



Record of foraging of ants (Hymenoptera, Formicidae) in vertebrate carcasses

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ABSTRACT. Knowing the importance of participation by insects at cadaverous decomposition processes, and the limited use of the family Formicidae in criminal investigations, this study aims to record the foraging activity of four genera of ants in carcasses of birds and mammals. Observations occurred accidentally in two locations in the State of Minas Gerais, Brazil. In total, seven species of ants foraging in eight vertebrate carcasses were recorded. In addition, the study reported for the first time the presence of *Wasmannia* in carcasses in Brazil.

Keywords: bird carcass, forensic entomology, necrophagous insects, social insects, *Wasmannia*.

Registro de forrageio de formigas (Hymenoptera, Formicidae) em carcaças de vertebrados

RESUMO. Sabendo da importância da participação dos insetos em processos de decomposição cadavérica e do uso limitado da família Formicidae em investigações criminais, o objetivo do presente estudo foi registrar a atividade de forrageio de quatro gêneros de formigas em carcaças de aves e mamíferos. As observações ocorreram de forma acidental em duas localidades do Estado de Minas Gerais, Brasil. No total, foram registradas sete espécies de formigas forrageando em oito carcaças de vertebrados. O trabalho registrou ainda pela primeira vez a presença do gênero *Wasmannia* em carcaças no Brasil.

Palavras-chave: carcaça de ave, entomologia forense, insetos necrófagos, insetos sociais, *Wasmannia*.

Introduction

The death of an organism is followed by a process of deterioration which, aided by decomposers, allows the cycling of nutrients and incorporates the organism's remains to the substrate (Oliveira-Costa, 2008). This process consists in a series of alterations originated by different groups of organisms such as bacteria, fungi, arthropods and opportunistic vertebrates (Almeida et al., 2010).

The study of the cadaver fauna may be applied in investigations on drug traffic, physical abuse and violent death, and is based on the entomological succession that takes place on the carcass (Oliveira-Costa, 2008). The difference in the exploration of the carcass during each stage of decomposition, along with knowing the duration of each stage of insect development, associated with abiotic parameters, such as temperature, allows the utilization of these arthropods in order to aid estimate the post-mortem interval (Catts & Goff, 1992).

The insects are the first organisms to detect and colonize dead animals, being present in every phase of the decomposition process (Carvalho, Thyssen, Linhares, & Palhares, 2000); among them, the most frequently used in forensic studies are the dipterous

belonging to the families Calliphoridae, Muscidae and Sarcophagidae (Rosa & Oliveira-Costa, 2013) and the Coleoptera families Dermestidae, Silphidae and Cleridae (Smith, 1986). Insect species associated to carcasses can be grouped into five ecological categories, according to Almeida et al. (2010): necrophagous, natural enemies, omnivores, opportunists and accidental.

Insects such as ants are able to opportunistically colonize vertebrate carcasses that show exudates and tissues in decomposition (Early & Goff, 1986; Campobasso, Marchetti, Introna, & Colonna, 2009). Ants can be found in any stage of decomposition, preying on arthropod eggs, larvae and pupae or feeding on rotten or fresh exudates (Early & Goff, 1986; Campobasso et al., 2009; Sales, Daemon & Lopes, 2015). Ants foraging on carcasses are well known and recorded by literature, in a way that some methods are suggested in order to sample these insects based specifically on this behavior (Oliveira-Costa, 2008).

Mammalian carcasses are the most well recorded regarding ant foraging, mainly due to the frequent use of pig carcasses in forensic entomology experiments in Brazil, in which the most common

genera are *Camponotus*, *Cyphomyrmex*, *Atta*, *Strumigenys*, *Pheidole*, *Odontomachus* (Cruz & Vasconcelos, 2006), *Ectatomma* (Cruz & Vasconcelos, 2006; Gomes, Gomes, & Desuó, 2009), *Pachycondyla* (Cruz & Vasconcelos, 2006; Gomes et al., 2007) and *Plathyrea* (Cruz & Vasconcelos, 2006; Gomes et al., 2007, 2009). Ants were also recorded foraging in other mammalian carcasses aside from humans (Oliveira-Costa, 2008), such as rabbits (Souza, Kirst & Kruger, 2008), cats (Maciel et al., 2015) and rats (Fonseca, Campos & Silva, 2015; Sales et al., 2015).

Although much is known about the relation between ants and vertebrate carcasses, the Formicidae family is not directly used in criminal investigations; however, studies on these insects' behavior help identify possible interferences caused on the process of decomposition. Therefore, the goal of the present study was to record and discuss the presence of ants on vertebrate carcasses, as well as describe its foraging behavior.

