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Nesting behaviour and notes on mimetic relationships of *Hoplisoides vespoides* (SMITH) from Brazil

(Hymenoptera: Crabronidae)

With 2 figures and 2 tables

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Summary

The nesting behaviour of *Hoplisoides vespoides* (SMITH, 1873) is described based on observations carried out in southeastern Brazil. Notes on mimetic relationships of this species with vespid wasps and with a stratiomyid fly are also provided. *Umbonia spinosa* (FABRICIUS, 1775) (Hemiptera: Membracidae) is reported as prey.

Zusammenfassung

Das Nistverhalten von *Hoplisoides vespoides* (SMITH, 1873) wird auf Grund von Beobachtungen in Südost-Brasilien beschrieben. Bemerkungen über die Mimikry-Beziehungen dieser Art zu Faltenwespen und einer Waffenfliege werden präsentiert. Die vorliegenden Beobachtungen haben gezeigt, dass *Umbonia spinosa* (FABRICIUS, 1775) (Hemiptera: Membracidae) eine Beute von *H. vespoides* ist.

Keywords

Wasp, biology, reproduction, mimicry, *Umbonia spinosa*, *Hoplitimyia mutabilis*.

Introduction

Hoplisoides Gribodo is a genus of ground-nesting solitary wasps distributed in all the continents except Australia (BOHART 1997, 2000). This genus contains about 80 species, but the biology of only a few of them was studied (see REINHARD 1925a, b, EVANS 1954, 1966, POWELL & CHEMSAK 1959, EVANS & O'NEILL 2007). *Hoplisoides vespoides* (SMITH, 1873) is distributed from Argentina to Mexico (BOHART 2000, AMARANTE 2002); the biology of this species is known only from the short notes by PATE (1941) and CALLAN (1977). In the present paper the nesting behaviour of *Hoplisoides vespoides* is described, based on observations carried out in southeastern Brazil. Notes on mimetic relationships of this species with vespid wasps and with a stratiomyid fly are also provided.

Material and methods

The study was conducted in January 2005, in a newly reclaimed area from the Lagoon of Piratininga, in the locality called Cafubá, city of Niterói, Rio de Janeiro State, southeastern Brazil. The nesting behaviour of four females was observed in detail from the early burrow excavation until the final nest closing, and about 20 other females were observed in distinct phases of the nesting cycle. Prey specimens collected from the wasps nest were measured, as follows: pronotum length (from the top of the corona to the end of the pronotum, excluding the tip of the wings), distance between umeral processes; and pronotum height (from the base of umeral process to the tip of the dorsal spine). Voucher specimens of the wasps and its preys and of the mimetic stratomyid fly were deposited in the Hymenoptera collection of the Museu Nacional – Universidade Federal do Rio de Janeiro (MNRJ).

Results

Digging behaviour and nest structure. The females nested in loose sand, the most in exposed sites; only one observed female was nesting near the base of a small plant. They dig the soil with the forelegs, throwing the sand backwards beneath the body. Apparently the mandibles are never used in the nest digging. It was not possible to determine in detail the nest architecture because the walls of the burrows collapse during the excavation, but in general lines, the nest is a strongly oblique burrow with a final cell parallel to the ground wherein the preys are stored. The sand excavated from the burrow forms a mound at the nest entrance. The females do not scatter this mound during the nest digging, but sometimes they remove lumps of sand from the portion of the mound nearer the nest entrance, apparently to avoid that the sand fall into the burrow. The depth of some nests, number of preys per nest, and the time spent in some phases of the nesting cycle are depicted in the Table I.

Temporary closing of the nest. Soon after the nest is ready, the females temporarily close its entrance. They enter the burrow headfirst, turn around inside the nest, and exit headfirst throwing sand backwards beneath the body with the forelegs, thus forming a sand plug that close the more superficial portion of the burrow. After that, sometimes, the females throw over the entrance some sand from the nest surroundings but they do not compact the sand over the nest. Then, the females leave in search for preys. Firstly, they tend to slowly fly in an upward direction, but suddenly they depart flying away more rapidly. The overall time spent in the temporary nest closing is less than one minute.

