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Predation record of bees (Apidae: Hymenoptera) by assassin bugs (Reduviidae: Hemiptera) in the cerrado

Registro de predação de abelhas (Apidae: Hymenoptera) por percevejos assassinos (Reduviidae: Hemiptera) no cerrado

Virley Gonçalves **RODRIGUES**[1]; Alexandre Camargo de **SOUZA**[1]; Márcio Junior **PEREIRA**[1]; Matheus Carneiro **HEINZELMANN**[1]; **Hélcio Reinaldo GIL-SANTANA**[2]; Pedro Vale de Azevedo **BRITO**[3]; Herick Soares de **SANTANA**[4]; Tatiana de Sousa **FIUZA**[1]; Paulo Vitor Divino Xavier de **FREITAS**[1]; Everton **TIZO-PEDROSA**[1] & Carlos de Melo e **SILVA-NETO**[1, 4, 5]

ABSTRACT
The predatory behavior of harpactorine assassin bugs on bees in different circumstances and locations is known and has been documented in the literature. In this paper we present three records of bee predation by two species of *Zelus* and one of *Heniartes* (Hemiptera: Heteroptera: Reduviidae: Harpactorinae), highlighting the predation behavior of the species in relation to stingless bees and the exotic bee *Apis mellifera* (Hymenoptera: Apidae: Apinae).
Keywords: Apidae, beekeeping, ecological interactions, meliponiculture, predation, Reduviidae.

RESUMO
O comportamento predatório de percevejos harpactoríneos sobre abelhas em diferentes circunstâncias e localidades é conhecido e já foi documentado na literatura. Neste trabalho, apresentamos três registros de predação de abelhas por duas espécies de *Zelus* e uma de *Heniartes* (Hemiptera: Heteroptera: Reduviidae: Harpactorinae), destacando o comportamento predatório das espécies em relação a abelhas sem ferrão e à abelha exótica *Apis mellifera* (Hymenoptera: Apidae: Apinae).
Palavras-chave: apicultura, Apidae, interações ecológicas, meliponicultura, predação, Reduviidae.

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INTRODUCTION

Ecological interactions are extremely variable (competition, predation, parasitism, among others) and consist of a range of behavioral and ecological repertoires that are ultimately responsible for life in terrestrial systems, the types of interactions that occur and the outcomes that these interactions can produce (DEL-CLARO & TOREZAN-SILINGARDI, 2012). The family Reduviidae, subfamily Harpactorinae, has the largest number of predator species in the order Hemiptera, represented by the Apiomerini and Harpactorini tribes of subfamily Harpactorinae in the neotropical region (MARQUES *et al.*, 2006). Estimated around 20 subfamilies and more than 7.000 species of Reduviidae, some of these individuals are known for their hymenopteran (bee and wasp) mimicry strategy (GIL-SANTANA, 2008; GIL-SANTANA *et al.*, 2015). The Reduviidae species richness can also be influenced by several environmental variables, such as temperature, precipitation, altitude, solar radiation and water vapor

[1] Universidade Estadual de Goiás (UEG), PPG Recursos Naturais do Cerrado, Av. Professor, n. 767, Jundiaí – CEP 75132-903, Anápolis, GO, Brasil.

[2] Instituto Oswaldo Cruz, Laboratório de Diptera, Manguinhos, Rio de Janeiro, RJ, Brasil.

[3] Universidade Federal de Goiás (UFG), *Campus* Samambaia, Goiânia, GO, Brasil.

[4] Instituto Federal de Goiás (IFG), Polo de Inovação, *Campus* Águas Lindas de Goiás, Goiânia, GO, Brasil.

[5] Corresponding author: carloskoa@gmail.com.

pressure, which condition the availability of resources, the survival of species and their interactions, so the Reduviidae species diversity increases as we approach the equator (FORERO *et al.*, 2011b).

