

Dung beetle (Coleoptera: Scarabaeinae) attraction to woodcreeper (Aves: Dendrocolaptidae) dropping in the central Amazon

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ABSTRACT

Bird droppings are an unusual food resource for coprophagous insects and used mostly by opportunistic decomposers. Among them, dung beetles feed mainly on dung, although the species differ in their trophic plasticity. Here we report a record of a dung beetle, *Canthidium* cf. *gracilipes*, reaching and manipulating the dropping of a passeriform bird, *Dendrocincla fuliginosa* (Dendrocolaptidae). The behavior was observed in an urban forest fragment located in the Amazonian city of Manaus, Brazil. Two hours after the bird defecated, the dung beetle reached the dropping and started manipulating them with its fore- and hindlegs. It did not eat the dung, though. For a clear understanding of the relationships between bird droppings and Amazonian dung beetles, it will be important to perform standardized experiments with a wide variety of native dung and carrion types.

KEYWORDS: Brazil; coprophagous; feeding behavior; Neotropics; Scarabaeidae; tropical forest

Atração de rola bosta (Coleoptera: Scarabaeinae) a excremento de arapaçu pardo (Aves: Dendrocolaptidae) na Amazônia central

RESUMO

Excrementos de aves correspondem a um recurso alimentar pouco comum para insetos coprófagos, sendo utilizados geralmente por decompositores oportunistas. Entre eles, os rola bostas se alimentam principalmente de fezes, entretanto a plasticidade alimentar varia entre as espécies. Neste estudo nós reportamos um registro do rola bosta *Canthidium* cf. *gracilipes* se aproximando de e manipulando os excrementos de uma ave passeriformes, *Dendrocincla fuliginosa* (Dendrocolaptidae). O comportamento foi observado em um fragmento localizado na cidade amazônica de Manaus, Brasil. Duas horas depois de que a ave defecou, o rola bosta se aproximou das fezes e começou a manipulá-las com as patas anteriores e posteriores. Entretanto, não se observou consumo do excremento. Para uma compreensão mais clara das relações entre os excrementos de aves e os rola bostas amazônicos, é importante a realização de experimentos padronizados com uma ampla variedade de fezes e carcaças nativas.

PALAVRAS-CHAVE: Brasil; coprófagos; comportamento alimentar; Neotrópicos; Scarabaeidae; florestas tropicais

Bird droppings feature as an unusual food resource for coprophagous insects. The white part of bird droppings is composed mostly by uric acid, which is rich in nitrogen (Hill *et al.* 2012), although this resource is not normally used as food by animals (Ramsay, 2013). Coprophagous insect species range from occasional to specialized feeders on bird droppings (Ramsay 2013; Ebert *et al.* 2019). Besides, other decaying material directly or indirectly produced by birds (*e.g.*, plant debris that grow in bird nests, feathers, and decomposing eggs) are also used by insect decomposers (Cartwright

1949; Pfrommer and Krell 2004). Overall, the interaction between insects and bird decaying matter is still poorly known. Therefore, it is important to report on occasional observations on bird-insect interactions, in order to build a body of knowledge on the trophic networks involving these biological groups.

Dung beetles (Coleoptera: Scarabaeinae) are essentially coprophagous insects, feeding mostly on fresh dung (Scholtz *et al.* 2009). In addition to coprophagy, dung beetles also

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exploit carrion, fruits, fungi, and some can even prey on other invertebrates (Noriega and Calle 2008; Halffter and Halffter 2009; Scholtz *et al.* 2009). Among the strictly or preferentially coprophagous species, there is a wide dietary breadth. There are species that feed on feces of many documented providers, such as *Saphobius edwardsi* Sharp, 1873, which feeds on mammal, bird, invertebrate, and reptile dung (Jones *et al.* 2012). In Brazil, it has been reported that dung beetles of the genera *Dichotomius* Hope, 1838, *Canthidium* Erichson, 1847, and *Canthonella* Chapin, 1930 are attracted to feces of omnivorous, carnivorous, and herbivorous mammals (Filgueiras *et al.* 2009; Bogoni and Hernández 2014). Nonetheless, there are species that present a strictly narrow diet, being attracted to the dung of specific species (Filgueiras *et al.* 2009; Bogoni and Hernández 2014).

