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Egg parasitoids of stink bugs (Hemiptera: Coreidae and Pentatomidae) on soybean and cowpea in Brazil

Antonio de Almeida Paz-Neto[1], Ranyse B. Querino[2,], and Cecilia B. Margaría[3]*

Abstract

Parasitoids naturally attacking stink bug (Hemiptera: Coreidae and Pentatomidae) eggs and interactions with their hosts were recorded on soybean (*Glycine max* [L.] Merril; Fabales: Fabaceae) and cowpea (*Vigna unguiculata* [L.] Walp.; Fabales: Fabaceae) host plants in Brazil. Egg masses of stink bugs collected from plant structures were observed daily until emergence of either parasitoids or bugs. Stink bugs were parasitized by 8 species of egg parasitoids: *Trissolcus urichi* Crawford, *Trissolcus teretis* Johnson, *Trissolcus bodkini* Crawford, *Telenomus podisi* Ashmead, *Phanuropsis semiflaviventris* Girault (Hymenoptera: Platygastridae), *Neorileya flavipes* Ashmead (Hymenoptera: Eurytomidae), *Ooencyrtus anasae* (Ashmead) (Hymenoptera: Encyrtidae), and *Anastatus* sp. (Hymenoptera: Eupelmidae). *Trissolcus urichi*, *Te. podisi*, *O. anasae*, and *N. flavipes* parasitized eggs of 2 or more species of stink bugs, and *Tr. urichi* and *Te. podisi* were the most generalist. *Phanuropsis semiflaviventris*, *Tr. teretis*, *Tr. bodkini*, and *Anastatus* sp. showed specialist behavior, because each of them parasitized only 1 species of stink bug.

Key Words: biological control; generalist; host; *Glycine max*; *Vigna unguiculata*

Resumen

Se registraron los parasitoides que atacan los huevos de los chinches (Hemiptera: Coreidae y Pentatomidae) de forma natural y las interacciones con sus hospederos sobre las plantas hospederas soja (*Glycine max* [L.] Merrill; Fabales: Fabaceae) y caupí (*Vigna unguiculata* [L.] Walp .; Fabales: Fabaceae) en Brasil. Se observaron masas de huevos de chinches recolectados sobre las estructuras vegetales todos los días hasta la emergencia de los parasitoides o chinches. Los chinches fueron parasitados por 8 especies de parasitoides de huevos: *Trissolcus urichi* Crawford, *Trissolcus teretis* Johnson, *Trissolcus bodkini* Crawford, *Telenomus podisi* Ashmead, *Phanuropsis semiflaviventris* Girault (Hymenoptera: Platygastridae), *Neorileya flavipes* Ashmead (Hymenoptera: Eurytomidae), *Ooencyrtus anasae* (Ashmead) (Hymenoptera: Encyrtidae) y *Anastatus* sp. (Hymenoptera: Eupelmidae). Las avispas *Trissolcus urichi*, *Te. podisi*, *O. anasae* y *N. flavipes* parasitaron los huevos de 2 o más especies de chinches, y *Tr. urichi* y *Te. podisi* fueron los más generalistas. Las avispas *Phanuropsis semiflaviventris*, *Tr. teretis*, *Tr. bodkini* y *Anastatus* sp. mostraron un comportamiento especialista, ya que parasitaron sólo una especie de chinche.

Palabras Clave: control biológico, generalista, hospedero, *Glycine max, Vigna unguiculata*

Stink bugs (Hemiptera: Coreidae and Pentatomidae) attack a variety of host plants and are a common and potentially severe pest of soybean (*Glycine max* [L.] Merrill; Fabales: Fabaceae) and cowpea (*Vigna unguiculata* [L.] Walp.; Fabales: Fabaceae) in Brazil. The phytophagous pentatomids are among the major insect pests on soybean. Feeding primarily on grains, they cause irreversible damage to seed development. *Euschistus heros* (F.), *Nezara viridula* (L.), and *Piezodorus guildinii* (Westwood) (Hemiptera: Pentatomidae) are examples of the most relevant stink bug species (Panizzi & Slansky 1985; Panizzi et al. 2012).