The genus *Zelus*, which is considered as generalist predator (ZHANG *et al.*, 2016), comprises about 71 described species, among them, *Z. leucogrammus* (Perty, 1833). Accordingly with Zhang *et al.* (2016), it is one of the most distinctive species, presenting a different characterization from other species as it is a medium-sized predatory bug with minimal variation in color. In the adult form, it has an elongated orange-red body color with alternating black and white bands on the abdomen, the pronotum wings and legs being black and, additionally, females are larger than males (PARO *et al*., 2001). Some insect's species, including aphids and hymenopterans, feed on sugary substances secreted by plants or in nectaries. Consequently, these insects' groups are part of the assassin bug diet (MARQUES *et al.*, 2006; LEITE *et al.*, 2011). Upon locating its prey, the bug sizes it with its legs and pierces the arthropod's soft parts with its labium to inject its digestive toxins enzymes (GRAZIA *et al*., 2024). *Zelus leucogrammus* distribution covers South America with records in Argentina, Brazil, Colombia and Paraguay and in Brazil it covers some regions of South, Southwest, Central-West, Northeastern (ZHANG *et al.*, 2016).

The resinous insects of Apiomerini tribe (Reduviidae: Harpactorinae), also known as bee killers, are known for their formidable predation and parental care strategies. They collect plant resins with their front paws and use this "sticky trap" to enhance their efficacy during prey capture. This is exemplified by the genus *Apiomerus* Hahn, 1831, in addition to which the Apiomerini also includes the relatively specific genus *Heniartes* Spinola, 1840 (31 spp.). The remaining genera are relatively small. In the process of oviposition, the female transfers the resin to the abdominal region, from where it is later removed using a comb on the metatibia to coat the egg clutch. The resin serves a dual purpose: it protects the eggs from desiccation and predators, and it is also used by nymphs that are precocious, as a sticky trap to catch their first meals (GIL-SANTANA & FORERO., 2010). The collection of resin by bee killer insects is therefore not only an unusual predation strategy but also represents a unique approach to maternal care (FORERO, 2011).

Several cases have been documented in which assassin bugs have preyed upon bees. Nogueira-Neto (1997) observed the presence of reduviids belonging to the genus *Apiomerus* at Jatiara Farm in the municipality of Luziânia (GO), noting that they were feeding on "Jataí" (*Tetragonisca angustula* (Latreille 1811)) and other Meliponines, waiting the opportunity to attack these bees, particularly on flowers. However, these reduviids were seen in the meliponary itself killing their victims in close proximity to the entrance to the hives or in the vicinity of a wild nest. Additionally, Gil-Santana & Forero (2010) delineated the predatory behavior of bees by assassin bugs (Hemiptera: Heteroptera: Reduviidae: Harpactorinae). The authors demonstrate that the species were documented in Rio de Janeiro, namely *Apiomerus mutabilis* Costa Lima, Seabra & Hathaway, 1951 and *Heniartes jaakkoi* Wygodzinsky, 1947, engaging in predation of bees, thereby substantiating the plausibility of this predatory behavior in natural ecosystems.

In another Meliponini bee predation record, Silva *et al*. (2016) reported the presence of Reduviidae in an arthropod survey associated with "Jandaíra" hives (*Melipona subnitida* (Duke 1910)) in the municipality of Mossoró (RN). In accordance with the findings of Silva & Gil-Santana (2004), the species *Apiomerus pilipes* can be regarded as a natural enemy of stingless bees. The study conducted in Amazonas (AM) showed that only females were observed preying on worker bees (*Melipona compressipes manaosensis* (Schwarz, 1932)), when the predation behavior exhibited by these females involved capture, immobilization, death, and manipulation of their prey.

A variety of natural enemies threaten the survival of bee colonies, including several ants' species, other bees, spiders, lizards, birds, small mammals, and frogs (PEREIRA *et al*., 2012). However, in a natural and balanced environment, these predators do not pose a significant threat to the development and stability of bee colonies. Nevertheless, for the scientific development of meliponiculture and beekeeping, particularly in the Brazilian biome cerrado, where there is a paucity of records and knowledge regarding predation interactions to bee species, it is crucial to comprehend the ecological interactions between bees and their predators. In this context, the objective of this study is to document the interactions between predatory insects and bees, with a particular focus on the predatory bugs *Zelus leucogrammus* and *Heniartes*, which prey on stingless bees and on the exotic bee *Apis mellifera*.

