

First report of *Peckia (Squamatodes) ingens* (Walker, 1849) (Diptera: Sarcophagidae) colonizing human corpse in the Neotropical region

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Abstract. We report a case of male corpse colonization found inside a residence in the municipality of Areia, Paraíba, Brazil. The body was found in the gaseous stage of decomposition and was colonized by fly larvae. We reared the larvae collected at the crime scene on a temperature-controlled. We supplied beef as a feeding substrate for the larvae until adult emergence to allow taxonomic identification. Three specimens of *Peckia (Squamatodes) ingens* emerged in the laboratory. Thus, we present the first record of the flesh-fly *Peckia (S.) ingens* colonizing a human corpse in Neotropical region, updating the list of species with forensic potential. In addition, information on the total time of the species development and the implications of these findings for the consolidation of forensic entomology in the Northeast region were discussed.

Keywords. Flesh flies; *Peckia*; Cadaverous colonization; Forensic Entomology.

INTRODUCTION

Forensic entomology is based on the interactions between insects and decomposing animals, and the knowledge about the presence and development of insects in human cadavers can assist in determining the *Post-Mortem* Interval (PMI) (Catts & Goff, 1992; Amendt *et al.*, 2007). In this context, the families Calliphoridae and Sarcophagidae are closely associated with decaying carcasses and corpses, being considered important colonizers (Vasconcelos *et al.*, 2014; Alves *et al.*, 2014; Vairo *et al.*, 2017; Meira *et al.*, 2020). However, species from the Fanniidae and Muscidae families have also been reported in cadavers (Vasconcelos *et al.*, 2014; Eulalio *et al.*, 2021). Species from these families were able to find and visit pig carcasses in the first hours after death (Alves *et al.*, 2014; Vasconcelos *et al.*, 2013).

The association of blow flies with human cadavers has received much attention in the

Neotropical region (Andrade *et al.*, 2005; Pujol-Luz *et al.*, 2006; Kosmann *et al.*, 2011; Thyssen *et al.*, 2018; Meira *et al.*, 2020; Eulalio *et al.*, 2021), which may be associated with its higher frequency in those resources. However, other groups have stood out in the cadavers' colonization (*e.g.*, Sarcophagidae), especially in indoor environmental cases (Vasconcelos *et al.*, 2014; Vairo *et al.*, 2017), high heights apartments (Vairo *et al.*, 2017), in hanged (Vasconcelos *et al.*, 2019) and charred bodies (Ramos *et al.*, 2018).

There are approximately 3,100 species of Sarcophagidae described worldwide (Pape *et al.*, 2011), of which 800 spp. occur in the Neotropical Region (Pape, 1996), where studies are still scarce. Sarcophagidae species are generally larviparous species, a biological advantage that assist with pioneering of its cadaveric colonization (Vairo *et al.*, 2017). In addition, this family has a large number of species with forensic potential in South America,

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mainly individuals of the *Peckia* and *Oxysarcodexia* genera (Carvalho & Mello-Patiu, 2008), which are widely found in studies with carcass and decaying baits in Brazil (Barros et al., 2008; Alves et al., 2014; Barbosa et al., 2015).

Peckia (Squamotodes) ingens (Walker, 1849) is endemic of the Neotropical region, with known distribution for Argentina, Belize, Brazil, Colombia, Costa Rica, Ecuador, Guyana, Mexico, Nicaragua, Panama, Paraguay, Peru, Puerto Rico and Venezuela (Buenaventura & Pape, 2013; Mello-Patiu, 2016). This species is generally collected in baits or carcasses in Colombia (Salazar-Ortega et al., 2012; Yepes-Guarisas et al., 2013; Valverde-Castro et al., 2017). In Brazil, it has already been registered in pig carcasses and small rodents in the Southeast (Moretti et al., 2008; Rosa et al., 2011; Mello-Patiu et al., 2014), Midwest (Barros et al., 2008), and Northeast (Vasconcelos et al., 2013) regions.