The red-banded stink bug *P. guildinii* has become a significant yield-limiting pest of soybean. Although already reported in the United States in 1892, *P. guildinii* was never considered an economically relevant pest until recently (Temple et al. 2013). *Crinocerus sanctus* (F.) (Hemiptera: Coreidae) and *P. guildinii* are important cowpea pests in Brazil. *Crinocerus sanctus* is considered one of the most widespread stink bugs on cowpea pods in the world (Jackai & Adalla 1997). In Brazil, *C. sanctus* is ranked as a key pest in some parts of northern Brazil (Pará, Amazonas, and Acre States) and as key or sporadic pest in the northeastern States (Mitchell 2000).

A biological control program to manage stink bug pests on soybean fields is desirable. Egg parasitoids are the main natural enemies of pentatomid stink bugs on soybean (Pacheco & Corrêa-Ferreira 2000) and are a good example of successfully applied biological control agents on this crop (Bueno et al. 2012). The parasitoid–host association of *Trissolcus basalis* (Wollaston) (Hymenoptera: Platygastridae) and *N. viridula* has become a favored model system in ecological, behavioral, and physiological research on insects (Austin et al. 2005). Results indicate that stink bug egg parasitoids and predators are significant factors in the biological control of stink bugs in corn fields (Tillman 2010).

In Brazil, 23 species of egg parasitoids of stink bugs in soybean have been confirmed, of which *Tr. basalis* and *Telenomus podisi* (Ashmead) (Hymenoptera: Platygastridae) show greater rates of parasitism than other species, and are commonly applied for stink bug control (Bueno et al. 2012). In contrast, research on the biological control of stink bugs attacking cowpea is scarce, and studies on parasitism on coreid eggs

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need to be developed. One of the most common egg parasitoids of coreids is *Gryon* spp. (Hymenoptera: Platygastridae) (Loiácono & Margaría 2002; Maltese et al. 2012; Marchiori 2013).

Stink bug populations in areas of grain and seed production have increased mainly because of the selection of populations that are resistant to the main insecticides used, and because of ecological imbalances caused by the improper use of broad-spectrum insecticides (Bueno et al. 2011, 2015). Thus, for sustainable crop management, biological control of stink bugs is becoming increasingly relevant within the context of integrated pest management (IPM). A survey of parasitoids is a fundamental step to the identification of species that may serve as potential biological control agents of stink bugs. Here we identified species of naturally occurring stink bug egg parasitoids and their host interactions on soybean and cowpea in mid-northern Brazil.

Materials and Methods

Field collections of eggs were carried out in Bom Jesus (9°16'5.71"S, 44°44'15.4"W) and Teresina (5°2'21.36"S, 42°47'22.44"W), Piauí, Brazil. The town of Teresina is located in a transition area between 2 biomes, Cerrado and Caatinga, with deciduous forest vegetation, whereas the municipality of Bom Jesus is located in an area of Cerrado, with vegetation typical for an ecologically stressed area, similar to savannah vegetation (IBGE 2004).

Stink bug eggs were collected from cowpea and soybean fields in 2011, 2012, and 2013, after visual inspection of plants. Samples were random and qualitative, in order to obtain the greatest possible diversity from the samples areas. We also searched for phytophagous bugs on alternative host plants near areas of soybean and cowpea cultivation, and collected egg masses found on coastal hibiscus (*Hibiscus tiliaceus* L.; Malvales: Malvaceae).

Collected egg masses were placed individually in small glass tubes and kept under laboratory conditions (25 ± 2 °C, 12:12 h L:D photoperiod) until the emergence of parasitoids or bug immatures. Emerged parasitoids were preserved in 70% alcohol. Species were identified according to Johnson (1984a,b, 1985, 1987a,b) and Grissell & Schauff (1990). Voucher specimens were deposited in the Insect Collection of Embrapa Meio-Norte, Teresina, Piauí, Brazil. A map with the geographical distribution of the main species of stink bug egg parasitoids in Brazil was drawn according to a survey based on data published in the scientific literature and on our own records.

Results and Discussion

Parasitized eggs of *Dichelops* sp., *E. heros, N. viridula*, *P. guildinii* (Hemiptera: Pentatomidae), and *C. sanctus* (Hemiptera: Coreidae) were collected from soybean plants. These same bug species were also collected from cowpea, with the exception of *E. heros*. All parasitized eggs on coastal hibiscus were those of *Antiteuchus sepulcralis* F. (Hemiptera: Pentatomidae) (Table 1).

