Entering behavior of *Gasteruption brachychaetum* Schrottky (Hymenoptera, Gasteruptiidae) into a nest of *Hylaeus Fabricius* (Hymenoptera, Colletidae)

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ABSTRACT. Entering behavior of *Gasteruption brachychaetum* Schrottky (Hymenoptera, Gasteruptiidae) into a nest of *Hylaeus* Fabricius (Hymenoptera, Colletidae). Nests of *Hylaeus* aff. *guaraniticus* (Schrottky, 1906) were parasited by females of *Gasteruption brachychaetum* Schrottky, 1906 in trap nests in São Paulo (Brazil). This is the first host record of a Gasteruptiidae in the Neotropical Region. The behavior of a *G. brachychaetum* female entering a host's nest is described as follows: an inquiline female hovered near the host's nest, landed and detected that a female of *H.* aff. *guaraniticus* was inside the nest, waited for the host female to fly out, entered backwards into the nest, remained there for almost six minutes, and then went out the nest. The development time of immature stages of *G. brachychaetum* varied between 16 and 299 days.

KEYWORDS. Evanioidea; *Gasteruption*; *Hylaeus*; parasitic wasp; solitary bee.

RESUMO. Comportamento de entrada de *Gasteruption brachychaetum* Schrottky (Hymenoptera, Gasteruptiidae) em um ninho de *Hylaeus* Fabricius (Hymenoptera, Colletidae). Ninhos de *Hylaeus* aff. *guaraniticus* (Schrottky, 1906) foram parasitados por fêmeas de *Gasteruption brachychaetum* Schrottky, 1906 em ninhos-armadilha em São Paulo (Brasil). Este é o primeiro registro de hospedeiro de um Gasteruptiidae na região Neotropical. O comportamento de uma fêmea entrando no ninho do hospedeiro é descrito: a fêmea inquilina pairou sobre o ninho do hospedeiro, pousou e detectou que a fêmea de *H.* aff. *guaraniticus* estava dentro do ninho, esperou a fêmea hospedeira voar para fora do ninho, entrou de costas no ninho, permanecendo no local por quase seis minutos, em seguida, partiu voando. O tempo de desenvolvimento dos imaturos de *G. brachychaetum* variou entre 16 e 229 dias.

PALAVRAS-CHAVE. Evanioidea; *Gasteruption*; *Hylaeus*; parasitóide; abelha solitária.

Larvae of gasteruptiids are predator-inquilines (Jennings & Austin 2004) or cleptoparasites (Gauld 1995) in nests of solitary bees and wasps. Host records include species of various aculeate families: Apidae (Anthophorini), Colletidae, Halictidae, Megachilidae, Stenotritidae, Sphecidae and Vespidae (Jennings & Austin 2004). Different species deposit eggs in different positions inside or outside the host's cell. The inquiline larva feeds on the host's egg or larva and later on its food storage. For example, the first instar larva of *Gasteruption caudatum* Szépligeti, 1903 behaves as an ectoparasitoid, sucking the egg fluids. The second instar larva feeds on the host's food storage. After consuming the entire contents of the cell, the larva may attack an adjacent cell. In this case, the gasteruptiid larva behaves as a predator, consuming almost the entire tissue of the larval bee and later feeding on the host's food (Malyshev 1966). The family was recently revised in the Neotropical Region by Jennings & Austin (1997, 2002) (Hyptiogastrinae) and Macedo (2009, 2011) (Gasteruptiinae).

While studying artificial nests for solitary bees, we found nests of *Hylaeus aff. guaraniticus (*Schrottky, 1906) attacked by females of *Gasteruption brachychaetum* Schrottky, 1906. This is the first host record of a Gasteruptiidae from the Neotropical Region. We describe one nest entering behavior sequence of an inquiline female, and also present notes about *G. brachychaetum* larval development time.

