

First record of myrmecophily in the scorpion *Birulatus israelensis* (Scorpiones: Buthidae)

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Abstract. The buthid scorpion genus *Birulatus* Vachon, 1974 includes three species, endemic to the Levant, each from a different location in Jordan, Israel and Syria, and all described from a single specimen. Fewer than ten specimens of the genus were collected so far. Nothing is known regarding their biology and ecology. During three collecting expeditions in the summer of 2016 near Mehola in the Jordan Valley, Palestine, 31 individuals of *Birulatus israelensis* Lourenço, 2002 (Scorpiones: Buthidae) were collected, all found exclusively on active foraging trails of the ant species *Messor ebeninus* Santschi, 1927, around their nests or coming in and out of the nests. These findings suggest that *Birulatus* has a myrmecophilous relationship with *M. ebeninus* ants.

Keywords: Ants, Levant, *Messor*

Zusammenfassung: Erster Nachweis von Myrmekophilie beim Skorpion *Birulatus israelensis* (Scorpiones: Buthidae). Die Skorpiongattung *Birulatus* Vachon, 1974 (Buthidae) enthält drei in der Levante endemische Arten, die jeweils nach einem Einzelexemplar aus Jordanien, Israel und Syrien beschrieben sind. Nicht einmal 10 Exemplare der Gattung wurden bisher gesammelt und ihre Biologie und Ökologie ist unbekannt. Bei drei Sammelexpeditionen im Sommer 2016 nahe Mehola im Jordantal, Palästina, wurden 31 Exemplare von *Birulatus israelensis* Lourenço, 2002 (Scorpiones: Buthidae) gesammelt, alle ausschließlich gefangen an aktiven Futterstraßen der Ameisenart *Messor ebeninus* Santschi, 1927 im direkten Umfeld der Nester. Diese Funde legen nahe, dass *Birulatus* eine myrmekophile Beziehung zu *M. ebeninus* hat.

The buthid scorpion genus *Birulatus* Vachon, 1974 includes three species, all described from a single specimen (Vachon 1974, Lourenço 2002, Stathi & Lourenço 2003). Scorpions in this genus are characterized by their small size (~2 cm; Fig. 1). So far, all individuals were found only in the Levant. Vachon (1974) described *Birulatus haasi* Vachon, 1974 from a single female specimen collected in Schauback (Ash Shawbak), Jordan. Two more specimens of this species were recently collected (Amr et al. 2015).

Lourenço (2002) and Stathi & Lourenço (2003) described two more species of this genus: *B. israelensis* Lourenço, 2002, from north-eastern Israel, and *B. astartiae* Stathi & Lourenço, 2003 from Syria. In 2011, another female specimen of *B. israelensis* was collected in the Judean Desert, Palestine (Loria & Prendini 2014, Prendini pers. comm.).

During the summer and autumn of 2016, collecting expeditions to the area of Mehola in the Jordan Valley were conducted to find additional individuals of *Birulatus*. During these expeditions, 31 individuals were collected, all found exclusively on active foraging trails of the ant species *Messor ebeninus* Santschi, 1927 or around their nests. In at least six instances, scorpions were observed going in and out of the nest itself, disregarded by the ants. This report presents evidence that *Birulatus* may be myrmecophilous.

Methods

There were three expeditions during July, August and October 2016, each for two moonless nights and a total of six nights. The search was concentrated around Mehola, 14 km south of the town of Bét-She'an, in the Jordan valley, Israel. Long: 35.516 Lat: 32.365 (WGS84). The sites were between the altitudes of -200m to -50m. In the first expedition, six sites were checked around this location that appeared suitable for *Birulatus*. Each site (~250 m²) was thoroughly searched after sunset by three or four people using ultraviolet flashlights. Twenty nests of the ant species *M. ebeninus* were subsequently



Fig. 1: *Birulatus israelensis* Lourenço, 2002 (photo Rony Livne)

marked by red & white tape attached to a nearby plant during daytime, and checked again after sunset (both around the nest and along the ant foraging trails). The more distant surroundings of the ant nests were searched as well.

