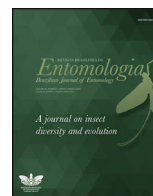




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Short Communication

First report of two species of scarab beetles
 (Coleoptera, Scarabaeidae) inside nests of *Azteca* cf. *chartifex* Forel
 (Hymenoptera, Formicidae) in Brazilian Amazonian Rainforest



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ABSTRACT

We report for the first time the occurrence of two species of scarab beetles, *Phileurus carinatus declivis* Prell, 1914 (Scarabaeidae: Dynastinae) and *Cyclidius elongatus* (Olivier, 1789) (Cetoniinae: Cremastocheilini) inside nests of *Azteca* cf. *chartifex* Forel, 1896, a neotropical arboreal ant species. This report indicates that these two beetle species are associated, at least as inquilines, to this ant species, although the nature of this relationship remains unclear.

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Nest building social insects creates a habitat that contains a wide range of resources. It may serve as an alimentary source, since their inhabitants can be preyed upon or even the nest itself can be eaten. It can also serve as shelter, functioning as a physical defense against the weather and predators. For this reason, the nests become a resource that can be exploited by other animals (Hölldobler and Wilson, 1990). In order to prevent from invaders, the ants have several defense mechanisms to protect the nest, such as a complex chemical recognition system amongst members of the same colony and a variety of chemical alarm signals (Vander Meer and Morel, 1998). Nevertheless, several animals denominated myrmecophiles live inside or close to ant nests (Rettenmeyer et al., 2010), many of which exploits the chemical recognition system of the ants (Lenoir et al., 2011). The complexity of the interactions between myrmecophiles and ants, plus the lack of general knowledge about the nature of most of them makes it difficult to categorize them (Mynhardt, 2013).

Ants from *Azteca* Forel, 1878 genus are neotropical, arboreal, characterized by their big carton nests (Longino, 2007). *Azteca chartifex* Forel, 1896 is a territorially dominant ant (Dejean et al., 2009), that aggressively defends its territory both intraspecifically and interspecifically (Dejean et al., 2007; Blüthgen and Stork, 2007).

They construct large nests, on heights that can reach up to 2 m from the ground level and are frequent in wetforests (Longino, 2007).

