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SHORT REPORT

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A checklist of Diptera collected in the Caña de Azúcar morgue of Aragua, Venezuela

José Nuñez Rodríguez¹, Mary Bonilla Villarreal² and Jonathan Liria^{3*}

Abstract

Background: Venezuela has experienced soaring rates of violent crime, in particular, homicides. The Aragua state with 142 to 168 crimes per 100,000 inhabitants has the highest homicide rate in the last 5 years. All these cases are transferred to the estate morgue. Entomological evidence on cadavers has been used as a tool to clarify the death causes. Due to this, we analyzed the occurrence of forensically important dipteran species on facilities of the Caña de Azúcar morgue in Aragua, Venezuela.

Findings: A total of 692 adult insects belonging to five species of Calliphoridae and Muscidae were collected at the Caña de Azúcar morgue premises (body holding area and autopsy room). *Chrysomya megacephala* and *Musca domestica* were the most frequent species in the morgue areas. Other species with forensic importance were also found: *Lucilia cuprina*, *Chrysomya albiceps*, and *Ophyra aenescens*.

Conclusions: The results could be used as additional sources of information in Venezuelan criminal investigations.

Keywords: *Chrysomya megacephala*, *Musca domestica*, Necrophagous insects, Blow flies, Forensic entomology

Main text

Human bodies suffer a series of physicochemical and microbiological changes that modify their anatomy. When necrophagous insects accelerate the decomposition process, it results to a difficulty for the forensic pathologist to establish the death cause. However, entomological evidence on cadavers has been used as a tool in criminal investigations such as clarifying the death causes, geographical location, and eventually transfer of the body (Smith 1986; González et al. 2011; Nuñez 2012).

The entomologist's work begins when there is entomological evidence, which requires a specialized study of the species involved, stage of development in which the insect was collected, life cycle, and other aspects of its biology. When obtaining this data, it is sought to provide information within the forensic context: primary species colonizer, ecological succession, development at the

temperature of the event site, geographical location, and environmental factors help to estimate the minimum postmortem interval (mPMI), as well as other circumstances regarding the cause of death (Gennard 2007; Amendt et al. 2010).

Venezuela has experienced soaring rates of violent crime, in particular, homicides (Tremaria 2016; UNODC 2019). Data regarded from a non-governmental organization known as the Venezuelan Violence Observatory provides information on homicide rates and showed that the Aragua state presents the highest homicide rate in the last 5 years (142 to 168 crimes per 100,000 inhabitants). All these cases are transferred to the estate morgue, located in Caña de Azúcar neighborhood at 130 km from the Caracas. This morgue has two main spaces: the body holding area with mortuary refrigerators for storage and the autopsy room area. However, since 2015, the refrigerators are only partially operational and serve for short-term storage only. Thus, all bodies are placed in the autopsy room in postmortem tables. After, autopsy unclaimed bodies are returned temporarily to the mortuary refrigerators. Under these

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conditions, some sarcosaprophagous Diptera species colonized some exposed bodies in the morgue area facilities.

From an entomological point of view, in Aragua state are recorded 36 flies species (23 Calliphoridae and 13 Muscidae), with eight species reported in forensic studies: *Calliphora vicina* Robineau-Desvoidy, 1830, *Chrysomya albiceps* (Wiedemann, 1819), *C. megacephala* (Fabricius, 1794), *Lucilia sericata* (Meigen, 1826), *L. cluvia* (Walker, 1849), *L. cuprina* (Wiedemann, 1830), *Cochliomyia macellaria* (Fabricius, 1775), and *Musca domestica* Linnaeus, 1758 (Cova-García 1964; Magaña et al. 2006; Löwenberg-Neto and Carvalho 2013; Thomas 2014; Velásquez et al. 2017).

This study aims to characterize the Diptera species, particularly Calliphoridae and Muscidae, present on bodies that arrived for autopsy at the Caña de Azúcar morgue, Aragua. This investigation can contribute to the creation of a database of local dipterans species of medico-legal importance in Venezuela.

Material and methods

The study was done in the Caña de Azúcar morgue (CAM), located at 10° 16' 29.2" north latitude and 67° 37' 17.3" west longitude, in the Mario Briceño Iragorry municipality of Aragua state. In CAM, two sites were selected: an autopsy room (AR) and a body holding area (BHA); in both sites were recorded temperature and relative humidity: 22.0 °C/70.0% and 36.0 °C/52.1%, respectively. The insects were collected in July 2016 from 10:00 to 12:00 h. The adult specimens were collected using entomological nets. In AR, the flies were sampled when flying around and resting in human corpses and medical instruments. There were also immature flies from a human male cadaver in chromatic stage, with larvae in the face and neck, which were collected. In BHA, the specimens were obtained resting in walls and the refrigerated cabinets. From a human male in saponification stage were collected adult flies. All adult flies were preserved in ethanol 70%, while the immature stages were sacrificed in boiled water and preserved in ethanol 70% and the cephalopharyngeal skeleton was dissected and slide mounted (Sukontason et al. 2004). Finally, the specimens were taxonomically identified using dichotomic keys for adults (Amat et al. 2008; Carvalho and Mello 2008; Patitucci et al. 2013) and immatures (Florez and Wolff 2009; Velásquez et al. 2010).

