Revista Brasileira de Entomologia 61 (2017) 275–276

SOCIEDADE BRASILEIRA DE ENTOMOLOGIA
FUNDADA EM 1937

REVISTA BRASILEIRA DE
Entomologia
A Journal on Insect Diversity and Evolution

www.rbentomologia.com

Short Communication

Can Sarcophagidae (Diptera) be the most important entomological evidence at a death scene? *Microcerella halli* as a forensic indicator

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ARTICLE INFO

Article history:
Received 11 April 2017
Accepted 28 June 2017
Available online 12 July 2017
Associate Editor: Rodrigo Kruger

Keywords:
Forensic entomology
Insect colonization
Development time
Flesh flies
Sarconesia chlorogaster

ABSTRACT

Although a corpse can harbor several species of flies, only a few have been sufficiently studied to be used as forensic indicators. Sarcophagidae are an example of how the forensic use of insects can be impaired by taxonomic and biological data limitation. This manuscript provides the first record of the Neotropical flesh fly *Microcerella halli* (Engel, 1931) on a human body and its use in forensics. *M. halli* and *Sarconesia chlorogaster* (Widemann, 1830) were sampled from a body located indoors at 20 °C. Only *M. halli* was used to estimate the mPMI (minimum post mortem interval) because it was the oldest larval stage on the corpse. Based on the development time of *M. halli* we estimate an mPMI of at least 10 days. In addition, we provide for the first time a case in which a flesh fly was the main source of entomological evidence in Southern Brazil. We also provide evidence that Sarcophagidae arrived before Calliphoridae in this case, an unusual successional pattern.

One of the main questions in medico-legal investigations is when the death occurred. In cases involving corpses with more than three days, the *post-mortem* interval (PMI) can be efficiently estimated using forensic entomology methods (Wells and Lamotte, 2001). Among several species groups occurring during the decomposition process, flies (Diptera), mostly blow flies (Calliphoridae) and flesh flies (Sarcophagidae), are the most important for forensic entomology purposes because of their necrophagous habit and early arrival on the body (Catts and Goff, 1992). This information coupled with the great amount of biological and behavioral data available make blow flies a key group for forensic entomology. Despite their value for forensic entomology, Sarcophagidae are not usually used for PMI estimation, mainly because of the small number of taxonomic and behavioral studies available (Vairo et al., 2015a). Therefore, the use of flies as evidence in Brazilian investigations has been limited by a series of factors including the lack of species data (due the high diversity of the group and small number of researchers), small number of trained forensic entomologists and an almost complete absence of collaborations between research centers and investigative police. Some of these issues have been overcome leading to the publication of case reports in the past years (Oliveira-Costa and MelloPatiu, 2004; Vairo et al., 2015b). Also, many Sarcophagidae species were sampled in dead bodies and animal carcasses (Vairo et al., 2011; Barros et al., 2008) increasing our knowledge of species distribution and its forensic potential. Although flesh flies are often recorded in forensic entomology studies in Brazil and we have more taxonomic resolution, they have not been used in a case as the main entomological evidence until now. Here we report the first case using flesh fly biological data to estimate the mPMI (minimum post-mortem interval) in Southern Brazil combined with the first record of *Microcerella halli* (Engel, 1931) on a human corpse.

Case report: On October 23, 2012, the body of a 77-year-old female was found on a tenth-floor apartment in downtown Curitiba (State of Paraná). The apartment did not have an air conditioning unit and the body was found lying face down on the bedroom floor, under a partially open window. The corpse showed distinct levels of decomposition being mostly swollen (late bloated), blisters on the back, detaching skin and discoloration spots. An external examination performed by the crime scene investigator from *Instituto de Criminalística do Paraná* (Criminalistics Institute of Paraná, IC-PR) showed no signs of trauma. The body had a maggot mass on the ventral surface, probably due to the extravasation of the internal organs, and maggots and pupae on the facial orifices. The entomological material (second/third instar larvae, pupae and adults) were

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http://dx.doi.org/10.1016/j.rbe.2017.06.004

collected by the investigator and delivered to the Forensic Entomology Group of *Universidade Federal do Paraná* around 2 h later. The puparium were medium-colored which indicates that pupariation began just before they were collected. A sample of larvae was killed in hot water (just after boiling, approximately 95 °C) and fixed in 70% alcohol as voucher specimens and the remaining larvae were reared with ground bovine meat in chambers under controlled conditions until the adult stage (20 °C, 70% RH). Voucher specimens were deposited in the *Coleção Entomológica Padre J. S. Moure* (DZUP).