Different mechanisms are involved in the recognition and attraction to different food types by dung beetles. Since chemical receptors in the antennae play a role in the recognition of food, the detection by the of volatile organic compounds in the food source is one of the main mechanisms that drive attraction to and food choice among dung beetles (Scholtz *et al.* 2009; Stavert *et al.* 2014; Weithmann *et al.* 2020). Not only one, but a bouquet of compounds is responsible for the recognition of food resource by beetles (Perrin *et al.* 2019; Weithmann *et al.* 2020). In addition to chemical compounds, the amount and texture of dung types is determinant for food attractiveness in dung beetles (Hanski and Cambefort 1991; Errouissi *et al.* 2004). Due to the scarce and ephemeral nature of feces, large and moist dung pads tend to be colonized by a high number of individuals and species (Scholtz *et al.* 2009).

There is scarce literature on the use of bird droppings by dung beetles. Most of the known cases were recorded in the USA, France, Mauritius island, Australia and New Zealand (Vinson 1951; Slay *et al.* 2012; Perrin *et al.* 2019; Stavert *et al.* 2014; Ebert *et al.* 2019). In North America, the use of bird droppings (chicken and pigeons) by dung beetles (*e.g.*, *Onthophagus cavernicollis* Howden & Cartwright, 1963) seems to be occasional or rare, as beetles are mostly attracted to the dung of other animals (Gordon and Cartwright 1974; Slay *et al.* 2012). Nonetheless, bird droppings seem to be a part, though not frequent, of the usual diet of dung beetles. For example, on the island of Mauritius, *Neosysiphus* Müller, 1942 beetles are usually attracted to fowl droppings (Vinson 1951; Lopes *et al.* 2023), while in France a few species belonging to genera such as *Onthophagus* Latreille, 1802 and *Copris* Geoffroy, 1762 are commonly found in the droppings of little bustards, *Tetrax tetrax* Linnaeus, 1758 (Perrin *et al.* 2019). New Zealand currently lacks a native land-mammal fauna (except for bats), but formerly harbored a rich community of large birds (*e.g.*, the kakapo and the extinct moas), which may have acted as the main food providers for dung beetles (Jones *et al.* 2012; Stavert *et al.* 2014). The same was perhaps

true for Mauritius, where the now extinct giant dodo (*Raphus cucullatus*, Linnaeus, 1758) may have co-existed with dung beetles (Vinson 1951; Lopes *et al.* 2023). However, to the best of our knowledge, there are almost no published records of dung beetles attracted to bird droppings in South America. In Peru, dung beetles were collected in bird droppings used as attractive bait, but the bird species were not identified (Larsen *et al.* 2006).

Here we report an observation of dung beetle attraction and manipulation of bird dropping in the Brazilian Amazon and discuss the biological and ecological implications of this habit.

The record was made on June 13th, 2022, a cloudy day at the beginning of the Amazonian dry season, at the campus of Universidade Federal do Amazonas (UFAM), in the city of Manaus, Amazonas state, Brazil, in the central Amazon region (3°05'S, 59°58'W, 60 m.a.s.l.). Located less than 10 km from the confluence between the Negro and Amazonas rivers, UFAM lies within a large urban forest remnant (650 ha). The observation was made in *terra firme* (*i.e.*, non-flooded) secondary forest, approximately 50 m near the forest edge. In a field experiment with woodcreeper birds (Dendrocolaptidae), an individual of plain-brown woodcreeper, *Dendrocincla fuliginosa* (Vieillot, 1818) (Figure 1a) defecated during handling. Two hours