Material and methods

Two countryside areas in the municipality of Juiz de Fora (21° 46' 02.72" S; 43° 22' 34.9" W and 21° 48' 21" S; 43° 22' 09" W) and one in the municipality of Goianá (21° 31' 40" S; 43° 9' 56" W), both in Minas Gerais State, Brazil, were occasionally observed in eight events between October 2012 and July 2015. These areas show warm subtropical climate with dry winters and rainy summers (Cwa), according to Köppen-Geiger (Sá Júnior, Carvalho, Silva, & Carvalho Alves, 2012). All of the approached areas can be classified as "Green areas" according to Maciel & Barbosa (2015).

Data collection on the species involved began as soon as a carcass was localized; it was recorded the cause of death (whenever possible), the carcass' decomposition status and the behavior shown by ants on the carcass. Data was sampled for about 30 minutes each two hours during all the period of interaction between ants and the carcass, which could last up to three days. In some cases, the carcass was removed by the local maintenance crew after the first day of observation.

Ants were screened in laboratory according to the dichotomous key suggested by Fernández (2003) and Baccaro et al. (2015) and deposited in the collection of the *Laboratório de Ecologia Comportamental e Bioacústica* of the *Universidade Federal de Juiz de Fora*, MG, Brazil. Samples of the material collected were sent to Dr. Jacques Delabie from the *Laboratório de Mirmecologia* of the *Centro de Pesquisas do Cacau*, in Itabuna-BA.

The identification of the carcasses was performed by comparison with a list of species of

mammals and birds already described for the region and by consulting the experts Dr. Artur Andriolo and Dr. Marco Manhães, of the *Universidade Federal de Juiz de Fora*.

Results and discussion

It were recorded ants in eight vertebrate carcasses, four of them being small mammals and four being birds. In the city of Juiz de Fora, the first record occurred in October 2012, when *Camponotus melanoticus* Emery individuals were observed foraging on the nasal and oral orifices of an opossum (*Didelphis aurita* Wied-Neuwied) in the early stages of decomposition (Table 1). In December 2014, a juvenile rufous-bellied thrush [*Turdus rufiventris* (Vieillot)] carcass in the early stages of decomposition was recorded showing ants of the *Camponotus rufipes* (Fabricius) species (Table 1); the bird had fallen from its nest during a storm in the night, and at the beginning of the following morning the ants were already foraging on the carcass, which lasted two days. After this period, the ants abandoned the carcass, which was then made entirely by bones.

Still in Juiz de Fora, an armadillo [*Euphractus sexcinctus* (Linnaeus)] carcass was found in June 2015 (Table 1), in an advanced decomposition stage. The carcass was fragmented in sparsely distributed pieces, and ants of the *Solenopsis saevissima* (Smith) species nested on the two biggest pieces, agreeing with the behaviors recorded by Maciel et al. (2015) in a domestic cat carcass (*Felis silvestris catus* Linnaeus), also in the Minas Gerais state, Brazil.

In July 2015, a blue-black grassquit [*Volatinia jacarina* (Linnaeus)] carcass in the early stages of decomposition was found, in which *S. saevissima* ants were recorded foraging on the cloaca and more intensively on the mouth and the nasal and ocular orifices (Table 1). The ants had already consumed most of the animal's head and used this part of the body as access to the body's interior. Another *D. aurita* opossum was found in August 2015; the carcass was in the first stage of decomposition and *C. rufipes* were recorded foraging actively on the carcass and inhibiting the presence of other necrophagous insects on the area (Table 1).

The last carcass recorded by the study in Juiz de Fora was found in November 2015, belonging to a saffron finch [*Sicalis flaveola* (Linnaeus)] in the early stages of decomposition. The juvenile bird fell from its nest and was found by *C. rufipes* ants, which started foraging before the finch died. These ants were present on the carcass for a whole day, being succeeded by *S. saevissima*, which buried the bird remains (and thus further agreeing with the typical behavior described for the species) (Table 1).

Table 1. List of the locality in which the species of vertebrate carcasses were found, and recorded ants in each carcass.