Nest provision and preys. The females store each nest cell with one or two adult females of *Umbonia spinosa* (FABRICIUS, 1775) (Hemiptera: Membracidae) (Fig. 1). The prey is completely and definitely paralysed by the wasp venom. Morphometric features of some preys collected from the wasp's nests are depicted in Table II.

Prey carriage and placement into the nest. After approximately 10-15 minutes absent from the nesting site, the females arrive slowly flying, carrying a prey venter to venter, held with the midlegs. They land precisely at the nest entrance; in any moment they walk on the ground carrying the prey. Apparently the females localize the nest during the slow flights over the nesting site. Then, without releasing the prey, the females open the sand plug, digging with the forelegs. In this moment the females maintain the prey held with the midlegs and sustain their own body with the hindlegs. When the females throw the sand backwards to open the plug, they move their body upward.

Table I. Nest depth, number of preys per nest and time spent in distinct phases of the nesting cycle of *Hoplisoides vespoides* (nest depth in cm; time in minutes).

Nest	Nest depth	No. of preys	Time spent in nest digging	Time spent in definitive nest closing	Total time of nesting
I	5	2	18	28	about 80
II	4	2	-	-	-
III	4.5	2	-	-	-
IV	4.5	1	-	15	-

Table II. Morphometric features of specimens of *Umbonia spinosa* (Hemiptera: Membracidae) collected from the nests of *Hoplisoides vespoides* (measurements in mm).

Prey	Pronotum length	Distance between umeral processes	Pronotum height
I	14.5	8	12.5
II	14.5	7.5	12
III	15	8	12.5
IV	15	8	12.5
V	15	8	13
VI	15	8	12.5
VII	14	7.5	11.5
VIII	13.5	7.5	11.5

Thus, the thrown sand passes beneath their body without hitting the prey. After has opened the plug, they plunge into the burrow and immediately release the prey, which remains blocking the nest entrance. Inside the nest the females turn around and, without exit from the burrow, grasp the dorsal spine of the prey with the mandibles and pull her into the nest. One observed female was not able to make the prey pass through the nest entrance after trying for about two minutes, apparently because the prey was too large. Then she, still inside the burrow, moved the prey using the mandibles, grasped one prey leg and successfully pull it into the nest. A white sausage-shaped egg was found on one of the observed prey; the position of this prey inside the nest suggests that the egg was put on the second hunted prey.

Definitive nest closure. Soon after storing the last prey into the nest, the females start to definitively close the nest opening. The behaviour is similar to when they close temporarily the nest. However, the sand is put deeper inside the burrow. Moreover, the females repeatedly enter the nest and exit throwing the sand backwards; thus the nest is almost completely filled with sand. After the burrow is levelled, the females scatter sand of the nest surroundings and of the sand mound resulted from the excavation. Then they compact the sand over the nest pounding with the tip of the gaster. While they are scattering the sand, their antennae remain downward. In a different way, when some ants approximated of one nest, the female charged against them with the antennae erected upward forming an approximately right angle with the head.

Mimicry. As its specific epithet implies, *Hoplisoides vespoides* has morphological features very suggestive of Vespidae mimicry, namely black-yellow striped colouration on the gaster and