MATERIAL AND METHODS

The initial observation was made in a domestic meliponary situated in the Goiânia region of the Goiás state (-16.587701, -49.292488), close to a peri-urban area. The assassin bug was recorded in August 2020, while other species individuals in immature stages were collected near the meliponary (figure 1). The second survey was conducted in Goiânia (GO) as well, in a region close to the Meia Ponte River, in February 2024, in an urban area with anthropogenic vegetation, adjacent to the river in the Vila Roriz neighborhood (-16.642834, -49.265401). The specimen was collected, placed in a container with 70% alcohol, photographed, and submitted for entomological identification. In both instances, the bugs were observed engaging in predatory behavior targeting bees, before their collection. The third record was conducted in the municipality of Pirenópolis, at Serra dos Pirineus region in May 2024, in a cerrado biome area, with well-preserved native vegetation (-15.827506, -48.905323) (figure 1).

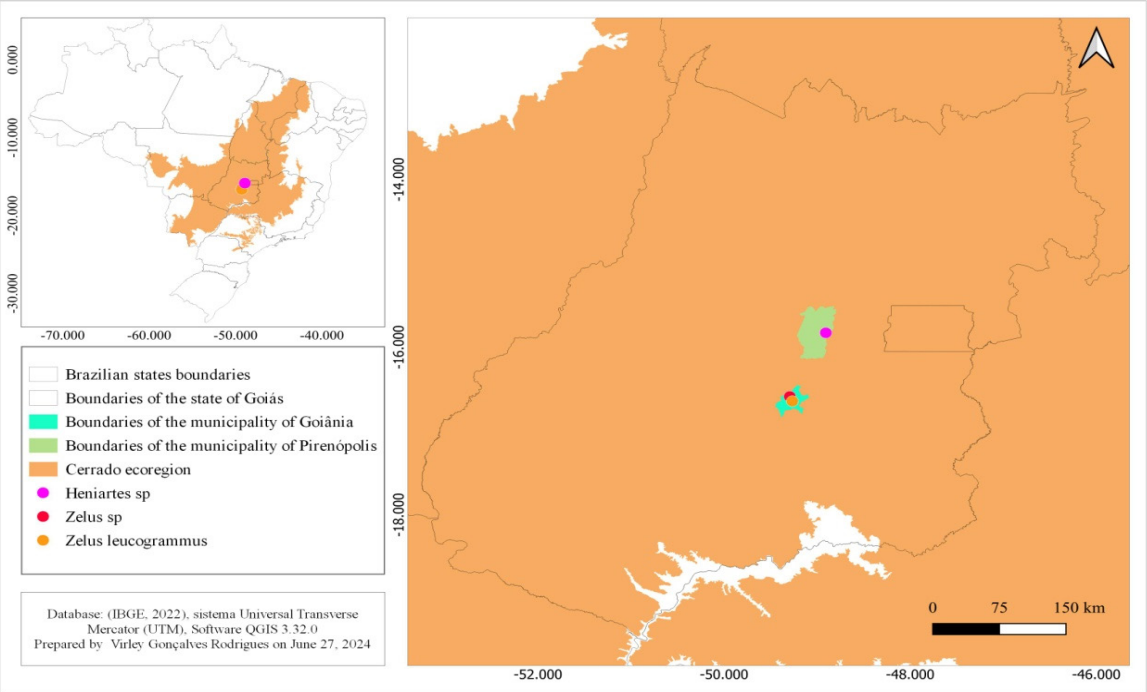

Figure 1 – Map of occurrence of predation records of bees (Apidae; Hymenoptera) by bugs (Reduviidae: Hemiptera: Harpactorinae) in the cerrado. Source: primary.

