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Scientific Note

New behavior report by *Canthon virens* (Mannerheim, 1829) (Coleoptera: Scarabaeidae: Scarabaeinae) in Southeastern Brazil

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Abstract. *Canthon virens* (Mannerheim, 1829) (Coleoptera: Scarabaeidae: Scarabaeinae) prey on leaf-cutting ants, using their body for provisioning larvae, as part of the reproductive behavior. Here, we report an observation of a new behavior of *C. virens* during the predation of *Atta laevigata* (Smith, 1858) (Hymenoptera: Formicidae) in Southeastern Brazil. We observed a *C. virens* rolling a fruit capsule of *Eucalyptus* sp., which may indicate an ant's escape strategy from the predation.

Keywords: *Atta*, Dung beetle, Food Resource, Leaf-cutting ants.

Dung beetles (Coleoptera: Scarabaeidae: Scarabaeinae) are known to feed upon animal dung, using it for food and reproduction (Halffter & Mathews 1966). This behavior results in essential ecosystem functions such as dung removal, bioturbation, increase in plant growth, secondary seed dispersal, and parasite control (Nichols et al. 2008; Braga et al. 2012; Griffiths et al. 2015). Despite their coprophage habits, dung beetles also feed on animal carcasses, decaying fungi and fruits, and other unusual food sources (Hanski & Cambefort 1991). Some species of Deltochilini Lacordaire, 1856 developed predatory behaviours, such as *Canthon virens* (Mannerheim, 1829) preying leaf-cutting ants (*Atta* spp.) and *Deltochilum* spp. preying millipedes (Silveira et al. 2006; Larsen et al. 2009; Silva et al. 2012).

The predation of leaf-cutting ants by *C. virens* was first described by Lichti (1937) and has been often reported since then (Hertel & Coli 1998; Forti et al. 2012; Aquino et al. 2018). The reproduction period of these beetles is synchronous to the leaf-cutting nuptial flights, when *Atta* Fabricius, 1804 females, after the nuptial flight, walk around open areas to find places to build new colonies (Marinho et al. 2011). Therefore, the beetles benetif from this abundant ephemeral food resource, as it only occurs a few days a year (Silveira et al. 2006). For most of the year, these beetles possibly feed on mammalian feces and ripe fruits (Vaz-de-Melo et al. 1998).

Forti et al. (2012) identified 28 steps of predatory behavior of *C. virens* on leaf-cutting ants, active in crops of *Eucalyptus grandis* in Southeastern Brazil. Briefly, the following main steps can describe this process: 1. Beetles approach the ant queens by walking or flying in a zigzag pattern; 2. They mount and decapitate the ants; and 3. Lastly, the beetle's roll the ant's body and bury them in the underground nests, where the beetle's larvae feed and develop using the ant's body as food (Silveira et al. 2006; Aquino et al. 2018). Despite this ethogram provided by Forti et al. (2012), here we report a new and unknown behavior of *C. virens* displayed during the predation of *A. laevigata.*

Canthon virens was observed in a modified peri-urban area (an abandoned soccer field surrounded by *Eucalyptus* trees, near to a pasture area) in October 2015, in Ritápolis municipality, Minas Gerais state, Brazil (21.012277°S 44.185727°W). During predation, an individual of *C. virens* rolled a fruit capsule of *Eucalyptus* sp. (Fig. 1) as if it were the body of a preyed ant.

The abdomen of the leaf-cutting ants and the capsule of the eucalyptus fruit are very similar in shape and color (Fig. 2), which suggests that the beetles may have confused both of them since the beetles might locate the ants by the vision and tactile guidance. The tactile sensation is highly developed in Scarabaeinae beetles, while vision is generally reduced (Halffter & Mathews 1966). However, Forti et al. (2012) also suggested that beetles use vision in their favor during predation, as they could locate the queens of *Atta* that were moving and the standing ones. Halffter & Mathews (1966) also reported that dung beetles use odor as one of the main ways to locate food sources.

Figure 1. Individual of *Canthon virens* (Mannerheim, 1829) rolling a fruit in a *Eucalyptus* capsule.

Atta queens are more vulnerable to predation after the nuptial flight (Forti et al. 2012) and, when threatened, leaf-cutting ants exhibit an aggressive response and release an alarm pheromone from their mandibular glands (Hughes et al. 2001), 4-Methyl-3-Heptanone ketone being the primary chemical compound released (Riley et al. 1974), but the amount and variety of compounds may vary between *Atta* species and castes (Hérnandez et al. 1999). Our observation suggests that the queen may have released alarm pheromones when perceiving the presence of the predatory beetles, and this compound may have been impregnated in the *Eucalyptus* capsule fruit since the beetles locate their food through odors captured by localized sensory receptors on their antennae (Halffter & Mathews 1966). Therefore, the beetle may have been tricked into rolling the fruit.

Figure 2. Comparison between *Atta laevigata* (Smith, 1858) female and *Eucalyptus* sp. fruit capsule.

We emphasize that further investigation is needed to verify whether the pheromone was released by chance on the fruit capsules (and other small objects) or intended to confound its predators, indicating a complex and elaborate anti-predation strategy. In *Atta laevigata* (Smith, 1858), queens have chemical compounds exclusive to this caste (Hérnandez et al. 1999). This may suggest that individuals of *C. virens* utilize these compounds to detect their prey, considering that the beetles were only recorded attacking queens in our observation.

We also observed that couples of *C. virens* acted together during decapitation. After the death of the leaf-cutting ant, two situations were observed during the rolling of the prey: 1. One beetle rolled its prey while the other remained attached to the ant's thorax and was rolled along with it (Fig. 3), which was the most commonly observed situation; and 2. The two beetles rolled the prey together (Fig. 4). After finding a suitable nesting place, only one beetle excavated the nest while the other remained attached to the ant's thorax (Fig. 5).

Figure 3. Individual of *Canthon virens* (Mannerheim, 1829) rolling the *Atta laevigata* (Smith, 1858) while the other beetle remained attached to the ant's thorax.

Aquino et al. (2018) reported mainly male beetles carrying out the predation, corroborating Silveira et al. (2006) that also reported the females of *C. virens* being opportunistic as they attacked ants when the male was around, and these authors also proposed that male beetles could use the prey as an attraction for mating females. However, Forti et al. (2012) reported that female beetles are responsible for capturing, decapitating, rolling, and burying the queens of *Atta* sp., demonstrating that there is no clear consensus on whether the males or females are the main predators, including the number of beetles that attack the leaf-cutting ants. For the conservationist concerns, we highlight the possible positive density-dependent of *C. virens* and *A. laevigata* females (Vaz-de-Mello et al. 2021). Considering the methods of pest control used to the leaf-cutting ants, the use of MIP or biological control served by the *C. virens* beetles may guarantee the dung beetles' species permanence. Also, it is needed very detailed biology, chemical responses, toxicology studies of *C. virens* to comprehend its potential use as a biological agent to control the leaf-cutting ants.

Figure 4. *Canthon virens* couple (Mannerheim, 1829) rolling *Atta laevigata* (Smith, 1858).

Figure 5. Individual of *Canthon virens* (Mannerheim, 1829) excavating the nest while the other remained attached to the *Atta laevigata*'s (Smith, 1858) thorax.

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Authors' Contributions

GCSO observed and registered the beetle's behavior; GCSO, NRH, JL, and LV wrote and reviewed the manuscript.

Conflicts of Interest Statement

The authors declare that they have no conflict of interest related to the publication of this manuscript.

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