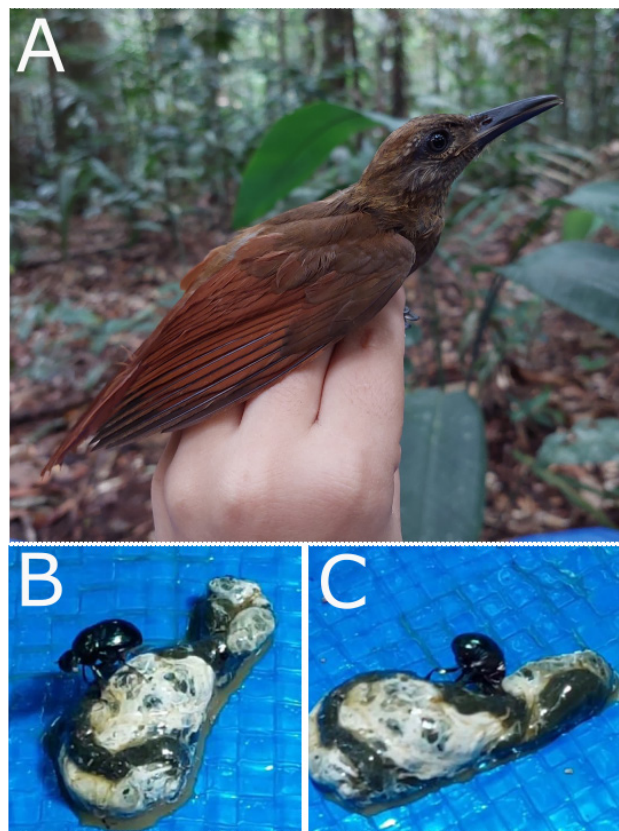


Figure 1. *Dendrocincla fuliginosa* (A) and a *Canthidium* cf. *gracilis* feeding on the bird's feces (B and C) in a forest fragment in Manaus, Amazonas state, Brazil.

later, *i.e.*, at 10:30 am, an individual of *Canthidium* cf. *gracilipes* Harold, 1867 reached the bird dropping (Figure 1b,c) and started manipulating it (see video at https://1drv.ms/v/s!AoTc5v8_5AJsg-cXPbewxLsqRW4vuw?e=IBobaW). The dropping was manipulated by the dung beetle using its fore- and hindlegs, in a way which appeared it was preparing a food mass for removal. During the observation, the entire fecal mass was manipulated and removed, which included both the uric acid and non-uric acid portion of the dropping. We did not observe the actual consumption of the dropping by the dung beetle. A few minutes after the beetle started interacting with the dropping mass, LAC collected the individual, which was later deposited in the entomological collection of Universidade Federal do Mato Grosso (UFMT), Cuiabá, Mato Grosso state, Brazil.

Unfortunately, as also argued by other authors (Cupello 2018), the rather limited taxonomic knowledge currently available on the genus *Canthidium* prevented us from definitively identifying the observed beetle to species level. Given how little is known about the Amazonian *Canthidium*, it possibly belongs to a yet undescribed species. One of us (FZVM), who has studied hundreds of type specimens of New World scarabaeines in European museums (see Vaz-de-Mello and Cupello 2018), can confirm that the individual belongs to *Canthidium gracilipes* Harold, 1867 or to a species closely related to it. Though *C. gracilipes* is currently known to be present only in French Guiana and Suriname (Cupello 2018), it is likely that, as is the case with many other dung beetle species occurring in this region, it is widespread at least in northeastern Amazonia and possibly westwards to the central Amazon region, where Manaus is located. For the time being, we identify the individual as *Canthidium* cf. *gracilipes*. Once the genus is better understood taxonomically, the specimen should be reassessed in order to confirm its identity.

In the Manaus area, carrion and human excrement have been used as bait for dung beetle sampling (Quintero and Halffter 2009; Ratcliffe 2013). There are many dung beetle species that are not collected (or rarely collected) in human feces or carrion-baited pitfall traps. Among them are the species of the genus *Dendropaemon* Perty, 1830, which seem to have a strict relationship with the nests of leaf-cutter ants and possibly termites (Génier and Arnaud 2016). But even species that are regularly coprophagous can be occasionally attracted to unusual baits. The dung beetle *Sylvicanthon seag* Cupello & Vaz-de-Mello, 2018, for example, was collected in the region using suspended pitfall traps baited with human urine in addition to feces-baited pitfall traps (RPS, personal observation). Whether *Canthidium* cf. *gracilipes* belongs to the same group as *Dendropaemon* (*i.e.*, a specialist in other food sources that rarely comes to pitfall traps) or to the group of *Sylvicanthon seag* (*i.e.*, a regular coprophagous species on mammalian dung that occasionally comes to unusual food sources) remains to be determined. At least on continental

lands, bird droppings are not the main food resource even for dung beetle species that feed on their feces (Gordon and Cartwright 1974; Perrin *et al.* 2019). Therefore, we believe that *Canthidium* cf. *gracilipes*, even if not regularly coprophagous, should not be a bird-dropping specialist. Further studies should test our hypothesis through standardized experiments in the Manaus area using a wide variety of native dung and carrion types as bait, in the same fashion as has been previously performed in Australia and New Zealand (Stavert *et al.* 2014; Ebert *et al.* 2019). The present record contributes to the knowledge on the occurrence of this rare behavior by dung beetles in the largest and most biodiverse rainforest worldwide.

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DATA AVAILABILITY

The data that support the findings of this study were published in this article.



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