

SHORT COMMUNICATION

Two myrmecophilous scale insects, *Cryptostigma urichi* (Cockerell) (Hemiptera, Coccidae) and *Farinococcus multispinosus* Morrison (Hemiptera, Pseudococcidae), cohabiting inside branches of *Anadenanthera falcata* (Benth.) Speg. (Fabales, Fabaceae) in the Cerrado area of São Paulo State, Brazil

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ABSTRACT. Two myrmecophilous scale insects, *Cryptostigma urichi* (Cockerell) (Hemiptera, Coccidae) and *Farinococcus multispinosus* Morrison (Hemiptera, Pseudococcidae), cohabiting inside branches of *Anadenanthera falcata* (Benth.) Speg. (Fabales, Fabaceae) in the Cerrado area of São Paulo State, Brazil. The soft scale *Cryptostigma urichi* (Cockerell, 1894) and the mealybug *Farinococcus multispinosus* Morrison, 1922 are reported cohabiting inside branches of *Anadenanthera falcata* (Benth.) Speg. (Angico-preto), both tended by the ant *Azteca oecocordia* Longino, 2007 (Hymenoptera, Formicidae). This interaction was observed in the Cerrado region *sensu stricto*, at the Federal University of São Carlos, UFSCar, Brazil. *A. oecocordia* is recorded for the first time in Brazil.

KEYWORDS. Ant-coccoids interaction; *Azteca oecocordia*; trophobiotic interactions.

RESUMO. Duas cochonilhas mirmecófilas, *Cryptostigma urichi* (Cockerell) (Hemiptera, Coccidae) e *Farinococcus multispinosus* Morrison (Hemiptera, Pseudococcidae), coabitando no interior de ramos de *Anadenanthera falcata* (Benth.) Speg. (Fabales, Fabaceae) em área de Cerrado do Estado de São Paulo, Brasil. O coccídeo *Cryptostigma urichi* (Cockerell, 1894) e o pseudococcídeo *Farinococcus multispinosus* Morrison, 1922 são registrados coabitando no interior de galhos de *Anadenanthera falcata* (Benth.) Speg. (Angico-preto), ambos atendidos pela formiga *Azteca oecocordia* Longino, 2007 (Hymenoptera, Formicidae). Essa interação foi observada em uma região de Cerrado *sensu stricto*, na Universidade Federal de São Carlos, UFSCar, Brasil. *A. oecocordia* é registrada pela primeira vez para o Brasil.

PALAVRAS-CHAVE. interação formiga-cocóideos; *Azteca oecocordia*; interações trofobióticas.

Ants establish mutualistic relationships with a large number of species of Coccoidea and other Sternorrhyncha. The coccoids constantly produce honeydew upon which the ants feed, and in return, this association can improve the survival of coccoids because the ants provide protection against the action of natural enemies and their constant collecting of honeydew reduces contamination of the coccoids by molds that often grow on the excreted honeydew (Way 1963; Gullan 1997; Flatt & Weisser 2000; Kondo & Gullan 2004). This kind of relationships between an ant and a homopteran in which trade-off of a sweet food source occurs benefiting both organisms and improving their lives can be called trophobiosis (Holldobler & Wilson 1990; Delabie 2001).

Trophobiotic interactions between coccoids and ants of the genus *Azteca* Forel, 1878 are estimated to have started in

the Miocene period 15–20 million years ago (Johnson *et al.* 2001) and have been observed inside domatias of trees for a long time (Beccari 1884 *apud* Wheeler 1942; Longino 2007).

Cryptostigma Ferris, 1922 (Coccoidea, Coccidae), a Neotropical genus recently revised by Kondo (2010), is comprised of 17 species which live mostly inside the hollow branches, twigs or trunks of their host plants in association with ants belonging to four different subfamilies: Dolichoderinae, Formicinae, Myrmicinae and Pseudomyrmecinae (Ferris 1922; Laing 1925; Morrison 1922, 1929; Newstead 1917, 1920; Qin & Gullan 1989; Kondo 2010), and rarely with stingless bees (Apidae, Meliponini) (Camargo and Pedro 2002a, b; Kondo 2010).

Cryptostigma urichi (Cockerell), one of the four species of *Cryptostigma* known from Brazil, has been reported from Belize, Brazil (Rio Grande do Sul), Colombia, Grenada,

Guyana, Suriname, Trinidad and Tobago associated with *Azteca alfari cecropiae* Forel, *Azteca* sp., *Camponotus novogrenadensis* Mayr (within nests of the termite *Hamitermes excellens* Emerson) and *Crematogaster brevispinosa* Mayr (Hempel 1900; Morrison 1922, 1929 *apud* Kondo 2010). Host plants of *C. urichi* include various species of Cecropiaceae, Fabaceae, Malvaceae (as Sterculiaceae), Moraceae, Polygonaceae, and Smilacaceae (Kondo 2010).