RESULTS

The initial photographic documentation pertained to a member of the *Zelus* genus, though the species could not be identified with certainty, due to the necessity of a male specimen to verify genitalia details. The specimen was observed in a metal structure containing "Jataí" bee nest boxes (*Tetragonisca angustula* (Latreille, 1811)). The reduviid was observed feeding on two "Jataí" bee specimens using its labium (figure 2A). Additionally, reduviid nymphs' specimens were observed on "Guapuruvu" (*Schizolobium parahyba* (Vell.) SF Blake) branches, where they were capturing "Jataí" bees that had collected resins from the tree.

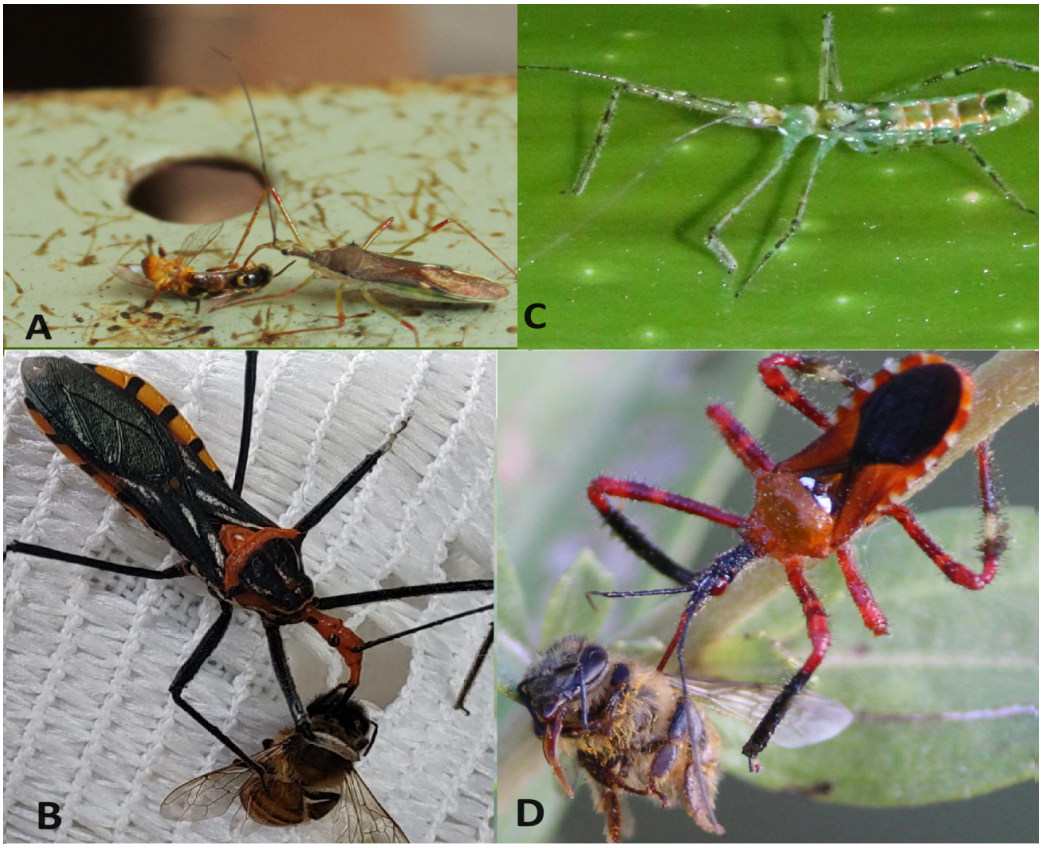

Figure 2 – A) *Zelus* sp. feeding on *Tetragonisca angustula* bee; B) *Zelus leucogrammus* feeding on *Apis mellifera*; C) *Zelus* sp. nymph; D) *Heniartes* sp. (Harpactorinae: Apiomerini) feeding on *Apis mellifera*. Source: primary.