Peckia (S.) ingens wide distribution and their frequent association with carcasses in Brazil strengthens the probable forensic applicability of the taxon in the country, which concentrates high homicide rates, mainly in the states of the Northeast region (Cerqueira et al., 2018). The main aim of the present study was to list the species of flies recorded on a cadaver found in an indoor environment and to report the first record of *Peckia (S.) ingens* colonizing it. This is the first report of *Peckia (Squamotodes) ingens* in a corpse in the Neotropical region.

MATERIAL AND METHODS

A total of 89 larvae were collected on the cadaver. These larvae were separated into plastic containers with minced beef as food and sawdust as substrate for pupation. These containers were maintained protected from direct sunlight, at room temperature $25 \pm 2^\circ\text{C}$, humidity of 70% and photophase of 12 h, and observed daily until adults' emergence. After emergency, the adults were killed by cooling in a freezer at -4°C for 72 h and kept in 70% alcohol. In addition, adults screening and identification were carried out with the aid of the keys proposed by Carvalho & Mello-Patiu (2008) and Buenaventura & Pape (2013).

To estimate the minPMI, the Accumulated Degree-Day (ADD) values were calculated according to the formula described by Lord et al. (1994) and Oliveira-Costa (2011). MinPMI was estimated using the larval instar at the most advanced stage, in this case, third instar larvae, which the development data of the species were obtained from Ferraz (1995).

RESULTS AND DISCUSSION

Case description: On April 5th 2018, the corpse of a male adult (60-year-old) was found at his residence in the municipality of Areia (6°57'46"S, 35°41'31"W), Paraíba, Brazil (Fig. 1). The corpse was found lying face down on his bed, covered in sheets and in the bloat decomposition state (Fig. 1B). After analyzing the crime scene, the victim's

Table 1. Dipterans emerged from larvae collected from a human cadaver in Center for Medicine and Forensic Dentistry (NUMOL), Campina Grande, Brazil.

Family	Species	Number of individuals	Previous register in cadaver
Calliphoridae	<i>Chrysomya albiceps</i>	8	Yes
	<i>Chrysomya megacephala</i>	36	Yes
	<i>Chrysomya putoria</i>	1	Yes
	<i>Cochliomyia macellaria</i>	10	Yes
Sarcophagidae	<i>Peckia (Squamotodes) ingens</i>	3	No

References: Andrade et al., 2005; Alves et al., 2014; Vasconcelos et al., 2014; Vasconcelos et al., 2019; Meira et al., 2020.

body was sent to the Center for Medicine and Forensic Dentistry (NUMOL), in Campina Grande (Paraíba), for necropsy. All entomological evidence was collected at NUMOL, placed in plastic containers and transported to the Laboratory of Systematics and Insect Bioecology, State University of Paraíba (UEPB), Campina Grande city.

A total of 58 larvae completed the cycle in the laboratory, belonging to the families Calliphoridae and Sarcophagidae (Table 1). Calliphoridae was the most representative family, with 55 specimens belonging to four species, *Chrysomya albiceps* (Wiedemann, 1819), *Chrysomya megacephala* (Fabricius, 1794), *Chrysomya putoria* (Wiedemann, 1819) and *Cochliomyia macellaria* (Fabricius, 1775), among which *C. megacephala* represented 65.5% of all emerged insects. In addition, all specimens of Calliphoridae emerged between 7 and 10 days after the collection of the immatures.

On the other hand, the three Sarcophagidae specimens were identified as *Peckia (Squamotodes) ingens* (Fig. 2), whose larvae took at least 23 days' post-collection to complete their life cycle. *Peckia (S.) ingens* cycle was longer than the observed by Ferraz (1995), who reported the need for at least 20 days for *Peckia (S.) ingens* to complete its cycle at 25.9°C . However, the bionomic data demonstrated here are corroborated by other studies, in which the Calliphoridae species need less time than the Sarcophagidae species to complete their life cycle (Rabêlo et al., 2011; Oliveira-Costa, 2011; Nassu et al., 2013). The minPMI was estimated based on the age of the larvae present in the corpse. The calculation of Accumulated Degree-Days showed that the female of *Peckia (S.) ingens* larviposited on April 4th, which reveals that the larvae found in the corpse had at least 24 hours of life. These results are corroborated by Ferraz (1995), who show that at temperatures between 25.9 to 27°C *Peckia (S.) ingens* needs 24-30 hours to reach the third larval stage.

