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Nesting behaviour of *Bembecinus agilis* (Smith, 1873) in the Biological Station of Santa Lúcia (southeastern Brazil)

(Hymenoptera: Apoidea: Crabronidae)

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Abstract: The nesting behaviour of the solitary wasp *Bembecinus agilis* (Smith, 1873) is described based on observations carried out in the Biological Station of Santa Lúcia (city of Santa Teresa, Espírito Santo State, southeastern Brazil), an area covered by the Atlantic Forest. Species of the following genera of leafhoppers (Hemiptera: Cicadellidae) are recorded as prey: *Acrogonia*, *Amblyscartidia*, *Crossogonalia*, *Deselvana*, *Dilobopterus*, *Exogonia*, *Hanshumba*, *Homalodisca*, *Juliaca*, *Oncometopia*, *Pamplonoidea*, besides an unidentified planthopper genus (Hemiptera: Flatidae). The wasp's cocoon is described.

Key words: Hymenoptera, Apoidea, Crabronidae, Sphecidae, wasp, biology, reproduction, cocoon, leafhopper, Cicadellidae

Introduction

Bembecinus Costa, 1859 is a genus of solitary ground-nesting wasps distributed in all the continents (BOHART & MENKE 1976, EVANS & O'NEILL 2007) and currently with 185 species (PULAWSKI 2009). EVANS & O'NEILL (2007) listed 22 species of *Bembecinus* for which exist published biological notes, but among these only a few species were detailed studied (e.g. EVANS 1955, GESS & GESS 1975, O'NEILL & EVANS 1983, O'NEILL *et al*. 1989, ZOLDA et al. 2001). *Bembecinus agilis* (Smith, 1873) is distributed in South and Central America (WILLINK 1949). RICHARDS (1937) and CALLAN (1991) published short biological notes on this spe-

cies based respectively on observations conducted in British Guiana and Trinidad. In the present paper the nesting behaviour of *B. agilis* is described in detail; a morphological description of its cocoon is also provided.

Material and methods

The observations were conducted in the Biological Station of Santa Lúcia (city of Santa Teresa, 19°56'10"S and 40°36'06"W, State of Espírito Santo, southeastern Brazil), an area covered by the Atlantic Forest. The females were observed during all the daily period of nesting activity in the following dates: November 11–12, 2007; December 15–16 2007; and February 21–22, 2008. About 30 females were observed in distinct phases of the nesting cycle; twelve nests were excavated and, when it was possible, they were measured using a paquimeter. The collected wasps were deposited in the Hymenoptera collection of the Museu Nacional – Universidade Federal do Rio de Janeiro (MNRJ) and the prey items were deposited in the Hemiptera collection of the same institution.

Results

Habitat, aggregation, daily activity

The assemblage of nesting females was observed in a slightly sloping place, on the margin of an unpaved road (Fig. 1). The nesting substrate was composed of earth mixed with sand; the soil was loosely compacted superficially and somewhat more compacted below. The place was exposed to the sun during all the period of nesting activity. Active nest of different females rarely was less than 1 meter from each other. Some females were seen at about 8:00 h resting on the nesting site, but females effectively in nesting activity appeared at about 10:00 h. At about 16:00 h the nesting activity ceased at all.

Nest structure and digging behaviour

The nests consisted of oblique burrows with one or two terminal cells parallel to the ground surface. From 12 excavated nests, 10 nests had one cell and two nests had two cells. The females dug the nest throwing earth backwards with their forelegs beneath the body; the earth reached up to

about 2 cm beyond the wasp's body. The mandibles were not used to dig the superficial loose soil, but it was not possible to determine if the mandibles were used to cut the deeper more compacted earth. When the female threw the earth backward, she moved the gaster upward (Fig. 2). Thus, the thrown sand freely passed beneath her body. But when she crawled the soil, she tended to maintain the gaster downward (Fig. 3). Some digging females grasped with the mandibles small stones and lumps of compacted earth and drag them, walking backwards up to about 5 cm away from the nest entrance. Sometimes during the nest digging the female scattered with the forelegs the mound of earth formed due the excavation. Accessory burrows were not observed.

Nest provision

The total of 70 identifiable specimens of prey (including 25 fragmented specimens) was collected from 10 provisioned nests (Table I). All prey items were leafhoppers (Hemiptera: Cicadomorpha: Cicadellidae) of the subfamilies Cicadellinae, Gyponinae or Deltocephalinae, except for a single Flatidae (Hemiptera: Fulguromorpha) (Table I). The females put the eggs in an empty cell of the nest (Fig. 4) and, some days after, she started to progressively provision the nest. Several specimens and different species of leafhoppers were found in each cell and both males and females were used (Table I). Nymphs were not found inside the nests, but one female carrying a nymph of leafhopper was captured. The size and colour of the prey were strongly variable; the total length of the prey body (measured from the corona to the tip of the forewings) ranged from 5 mm to 13 mm.

