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# Stingless Bees (Hymenoptera: Apidae: Meliponini) Attracted to Animal Carcasses in the Brazilian Dry Forest and Implications for Forensic Entomology

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**Abstract**
The association of stingless bees with pig carcasses exposed in a Brazilian Dry Forest area were examined. Modified Shannon traps were settled together to collect these insects during two seasons (dry and rainy). 564 bees were collected, belonging to three tribes and nine species. The majority of bees (75.5%) was collected during the dry season, and *Partamona seridoensis* Pedro & Camargo (32.8%) and *Trigonisca* sp. (20.9%) were the most abundant species. Five decomposition stages were recognized, being the bloated, active and advanced decay the most attractive to the bees. Considerations about seasonal foraging and use of bees in the forensic entomology scope are presented.

## Introduction

Bees are known for foraging majorly on floral resources as pollen, nectar and oil (Roubik, 1989; Wcislo & Cane, 1996), acting as pollinators of angiosperms. However, many bee species forage on other nutritional sources, as hemipteran's honeydews (Camargo & Pedro, 2002), and on materials to be used in their nest building. Mud, feces, plant parts, exudates and animal carcasses can be incorporated by bees to the material used in the construction and sealing of the nest (Wille, 1983; Baumgartner & Roubik, 1989; Noll et al., 1996).

Amongst the bees, the Neotropical perennial social bees (Meliponini) have been the most recorded on animal carcass or flesh bait (Wille, 1962; Baumgartner & Roubik, 1989; Silveira et al., 2005). Stingless bees comprise over 500 species (Michener, 2013), mainly generalist pollen and nectar consumers. However three species are known by necrophagous obligate habits: *Trigona crassipes* (Fabricius), *Trigona hypogea* Silvestri and *Trigona necrophaga* Camargo & Roubik (Roubik, 1982; Camargo & Roubik, 1991). Their corbiculae are not adjusted to transport pollen (Camargo & Roubik, 1991) and the workers gather animal flesh as protein resource which is transported, processed and stored in the food pots (Noll et al., 1996). Most species attracted to animal carcasses probably visit them only for nest materials, liquid exudates, or salts, rather than for protein source (Baumgartner & Roubik, 1989).

The exploitation of carcasses by stingless bees appears to be common; however few studies have reported this behavior and their forensic use. Several entomological surveys with baited traps and animal carcasses conducted across the Andes (Baumgartner & Roubik, 1989; Wolff et al., 2001), Lowland tropical forests (Cornaby, 1974; Roubik,

1982), Amazon forest (Silveira et al., 2005), Atlantic forest (Farias, 2012) and urban areas in the southeastern Brazil (Gomes et al., 2007), recorded many bee species foraging on these ephemeral sources. Nevertheless, no information has been obtained from the Brazilian seasonally dry tropical forest (Caatinga), generally poorly investigated about the ecology of its insect fauna (Aguiar & Martins, 1997; Vasconcellos et al., 2010; Alves et al., 2014; Santos et al., 2014).

Throughout the animal decomposition, a succession usually occurs as insect species exhibit associations to the decomposition stages providing better supply for their offspring (Smith, 1986). This process can be useful in determining the postmortem interval (PMI) in a forensic approach (Goff & Flynn, 1991). Furthermore, endemic species collected on corpses found in any environment can be the clues to know where the deaths took place (Benecke, 1998).

Here we present a list of the carrion-foraging bees on pig carcasses in a seasonally dry tropical forest from the northeastern Brazil. We asked: (1) Do bees seasonally explore carrion in this environment? (2) How abundant were the bees throughout the carcass decomposition stages? We also briefly discuss about the concernment on bees as a tool in a forensic approach.

## Material and Methods

The study was carried out at the Private Reserve for the Environmental Inheritance Fazenda Almas, São José dos Cordeiros, PB, Brazil (07°28'19" S, 36°53'40" W). The reserve covers 3,505 ha (600-720 m a.s.l.) and the climate of the region is defined as warm semi-arid (BSh – Köppen climate classification). The vegetation is highly deciduous during the dry season and ranges from open to dense arboreal. The soil is sandy and topographically irregular, with inselbergs and rocky outcrops (Vasconcellos et al., 2010).

