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Observations on *Hoplisoides vespoides* (F. SMITH, 1873) in Costa Rica (Crabronidae, Bembicinae, Gorytini)

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Abstract

A small aggregation of nesting Sand wasps *Hoplisoides vespoides* was found in Costa Rica. Behaviour of wasps related to digging nests, entering nests with prey and provisional nest closure is described and documented with photographs. Exclusive use of adult tree hoppers of genus *Umbonia* as prey is confirmed and discussed. A mimicry relation to a social Vespid wasp is presumed and a possible model species suggested.

Zusammenfassung

Eine kleine Nestaggregation der Grabwespe *Hoplisoides vespoides* wurde in Costa Rica aufgefunden. Das Verhalten der Wespen bezüglich des Nestgrabens, des Beuteeintrags und des provisorischen Verschließens des Nestes wird beschrieben und abgebildet. Die ausschließliche Nutzung adulter Buckelzirpen der Gattung *Umbonia* als Beutetiere wird bestätigt und diskutiert. Eine Mimikrybeziehung zu einer sozialen Faltenwespenart wird angenommen und ein wahrscheinliches Model vorgeschlagen.

Observation site and conditions

During a visit to Costa Rica in late September a small nesting aggregation of the Sandwasp *Hoplisoides vespoides* was discovered in a small gravel depot on the premises of La Selva Biological Station (Estacion biologica La Selva) run by the OTS (OET, Organisacion para estudios tropicales). The gravel was stored in the open and had probably been taken from the banks of the Rio Puerto Viejo nearby. It consisted of a mixture of coarse sand (1-2 mm) with up to medium sized gravel (2-3 cm). Smaller particles were predominant. Though dry superficially, the material was quite moist only a few cm below the surface. The surface was partially level and partially forming a mound 1 m high. Nests (n=15 approx.) were found in the level part as well as in the eastern slope of the mound. The gravel depot (Fig. 6) received full sun only in the mornings (facing east), while it was partially shaded at noon and completely shaded in the afternoon, due to adjacent vegetation of shrubs and trees. Temperatures did not exceed 30 degrees centigrade and the weather was fine during the period of observations with but little rain only in the late afternoons or early evenings. Such a spell of fine weather at this time of the year is called a “veranillo” (= small summer)

locally in Costa Rica's predominantly wet Atlantic (Caribbean) Slope. Observations were made from September 23rd to 26th 2007.

The wasps

The stocky wasps measure around 13 mm in length. The head, metasoma and legs are predominantly reddish brown with narrow yellow markings and very short, thin and dense golden pilosity giving it a silky sheen from certain angles. This prompted CAMERON to christen the species *sericea* (= silky) in 1905 and *aureopilosellus* (= golden haired) in 1921, thus creating more synonyms (see PULAWSKI 2007). The mesosomal segments are broadly ringed golden yellow behind. The wings are usually held raised and spread at an angle when outside the tunnel. The resulting similarity to a Vespid wasp (hence Smith's name of *vespoides*, see below) is enhanced additionally by darkened frontal margins of the forewing tips, which give an illusion of longitudinally folded wings.

Digging behaviour

When the wasps were first discovered, several of them were digging nests on the site described above. The digging is done in a *Bembix*-like manner, but probably owing to the greater particle size, no jet of substrate was observed behind the digging wasps. The fore tarsi are equipped with a row of long paired stout bristles forming a comb (= pecten), stiff enough to rake the coarse material. Probably because of the moisture, nest entrances kept stable even when dug into steep slopes (Fig. 2). Sometimes a wasp was observed tugging a substantial piece of gravel out of the nest gallery under construction by walking backwards while clamping it between its mandibles (Fig. 1). Digging was done exclusively with the forelegs and material was spread in front of the burrow by walking backwards and moving the inward bent fore tarsi backwards in unison, as *Bembix* does. The first few cm of the nest tunnels appeared to have been dug at almost right angles to the soil surface, further down the angle probably changed. No nests have been dug up, though.

