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Gasteruptiidae (Hymenoptera, Evanioidea) of three savannah phytophysiognomies of the Estação Ecológica do Jataí, in southeastern Brazil, under three sampling methods and a new record for *Gasteruption helenae* Macedo, 2011

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Abstract: In this study, the Gasteruptiidae species found at the Estação Ecológica de Jataí (EEJ), in Luiz Antonio, São Paulo, Brazil, were documented, based on a survey carried out with Malaise, Moericke and light traps that lasted for three years, between January 2007 and December 2009. During the samplings at EEJ, 13 female specimens of *Gasteruption* Latreille, 1796 were captured: six of *G. bispinosum* Kieffer, 1904, six of *G. brasiliense* (Blanchard, 1840) and a single specimen of *G. helenae* Macedo, 2011 that is the first record for São Paulo state.

Key words: Brazilian savannah, *Gasteruption bispinosum*, *Gasteruption brasiliense*, *Gasteruption helenae*, Neotropical Region.

INTRODUCTION

Gasteruptiidae (Hymenoptera: Evanioidea) is a small and distinctive group of parasitic wasps with worldwide distribution (Gauld 2006, Zhao et al. 2012). They are recognized from other wasps by the elongated neck-like propleuron, the highly attached metasoma on the propodeum and the swollen hind tibiae (Zhao et al. 2012, Tan et al. 2016). The family is comprised of about 500 described species, divided in two subfamilies: Gasteruptiinae and Hyptiogastrinae (Crosskey 1953, Jennings & Austin 2002, Gauld 2006, Smith 2006, Macedo 2011).

Macedo (2009) revised the Gasteruptiinae and proposed the division of the subfamily into four genera: the cosmopolitan *Gasteruption* Latreille, 1796, predominant, with some 400 species, and other three genera restricted to the Neotropical region: *Plutofoenus* Kieffer, 1911, *Trilobitofoenus* Macedo, 2009 and *Spinolafoenus* Macedo, 2009, with seven species in total. The Neotropical fauna of Hyptiogastrinae includes two *Pseudofoenus* Kieffer species (Jennings & Austin 2002). Macedo (2011) revised the Neotropical fauna of *Gasteruption* and found 26 species, 10 of them with recorded occurrence for Brazil and five for the state of São Paulo.

Larval instars of Gasteruptiidae act as predator-inquilines in nests of solitary bees including Apidae, Colletidae, Crabronidae, Halictidae, Megachilidae, and Stenotritidae (Jennings & Austin 2004, Zhao et al. 2012); there is no direct evidence for wasps being hosts of Gasteruptiidae (Crosskey 1953, Gauld 1995, Jennings & Austin 1997a, b, 2004).

Very little is known about the hosts of Neotropical Gasteruptiidae, with only four known hosts: *Gasteruption brachychaetum* Schrottky, 1906 - host: *Hylaeus* sp. (Hym.: Colletidae)

(Macedo et al. 2012), *G. floridanum* (Bradley, 1908) - hosts: *Hylaeus cressoni* (Cockerell, 1907) (Hym.: Colletidae) and *Trypoxylon frigidum* Smith, 1856 (Hym.: Crabronidae) (Walkley 1967), *G. kaweahense* (Bradley, 1909) - host: *Ceratina pacifica* Smith, 1907 (Hym.: Apidae) (Daly et al. 1967, Parker & Bohart 1968) and *G. visaliae* (Bradley, 1909) - host: *H. cressoni* (Parker & Bohart 1968).

This study aimed to characterize the diversity of Gasteruptiidae collected in areas of riparian vegetation, Brazilian savannah, and savannah woodland vegetation at Estação Ecológica de Jataí (EEJ), to evaluate the collection methods used to catch this group of parasitoids and provide new distribution records.

Knowledge about the composition of the parasitic Hymenoptera fauna in the Cerrado Biome is very important: this environment is one of most threatened by human action in the world. Using comparison of images from the Landsat and CBERS satellites the Brazilian Ministry of the Environment mapped the deforestation in Cerrado between 2002 and 2008 and found that the Cerrado vegetation cover suppressed was 85,074 km², which accounts approximately 14,000 km² deforested annually in that period (Brasil 2009).