Farinococcus multispinosus Morrison is a unique species within *Farinococcus*, and it is known from Brazil, Costa Rica and Guyana. This species has been reported cohabiting with two species of *Cryptostigma* in Guyana: with *C. urichi* inside domatia of *Triplaris surinamensis* tended by the ant *Pseudomyrma triplaris* (Wheeler 1942); and with *C. inquilinum* (Newstead), in internodes of branches of *Triplaris weigeltiana*, tended by *Pseudomyrmex viduus* (Ward 1999).

Cryptostigma urichi, *Farinococcus multispinosus* and *Azteca oecocordia* Longino, 2007 (Fig. 1) were first observed inside branches of *Anadenanthera falcata* (Fabaceae), in December 2008, in the Cerrado *sensu stricto* at the Universidade

Federal de São Carlos, (UFSCar), located between the coordinates 21°58'22"00"S and 47°51'47"52"W. Additional collections were made in the same place: January and August 2009, December 2011, and January 2012 in order to confirm these novel scale insect-ant mutualistic interactions.

In the first collections, plants of *A. falcata*, were chosen at random, and the branches were opened with a knife, and the coccoids and ants, when present, were stored separately in 75% and 95% ethanol respectively to posterior slide-mounting and identification. In the last collection, 20 trees of variable sizes were chosen. For each tree, one segment of 30 cm from different branches were sampled and all scale insects and ants found inside were quantified and calculated the simple mean (\bar{x}) and standard deviation (*sd*). The basal diameter of the tree trunks of these trees were measured (Brito 1997).

Permanent slides of the specimens were prepared following the method for Coccoidea used by Gullan (1984). The species were identified under an optical microscope, using the keys by Williams & Granara de Willink (1992) for mealybugs, Hodgson (1994) for Coccidae genera, and Kondo