We recorded 8 species of egg parasitoids from 4 families: *Trissolcus urichi* Crawford, *Trissolcus teretis* Johnson, *Trissolcus bodkini* Crawford, *Telenomus podisi*, *Phanuropsis semiflaviventris* Girault (Hymenoptera: Platygastridae), *Ooencyrtus anasae* (Ashmead) (Hymenoptera: Encyrtidae), *Neorileya flavipes* Ashmead (Hymenoptera: Eurytomidae), and *Anastatus* sp. (Hymenoptera: Eupelmidae) (Table 1, Fig. 1). *Piezodorus guildinii*, *N. viridula*, and *Dichelops* sp. eggs were parasitized by 4 parasitoid species, *E. heros* and *A. sepulcralis* by 2 species, and *C. sanctus* by only 1 parasitoid species.

Trissolcus urich and *Te. podisi* parasitized eggs of all collected pentatomids, except *A. sepulcralis*, which was exclusively parasitized by *P. semiflaviventris* and *Tr. bodkini*. *Crinocerus sanctus* was parasitized only by *O. anasae*. *Trissolcus urichi*, *Te. podisi*, and *O. anasae* occurred on the greatest variety of stink bugs, suggesting that these species are generalists.

In Teresina, Piauí, interactions between the stink bugs *P. guildinii*, *N. viridula*, *E. heros*, *C. sanctus*, *A. sepulcralis*, and *Dichelops* sp. and the parasitoids *Tr. urichi*, *Tr. teretis*, *Tr. bodkini*, *Te. podisi*, *P. semiflaviventris*, *N. flavipes*, *O. anasae*, and *Anastatus* sp. were re-

Table 1. Interactions between stink bugs and egg parasitoids collected from soybean, cowpea, and coastal hibiscus.

Municipality	Plant species	Stink bug species	Parasitoid species
Bom Jesus	cowpea	*Dichelops* sp.	*Telenomus podisi*
Teresina	coastal hibiscus	*Antiteuchus sepulcralis*	*Phanuropsis semiflaviventris*
		Antiteuchus sepulcralis	*Trissolcus bodkini*
Teresina	soybean	*Piezodorus guildinii*	*Trissolcus urichi*
		Piezodorus guildinii	*Trissolcus teretis*
		Piezodorus guildinii	*Telenomus podisi*
		Piezodorus guildinii	*Ooencyrtus anasae*
		Nezara viridula	*Trissolcus urichi*
		Nezara viridula	*Neorileya flavipes*
		Nezara viridula	*Telenomus podisi*
		Nezara viridula	*Ooencyrtus anasae*
		Euschistus heros	*Telenomus podisi*
		Euschistus heros	*Trissolcus urichi*
		Dichelops sp.	*Trissolcus urichi*
		Dichelops sp.	*Telenomus podisi*
		Dichelops sp.	*Anastatus* sp.
		Dichelops sp.	*Neorileya flavipes*
		Crinocerus sanctus	*Ooencyrtus anasae*
Teresina	cowpea	*Piezodorus guildinii*	*Trissolcus urichi*
		Crinocerus sanctus	*Ooencyrtus anasae*
		Nezara viridula	*Neorileya flavipes*