This inventory will assist in the provision of subsidies, however modest, for possible conservation strategies for Cerrado biome species, as well as to highlight the importance of conducting research in the few natural areas of the Cerrado Biome that still exist in the State of São Paulo.

MATERIALS AND METHODS

The studied specimens were collected in samplings occurred between January 2007 and December 2009 at EEJ, an environmental preservation area, which has 9,074 ha and is located in the municipality of Luiz Antônio, São Paulo State, Brazil. Habitats of the EEJ include dry mesophytic semideciduous forest and the Brazilian savannah (Kronka et al. 2005); remnants of *Eucalyptus* sp. and *Pinus* sp. cultivars; and aquatic habitats located near Mogi-Guaçu River. The climate is Köpen AW type (tropical with wet summers and dry winters) and the total annual rainfall of 1,433 mm is concentrated between November and April; the mean annual temperature is 21.7° C (Cavalheiro et al. 1990).

Sampling of Hymenoptera was performed every two weeks between December 2006 and November 2009 as described in Versuti et al. (2014).

In the laboratory, Gasteruptiidae were separated from other Hymenoptera and stored in plastic vials with 70% ethanol and later air dried, mounted on entomological pins and labeled.

The specific identifications of the studied specimens were made by A.C.C. Macedo.

Images were taken using a digital camera Leica MC170 HD attached to a stereomicroscope Leica M205C APO and specimens illuminated with high diffuse dome illumination Leica LED5000 HDI. Focus stacking of images was done using Helicon Focus (version 5.3). The figures were prepared using Adobe Photoshop (version 11.0).

The voucher specimens examined in this study have been deposited in the Coleção Entomológica do Laboratório de Sistemática e Bioecologia de Parasitoides e Predadores (LRRP# 2695-2703, 5305-5308), of the Instituto Biológico / Ribeirão Preto (Ribeirão Preto, SP, Brazil), N.W. Perioto, curator. The collections were done under a Brazilian Biodiversity Information and Authorization System (SISBIO) license# 16473-1.

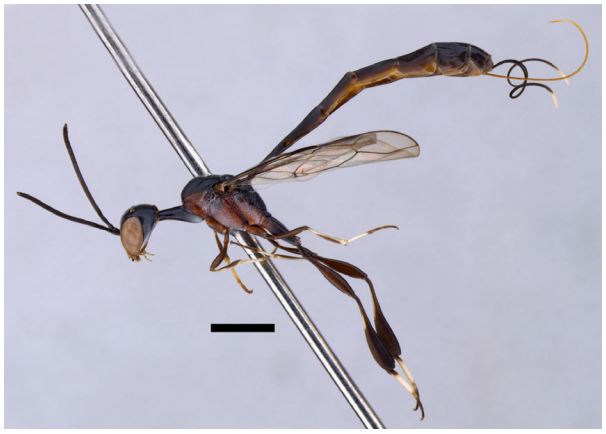

Figure 1. ***Gasteruption bispinosum*** **Kieffer, 1904, habitus. Scale bar = 2 mm.**

Figure 2. ***Gasteruption brasiliense*** **(Blanchard, 1840), habitus. Scale bar = 2 mm.**

Examined material

Gasteruption bispinosum

Kieffer, 1904
Figure 1
Brasil, SP, Luiz Antonio, Est. Ecológica de Jataí, 21°37′23,7″S / 47°48′27,8″W, Mata ciliar, arm. Malaise, 7/XI/2007, 10/XII/2008, 16/IX/2009, NW Perioto e equipe, cols., LRRP# 2695, 2697, 2696, 3♀ (LRRP); same data except 21°36′47″S / 47°49′04″W, arm. luminosa, 23/XII/2008, 28/I/2009, LRRP# 2698, 2699, 2♀ (LRRP); same data except 21°36′11,6″S / 47°46′10,1″W, Cerradão, 11/X/2007, LRRP# 2701, 1♀ (LRRP).