Bringing in prey

Wasps were active during daylight hours from late morning to late afternoon. Though the aggregation was monitored several times daily after discovery, only one female was observed on one day (Sept. 26th between 4 and 5 p.m.) to bring in prey. When I saw the female coming in with a prey for the first time, it descended slowly and deliberately, as described by CALLAN (1976). When impulsively I moved towards it, it immediately dropped its prey (Fig. 5) and flew off. I picked up the prey insect and was amazed to hold a big and bizarre tree hopper, with a huge spine like projection on its back. I stepped back a bit and hoped, the wasp would return soon with another prey.

Indeed, in a matter of minutes, the wasp was back and descended to her nest, the location of which could only be guessed from the trajectory of the descending wasp, as it was closed and made invisible before. In flight, the tree hopper was carried belly to belly, again confirming the observations of CALLAN (1976). As I bowed forward to take a photograph, the wasp again dropped her prey, which fell to the ground within centimetres of the hidden nest entrance. But this time the wasp circled back and landed near. It started walking in small loops, trying to relocate the lost prey. After some searching, the paralyzed hopper was found, seized, re-stung, picked up and transported the very short distance to the hidden entrance on foot. On this occasion, irregularly as turned out later, the hopper's back touched the wasps belly, with the huge spine passing the wasp's metasoma sideways (Fig. 3). Of course, the long spine on the hoppers back got stuck in the coarse sand and the wasp released the prey to turn around inside her tunnel and grip the hopper from below. With a few twists and turns (like turning a key) it was dragged in and stowed away inside the nest. Between hunting trips the wasp closed and concealed the entrance thoroughly (see below). Bringing in the third prey, the wasp had become accustomed to my presence and did not drop its hopper prey. By keeping it in the in-flight position upon landing, the long spine in the back of the hopper ploughed the gravel and the wasp went into a near head-stand and started to open the concealed nest entrance with quick movements of her fore tarsi. In a matter of seconds the entrance had been opened and the wasp entered, pressing the prey belly to belly, this time applying her regular method (Fig. 4). The hopper got stuck again and had to be dragged in from below. A few minutes later wasp resurfaced.

Preliminary closure of the nest

Now the wasp started to fill the uppermost part of the tunnel with sand and gravel raked in from the surroundings (Fig. 2). After the entrance had been filled, the female spent some minutes of raking soil particles in this direction and that, until the nest entrance was levelled and concealed completely. Then the wasp took off, facing the hidden nest entrance, gaining height slowly at first, flying a few loops and finally disappearing in the direction of the tree canopies nearby. To catch a tree hopper and return to the nest took only about ten minutes, so the wasp probably found her prey not too far away.

Identifying prey and wasp species

As I stayed in Costa Rica as a Natural History visitor, it was not possible to take voucher specimens. But luckily identification turned out to be possible without. All six prey observed being brought to the nest obviously belonged to the same species of *Umbonia*. It was later identified to be *U. crassicornis* from my photographs by REX COCROFT (in lit.)

Fig. 1: *Hoplisoides vespoides* female digging her nest. Photos 1-5: BERNHARD JACOBI.

Fig. 2: *Hoplisoides vespoides* female closing her nest, raking gravel backwards.

Fig. 3: *H. vespoides* female opening her nest, holding tree hopper prey irregularly.

Fig. 4: *Hoplisoides vespoides* female entering nest with prey held normally.

Fig. 5: Paralysed adult tree hopper *Umbonia crassicornis*, dropped by the wasp.

Fig. 6: Nesting site: Gravel depot at La Selva/Costa Rica (Photo: PAUL ZBOROWSKI).

The familial, subfamilial and tribal affiliations of the wasp species observed (i.e. Crabronidae, Bembecinae, Gorytini) were readily apparent. As the extensive collection of insects formerly held in La Selva had been moved to INBio, I was not able to it identify the wasp to genus and species in La Selva. Back home I searched the web. The combination of the wasp tribe and prey family soon led to the Gorytine genus *Hoplisoides*. The majority of *Hoplisoides* species prey on Membracidae (EVANS & O´NEILL 2007).

Using the invaluable online CATALOG OF SPHECIDAE sensu lato (= Apoidea excluding Apidae) compiled by W. J. PULAWSKI, specifically Hoplisoides.pdf (last updated Oct. 21st, 2007) the telltale synonym of *Hoplisoides umbonicida* PATE, 1941 (see BOHART 1997) led me to the valid name of *H. vespoides* (F. SMITH, 1873) as a probable ID.