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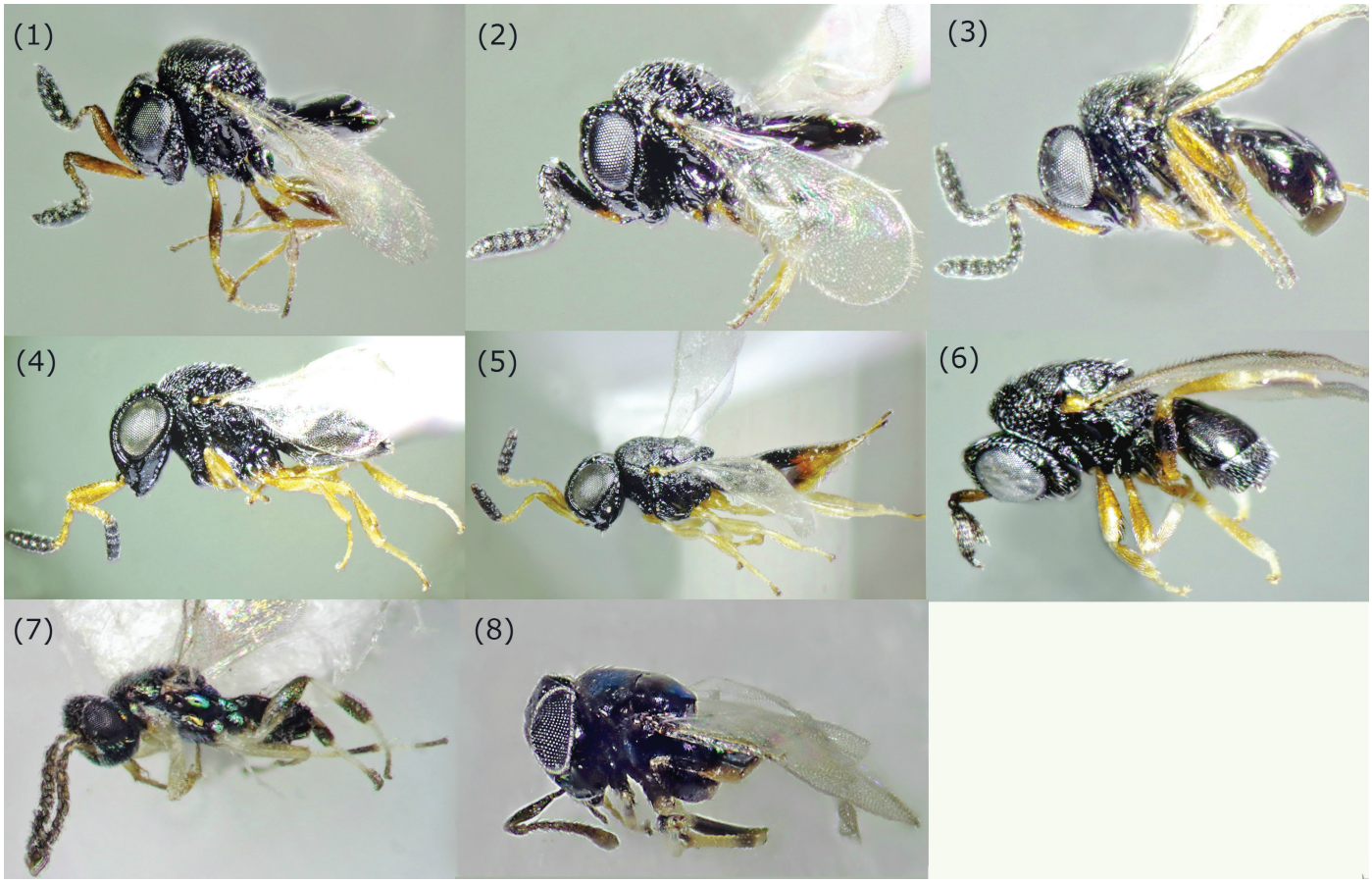


Fig. 1. Female, lateral view. (1) *Trissolcus urichi*, (2) *Trissolcus teretis*, (3) *Telenomus podisi*, (4) *Trissolcus bodkini*, (5) *Phanuropsis semiflaviventris*, (6) *Neorileya flavipes*, (7) *Anastatus* sp., (8) *Ooencyrtus anasae.*

corded for both crops, whereas in Bom Jesus, Piauí, only *Dichelops* sp. eggs were found on cowpea, which were uniquely parasitized by *Te. podisi*.

Trissolcus urichi and *Te. podisi* seem to prefer eggs of the 2 main *Dichelops* species found in Brazil: *D. furcatus* (F.) and *D. melacanthus* (Dallas), which were also observed in soybean crops in Mato Grosso do Sul and Distrito Federal by Santos (2008) and Laumann et al. (2010), respectively. *Dichelops* sp. and *N. viridula* were also parasitized by *N. flavipes*. Ours is the first record of *N. flavipes* parasitism of eggs of the pentatomid *N. viridula* in cowpea, although Corrêa-Ferreira & Moscardi (1995) had already reported *Neorileya* sp. parasitism on eggs of *N. viridula* and *D. melancanthus* in soybean in Londrina, Paraná, Brazil.

Crinocerus sanctus is a major pest of cowpea but few studies have involved its natural enemies. Our results demonstrated parasitism by *O. anasae* of *C. sanctus* as well as of *P. guildinii* and *N. viridula* eggs in Brazil. However, *Ooencyrtus* sp. has previously been recorded on stink bug eggs at various locations; for example, on *P. guildinii* in Minas Gerais, Brazil (Venzon et al. 1999), and on *N. viridula* from corn crops in Georgia, USA (Tillman 2010).