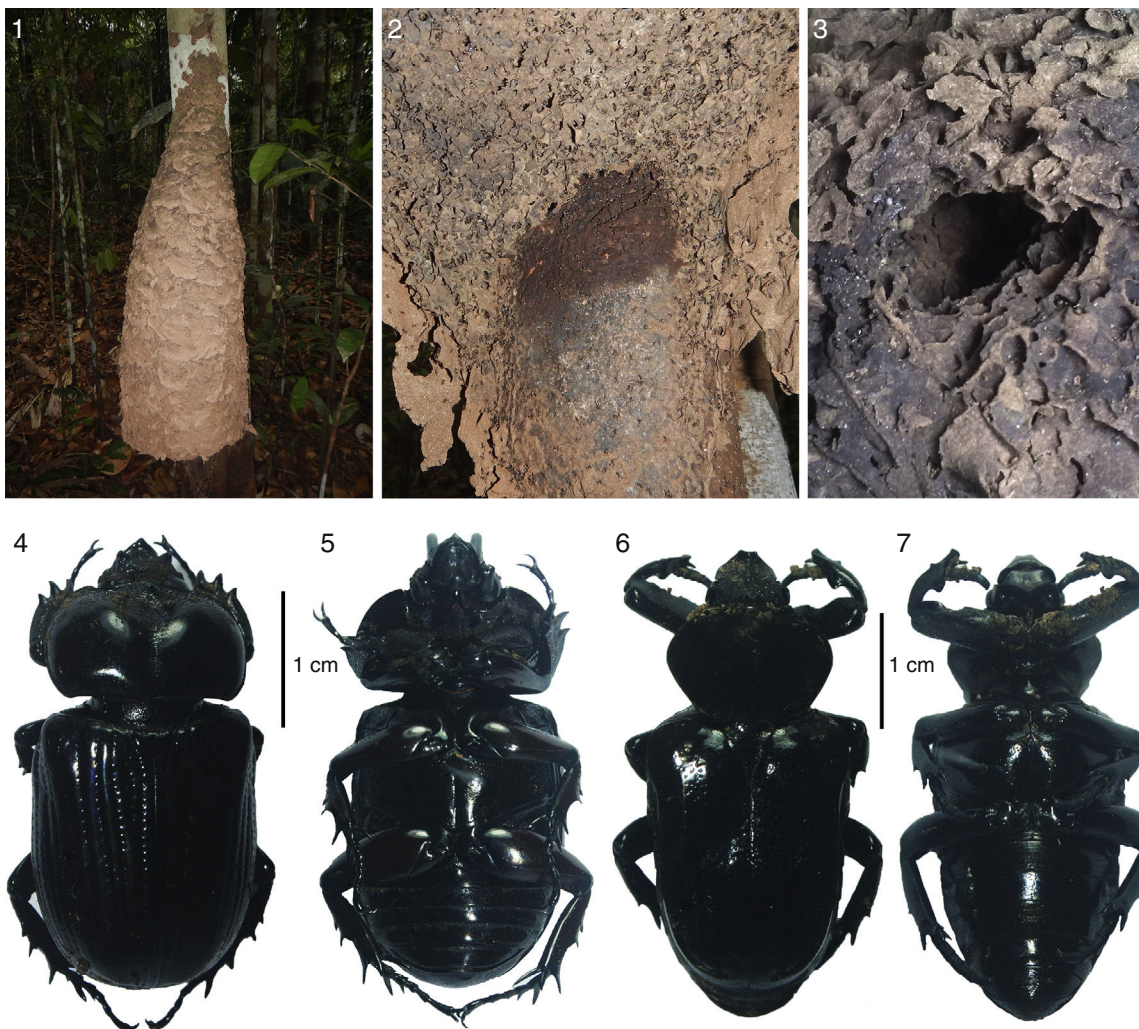
Amongst the myrmecophiles insects, Coleoptera is one of the most diverse, with at least 33 families reportedly interacting with ants (Parker, 2016), although there is no behavioral data for at least 15 of them (Mynhardt, 2013). The beetles have different strategies to surpass the defense mechanisms of its hosts, such as chemical mimicry by production or acquisition of specific hydrocarbons from their hosts (Vander Meer and Wojcik, 1982), morphological mimicry (Akre and Rettenmeyer, 1967), secretion of defensive or attractive compounds (Geiselhardt et al., 2007) or morphological defenses, such as reduced appendages (Ratcliffe and Micó, 2001).

Specimens were collected in September and October 2014, in Reserva Florestal Adolfo Ducke, north of Manaus city, Amazonas, Brazil. This is a “Terra-Firme” wetforest, with an average annual temperature of 26 °C. The annual rainfall varies from 1.750 mm to 2.500 mm (Marques-Filho et al., 1981). Four *Azteca* cf. *chartifex* nests with sizes ranging from 1 m to 1.5 m were collected in different trees. Nests were located at a height of 1–2 m from the ground level.

Nests were sectioned by its lower third (Figs. 1–3), to allow the colony recovery. The removed portion was then placed inside a plastic bag and taken to a freezer, to kill the insects. Then the nest piece was examined manually at the laboratory “Laboratório de Fauna de Solo – Instituto Nacional de Pesquisa da Amazônia”,

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Figs. 1–7. *Azteca* cf. *chartifex* nest and its associated myrmecophile beetles. 1, Nest, sectioned at its third lower part, which was searched for myrmecophiles. 2, Upclose view of upper nest part, with no sight of large galleries. 3, Large gallery on the collected nest piece, in which one beetle was found. 4, *Phileurus carinatus declivis*, dorsal view. 5, *Phileurus carinatus declivis*, ventral view. 6, *Cyclidius elongatus*, dorsal view. 7, *Cyclidius elongatus*, ventral view.

with a stereo microscope and featherweight tweezers to find the myrmecophiles.

Collected specimens were deposited in the following collections: INPA (Coleção Entomológica do Instituto Nacional de Pesquisas na Amazônia, Manaus, Amazonas – Márcio de Oliveira) and CERPE (Coleção Entomológica da Universidade Federal Rural de Pernambuco, Recife, Pernambuco – Paschoal C. Grossi).

Twelve specimens of the Scarabaeidae *Phileurus carinatus declivis* Prell, 1914 (Dynastinae, Phileurini) (Figs. 4 and 5) were found, being present in all sampled nests, with the quantity of specimens found varying between two and four specimens in a single nest. There was no external openings in the nests, which indicates the ants reconstructs the damaged structure after the beetle entrance, or even that the larvae of this species develops inside the nest. The galleries built by the beetles are deep, with an extension superior to 40 cm, allowing us to infer that the beetles are well adapted to the contact with the ants.

