

High in the sky: the black soldier fly (Diptera: Stratiomyidae) inhabiting the forest canopy in the central Amazon, state of Amazonas, Brazil

Alto no céu: a mosca soldado-negro (Diptera: Stratiomyidae) habitando o dossel de uma floresta na Amazônia Central, estado do Amazonas, Brasil

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Abstract: *Hermetia illucens* (Linnaeus, 1758), the black soldier fly, has been recorded for the first time inhabiting the canopy in a primary forest area in the central Amazon, in the state of Amazonas, Brazil. This record shows that the species is able to colonize environments up to 40 meters high and that the larvae are able to decompose organic matter at different stratification levels.

Keywords: *Hermetia illucens*. Hermetiinae. Decomposers. Immatures.

Resumo: *Hermetia illucens* (Linnaeus, 1758), a mosca soldado-negro, é registrada pela primeira vez habitando o dossel em uma área de floresta primária na Amazônia Central, no estado do Amazonas, Brasil. Esse registro mostra que esta espécie é capaz de colonizar ambientes com até 40 metros de altura e que suas larvas são capazes de decompor matéria orgânica em diferentes níveis de estratificação.

Palavras-chave: *Hermetia illucens*. Hermetiinae. Decompositores. Imaturos.

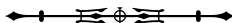
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INTRODUCTION

The forest canopy is considered the most complex and diverse stratum of organisms on the planet (Lowman & Wittman, 1996). Studies related to arboreal arthropods have intensified with the development of new canopy collecting techniques (Linsenmair *et al.*, 2001; Basset *et al.*, 2003), which have provided information on the abundance, diversity, distribution and trophic guilds of its communities (Santos *et al.*, 2003).

Among the insects, Diptera is one of the most abundant in the canopy (Guerrero *et al.*, 2003; Felix *et al.*, 2012). They are excellent flyers and seek resources in various natural environments, playing the role of predators, pollinators, pests and decomposers (Marshall & Kirk-Spriggs, 2017).

Hermetia illucens (Linnaeus, 1758) (Figure 1A), known as the black soldier fly, is a synanthropic polysaprophagous fly presumed native to the Neotropics, but currently with a cosmopolitan distribution, especially in the warmer parts of the world, due to human activity and commerce (Woodley, 2001; Roháček & Hora, 2013). Larvae of *H. illucens* are known to feed on a wide range of decaying organic matter. In the past few decades, there has been a considerable interest in using these larvae for organic waste control, composting, and animal food supplements (see Bondari & Sheppard, 1981; De Marco *et al.*, 2015; Lalander *et al.*, 2015; Nguyen *et al.*, 2015). The larvae can be found in corpses and are used for the estimation of the post-mortem interval in forensic entomology (Lord *et al.*, 1994; Pujol-Luz *et al.*, 2008; Martínez-Sánchez *et al.*, 2011). Moreover, the immature stages and bionomy of *H. illucens* in the central Amazonia were described by Barros *et al.* (2018, 2019).

Despite extensive knowledge of the bionomy of *Hermetia illucens*, information on the behavior of this species in primary forests is still lacking. For instance, little is known about the flight height, colonization and function of *H. illucens* in the decomposition process in the canopy. Here we record for the first time the occurrence of *H. illucens* in the canopy, 40 m above the ground.



Figure 1. A) Lateral habitus of male of *Hermetia illucens* (Linnaeus, 1758); B) decaying wooden box in top of the tower; C) metal tower of ZF-2 station; D) larva of *H. illucens* feeding in decaying wood highlighted; E) larvae rearing in laboratory. Photos: M. M. Soares (2019).

MATERIAL AND METHODS

The specimens were collected from a decaying wooden box in a metal tower 40 m above the ground (Figures 1B and 1C). The box was used to transport equipment during the tower renovation in 2015 and was forgotten at the top of the tower. MMMS noted that the box had previously been colonized by termites, but they no longer occupied it when *H. illucens* larvae were found. The tower is located a reserve of the National Institute of Amazonian Research (INPA) - Tropical Silviculture Experimental Station, at km 934 of BR 174 on the road ZF-2 (2° 35' 21" S – 60° 06' 55" W), herein called ZF-2 station (Figure 2). This area is about 50 km north of Manaus in the state of Amazonas, Brazil.

The collection was performed on February 1st, 2019, during the rainiest period. The average local temperature is 26° C (min = 23° C, max = 31° C), relative humidity corresponding to 80% and average annual rainfall equal



Figure 2. Localization of the ZF-2 tower at Tropical Silviculture Experimental Station, Manaus, state of Amazonas, Brazil.

to 2,286 mm³ (Costa *et al.*, 2013). The vegetation in the vicinity of the tower is of humid tropical rainforest, with characteristics typical of the central part of the Amazon region (Higuchi *et al.*, 1998).

RESULTS AND DISCUSSION

We collected 32 larvae of *H. illucens* with the help of entomological forceps, from which two were euthanized in heated water to identify the species. The individuals were stored in 30 ml plastic tubes and then transported to the laboratory.

The larvae were reared at room temperature in a 500 g plastic container under vermiculite as a substrate for pupation (Figure 1E). A food source was not necessary because the larvae were in the sixth stage, the pre-pupal period, when fly larvae do not feed. The top of the plastic container was covered by voile fabric and was fastened with an elastic band. The development of the immatures was

documented until the adults emerged. The individuals were euthanized 24 hours after emergence, then pinned, labeled and deposited in the invertebrate collection of the INPA.

For the identification of the adults, we used Ildie & Mileti (1976), and for identification of immatures, Barros *et al.* (2018). The adult was photographed with a Leica MC170 HD digital camera coupled on a Leica M165C stereomicroscope. The photographs were stacked and combined into a single image using Leica Application Suite V4.11.

The collected larvae fed on the decaying wood (Figure 1D). This habit is common, since *H. illucens* is a very general scavenger and is able to feed on fruits, meat, fallen tree trunks, as well as microorganisms such as fungi and bacteria (Liu *et al.*, 2008).

The only available information on the presence of *Hermetia* species in canopy is found in Pujol-Luz *et al.* (2016), where adults of *H. pulchra* Wiedemann, 1830 were collected by Malaise traps installed in the canopy.

The presence of *H. illucens* in the canopy may indicate that this species can be found at different stratification levels in primary forest. In addition, the presence of larvae and pupae in this environment points that not only females have the ability to fly 40 meters above the ground, but also immatures can fully develop and act upon the decomposition of organic matter at this stratification level.

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