Gasteruption brasiliense

(Blanchard, 1840)
Figure 2
Brasil, SP, Luiz Antonio, Est. Ecológica de Jataí, 21°35′17,7″S / 47°47′28,2″W, Cerrado, arm. Malaise, 5/XII/2007, 15/X/2009, NW Perioto e equipe, cols., LRRP# 2702, 2703, 2♀ (LRRP); same data except 21°36′47,0″S / 47°49′04,0″W, Mata ciliar, arm. luminosa, 19/XII/2007, LRRP# 5305, 5306, 5307, 3♀ (LRRP) and 15/IV/2009, LRRP# 5308, 1♀ (LRRP).

Gasteruption helenae

Macedo, 2011
Figure 3
Brasil, SP, Luiz Antonio, Est. Ecológica de Jataí, 21°35′17,7″S / 47°47′28,2″W, Cerrado, arm. Malaise, 5/XII/2007, NW Perioto e equipe, cols.; LRRP# 2700, 1♀ (LRRP).

RESULTS AND DISCUSSION

Gasteruptiidae is occasionally collected on insect surveys with Malaise traps but, in several studies carried out in Brazil in areas of Atlantic Forest (Azevedo et al. 2002, 2003, Perioto & Lara 2003, Perioto et al. 2005, Sobczak & Vasconcelos Neto 2015, among others), Brazilian savannah (Perioto et al. 2008, Lara et al. 2015) and in cultivated areas (Klesener et al. 2013) none of these insects were obtained.

In this study, carried out at EEJ, a large sampling effort was employed to capture parasitic Hymenoptera: a. 6,570 trap-days with Malaise traps, divided into 2,190 trap-days in each one of the three studied environments

Figure 3. ***Gasteruption helenae*** **Macedo, 2011, habitus. Scale bar = 2 mm.**

- Brazilian savannah, savannah woodland vegetation and riparian vegetation; b. 6,570 trap-days with Moericke traps, divided into 730 trap-days in Brazilian savannah and savannah woodland vegetation, respectively, and 2,190 trap-days in riparian vegetation and, c. 624 trap-days with a light trap in riparian vegetation, totaling an effort of 10,844 trap-days.

During the three years of sampling at EEJ only 13 (all female) specimens of *Gasteruption* were obtained: six of *G. bispinosum* Kieffer, 1904, six of *G. brasiliense* (Blanchard, 1840) and a single specimen of *G. helenae* Macedo, 2011 (Table I). The fact that all Gasteruptiidae obtained were collected between September and January allows us to infer that, at the EEJ, the highest frequency of Gasteruptiidae occurs in the hottest and humid months of the year.

The small number of specimens collected precludes more sophisticated analyzes of abundance and population fluctuation. The reasons that lead to this small catch rate are unknown and factors such their development in small populations and/or the low efficiency of the traps used should be taken into account.

Of the six specimens of *G. bispinosum* captured, five were obtained from the riparian forest and one from the savannah woodland vegetation; four of them were collected with Malaise traps and two with light traps. Of the six specimens of *G. brasiliense* captured, four were obtained from the riparian forest, all of them with light traps, and two from the Brazilian savannah, with Malaise traps. The only specimen of *G. helenae* was obtained from Brazilian savannah and was captured with Malaise traps (Table I). No one Gasteruptiidae was captured with Moericke traps.

Almost 50% of the specimens of Gasteruptiidae obtained were captured with light traps (Table I); such fact indicates that the use of this colection artifact, unusual for the capture of this group of insects, can increase the availability of these insects in collections; also indicates the necessity of future studies on the behavior of such insects since it is presumed that they have diurnal habits.