Interestingly, *Peckia (S.) ingens* was found in the present study associated with a human cadaver in the bloat decomposition state. The association of *Peckia (S.) ingens* with the gaseous stage, which is characterized by inflation of the abdomen due to the accumulation of gas (Payne, 1965; Oliveira-Costa, 2011), has also been observed in experiments with pig carcasses (Barros et al., 2008). We believe that the species shows a preference for this stage of decomposition.

We present here the first record of *Peckia (S.) ingens* colonizing a human cadaver in Neotropical region. Our affirmation was based on the most current compilation

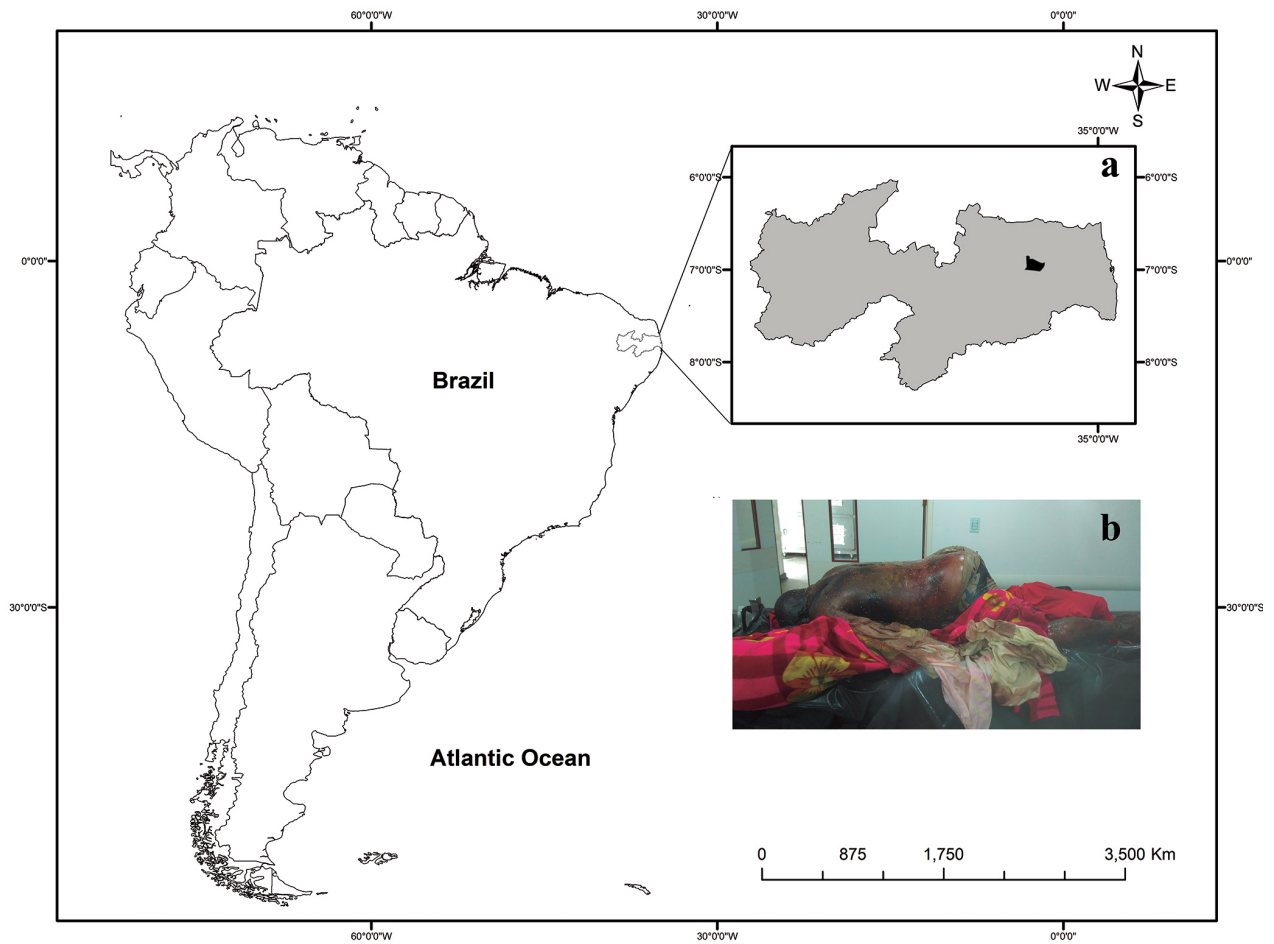


Figure 1. (A) Crime scene location in the state of Paraíba (B) crime scene overview and human corpse.