Ants were identified by Dr. Armin Ionescu of the Steinhardt Museum of Natural History, Tel Aviv University.

Scorpions were collected alive and maintained at ambient temperature. Dead scorpions were preserved in 96% ethanol. Identification was conducted using a dissecting microscope with the aid of taxonomic literature (Lourenço 1999, Lourenço 2002, Stathi & Lourenço 2003). Sex was determined by measuring the difference in the angle, position and length of the pectines between the sexes (Polis 1990, Stockmann & Ythier 2010) or by the presence of spermathecal plugs (Peretti 2010).

Results

Thirty-one scorpions were collected, all found along the foraging trails of *M. ebeninus* and around their nests between July and October 2016. The scorpions demonstrated the typical characters of the genus *Birulatus* as mentioned by Vachon (1974), Lourenço (1999), Lourenço (2002) and by Stathi & Lourenço (2003). They were morphologically similar to the *B. israelensis*, except with reduced lateral eyes, as observed previously by L. Prendini (pers. comm.) and Loria & Prendini (2014). Of the 31 individuals collected, three were males and 28 were females (1:9 ratio). Two of the 31 individuals collec-

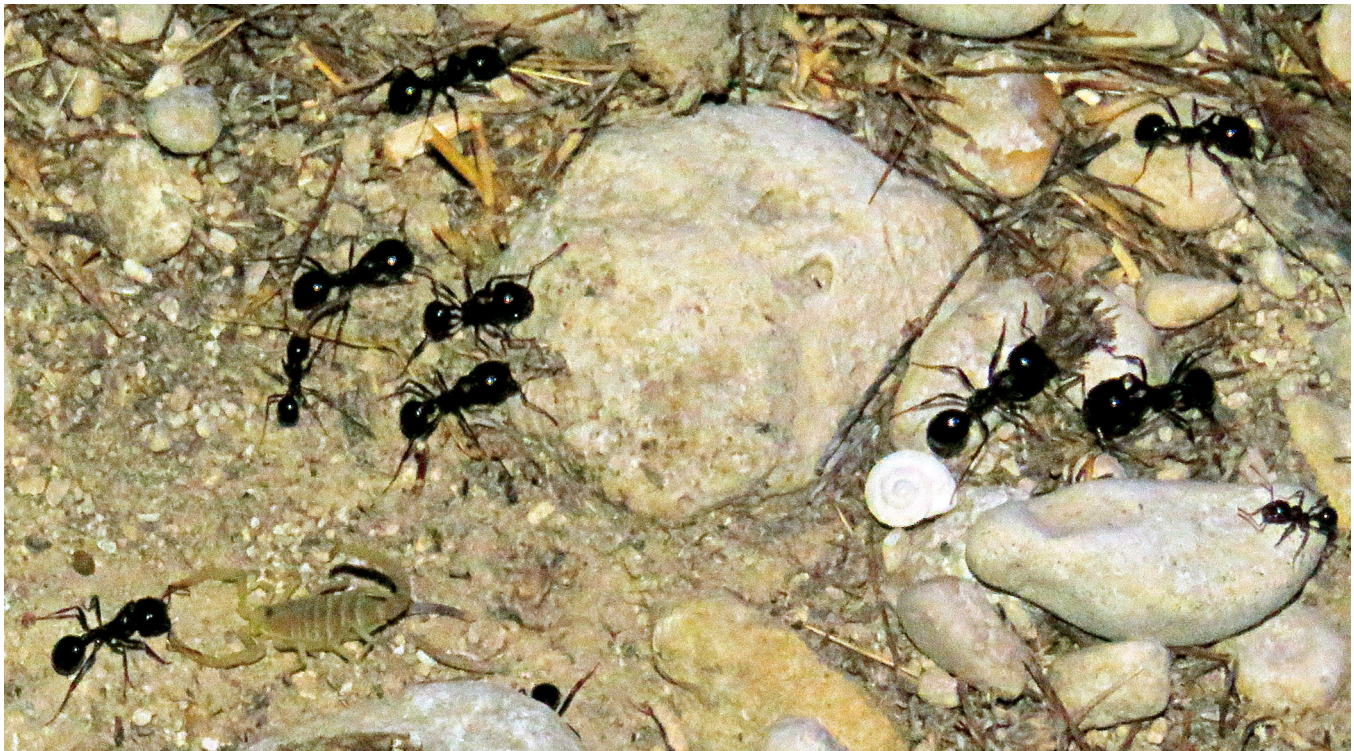


Fig. 2: *Birulatus israelensis* Lourenço, 2002 pauses on the ant trail and lets an ant examine it with her antennae (photo Yoram Zvik)

ted were immature under 1 cm long and the rest were sub-adults and adults with a maximum length of 2.1 cm (anterior carapace margin to tip of telson).

All individuals of *Birulatus* were found exclusively around *Messor ebeninus* nest openings, or on their active foraging trails, and demonstrated a unique behaviour of pausing and allowing the ants to check them frequently (Fig. 2). In at least six instances, scorpions were observed going in and out of the nest itself, disregarded by the ants. Beside scorpions of the genus *Birulatus*, six other scorpion species were found regardless the presence or absence of *Birulatus*: *Androctonus crassicauda* Olivier, 1807 (20 individuals), *Leiurus hebraeus* (Birula, 1908) (~300 individuals), *Compsobuthus schmiedeknechti* Vachon, 1949 (10 individuals), *Compsobuthus carmelitis* Levy, Amitai & Shulov, 1973 (6 individuals), *Scorpio palmatus* Ehrenberg, 1828 (~150 individuals) and *Nebo hierichonticus* Simon, 1872 (10 individuals). The scorpions from the different species observed in the field appeared to avoid close encounters with the ants, and in one case a young *L. hebraeus* that approached the nest was immediately attacked by the ants.