We sampled the bees with a usual method for forensic entomology research (Alves et al., 2014). Two pig carcasses with ~15 kg in weight were placed nearly 50 m from each other in the dry season (October 2010) and in the rainy season (February 2011). The animals were slaughtered by a single gunshot to the head shot by a forensic examiner of the Instituto de Polícia Científica da Paraíba (IPC/PB). Each carcass was exposed into an iron cage (3x10 cm mesh opening) with a modified Shannon trap over it. A collecting tube containing 70% alcohol was connected to the top of each trap. The sampling was conducted daily until the end of the decomposition (15 days) and its stages were classified using the descriptions and terminology adopted by Goff (2009). The dry stage (i.e. only the bones and hair retained) was not observed. The average temperature and relative humidity recorded along the dry and rainy period were 26.9±1.8°C / 63.8±19.4% and 24.5±1.3°C / 78.5±11.7%, respectively.

Voucher specimens were deposited in the Entomological Collection of the Departamento de Sistemática e Ecologia, Universidade Federal da Paraíba (DSEC/UFPB). C.F. Martins identified the collected bee specimens using keys and the reference collection of the same institution (DSEC/UFPB). A license was granted by the Comitê de Ética no Uso de Animais (CEUA/UFPB) for the study.

## Results and Discussion

Nine bee species in a total of 564 individuals attracted by the carcasses were collected in both seasons and the stingless bees (Meliponini) were by far the most frequent (89.7%) among them. *Partamona seridoensis* Pedro & Camargo was the most abundant species (N=185), followed by *Trigonisca* sp. (N=118), *Plebeia flavocincta* (Cockerell) (N=83) and *Trigonisca pediculana* (Fabricius) (N=74) (Table 1).

The bees were more abundant in the dry season (75.5%) rather than in the rainy season. Moreover, the four most frequent stingless bee species in the whole sampling were more recorded in the dry period indicating a remarkable seasonal tendency. On the other hand, the Africanized honey bee *Apis mellifera* Linnaeus was more abundant in the rainy rather than in the dry period (Table 1).

Five stages of decomposition were perceived: fresh, during 2.0±0 days; bloated, 2.5±0.5 days; active decay, 2.2±0.43 days; advanced decay, 3.2±1.3 days; and postdecay, 6.0±1.22 days. In general, the majority of the bees were collected in the bloated, active and advanced decay stages (Table 1), when the liquid parts are available, the process of putrefaction increases, and a notable decomposition stink is emitted (Goff, 2009). The exceptions were *P. seridoensis*, being more frequent in postdecay along the dry period, and *P. flavocincta*, the only species present in the fresh stage. In the Caatinga ecosystem, where water is a real limiting resource, it is understandable that the bees are present in all stages of decomposition, even though showing differences in richness and diversity. Payne and Mason (1971) recorded bees on carrion only while fluids were present in the South Caroline, USA. The authors observed a behavior of sucking up the foul-smelling juices. Gomes et al. (2007) found bees mainly in the initial decomposition stages on pig carrions at southeastern Brazil as well.

Surveys carried out in the Brazilian seasonally tropical dry forest sampled low species richness for bees compared to other environments, e.g. Cerrado (Brazilian savanna) and Tropical rain forest; however a high percentage of endemic species has been reported for the region (Aguiar & Martins, 1997; Zanella, 2000). Among the species we recorded, *P. seridoensis* is endemic to Caatinga areas (Zanella, 2000). Thus, in the forensic entomology scope, whether these bees were found on a corpse in a different area, either hooked or dead inside the clothes, this would indicate a displacement from the place of death (Benecke, 1998). Farias (2012) collected 13 bee species on pig carcasses in an Atlantic rainforest area localized in Paraíba state as well; only *P. flavocincta* was found in common with the present study. This

**Table 1**. Absolute (n) and relative (%) frequencies of bees on pig carcasses along their decomposition stages in the dry season (Oct/2010) and rainy (Feb/2011) season in a dry tropical forest from the northeastern Brazil. FR: fresh; BL: bloated; ACT: active decay; ADV: advanced decay; PD: postdecay.