MATERIAL AND METHODS

We obtained nests of *H. aff. guaraniticus* by setting up trap-nests. This method is widespread for the capture of solitary bees and consists of offering artificial cavities through cardboard tubes lodged in perforated wooden blocks or bamboo tubes (Camillo *et al.* 1995; Garófalo *et al.* 2004). Artificial nests were made of paper tubes inserted in holes (Fig. 1A). Between March 2007 and February 2009 we offered holes around 300 tubes of different diameters (3 mm to 10 mm) and depths (30 mm to 120 mm).

The traps were placed in the garden of the Laboratório de Abelhas (Bee Lab) in the campus of Universidade de São Paulo, in São Paulo, Brazil (23°33'S, 46°43'W).

Established nests were removed from the traps and taken to the laboratory where they remained lodged in individual glass tubes. The emerging individuals were killed with ethyl acetate and prepared for entomological collection. Finally,

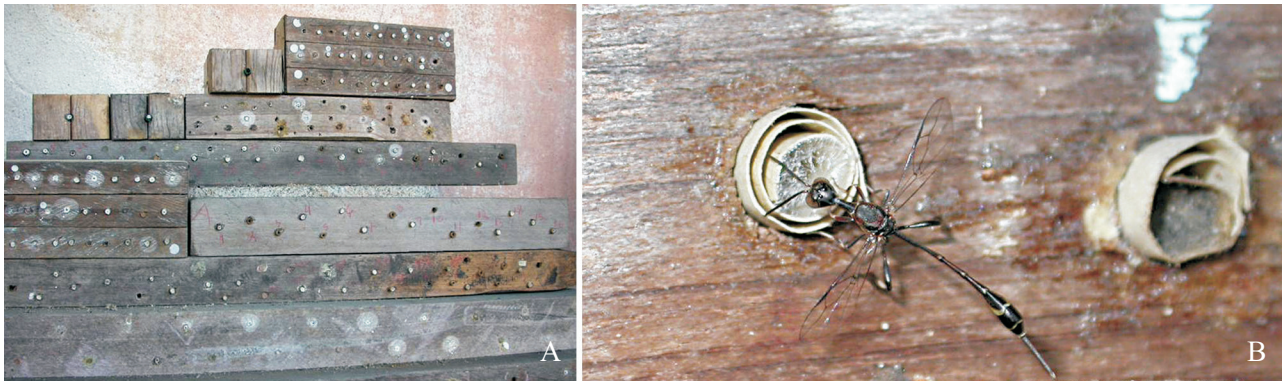

Fig. 1. A. Trap nests in the study site; B. A female of *Gasteruption brachychaetum* on a nest of *Hylaeus* aff. *guaraniticus*.

we opened the nests for internal inspection of the cells and mortality record.

Along visual observations of the artificial nests, we found a *G. brachychaetum* female flying near the area. We video recorded this female performing a behavior sequence of entering a *H. aff. guaraniticus* nest. Based on this unique recorded sequence, each phase of the inquiline female's behavior was illustrated.

Specimens were deposited in the Museu de Zoologia da Universidade de São Paulo (MZSP) (*G. brachychaetum*) and in the Entomological Collection Paulo Nogueira Neto (CEPANN), Instituto de Biociências da Universidade de São Paulo (*G. brachychaetum* and *H. aff. guaraniticus*).

RESULTS AND DISCUSSION

Nests of *Hylaeus aff. guaraniticus*. The female of *H. aff. guaraniticus* searched for a wooden cavity and started building the nest after her choice. The nests were made of a delicate and transparent membrane forming series of "cellophane-like" cells, typical of hylaeine bees (Almeida 2008 and references therein). The female built an operculum at the entrance at the beginning of the nesting process, which had a small hole in the middle and allowed the passage of the female, but we suppose that it helps to avoid alien invasion (Cordeiro & Alves-dos-Santos 2008). This bee does not have a scopa on the legs, like other colletids, and transports the pollen inside its crop. The pollen provision is pasty, almost liquid, which is also typical of Hylaeinae (Almeida 2008).