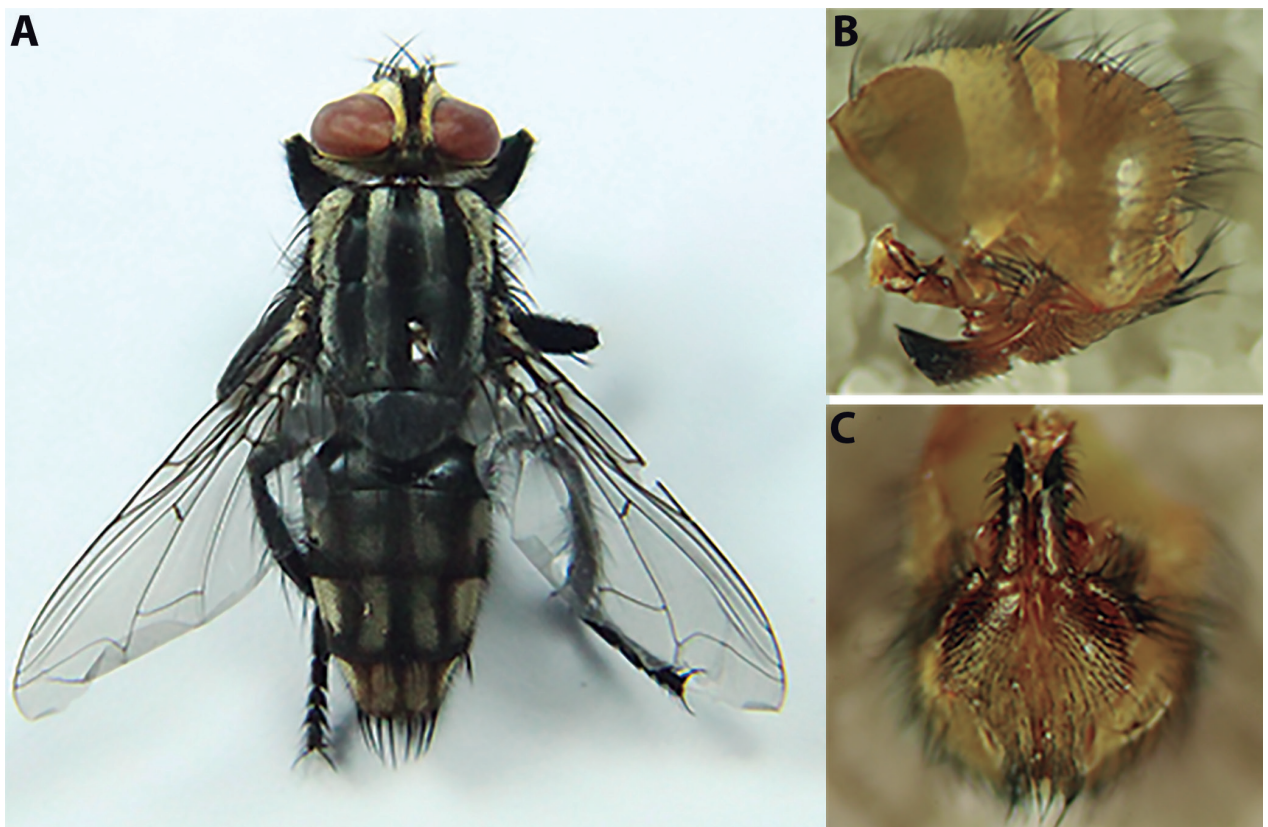


Figure 2. *Peckia (Squamatodes) ingens* (Walker, 1849) (Diptera: Sarcophagidae): (A) Habitus, dorsal view; (B) Syntergosternite 7+8, epandrium, cercus, surstylus and phallus, lateral view.; (C) Cerci, posterior view.

about the Diptera species with forensic importance for the Neotropical region (Alves *et al.*, 2014), which lists only 14 Sarcophagidae species, and does not mention *Peckia (S.) ingens* in human cadavers. On the other hand, new occurrences of species have been reported in corpses, especially for *Peckia* and *Microcerella* genus (Vairo *et al.*, 2017; Ramos *et al.*, 2018).

Peckia (S.) ingens is an endemic species for the Neotropical region, with wide geographic distribution, occurring in many countries in South America (Buenaventura & Pape, 2013; Mello-Patiu, 2016). In Brazil, *Peckia (S.) ingens* occurs in urban areas (Oliveira & Vasconcelos, 2010), rainforest fragments (Vasconcelos *et al.*, 2013), rural environments (Valverde-Castro *et al.*, 2017), Amazon region (Sousa *et al.*, 2014), Caatinga (Alves *et al.*, 2014), and Cerrado (Barros *et al.*, 2008; Rosa *et al.*, 2011). This wide environmental plasticity of the species strengthens its forensic potential, since it can be found in the colonizing fauna of different landscapes.

Corpses taken to the NUMOL are generally victims of violent death, whose absence of witnesses at the moment of death makes the work of the Police difficult. Therefore, entomological evidence becomes an important tool for clarifying major issues (e.g., when did the crime occur?). In this context, the present study strengthens the theoretical framework for the region where the study was carried out and although the collection was not carried out at the crime scene, the fauna found is similar to that observed in several cases by Meira *et al.