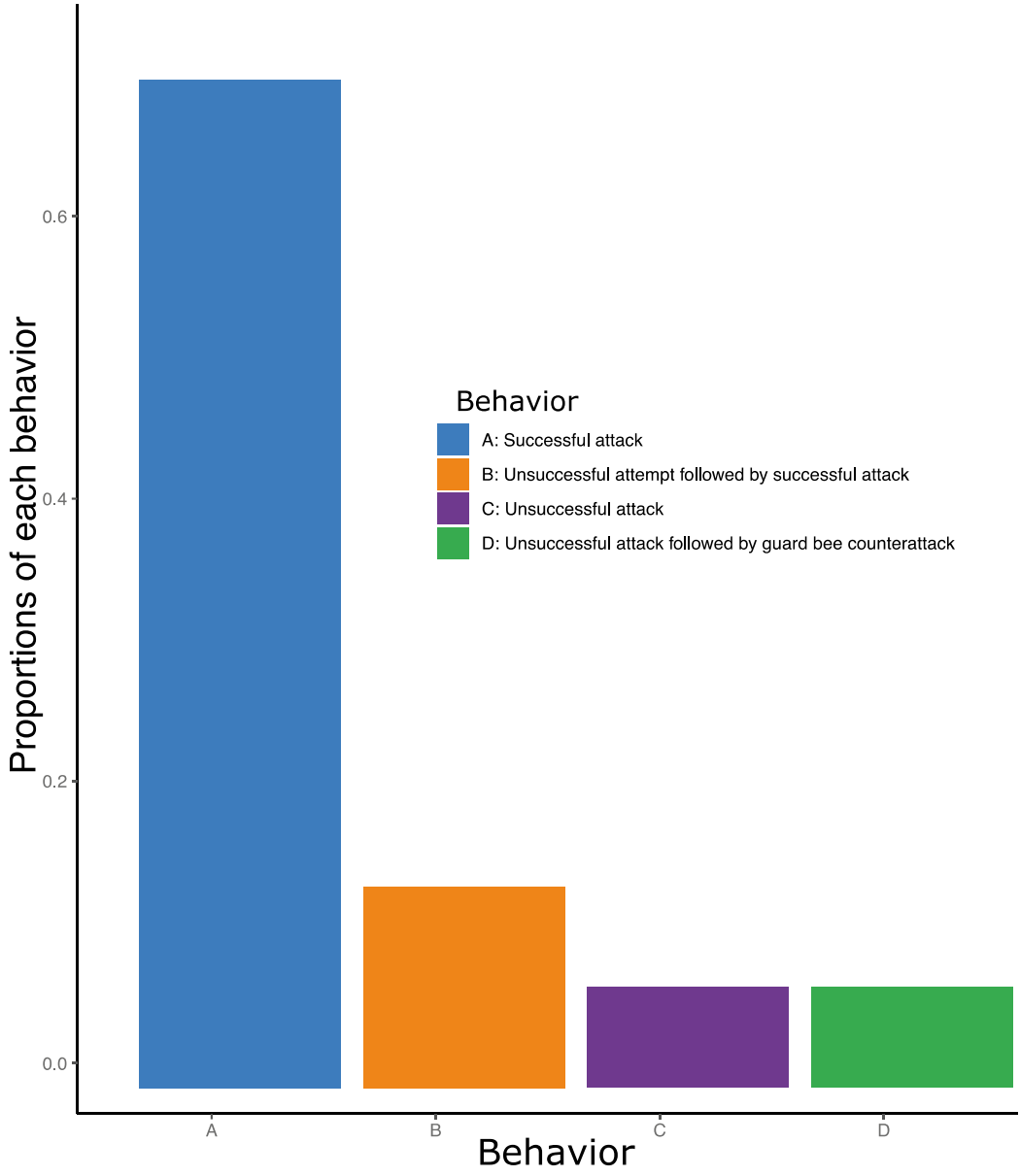

Figure 3. Proportion of each behavior displayed by wasps and bees.

push the wasps away. Four different behavioral sequences of this attack/defense behavior were recorded: (1) A successful attack occurs when the wasp successfully preys on a bee ($n = 10$) and flew away carrying it (Supplementary Video 1a), (2) following unsuccessful attempts, the wasp eventually achieves successful preying ($n = 2$) (Figure 1), (3) an unsuccessful attack occurs when the wasp fails to prey on the bees ($n = 1$), and (4) an unsuccessful attack is followed by a guard bee attacking the wasp by biting its wing ($n = 1$) (Figures 2 and 3).

