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; Weislo & 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 Trigona 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 Carolina, 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 carriions 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.

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