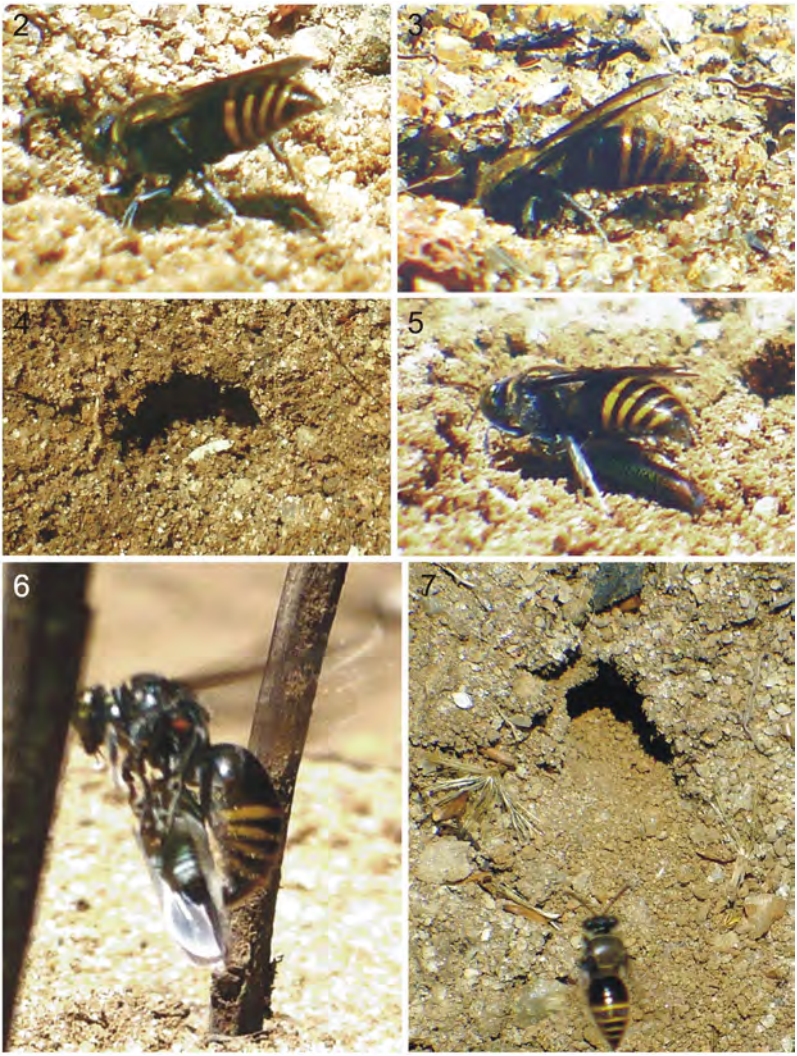
Temporary closing of the nest

The females maintained the nest closed while they were absent. In order to construct the closure, they came out from the burrow walking forward and, when arrived at the nest entrance, they threw the earth backwards beneath the body, forming a plug that closed the nest. Occasionally, the females hammered the earth of the plug with the tip of the gaster. After the plug being ready, the females scattered the earth around the nest entrance. The overall time spent in temporary closing the nest was about 20–30 seconds. After that, they hovered the nesting site about 5–10 cm over the ground in circular flights and leaved.

Fig. 1: Nesting site of *Bembecinus agilis* in the Biological Station of Santa Lúcia (southeastern Brazil).

Prey manipulation

The collected prey specimens did not show any visible reaction to mechanical stimulus, indicating that the wasp's venom caused the complete and definitive paralysis of the prey or perhaps its death. The females arrived at the nesting site in flight holding the prey, which stayed positioned venter to venter and head forward. The wasps used the hind- and midlegs to hold the prey in flight (Fig. 6). When the females landed near the nest, they kept holding the prey with the midlegs and used the fore- and hindlegs to sustain her own body and to walk on the ground (Fig. 5). At the nest entrance, the females dug the temporary plug without releasing the prey, using the forelegs to throw the earth backwards beneath the body, and plunged into the nest. During the excavation of the temporary plug, the females usually touched the ground with the antennae. One female, which was carrying an unusually large leafhopper, released the prey at the entrance when she entered the nest. Then she turned back inside the nest, grasped the prey with mandibles and pulled her into the burrow.



Figs 2–7: Nesting habitat of *Bembecinus agilis*. (2) Digging female with the gaster upward, throwing earth beneath the body; (3) digging female with the gaster downward, crawling the earth; (4) empty cell of the nest with a wasp's egg; (5) female walking carrying a prey, repair that the midlegs are used to hold the prey and the forelegs

and hindlegs to walk; (6) female taking off from ground with the prey held with the midlegs and hindlegs; (7) apprehensive female, after have been threatened, hovering in front of the open nest.

Table I: Number of cells, prey species, number of prey and nest depth of some nests of *Bembecinus agilis* studied in the Biological Station of Santa Lúcia (southeastern Brazil).