4. DISCUSSION

Previous reports suggest a generalist preying behavior of *P. ignobilis* (Gomes et al. 2007). The current observation introduces to the Neotropical region a not well-documented case of wasps killing bees at the nest entrance, similar to the classic case of *V. velutina* and the honey bees. Although *P. ignobilis* is probably more opportunistic than specialized in *T. angustula*, many questions need to be answered for a better understanding of this interaction. Here, we observed more often events which the wasps seem to have advantage in this agonistic interaction. Although we observed one event which the stingless bee guard counterattacked the wasps, we did not know if this ended efficiently since they were missed after falling on the grass surrounding the nest.

Polybia ignobilis is a generalist predator and, as other social wasp foragers, probably do not behave as eventual killers. They prey on several resource items, including caterpillars and adult insects. Previous studies reported their predation behavior on Diptera, Hemiptera, Hymenoptera, Coleoptera, and mainly Lepidoptera of several species (Gobbi and Machado 1986; Gomes et al. 2007). Although wasps preying on bees has not been deeply investigated (but see Koedam et al. 2009), it has been mentioned that members of the Kayapó indigenous tribe, in the Amazon forest, assigned two species of *Polybia* to enter the nest of stingless bees and steal honey (Camargo and Posey 1990). Certainly, it is worth continuing to study such interactions in the Neotropics and learn which are the mechanisms trigging these interactions and how they evolved. For instance, we did not observe a massive bee attack to the wasp, as seen in Asian honey bees defending against *V. velutina*. In the future, it would be interesting to study whether there is a chemical mechanism by which *P. ignobilis* locates this particular bee species and to investigate whether bees rely on visual, chemical, or a combination of sensory cues to detect the presence of the predator.

Although our observations reveal an interesting interaction at the nest entrance and show the consume of *T. angustula* guards by *P. ignobilis* as a protein source, several other questions remain. For instance, could the absence of a massive attack behavior by the bees have allowed for predation conditions on a small scale? What would happen whether the guards are killed by multiple attacks of the wasps, would this consequently lead to wasp invasion and steal of the honey, as observed by the Kayapó indigenous people reported earlier (Camargo and Posey 1990)? It would be interesting for researchers to connect to stingless beekeepers in the natural distribution range of *T. angustula* to gain more information in this interaction to clarify this predator-prey interaction and follow if this emerges as a potential threat to stingless bees in the future.

SUPPLEMENTARY INFORMATION

The online version contains supplementary material available at https://doi.org/10.1007/s13592-024-01063-x.

ACKNOWLEDGEMENTS

The authors thank Patricia Nunes-Silva for commenting in the manuscript.

AUTHOR CONTRIBUTION

SB: collected and analyzed the data, drafted the first version, wrote the final version. AS: identified the wasp species, contribute with the draft version, collaborate in the final version.

FUNDING

Open Access funding enabled and organized by Projekt DEAL. Thanks to Aurelia Stiftung and Software AG-Stiftung for funding the first author.

DATA AVAILABILITY

The whole data is available in the main text as well as in the Supplementary Material.

CODE AVAILABILITY

Not applicable.

DECLARATIONS

Ethics approval Not applicable.

Consent to participate Not applicable.

Consent for publication Not applicable.

Conflict of interest The authors declare no competing interests.

REFERENCES

Arca M, Papachristoforou A, Mougel F et al (2014) Defensive behaviour of *Apis mellifera* against *Vespa velutina* in France: testing whether European honeybees can develop an effective collective defence against a new predator. Behav Processes 106:122–129. https://doi.org/10.1016/j.beproc.2014.05.002

Baudier KM, Ostwald MM, Grüter C et al (2019) Changing of the guard: mixed specialization and flexibility in nest defense (*Tetragonisca angustula*). Behav Ecol 30:1041–1049. https://doi.org/10.1093/beheco/arz047

Bichara Filho CC, Gilberto GM, Dos Santos Filho AB et al (2010) Foraging behavior of the swarm-founding wasp *Polybia* (*Trichothorax*) *sericea* (Hymenoptera, Vespidae): daily resource collection activity and flight capacity. Sociobiology 55:899–907