Most egg parasitoids of stink bugs on soybean show a generalist behavior by parasitizing eggs of various species. However, some species have a strong preference for a particular host, such as *Te. podisi* for eggs of *E. heros* and *Tr. basalis* for eggs of *N. viridula* (Corrêa-Ferreira 2002). Furthermore, Cingolani et al. (2014) confirmed that *P. guildinii* is a more suitable host for *Te. podisi* and *Tr. urichi* than for *Tr. basalis*. Polyphagy by egg parasitoids can favorably impact their suitability as control agents because alternate hosts may assist their permanence and population growth in the field (Corrêa-Ferreira 2002). The parasitoids *Tr. urichi*, *Te. podisi*, *O. anasae*, and *N. flavipes* parasitized eggs of 2 or more stink bug species, with *Tr. urichi* and *Te. podisi* showing the most generalist behavior.

In contrast, *P. semiflaviventris*, *Tr. teretis*, *Tr. bodkini*, and *Anastatus* sp. showed specialist behavior, each parasitizing only a single stink bug species. *Phanuropsis semiflaviventris* and *Tr. bodkini* exclusively parasitized eggs of *A. sepulcralis*. Similar observations were made on *P. semiflaviventris* that parasitized eggs of *A. sepulcralis* on *Hibiscus pernambucensis* Arruda (Malvales: Malvaceae) in Rio de Janeiro, Rio de Janeiro State (Santos & Albuquerque 2001), and on *Tr. bodkini* that parasitized eggs of *Antiteuchus tripterus limbativentris* in Cali, Colombia (Eberhard 1975). We recorded *Tr. bodkini* for the first time to parasitize eggs of *A. sepulcralis* in Brazil.

Because of its generalist behavior, *O. anasae* is of interest as a biological control agent of bugs on cowpea fields, where it was the only egg parasitoid of *C. sanctus*. In Brazil, egg parasitoids on stink bugs were sampled in several states (Fig. 2), following the distribution of stink bugs and the expansion of soybean and cowpea production. Generalist parasitoid species tend to have a wider distribution, as is the case for *Te. podisi* that was registered at least in 10 of the 26 Brazilian states. On the other hand, for *Trissolcus* species, our results as well as data from the scientific literature indicate that *Tr. basalis* predominates in central southern Brazil and *Tr. urichi* in central northern Brazil.

The results of this study contribute to the knowledge of interactions between egg parasitoids and phytophagous bugs, with new records of host associations and geographic distribution.

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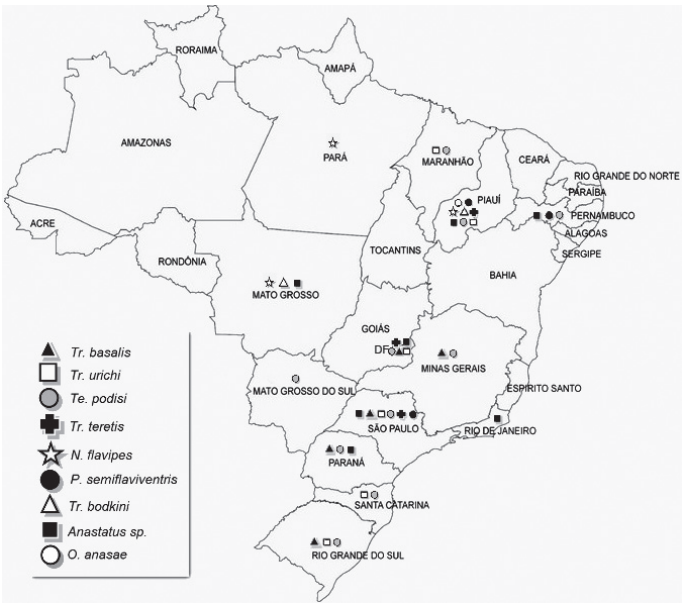


Fig. 2. Map of the known occurrence of the stink bug parasitoids *Trissolcus basalis*, *Tr. urichi*, *Tr. teretis*, *Tr. bodkini*, *Telenomus podisi*, *Phanuropsis semiflaviventris*, *Neorileya flavipes*, *Ooencyrtus anasae*, and *Anastatus* sp. in Brazil.

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