Nest entering behavior of *Gasteruption brachychaetum*. Nests of *H. aff. guaraniticus* were successfully parasitized as evidenced by the emergence of 10 adult specimens of *G. brachychaetum.* Inquiline females are able to oviposit in host's nests in the period when opercula are open. They seem to select the cells of *H. aff. guaraniticus*, because other bee species have been found nesting in the study site (Alves-dos-Santos 2003). Colletid bees have already been recorded as hosts of *Gasteruption* from Nearctic, Palaearctic, Afrotropical and Australian regions (Jennings & Austin 2004).

The sequence of nest entering of a *G. brachychaetum* female is illustrated in Fig. 2. The female flew in direction to an active host's nest and hovered nearby it (Fig. 2B), landed near a neighbor inactive nest and walked in direction to the hole of the active nest (Fig. 2C). The inquiline female antennated on the operculum, probably detecting the adult female bee inside the nest (Figs. 1B, 2D), walked backwards (Fig. 2E) and "hid" herself near an unoccupied nest (Fig. 2F), waiting for the adult bee to leave the nest. The bee put her head out the nest, put her head back into the nest, and after flew out (Fig. 2G). After seeing the bee leaving, *G. brachychaetum* female moved to the nest (Fig. 2H), antennated on the entrance, and entered backwards the nest (Fig. 2I). The inquiline female remained for almost six minutes inside the host's nest (Fig. 2J), when she was able to oviposit. After that she left the nest (Fig. 2K), hovered nearby the place and flew away (Fig. 2L).

Although we have observed only one event of the entering sequence of *G. brachychaetum* into a host's nest, we found original information about behavior in gasteruptiids, such as the inquiline female walking backwards after detecting the adult bee inside the nest, waiting "hid", and using visual information to see the bee leaving the nest.

As the inquiline female has gone directly to the host's nest, it is possible she had previously learned its location, which has also been suggested for cleptoparasitic bees (Vinson *et al.* 2010). The behavior of waiting for the female bee leaving the nest is similar to the Megachilidae cleptoparasitic genus *Coelioxys* (Vinson *et al.* 2010).

The behavior of entering the host's nest seems not to be the most common among Gasteruptiinae. It may be related to the ovipositor length of each species. *G. brachychaetum* is the South American species in the subfamily with the shortest ovipositor, between 0.21–0.35 times metasomal length (Macedo 2011). Most Gasteruptiinae have ovipositors as long as or longer than metasomal length (Macedo 2009, 2011). It seems the most common way that Gasteruptiinae species use to reach host's nests is to insert the ovipositor into the wood, as is the case of *Gasteruption jaculator* (Linnaeus, 1758) (Jennings & Austin 2004). On the other hand, in Hyptiogastrinae, *Pseudofoenus*, whose species have short ovipositors, were observed entering a ground nest of a colletid bee (Jennings & Austin 2004).