* (2020). In addition, work with collecting evidence at the Center for Medicine and Forensic Dentistry from Campina Grande was important for the faunal survey of the insects and strengthens the collaboration with the universities.

The presence of *Peckia (S.) ingens* colonizing a human corpse still reinforces the importance of case studies for mapping the cadaveric fauna, since many of the faunistic studies are conducted with decaying animal carcasses (Rosa *et al.*, 2011; Vasconcelos *et al.*, 2013, Sousa *et al.*, 2014). These data are important, and especially for the northeastern Brazil, where studies are still incipient and unsolved homicide rates are alarming (Cerqueira *et al.*, 2018). In addition, with the record of the colonization of human corpses by *Peckia (S.) ingens*, we contributed to validate the species' forensic importance and provide preliminary support for its use in the estimation of min-PMI. Additional studies on the biology of the species can still assist in the resolution of future death cases with entomological evidence, and strengthen the partnership between entomologists and the Scientific Police of Northeast Brazil.

AUTHORS' CONTRIBUTIONS: SEFG, DMPM, TMB, RCAPF, CLB: Conceptualization, Writing – review & editing, Investigation; **SEFG, DMPM, CLB:** Data curation, Formal Analysis, Methodology, Visualization; **SEFG, DMPM, TMB, CLB:** Writing – original draft; **RCAPF, CLB:** Funding acquisition; **CLB:** Project administration; Resources; Software; Supervision; Validation. All authors actively participated in the discussion of the results, they reviewed and approved the final version of the paper.

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