Nest	**Cell**	**Prey species**	**Number of specimens**	**Nest depth (cm)**
I	unique	*Amblyscartidia* sp.	1 ♀	6
		Hanshumba sp.	1 ♂
		Unidentified Cicadellini	1 ♀
		Unidentified Deltocephalinae	1 ♀
		Fragmented specimens	12
			Total: 16
II	1	*Acrogonia* sp.	1 ♀	5.5
		Crossogonalia hectica (Signoret, 1854)	1 ♀
		Deselvana excavata	1 ♂
		(Lepeletier & Serville, 1825)	1 ♂
		Dilobopterus trinotatus	1 ♂
		(Signoret, 1853)	1 ♀
		Hanshumba sp.	1 ♀
		Juliaca sp.	2 ♂, 1 ♀
		Oncometopia sp.	1 ♀
		Unidentified Cicadellini	3
		Unidentified Gyponinae	Total: 14
		Fragmented specimens	
II	2	Fragmented specimens	-	5.5
III	Unique	*Juliaca* sp.	1 ♂	8
		Unidentified Gyponinae	1 ♀
		Fragmented specimens	3
			Total: 5
IV	Unique	*Hanshumba* sp.	2 ♂	?
		Exogonia sp. 1	1 ♀, 1 ♂
		Exogonia sp .2	1 ♀, 1 ♂
		Fragmented specimens	5
			Total: 11

Nest	Cell	Prey species	Number of specimens	Nest depth (cm)
V	Unique	*Hanshumba* sp.	1 ♂	?
VI	Unique	*Hanshumba* sp. Fragmented Cicadellini	1 ♀ 2 Total: 3	
VII	1	*Hanshumba* sp. *Exogonia* sp. 2	1 ♂ 1 ♀ Total: 2	6.5
VII	2	Fragmented specimens	-	4.5
VIII	Unique	Fragmented specimens	-	3
IX	Unique	*Dilobopterus trinotatus* (Signoret, 1853) *Dilobopterus* sp. *Homalodisca* sp. *Oncometopia* sp. Unidentified Cicadellini	7 ♀ 1 ♀ 1 ♀ 1 ♀ 1 ♂ Total: 11	4.5
X	Unique	*Homalodisca* sp. *Oncometopia* sp. *Pamplonoidea yalea* Young, 1977 Unidentified Flatidae	1 ♀ 2 ♂, 2 ♀ 1 ♂ 1 ♂ Total: 7	3

Natural enemy and defensive behaviour

One specimen of *Tropidurus torquatus* Wied, 1820 (Squamata: Tropiduridae), which is locally a common species during the summer in open areas, was observed preying upon a female *B. agilis*. The lizard followed the flying wasp and grasped her when she was hovering over the nesting site.

When the females were threatened near the nest during the nesting cycle, usually they quickly took off from the ground and remained hovering over the nest (Fig. 7). If the threat remained they flied away from the nesting site. Defensive or apprehensive motor patterns of the female on the ground were not observed.

Description of the cocoon of *B. agilis*

The cocoon is formed by an external layer and an internal capsule. The external layer is constructed with remains of wings and heads of prey items and a few small pebbles loosely joined with silken threads; ovoid shaped; 15 mm long and 8 mm wide. The internal capsule is constructed with clay and small pebbles; ovoid shaped; 14 mm long and 6 mm wide; lined inside with white silken threads; thickness of wall about 0.25 mm; with six small pores in the midline.

Material examined: one cocoon from which a predefecating larva was collected.

Concluding remarks

EVANS (1955) revised the behaviour of *Bembecinus* and commented that the species of the genus are behaviourally similar. The herein presented observations on *B. agilis* corroborate the assertion by EVANS, since the nesting behaviour of this species is in general similar to those of several other species of the genus. Remarkably, the motor patterns used in the nest digging and prey manipulation are widespread in the genus and shared with species of several other Bembecinae genera. Thus, females of distinct species of *Bembecinus* are similar in (1) digging the nest with the forelegs throwing the sand backward beneath the body and (2) without extensive use of the mandibles; (3) in carrying the prey in flight, (4) with the legs, (5) and positioned venter-to-venter and head forward; (6) in entering the nest without releasing the prey. Two other remarkable behavioural features are common to all known species of *Bembecinus*, but shared with only a few species of other genera of Bembecinae, especially of the genus *Bembix*: (1) progressive provision of the nest and (2) oviposition in an empty cell of the nest. On the other hand, although the behaviour of *Bembecinus* could seem to be somewhat uniform, it must be considered that the behaviour of a small fraction of the total number of the species of this large and complex genus is known; besides this, studies after those by EVANS (1955) demonstrated peculiar behavioural patterns in some species (e.g. GESS & GESS 1975, KROMBEIN 1984). Therefore, more expressive behavioural variability in this genus can be further revealed by studies on other species.

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