The insects were identified as *Sarconesia chlorogaster* (Wiedemann, 1830) (Calliphoridae) (second and third instar larvae) and *M. halli* (Engel, 1931) (Sarcophagidae) (third instar and pupae), both Neotropical species. *S. chlorogaster* is associated with cold climate regions (Vairo et al., 2015b) and *M. halli*, which occurs from northeast to south Brazil, and had previously only been found feeding on animal carcasses (Nassu et al., 2014; Vairo et al., 2011).

Usually when larval development data is available, the mPMI can be estimated through ADH (accumulated degree hours) or developmental equations (Vairo et al., 2015b). As developmental rates data of both species are available for Brazilian populations at temperatures close to the death scene temperatures (Nassu et al., 2014; Lecheta et al., 2015) the equations predicting the time of development were used to provide mPMI estimation. We used temperature data provided by the closest weather station (SIMEPAR station around 4.5 km from the death scene) since we did not have the indoor data available. It is noteworthy that the temperature inside the apartment was similar than that outside, based on the information provided by the investigator. After analyzing the body conditions, the samples and the decaying process, the mPMI was estimated using the average temperature of the week before the body discovery, 20 °C. Since the pupariation started just before puparium were collected and there were no data available on intrapuparial development of *M. halli* we decided, conservatively, to estimate mPMI using the third instar larvae age. Also, as there was no empty puparium from the death scene, use data on the intrapuparial period would bias the mPMI estimative. Nassu et al. (2014) presents a linear development model and, consequently, a development rate equation ($1/D$) for *M. halli*. According to our estimation *M. halli* developing at 20 °C, colonized the body at least 10 days before being sampled i.e. from at least the morning of October 13 or earlier. The same method was used to estimate the age of the *S. chlorogaster* third instar larvae and the estimation is approximately 7 days. Considering *S. chlorogas*ter, the first oviposition occurred on October 16.

Under normal access conditions blow flies can find corpses within minutes after death while flesh flies usually colonize later (Byrd and Castner, 2010). However, when compared to outdoor body colonization, indoor colonization can have Sarcophagidae species arriving first (Goff, 1991) and fewer Calliphoridae species (Anderson, 2011). Also, blow fly colonization on indoor environments can be delayed (Reibe and Madea, 2010).

Based on our results, *M. halli* arrived 3 days earlier than *S. chlorogaster*. As forensic entomologists, we can hypothesize two scenarios to explain why *M. halli* arrived earlier than *S. chrologaster*. First, *M. halli* could be already in the apartment prior death and consequently would be the first species to colonize the corpse. Also, because the death occurred on a tenth-floor, the number of flies sampled would be lower than in lower floors due to accessibility constraints (Goff, 1991). This is what exactly we found, lower number of necrophagous species than found in lower floors (Vairo et al., 2015b; Vasconcelos et al., 2014).

In the present case, based on our estimation using *M. halli* third instar larvae the mPMI was at least 10 days. This case represents not only the first report of *M. halli* on human corpses but also the first case in Southern Brazil where the mPMI was estimated using Sarcophagidae as the main entomological evidence. The presence of only two species at the scene highlights the need for more in depth understanding of indoor colonization patterns in high-rise floors and buildings together with physiological and behavioral studies of carrion species. This may provide insight into how insects access high floor apartments and it would be valuable for gathering information about the entomological fauna associated with corpses and the variables affecting its succession pattern and its potential use as evidence.

Conflicts of interest

The authors declare no conflicts of interest.

Acknowledgments

We thank the Forensic Scientists of Paraná – *Seção de Crimes contra a Pessoa* for all the support and the institutions *Conselho Nacional de Desenvolvimento Científico e Tecnológico* (CNPq) for research grant MOM (proc. 307947/20092), RCC (proc. 207182/20140), *Fundação Araucária* for research grant MOM (proc. 686/2014) and the four reviewers for the comments and suggestions.

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