Date	Locality	Vertebrate carcass	Ant specie
Oct/2012	JF	<i>Didelphis aurita</i> Wied-Neuwied	<i>Camponotus melanoticus</i> Emery
Dec/2014	JF	<i>Turdus rufigiventris</i> (Vieillot)	<i>Camponotus rufipes</i> (Fabricius)
June/2015	JF	<i>Euphractus sexcinctus</i> (Linnaeus)	<i>Solenopsis saevissima</i> (Smith)
July/2015	JF	<i>Volatinia jacarina</i> (Linnaeus)	<i>Solenopsis saevissima</i> (Smith)
Aug/2015	JF	<i>Didelphis aurita</i> Wied-Neuwied	<i>Camponotus rufipes</i> (Fabricius)
Nov/2015	JF	<i>Sicalis flaveola</i> (Linnaeus)	<i>Camponotus rufipes</i> (Fabricius)
			<i>Solenopsis saevissima</i> (Smith)
Apr/2014	Gn	<i>Mus musculus</i> (Linnaeus)	<i>Camponotus melanoticus</i> Emery
			<i>Camponotus</i> sp.
			<i>Crematogaster</i> sp.
Apr/2014	Gn	<i>Coturnix coturnix</i> (Linnaeus)	<i>Camponotus melanoticus</i> Emery
			<i>Camponotus</i> sp.
			<i>Wasmania</i> sp.

JF = Juiz de Fora; Gn = Goiânia.

In the municipality of Goiânia, two vertebrate carcasses were found in April 2014. In the first carcass, a rat [*Mus musculus* (Linnaeus)] in the early stages of decomposition, the ants *C. melanoticus*, *Camponotus* sp. and *Crematogaster* sp. were recorded foraging, especially in the nasal, oral and auricular orifices (Table 1). *Crematogaster* sp. was recorded foraging on the tail scales and the ear cartilage, and was dominant over the other ants; on its absence, *C. melanoticus* took the dominance over the carcass. The *Crematogaster* genus was also recorded in a carcass of the rodent *Rattus norvegicus* (Berkenhout, 1769) by Fonseca et al. (2015). In a quail carcass [*Coturnix coturnix* (Linnaeus)] in the early stages of decomposition, it were recorded the species *C. melanoticus*, *Camponotus* sp. and *Wasmania* sp. foraging on the bird's cloaca and ocular orifices, the cloaca being the area preferred by *C. melanoticus* and the ocular orifice being preferred by the other two species (Table 1).

The present records corroborate experimentation studies on pigs (Cruz & Vasconcelos, 2006; Gomes et al., 2007, 2009; Andrade-Silva, Pereira, Silva, Delabie, & Rebelo, 2015) regarding the *Camponotus* genus and on other animals regarding the genera *Solenopsis* (Maciel et al., 2015) and *Crematogaster* (Oliveira-Costa, 2008). The *Wasmania* genus, recorded in this study, stands out as the first record of this genus on vertebrate carcasses in Brazil.

The foraging behaviors recorded on bird carcasses are similar to those on mammal ones; the difference is due to the smaller body size and thinner skin, which favors the entrance of ants in the carcass interior and hastens the carcass consumption. The ant fauna present in mammals and birds is similar (Table 2), except for *Wasmania* sp., which was recorded only in *C. coturnix*. Ant foraging in carcasses is still poorly known and related in literature, which justifies the first record of *Wasmania* for Brazil in this study. This way, the records in this research contribute with this

knowledge and offer subsidies to studies directed to those vertebrates.

Table 02. Relation between ant species and vertebrate carcasses which were recorded.

Ant species	Carcass						
	Da	Tr	Es	Vj	Sf	Mm	Cc
Formicinae							
<i>Camponotus melanoticus</i> Emery	X					X	X
<i>Camponotus rufipes</i> (Fabricius)	X	X			X		
<i>Camponotus</i> sp.						X	X
Myrmicinae							
<i>Crematogaster</i> sp.						X	
<i>Solenopsis saevissima</i> (Smith)			X	X	X		
<i>Wasmania</i> sp.							X

Da = *Didelphis aurita* Wied-Neuwied; Tr = *Turdus rufigiventris* (Vieillot); Es = *Euphractus sexcinctus* (Linnaeus); Vj = *Volatinia jacarina* (Linnaeus); Sf = *Sicalis flaveola* (Linnaeus); Mm = *Mus musculus* (Linnaeus); Cc = *Coturnix coturnix* (Linnaeus).

From the behavior observations, it could be detected an inhibition of other necrophagous insects by the ants, which corroborates the results of Sales et al. (2015), who described a negative correlation between the presence of ants and flies in rat carcasses. Thus being, it is possible to state that the presence of ants in carcasses, especially in urban centers, can modify the whole succession process during a cadaveric decomposition event.

In addition, the records showed the presence of ants in vertebrate carcasses in all the seasons of the year, which means that this event is not a foraging alternative during dry periods and rather a common behavior performed by these insects when offered a valuable energetic resource. This fact further explicates the importance of more focused studies, since the foraging in carcasses makes up part of the ants' behavioral ecology.

Conclusion

Considering that ants has becoming more prominent as insects of forensic interest, the results of this work increase the diversity of taxa known as colonizers of vertebrate carcasses, increasing knowledge about the behavioral ecology of these insects.

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