Camargo JMF, Posey DA (1990) O conhecimento dos Kayapó sobre as abelhas sociais sem ferrão (Meliponidae, Apidae, Hymenoptera): notas adicionais. Bol Do Mus Para Emílio Goeldi, Série Zool 6:17–42

Carpenter JM, Marques OM (2001) Contribuição ao estudo dos vespídeos do Brasil. Universidade Federal da Bahia, Departamento de Fitotecnia, Bahia, CD-ROM, p 147

Elisei T, Junior CR, Prezoto F (2021) Economic importance of Neotropical social wasps BT - Neotropical social wasps: basic and applied aspects. In: Nascimento FS, Barbosa BC, Somavilla A (eds) Prezoto F. Springer International Publishing, Cham, pp 443–457

Gobbi N, Machado VLL (1986) Material capturado e utilizado na alimentação de *Polybia* (Trichothorax) *ignobilis* (Haliday, 1836) (Hymenoptera, Vespidae). An Da Soc Entomológica Do Bras 15:117–124

Gomes L, Gomes G, Oliveira HG et al (2007) Foraging by *Polybia* (Trichothorax) *ignobilis* (Hymenoptera, Vespidae) on flies at animal carcasses. Rev Bras Entomol 51:389–393. https://doi.org/10.1590/S0085-56262007000300018

Jeon MG, Kim TG, Jung JC, Choi MB (2019) Prey diversity of *Polistes rothneyi* koreanus in different landscapes using DNA barcoding. J Appl Entomol 143:1052–1063. https://doi.org/10.1111/jen.12681

Jones SM, van Zweden JS, Grüter C et al (2012) The role of wax and resin in the nestmate recognition system of a stingless bee, *Tetragonisca angustula*. Behav Ecol Sociobiol 66:1–12. https://doi.org/10.1007/s00265-011-1246-7

Kärcher MH, Ratnieks FLW (2009) Standing and hovering guards of the stingless bee *Tetragonisca angustula* complement each other in entrance guarding and intruder recognition. J Apic Res 48:209–214. https://doi.org/10.3896/IBRA.1.48.3.10

Koedam D, Slaa EJ, Biesmeijer JC, Nogueira-Neto P (2009) Unsuccessful attacks dominate a drone-preying wasp's hunting performance near stingless bee nests. Genet Mol Res 8:690–702. https://doi.org/10.4238/vol8-2kerr032

Nogueira NP (1970) Criação de Abelhas Indígenas sem ferrão. Editora Chácaras e Quintais, São Paulo, p 369

Prezoto F, Giannotti E, Machado VLL (1994) Atividade forrageadora e material coletado pela vespa social *Polistes simillimus* Zikán, 1951 (Hymenoptera, Vespidae). InSecta 3:11–19

Prezoto F, Maciel TT, Detoni M et al (2019) Pest control potential of social wasps in small farms and urban gardens. Insects. https://doi.org/10.3390/insects10070192

Richards OW (1978) The social wasps of the Americas excluding the Vespinae. Britsh Museum Press, p 587

Somavilla A, Schoeninger K, De Castro DGD et al (2016) Diversity of wasps (Hymenoptera: Vespidae) in conventonal and organic guarana (Paullinia cupana, var. sorbilis) crops in the Brazilian Amazon. Sociobiology 63:1051–1057. https://doi.org/10.13102/sociobiology.v63i4.1178

Sühs RB, Somavilla A, Köhler A, Putzke J (2009) Vespídeos (Hymenoptera, Vespidae) vetores de pólen de *Schinus terebinthifolius* Raddi (Anacardiaceae), Santa Cruz do Sul, RS, Brasil. Rev Bras Biociências 7:138–143

Vieira MF, Shepherd GJ (1999) Pollinators of *Oxypetalum* (Asclepiadaceae) in southeastern Brazil. Rev Bras Biol 59:693–704. https://doi.org/10.1590/S0034-71081999000400018

Wittmann D, Radtke R, Zeil J et al (1990) Robber bees (Lestrimelitta limao) and their host chemical and visual cues In nest defense by *Trigona* (*Tetragonisca*) *angustula* (Apidae: Meliponinae). J Chem Ecol 16:631–641