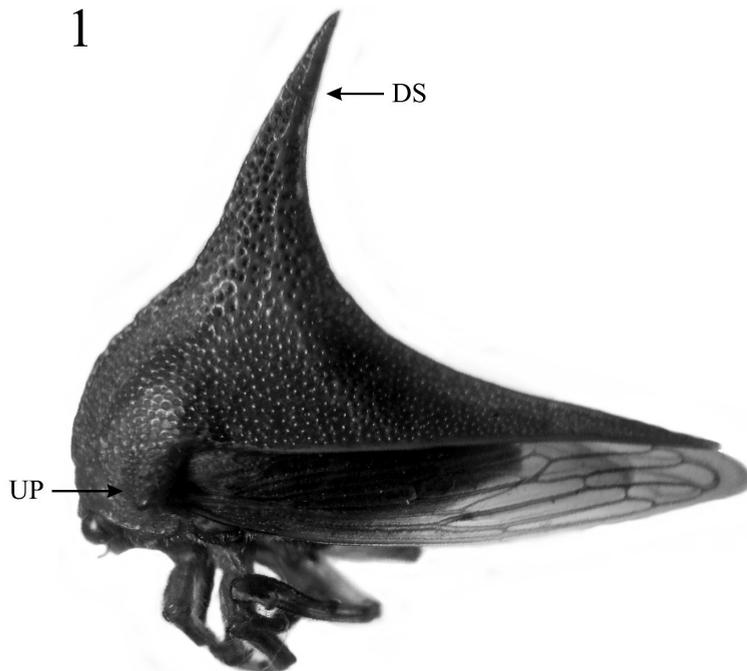


Fig. 1. *Umbonia spinosa* (Hemiptera: Membracidae) (lateral view). Specimen collected from a nest of *Hoplisoides vespoides* (DS = dorsal spine; UP = umeral process). - Fig. 2. *Hoplitimyia mutabilis* (Diptera: Stratiomyidae) (dorsal view). Specimen collected on the nesting site of *Hoplisoides vespoides*.

darkened forewings costal area (blackish colouration of most marginal cell and submarginal cell II, and superior portion of the submarginal cell III; brownish colouration of portions of the submarginal cell I, medial and discoidal cells). The later feature, plus the fact of the females left the wings a little open and forming an oblique angle in relation to the body when they excavate the nests, makes their wings resembling the peculiar longitudinally folded wings of vespids in resting position. It is remarkable that, a specimen of *Hoplitimyia mutabilis* (FABRICIUS, 1787) (Diptera: Stratiomyidae) was found resting on the ground near the nesting sites of *Hoplisoides vespoides*. The morphology of that fly is strongly vespid-mimic (Fig. 2) and it is very similar to *Hoplisoides vespoides* in features as follows: similar body size, abdomen basally constricted, darkened costal area of the wings, body in general black with yellow strips on the abdomen.

Discussion

The most of the previously studied species of *Hoplisoides* share behavioural features as the following: (1) nest gregariously in (2) sandy soil; (3) dig multicellular nests (4) throwing the sand backwards with forelegs; (5) transport the prey in flight (6) held with the midlegs; (7) put several small preys per nest cell; (8) close temporarily the nest entrance; (9) fly slowly when leaves or arrives at the nesting site (e.g. REINHARD 1925a, EVANS 1954, POWELL & CHEMSAK 1959, BOHART & MENKE 1976, CALLAN 1977, SANCHEZ & GENARO 1992, EVANS & O'NEILL 2007). Although *Hoplisoides vespoides* shares several behavioural features with other species of the genus, it is remarkably different in nesting solitarily; in constructing unicellular nests; and in storing the nests with a smaller number of a larger prey species. Solitary nesting and construction of unicellular nest can be local ecologically-determined features. On the other hand, the use of larger preys seems to be a more stereotyped feature, probably related to the fact that *Hoplisoides vespoides* is one of the largest species of the genera. The use of the dorsal spine of the prey to pull her into the nest was not mentioned in other *Hoplisoides* species. This behaviour could partially explain the specialized use of *Umbonia spinosa* as prey by *Hoplisoides vespoides*.

Vespids-mimic morphological features were observed in some species of *Hoplisoides* (e.g. BOHART 2000), as well the habit of let the wings elevated during the nest excavation (SANCHEZ & GENARO 1992). HANDLIRSCH (1888) suggested a mimetic relation among *Hoplisoides vespoides* and a species of the eumenine genus *Odynerus* LATREILLE (Hymenoptera: Vespidae). Certainly, morphological and behavioural features of *Hoplisoides vespoides* make this species similar to several co-occurring Vespidae species common in Atlantic forest from southeastern Brazil. These vespids clearly form a Müllerian mimicry ring, of which *Hoplisoides vespoides* apparently is one element, even that this species is not so aggressive as usually are the vespids. Differently, *Hoplitimyia mutabilis* could be interpreted as a Batesian mimetic with a generalised vespid model, but at least locally *Hoplisoides vespoides* seems to be its model.

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