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New records of the black soldier fly *Hermetia illucens* (Diptera: Stratiomyidae) in Serbia and Montenegro

Original Article

Saša S. Stanković
University of Niš, Faculty of Sciences and Mathematics, Department of Biology and Ecology, Višegradska 33, 18000 Niš, Serbia
sasasta@gmail.com (corresponding author)

Aleksandra Trajković
University of Niš, Faculty of Sciences and Mathematics, Department of Biology and Ecology, Višegradska 33, 18000 Niš, Serbia

Vladimir Žikić
University of Niš, Faculty of Sciences and Mathematics, Department of Biology and Ecology, Višegradska 33, 18000 Niš, Serbia

Abstract:

This paper presents the first report of *Hermetia illucens* (Linnaeus, 1758), commonly known as the black soldier fly, in Serbia. The discovery comprises two specimens collected in the village of Stari Ledinci, near Novi Sad, captured inside a facility adhered to window glass. Furthermore, we document the presence of black soldier fly specimens in Montenegro, where three individuals were captured using a sweeping net.

Key words:
black soldier fly, *Hermetia illucens*, Serbia, first report

Apstrakt:

Novi nalazi crne vojničke muve *Hermetia illucens* (Diptera: Stratiomyidae) u Srbiji i Crnoj Gori

Ovaj rad predstavlja prvi nalaz crne vojničke muve *Hermetia illucens* (Linnaeus, 1758) u Srbiji. Dva primerka crne vojničke muve su sakupljena u selu Stari Ledinci, blizu Novog Sada, pronađena unutar objekta na staklu prozora. Takođe, dokumentujemo prisustvo crne vojničke muve u Crnoj Gori, gde su tri jedinke uhvaćene entomološkom mrežom.

Ključne reči:
crna vojnička muva, *Hermetia illucens*, Srbija, prvi nalaz

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Introduction

Hermetia illucens (Linnaeus, 1758), popularly known as the black soldier fly (BSF), belongs to the subfamily Hermetiinae of the dipteran family Stratiomyidae. Approximately 80 congeneric species are distributed mostly in the tropical regions, particularly the Neotropics (Fachin & Carvalho-Filho, 2020). Although *H. illucens* originates from Central and South America, it has become a widespread species present on all continents (Demetriou et al., 2022). This cosmopolitan distribution is a result of its high tolerance to various climate conditions, as well as its plasticity in terms of food sources. The BSF has become one of the most commonly farmed insects intended for entomophagy, primarily in an attempt to substitute fish meal, the easily deteriorating and expensive protein component of traditional livestock feed. Also, considerable research focuses on BSF biotransformation abilities (Wang & Shelomi, 2017; Kumar et al., 2021) since it plays an important role in the recycling of nutrients in nature. Adult black soldier flies have poorly developed mouth parts, and typically do not eat or they feed on nectar and other sugars (Sheppard et al., 2002). Primarily saprophagous, BSF larvae feed on decaying organic matter such as rotten plant and animal waste, manure, etc. (Gobbi et al., 2013). Thus, the larvae thrive on various organic waste originating from households and green markets (Newton et al., 2005). The simplicity of BSF breeding led to the development of insect farms across the globe. World's first commercial fly farm was established in 2008 in South Africa, afterwards the mass production reached Europe (Spain, the Netherlands, France, Ireland), Asia (Malaysia, Singapore), America (US, Chile) (VMR, 2024) and Australia (Digiacomo, 2023). The profitability potential and the risks associated with the use of insects as animal feed are under scrutiny in several countries of the European Union, and legislation is being actively adjusted to address the issue. These regulatory acts are also being considered in Serbia (Urošević et al., 2019).