Specimens examined. 9♂ e 3♀ – BRASIL, Amazonas, Manaus, Reserva Ducke, 20.ix.2014, trilha do igarapé do Acará, interior de ninho de *Azteca* cf. *chartifex*, (A. M. Silva-Neto, D.M.M. Mendes, D. Campos & J.R. Oliveira leg.) (2♂ e 1♀); *idem*, trilha ao lado dos alojamentos da base sede, 21.ix.2014, (3♂ e 1♀); *idem*, trilha de saída da reserva, 21.ix.2014, (2♂); *idem*, trilha do igarapé do Acará, 05.x.2014, (2♂ e 1♀) (CERPE, INPA).

Only one male specimen of the Cetoniinae *Cyclidius elongatus* (Olivier, 1789) (Cetoniinae, Chremastocheilini) (Figs. 6 and 7) was found inside a nest of *A. cf. chartifex*, in similar conditions to the previous species.

Specimen examined. 1♂ – BRASIL, Amazonas, Manaus, Reserva Ducke, 20.ix.2014, trilha do igarapé do Acará, interior de ninho de *Azteca* cf. *chartifex*, (A. M. Silva-Neto, D.M.M. Mendes, D. Campos & J.R. Oliveira leg.) (CERPE).

There are few publications about the life stories of *Phileurus* species, although it is known that both larvae and adults can be found inside dead tree trunks, of which they possibly feed at larvae stage (Ritcher, 1966; Morelli, 1991; Lamant-Voirin, 1995; Ratcliffe and Morón, 1997; Dechambre, 1998); or prey on other larvae at adult stage (Ratcliffe and Morón, 1997; McCleve, 2007). This taxon was recently reviewed by Grossi and Saltin (2014) and had its status confirmed, apparently belonging to Amazon populations, with distribution extending to areas that previously had connection with the Amazon forest. Until now myrmecophily was only registered for the *Phileurus* genus by Deloya (1988), to the species *Phileurus vagus* (Olivier, 1789) in Mexico, as an inquiline of *Atta mexicana* (Smith, 1858), a group of ants far less aggressive than those belonging to the genus *Azteca*.

For Cetoniinae there are 52 records of new world species associated in some way with ants, but this is the first record of

myrmecophily for the genus *Cyclidius*, as well as the first record of a Cetoniinae myrmecophile for *Azteca* ants (Puker et al., 2015). *Cyclidius* is the largest neotropical genus in the tribe regarding to body size, and has six species to date. Although its habits are unknown, morphological evidences pointed that they were associated with social insects, due to the reduction of its appendages, an adaptation shown by other scarabaeoids that lives in termite and ant nests (Ratcliffe and Micó, 2001). Its tribe, Cremastocheilini, have the highest number of species associated with ants, with 31 species distributed in two genera in neotropic region (Puker et al., 2015). *Cremastocheillus* species, the most studied genus of myrmecophile in this tribe prey on ant larvae while are treated indifferently by the ants (Cazier and Mortenson, 1965). Morphological adaptations, such as thickened integument, retractile antennae and concealed mouthparts protects them from ant attacks, as well as defensive secretions from the anal opening when disturbed (Alpert and Ritcher, 1975).

Some Coleoptera are able to capture hydrocarbons from the cuticle of their ant hosts, being accepted by the colony (e.g. Vander Meer and Wojcik, 1982; Talarico et al., 2009). Both *P. carinatus declivis* and *C. elongatus* have bristles that either are or function as trichomes, which can possibly exudate compounds attractive to ants. Something similar could be occurring with those two species being reported as *Azteca* myrmecophiles.

Comprehensive samplings, including *Azteca* nests from different species and localities are needed to be done, to verify if more species from the genera *Phileurus* and *Cyclidius* are *Azteca* myrmecophiles. In addition, we need to know to which extent the life cycles of those beetles are associated with the ants. Observations of myrmecophiles are difficult. For most cases it is only possible to infer about their behavior through their morphological characteristics. How those species avoid ants defense system remains unanswered.

Conflicts of interest

The authors declare no conflicts of interest.

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