Of 20 ant nests observed, ten contained remains of dead *Birulatus* or parts of their exuvia, even at times when live specimens were not found around the nest. In two incidents, ants were observed carrying a dead, dry body of *Birulatus* out of the nest. Most of the scorpion remains were recovered from organized piles of dead ant bodies, suggesting that the ants treat the scorpions the same as they treat other nest member ants.

Discussion

These observations offer some primary evidence for a myrmecophilous relationship between *Birulatus* sp. and *Messor ebeninus*, the first such relationship ever recorded. During the field observations, no aggressive or negative interactions were observed between the *Birulatus* scorpions and the ants. The ants

neither attack, nor serve as prey for the scorpions. How the scorpion avoids being attacked by the ants remains to be determined. Possible benefits to the scorpions from the relationship might include the following:

1. The *Messor* nest is a well-protected, environmentally-stable and resource-rich space, which may provide a suitable shelter (Kronauer & Pierce 2011). Large colonies provide a greater variety of microhabitats and can sustain larger and more stable populations of guests over longer time periods (Kronauer & Pierce 2011).
2. Ant colonies are well defended, so from the perspective of a myrmecophile, they provide an 'enemy free space' (Kronauer & Pierce 2011).
3. Colonies of *M. ebeninus* can persist for a long time, as some queen ants are known to live up to 30 years (Jemielity et al. 2005), perhaps offering a long-term environment for the scorpions. Although it is unlikely that individual *Birulatus* scorpions live for more than a few years, the possibility of successive generations cohabiting a single ant nest should be investigated.
4. Ant species with large colonies can harbour a high diversity of myrmecophiles (Pérez-Lachaud & Lachaud 2014), which in turn may serve as potential prey for the scorpions. The scorpions may also feed on the ant eggs and larvae as with some other myrmecophiles (Kronauer & Pierce 2011, Hölldobler & Wilson 1994).

Possible advantages to the ants from this relationship remain unclear, but perhaps the scorpions control the number of parasitic myrmecophiles or predators in the nest.

The observations described above suggest the existence of a positive interaction between *B. israelensis* scorpions and *M. ebeninus* ants. Further research is required to explore the nature of the relationship and whether other *Birulatus* species are also associated with ants or with other burrowing organisms.

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