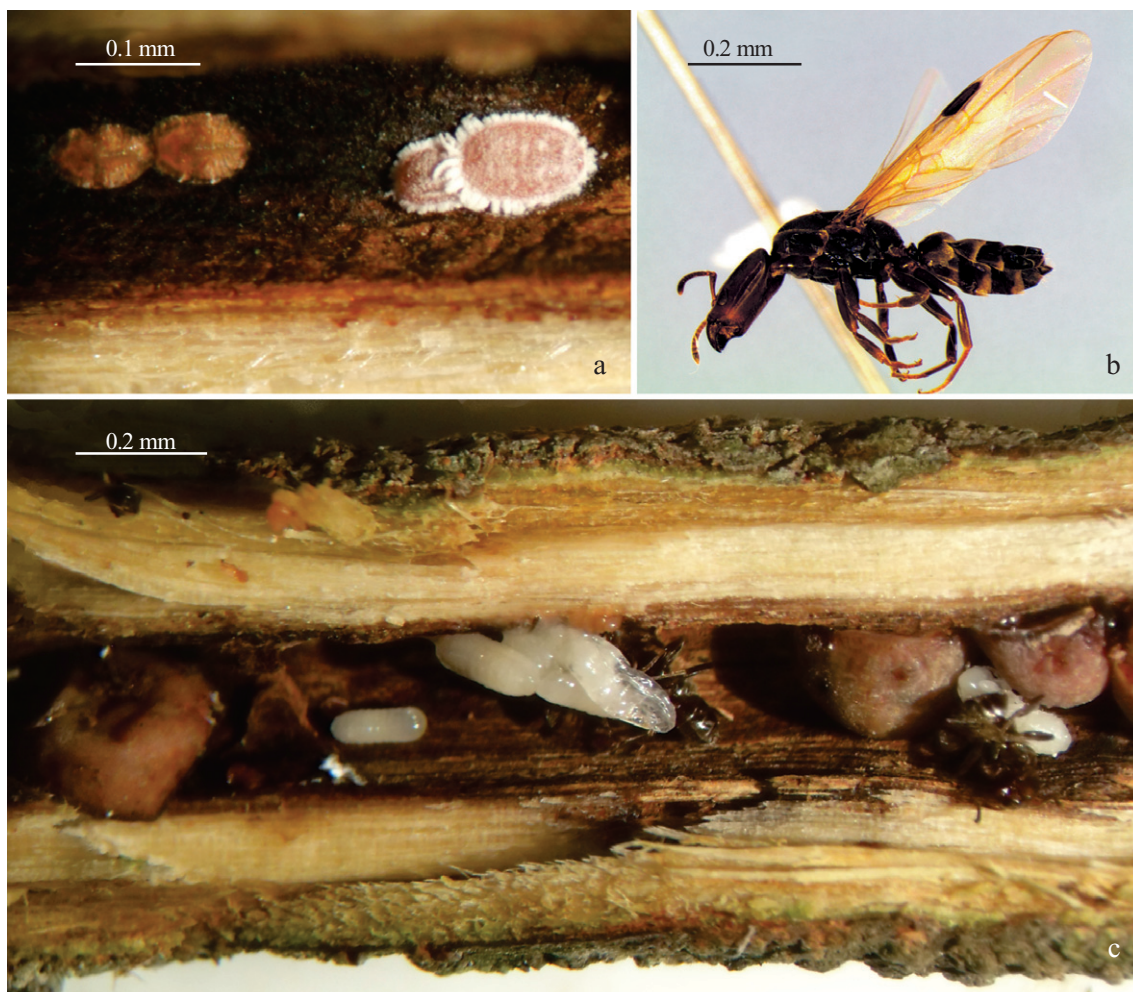


Fig. 1. Scale insects cohabiting in branches of *Anadenanthera falcata* within *Azteca oecocordia* colony. a) *Cryptostigma urichi* (left) and *Farinococcus multispinosus* (right) cohabiting inside branches of *Anadenanthera falcata*; b) Queen of *A. oecocordia*; c) Nest of the *Azteca oecocordia* associated with *Cryptostigma urichi*.

(2010) for coccids of the genus *Cryptostigma*. The ants were sent to a specialist for identification. The insects were deposited in the entomological collection of the Department of Ecology and Evolutionary Biology at UFSCar.

The coccoids *C. urichi* and *F. multispinosus* and the ant *A. oecocordia* were observed within the hollow branches in at least one tree of *A. falcata*, in all periods sampled. Groups of these two species of coccoids were observed alone or cohabiting the same hole, together with the ants (Fig. 1a).

The scale insects were found in nine (45%) of the trees sampled. Of the two species of scale insects observed, *C. urichi* was the most abundant with 0-20 ($\bar{x} = 2.35$; $sd = 4.68$) specimens in each hollow branch sampled. Specimens of *F. multispinosus* when present, only 1-5 specimens were observed in each hollow branch. All life stages of both coccoids were present, indicating that these two coccoid species complete their life cycles inside the branches of *A. falcata*. The number of *A. oecocordia* ants (Fig. 1b) found inside the opened branches was 0-178 ($\bar{x} = 12.25$; $sd = 42.71$) specimens in 8 (40%) sampled trees. Nests with immature ants were found inside the branches, always near the *C. urichi* aggregations (Fig. 1c).

Both, ants and scale insects were found inhabiting branches from 1 cm in diameter in young and older trees. *Cryptostigma urichi* was most common in trees with tree trunks with more than 0.36 cm of basal diameter and *F. multispinosus* was also present in younger trees with tree trunks from 0.12 cm of basal diameter.

No natural enemies were observed to be associated with the coccoids. The ants were very aggressive when the coccoids were manipulated, indicating that they provide protection to the coccoids. Furthermore, these insects gain additional protection from natural enemies due to their habit of living inside hollow branches that provide isolation from the external environment.

The hollow branches in which the scale insects were found had small entrance holes from which the ants entered and exited. *Anadenanthera falcata* apparently does not have natural domatia, and thus the hollow branches were probably tunneled by the ants or other xylophagous herbivores that may have previously inhabited these spaces.

According to the literature, the introduction of scale insects inside holes of domatia or other kind of cavities present in the host plants, could occur in two ways: scale insects (immatures or adult females) could be transported by ants (workers or founding queens); or the crawlers could walk by themselves to enter the holes (Gullan 1997; Delabie 2001; Johnson *et al.* 2001; Moog *et al.* 2005). Although Kutscher & Koteja (2000) described and illustrated the fossil of a female of *Matsucoccus* species (Hemiptera, Coccoidea, Matsucoccidae) held between mandibles of an ant, *Azteca* sp. that were both preserved in Dominican amber, no extant *Azteca* ant species have been recorded transporting coccid and pseudococcid species. Nevertheless, it still remains uncertain the way in which these scale insects were introduced into the hollow branches of *A. falcata* in this study.

Azteca oecocordia described by Longino (2007) is known only from Monteverde in Costa Rica, living in a specific association with *Cordia alliodora* (Longino 2007). Despite the morphological similarity between Brazilian and Costa Rican specimens of *A. oecocordia*, phylogenetic analysis should be conducted in order to evaluate some possible interspecific convergences (J. Longino pers. com.). *Azteca oecocordia* is reported for the first time in Brazil.

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