| Bee species | | Dry | | | | | | Rainy | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | FR | BL | ACT | ADV | PD | n | FR | BL | ACT | ADV | PD | n | n | % |
| APIDAE | | | | | | | | | | | | | | | |
| APINAE | | | | | | | | | | | | | | | |
| Apini | *Apis mellifera* Linnaeus | - | - | 1 | - | 1 | 2 | - | 1 | 36 | 12 | 6 | 55 | 57 | 10.2 |
| Meliponini | *Melipona asilvai* Moure | - | - | - | 1 | 4 | 5 | - | - | 1 | 5 | 2 | 8 | 13 | 2.3 |
| | *Partamona seridoensis* Pedro & Camargo | - | 17 | 12 | 20 | 83 | 132 | - | - | 21 | 24 | 8 | 53 | 185 | 32.8 |
| | *Plebeia flavocincta* (Cockerell) | 23 | 19 | 7 | 3 | 20 | 72 | - | 4 | 7 | - | - | 11 | 83 | 14.7 |
| | *Scaptotrigona* aff. *tubiba* Smith | - | - | - | - | 1 | 1 | - | - | - | - | - | - | 1 | 0.2 |
| | *Trigona spinipes* (Fabricius) | - | 6 | - | 1 | 22 | 29 | - | - | 1 | 1 | 1 | 3 | 32 | 5.7 |
| | *Trigonisca pediculana* (Fabricius) | - | 27 | 11 | 17 | 12 | 67 | - | - | 6 | 1 | | 7 | 74 | 13.1 |
| | *Trigonisca* sp. | - | 16 | 20 | 62 | 20 | 118 | - | - | - | - | - | - | 118 | 20.9 |
| HALICTIDAE | | | | | | | | | | | | | | | |
| HALICTINAE | | | | | | | | | | | | | | | |
| Augochlorini | *Augochlora* sp. | - | - | - | - | - | - | - | 1 | - | - | - | 1 | 1 | 0.2 |
| Total | | 23 | 85 | 51 | 104 | 163 | 426 | - | 6 | 72 | 43 | 17 | 138 | 564 | 100 |

fact reinforces the application of theses insects in investigations of translocation of bodies.

The stingless bee species are abundant in the Caatinga (Aguiar & Martins, 1997). Their perennial colonies are established under favorable conditions in the rainy season, with a short period of abundant floral resources and an extensive period of scarcity in the dry season, following the phenological dynamics of floral resources (Machado et al., 1997). The increase in plant biomass during the rainy season in the Caatinga represents an increase in resources for many insects, including hymenopterans (Vasconcellos et al., 2010). On the other hand, a few plant species are able to produce flowers in the dry season (Machado et al., 1997).

Thus, based on the seasonality, we suggest that bees use animal carcasses as a possible source of water, and salts during inhospitable periods. It is noteworthy the presence of small pots containing an aqueous acid substance, besides the typical honey and pollen pots, in a nest of *P. seridoensis* in the studied area, as observed in some other species of *Partamona* (Camargo & Pedro, 2003). In another area of Caatinga, close to a slaughterhouse, the honey of a colony of *Melipona asilvai* Moure presented a pronounced taste of leather in the dry season, and *Frieseomelitta dispar* (Moure) collected fat for nest building (C.F. Martins, personal observation). As stated before, pasteurization of the honey of most stingless bee species is recommended for prevent contaminations (Nogueira-Neto, 1997). This is particularly relevant if honey is harvested in the dry season in the Caatinga or if colonies are close to areas with animal feces or carcasses, as e.g. slaughterhouses. Increasing frequencies of bees in carrions traps and carcasses during dry periods were also observed in Amazon forest and Atlantic forest areas (Silveira et al., 2005; Farias, 2012). However, carcasses are rare and unpredictable, and bees compete for them, but probably in a different way, with many other insects, mainly flies and beetles (Alves et al., 2014; Santos et al., 2014), which makes flesh an expensive resource (Noll et al., 1996).

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