Gasteruption bispinosum and *G. brasiliense* (Blanchard, 1840) have known occurrences for the State of São Paulo (Macedo 2011). *Gasteruption*

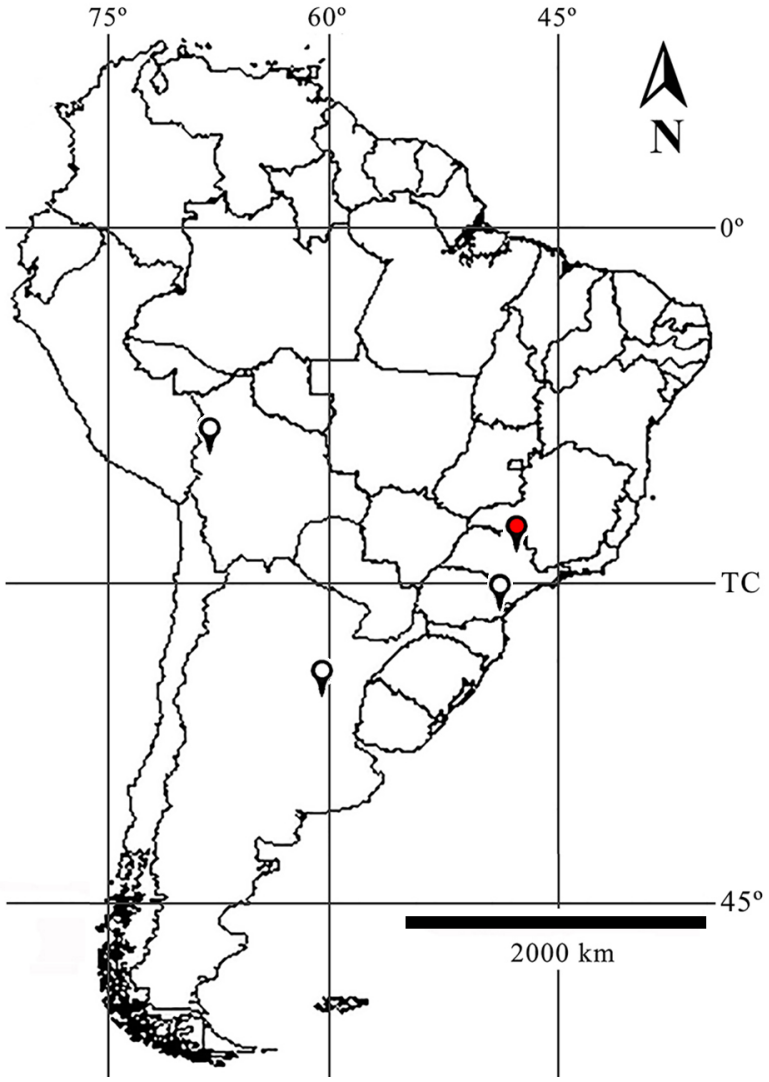

Figure 4. Map indicating the known occurrences of *Gasteruption helenae* Macedo, 2011 (black dots with white marks) and the new record of distribution (black dot with red mark). TC = Tropic of Capricorn.

Table I. Species of *Gasteruption* Latreille, 1796 obtained at the Estação Ecológica de Jataí between January 2007 and December 2009: number of specimens per environment, trap used, and sample effort in trap-days.

Species of *Gasteruption*	n	Environment	Trap	Sampling effort (in trap-days)
G. bispinosum Kieffer, 1904	1	savannah woodland vegetation	Malaise	2190
G. bispinosum Kieffer, 1904	3	riparian vegetation	Malaise	730
G. bispinosum Kieffer, 1904	2	riparian vegetation	light trap	312
G. brasiliense (Blanchard, 1840)	2	Brazilian savannah	Malaise	1095
G. brasiliense (Blanchard, 1840)	4	riparian vegetation	light trap	156
G. helenae Macedo, 2011	1	Brazilian savannah	Malaise	2190

helenae is now mentioned by the first time for that state, so this study extends its range about 1,700 km northeast, 2,200 km southwest and 470 km northeast in Entre Rios (Argentina), La Paz (Bolivia) and Curitiba (Brazil), respectively, the previous records (Figure 4).

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N.W.P. and R.I.R.L. participated in the design, planning and, development of the experiment and contributed with the sample preparation. A.C.C.M. identified the material studied. All authors have discussed the results and contributed to the writing of the manuscript.