The second record was an individual of *Zelus leucogrammus* (Perty, 1833) (Reduviidae: Harpactorinae: Harpactorini), which was observed preying on the exotic bee *Apis mellifera* Linnaeus, 1758 (figure 2B). The genus *Zelus* has a wide distribution throughout South America, with only one record in Cuba (Caribbean). In Brazil, the species is predominantly found in the northern regions, including the state of Amazonas, and then progresses through the central-western states (such as Goiás). It is particularly prevalent in the southwestern states of Minas Gerais, São Paulo, Rio de Janeiro, and Espírito Santo, with isolated occurrences in the southern state of Rio Grande do Sul.

The third specimen was identified as an individual of the genus *Heniartes* Spinola, 1840 (Reduviidae: Harpactorinae: Apiomerini), which was observed preying on the exotic bee *Apis mellifera* Linnaeus, 1758 (figure 2D). The insect was discovered on a *Tithonia rotundifolia* (Mill.) S.F. Blake flower, where it was observed feeding on the bee that had been engaged in foraging activities.

OBSERVATIONS

Brazil. Goiás. Goiânia (figure 2A); -16.587701; -49.292488; 03.VIII.2020; Silva-Neto C. M.; human observation and photo recording. Meia Ponte River (figure 2B); -49.292488; -49.265401; 06.II.2024; Silva-Neto C. M.; human observation and photo recording. Goiânia (figure 2C); -16.587701; -49.292488; 03.VIII.2020; Silva-Neto C. M.; human observation and photo recording. Pirenópolis. Serra dos Pirineus (figure 2D); -15.827506; -48.905323; 20.V.2024; Silva-Neto C. M.; human observation and photo recording.

DISCUSSION

The primary records in this study pertain to the occurrence of *Zelus* feeding on bee *Tetragonisca angustula* and the feeding of *Zelus leucogrammus* and *Heniartes* sp. on *Apis mellifera*. All records are relevant to national apiculture and beekeeping, as they present a group of insects that can interact with colonies and may (or may not) cause some type of damage to the development of bees.

The observed predation event indicates complex ecological relationships that require further study that may lead to the understanding of the predatory capacity of these bugs on native and exotic hymenopterans species, as well as whether the preference for any of these prey and this relationship may have ecological significance for discussions about the conservation of bees, which are key species specializing in the ecosystem service of pollination, helping to develop and balance biodiversity.

The record of assassin bugs that feed on bees is of significant importance in both meliponiculture and beekeeping. This is evidenced by the findings of Silva & Gil-Santana (2004), and Silva *et al*. (2016), who report the predation of other genera of assassin bugs on bees in meliponaries. Another noteworthy aspect of our study is the scarce documented instances in the literature of predatory assassin bugs preying on bees from the tribe Meliponini. The observation of feeding on *Apis mellifera* may signify a novel interaction behavior between reduviids, native and exotic bees. This highlights the predatory preference of these individuals, reinforcing their status as natural enemies of bees, with a high probability of causing harm to nesting sites. This study contributes to the understanding of the interactions between reduviid and bees, thereby expanding our knowledge about the ecological dynamics of these organisms.

The results provide valuable insights for the conservation of bees and maintenance of biodiversity, emphasizing the necessity for further studies to fully elucidate these complex relationships. It can be concluded that predatory reduviid bugs are natural enemies of bees, exhibiting hunting patterns and adapting to the availability of habitat resources.

The study presents records of genus *Zelus* and *Heniartes* assassin bugs feeding on native and exotic bees, highlighting complex ecological relationships that deserve more detailed research. The need to understand the predatory capacity of these reduviids in relation to Hymenoptera species, including native and exotic bees, is crucial to assess their impact on the biodiversity and bees conservation, as it is known that bees play a fundamental role as pollinators.

CONCLUSION

The results highlight the importance of research on the ecology of these assassin bugs, their ecological interaction, aiming to better understand their predatory capacity and food preferences as the presence of these bugs sucking *Tetragonisca angustula* bees and *Apis mellifera* raises important questions about the ecological relationships between predators and prey.

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