Results and discussion

From the collected 692 adult specimens from Muscidae (78.2%) and Calliphoridae (21.8%), *Musca domestica* was the most abundant species (77.6%), followed by *Chrysomya megacephala* (19.5%), *Lucilia cuprina* (1.7%), *Ophyra aenescens* (Wiedemann, 1830) (0.6%), and

Chrysomya albiceps (0.6%). In BHA, five species were registered, while in AH only two species were collected: *C. megacephala* and *M. domestica* (Table 1). From human corpses were collected 224 larvae identified as *C. megacephala* in the 2nd instar larvae with 8.0 ± 0.19 (7.1–8.6) mm mean length. The colonization initiated in natural cavities (mouth and nostrils) and the neck area associated with the autopsy Y-shaped incision, with 3-day larvae development at 22 °C.

Within dipterans of medico-legal importance, Calliphoridae is the taxa with most evidence in forensic entomology. Also, many other species have been described as primary colonizers of the human bodies and other experimental biomodels, even in cases of myiasis. This relationship is useful because it allows to estimate an interval from colonization of the body to its discovery, tracing minimum margins in the death data. This is achieved by taxonomic determination of the species of forensic importance, as well as their instar identification to establish the mPMI (Vanin et al. 2011; Thyssen et al. 2012; Ururahy et al. 2013). In this study, three Calliphoridae species were registered in the facilities of CAM, which coincides with previous entomological studies in the Aragua state (Magaña et al. 2006; Velásquez et al. 2017). The most abundant species *C. megacephala* is used as a model for developing techniques in medicocriminal forensic entomology (Gruner et al. 2017; Badenhorst and Villet 2018). In a similar investigation conducted in the Cali Institute of Legal Medicine-Colombia, the following species were reported: *C. macellaria*, *C. megacephala*, *C. rufifacies* (Macquart, 1842), and *Musca domestica* (Barreto et al. 2002). More recently, in the Judicial Morgue of the Institute of Legal Medicine of Panama city, Panama, the following species were reported: *C. rufifacies*, *C. megacephala*, *C. macellaria*, and *Hemilucilia semidiaphana* (Rondani, 1850); the latter was recorded associated to human bodies found in suburban and forested environments (Bermudez and Pachar 2010). Later, Costa-Oliveira and Vasconcelos (2010) studied the Diptera associated with cadavers at the Institute of Legal Medicine of Recife city, Brazil. These authors reported five species present on cadavers:

Table 1 Adult Diptera species collected in the autopsy room and body holding area from the Caña de Azúcar morgue

Family	Species	Site/specimens collected	
		AR	BHA
Calliphoridae	<i>Chrysomya megacephala</i>	96	39
	<i>C. albiceps</i>	–	4
	<i>Lucilia cuprina</i>	–	12
Muscidae	<i>Musca domestica</i>	216	321
	<i>Ophyra aenescens</i>	–	4

AR autopsy room, BHA body holding area

C. albiceps, *C. megacephala*, *C. macellaria*, *Oxysarcodexia riograndensis* (Lopes, 1946), and *Ravinia belforti* (Prado & Fonseca, 1932), these last two belonging to the Sarcophagidae family. In a recent study in the surroundings of the morgue Hospital in Puerto Cabello city, Venezuela, *Lucilia cuprina*, *Lucilia eximia* (Wiedemann, 1819), *C. macellaria*, *C. albiceps*, and *C. megacephala* (Nuñez et al. 2016) were found.

Some authors emphasized the importance of Muscidae species for mPMI estimation (Ramirez 2012); but this taxa and Sarcophagidae are little studied in Venezuela. In this study, the Muscidae species coincide with investigations carried out in Carabobo state (Liria 2006; Nuñez et al. 2016). Also, some investigations reported *O. aeneus* associated with the active decomposition process (Ramos et al. 2014; Mariani et al. 2014); also, this species was reported in urban areas and abundant in the dry season (Patitucci et al. 2010).

Conclusion

This study records five species of Calliphoridae and Muscidae present in the facilities of the judicial CAM. The BHA area showed high species richness and the AR area the lowest. *Chrysomya megacephala* and *Musca domestica* were the most abundant species recorded in both morgue areas. The checklist hereby provided can be used as a complementary source in Venezuelan criminal investigations.

Abbreviations

AR: Autopsy room; BHA: Body holding area; CAM: Caña de Azúcar morgue; mPMI: Minimum postmortem interval

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Adherence to national and international regulations

Not applicable.

Authors' contributions

JNR contributed to the idea of the research and the study design, collected the insects, and wrote the first article draft. MBV allowed access to the morgue facilities and collaborated with the first article draft. JL contributed to the final manuscript and revised the paper. The authors read and approved the final manuscript.

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Ethics approval and consent to participate

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Consent for publication

This study does not include publishing of personal data.

Competing interests

The authors declare that they have no competing interests.

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