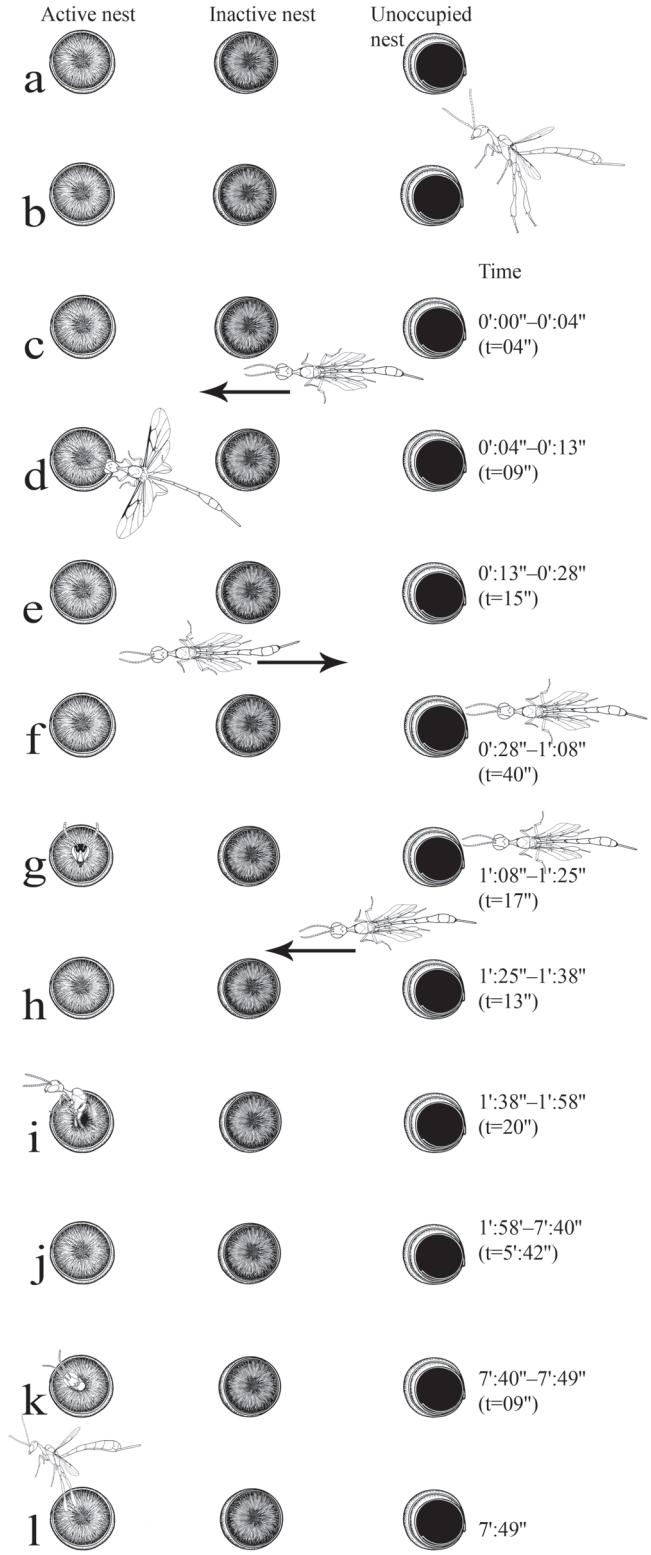

Fig. 2. Sequence of behavior of a *Gasteruption brachychaetum* female entering a nest of *Hylaeus* aff. *guaraniticus*. The sequence was timed since the female landed near the nest until she flew away. See text for explanation.

Larval development of *Gasteruption brachychaetum*. Ten females of *G. brachychaetum* emerged from nine artificial nests of *H. aff. guaraniticus*. Two other larvae of *G. brachychaetum* have died (Table I). Eggs or immature stage specimens were first observed in April 2007, although we do not have the exact oviposition date. It was observed a high variation in development time. Five specimens observed since larval stage spent between 203 and 299 days to reach the adult stage, but one larva spent only 16 days. Otherwise, the two specimens observed since egg stage spent 33 and 35 days until the adult stage.

Table I. Development time data of *Gasteruption brachychaetum** in nests of *Hylaeus* aff. *guaraniticus*.

First day of observation	Stage on 1st day	Emergency date	Number of specimens	Development time (days)
10.iv.07	egg	13.v.07	1	33
10.iv.07	egg	15.v.07	1	35
09.iv.07	larva	21.i.08	1	282
09.iv.07	larva	10.ii.08	1	299
09.iv.07	larva	Died	1	–
10.iv.07	larva	10.xii.07	1	240
10.iv.07	larva	Died	1	–
11.iv.07	larva	04.xi.07	1	203
13.iv.07	larva	28.xi.07	1	225
17.iv.07	larva	03.v.07	1	16
10.iv.07	pupa	21.iv.07	2	11
Total			12	

*All 10 emerged adults were females.

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