W. J. PULAWSKI (in lit.) found: "The details of wing coloration, body coloration, and leg color pattern agree nearly perfectly [with *Hoplisoides vespoides*]."

Discussion

Implications of harvesting a subsocial prey species

PATE (1941) as well as CALLAN (1977) reported exclusive use of *Umbonia* (Hemiptera, Membracidae) as prey by *Hoplisoides vespoides*. In Trinidad CALLAN (1977) reported *Umbonia spinosa* as prey. Given my own observation of use of *Umbonia crassicornis*, *H. vespoides* seems to be specialized (genus level) on using *Umbonia* species adults.

On commenting my observations COCROFT (in lit.) wrote: "…the wasps must have found a pre-reproductive aggregation of *Umbonia*; the insects develop to adulthood in a family group, and after adult eclosion remain aggregated for another week or more before dispersing."

Given this peculiarity of the prey species biology, it becomes apparent, that there is but a narrow time window to harvest from a prey aggregation discovered. Possibly wasps are able to recognize a prey aggregation even when members are still immature and bag them only after their final moult. This would easily explain the rapid succession of prey brought to the nests, and also why only one female in the nesting aggregation was observed provisioning in several days of (discontinuous) observation. This apparently was the lucky one, who knew an aggregation. Apparently, *Hoplisoides vespoides* is mass-provisioning its brood cells, bringing in the full amount of prey necessary to bring up one larva in quick succession.

The prey species *Umbonia crassicornis* is known to practise maternal brood care. While other species of *Hoplisoides*, like *H. hamatus* (see EVANS & O'NEILL 2007), prey on Membracid nymphs, *H. vespoides* seems to hunt exclusively for adults. On harvesting hopper adults *Hoplisoides vespoides* apparently avoids competition with the social Vespid wasp *Pseudopolybia compressa*, which was observed to prey on the nymphs of *Umbonia crassicornis* by COCROFT (2002) in south-western Costa Rica. This author analyzed signalling behaviour of nymphs (synchronized vibrational signals, see COCROFT 1999a, b) that elicited defensive actions (wing buzzing, kicking) by the mother hopper.

Not being the only insect predator of *Umbonia*, removing the protective mother as a prey, before the nymphs went through their final moult would be counter-productive for *Hoplisoides vespoides*, as this would support the competing *Pseudopolybia* and other insect predators in removing (future) prey in their nymphal stages. It has been shown, that disappearance of the mother "results in greatly increased predation on nymphs" (COCROFT 1999a).

Vespid wasp mimicry by a Sand wasp?

The similarity of *Hoplisoides vespoides* to a Vespid wasp, which has already been noticed by the author of the original description F. SMITH in 1873, raises the question, if this is a case of mimicry. In my opinion this is quite certain. The second question is which species (or group of similar species) acts as the Vespid model? I asked a specialist on Neotropical Vespids for help.

SEAN O'DONNEL (in lit.) wrote: "I do have a putative model for your wasp: *Brachygastra mellifica*. In Costa Rica, *Brachygastra mellifica* is fairly common and has large colonies - several thousand adults at least, if not tens of thousands. The workers are pretty nasty with barbed stings. They are mimicked by other Hymenoptera, so I am not surprised to see your wasps copying them. There are several features of body and wing coloration, and body shape, in your wasp that make me think that this is a specific pair wise mimicry, rather than a general paper wasp mimicry."

As female *Hoplisoides* also possess a sting of unknown painfulness, this would be a case of Muellerian mimicry, two or more protected species sharing the same aposematic livery. *Brachygastra* (formerly *Nectarina*) are honey storing social paper wasps, like *Polybia occidentalis*. Because of their precious resources they are especially prone to sting. To me it seems quite possible, that these wasps collect the sweet exudations of the treehoppers besides the nectar of flowers. This, alongside with the habit of *Brachygastra* to nest high up in trees, would ascertain the necessary spatial proximity between model and mimic.

As *Hoplisoides* is by far the least numerous partner in that mimicry pair, this should help greatly to reduce losses through flycatchers, tyrants and motmots, when searching for hopper prey around tree tops and twig tips, which are the favored hunting grounds for these insectivorous birds. The simultaneous activity of *Brachygastra* in the same forest stratum certainly benefits *Hoplisoides vespoides.*

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