Although BSFs originate from warm and humid habitats, they have successfully established populations in temperate regions as well (Spranghers et al., 2017). The first European record dates back to early 1926, when it was discovered in Malta (Lindner,

1936). Subsequently, the species began spreading across the western Mediterranean; the Iberian Peninsula (Leclercq, 1997), and later, the Balkan Peninsula, i.e., its coastal countries (Beschovski & Manassieva, 1996; Tsagkarakis et al., 2015). The BSF has been recorded further north beyond the Mediterranean basin, in France (Chevin, 1986), Switzerland (Sauter, 1989), Germany, and the Czech Republic, which is its northernmost distribution point in Europe (Roháček & Hora, 2013). Recently, in some databases, such as GBIF (2024) it has been reported from Sweden, Estonia, Benelux, and Great Britain. Although BSF spreads naturally, the process is further aided by human-mediated transport. The BSF larvae's efficient consumption of organic waste renders them valuable agents in composting processes. They can effectively convert organic waste into nutrient-rich, high-protein biomass (Czekała et al., 2020). Although there is no data on commercial farming in Serbia nor Montenegro, local attempts at rearing closed BSF colonies are probable, especially within amateur herpetoculture circles. While citizen science databases iNaturalist and Alciphron (Alciphron database © 2014-2024 HabiProt) have documented encounters with the species in the vicinity of Belgrade for Serbia, *H. illucens* has never been officially registered.

Fig. 1. Sampling sites; Serbia, Stari Ledinci and Montenegro, Kotor

Similarly in Montenegro, where no records have been published since Beschovski & Manassieva, (1996), database iNaturalist reports several observations, especially along the coastal line. Through reporting on the wild-caught specimens, we officially confirm the presence of BSF in Serbia for the first time. Additionally, we provide the first recent confirmation for Montenegro.

Materials and Methods

Material was collected during the year 2023 in Serbia and Montenegro (**Fig. 1**). In Serbia, two adult specimens of the black soldier fly were collected by hand, inside a facility on the window glass in the village of Stari Ledinci, near the city of Novi Sad. The Montenegro sample originates from Kotor and was collected by a sweeping net.

All specimens are dry mounted, pinned, and kept in the collection at the Faculty of Sciences and Mathematics, University of Niš. Legator abbreviations are as follows: VŽ = Vladimir Žikić, SS = Sandra Stanković, MP = Mihajlo Popović.

Results

Material examined: SERBIA: Stari Ledinci, 45°11'19.2"N, 19°48'24.1"E, 15.09.2023, 1 ♀, 1 ♂, leg. VŽ (**Fig. 2**). MONTENEGRO: Kotor, 42°25'15.9"N, 18°45'53.8"E, 05.06.2023, 1 ♀, 2 ♂♂, leg. SS & MP.

Remarks: *Hermetia illucens* is a moderately large fly usually measuring around 15 mm in body length (ranging from 12 mm to 20 mm). On average, females are generally larger than males. The BSF bears some resemblance to wasps. The head is relatively small in proportion to the body, glossy black with a white stripe running along the lower part of the face. Large broadly separated eyes are also black. Antennae with eight flagellomere segments, with the last segment equal in size to the other segments' combined length; usually, dark brown to black (Oliveira et al., 2016). Thorax is shiny black. Legs are mainly black with white tarsi. The hind tibia also has white coloured basal part. The wings are smoked brown. Five abdominal segments are predominately black except the posterior margin of the first segment and almost the entire second segment having a pair of translucent white oblong spots (Rozkošný, 1982; Oliveira et al., 2016). The white abdominal spots are one of the important and conspicuous characteristics in BSF recognition. However, the extent i.e., the size of the white markings on the female abdomen is particularly variable.

Fig. 2. Appearance of the female of *H. illucens* sampled in Serbia, Stari Ledinci; Photo: S. Stanković

Discussion

Since the black soldier fly has been present in Europe for almost a century, starting from Malta (Lindner, 1936) and later spreading to the continental part (Demetriou et al., 2022), it was a matter of time before it reached the entire Balkan region. Although BSF demonstrates the ability to adjust to the environmental conditions of many newly colonized areas (Kaya et al., 2021), at this point, we cannot determine the origin of the specimens discussed in this paper. Introductions from neighbouring countries, such as Hungary, should not be excluded, as there are reports of both large-scale commercial farming (BSF Systems Kft., 2024) and small BSF pet food production. Moreover, in 2022, BSF was already reported present in Hungary (Murányi, 2022). The specimens from Serbia were caught in mid-September, which is a rather late finding, as most of the encounters in Europe are during the early summer season. This suggests that the specimens might have been escaped from putative house farming. On the other hand, the locality is suburban, with a lot of small conventional livestock farms and, subsequently, plenty of available manure and organic waste. The finding from Montenegro is from early June, implying that a population in this Mediterranean country might have been established. According to Demetriou et al. (2022) black soldier fly has the potential to spread into all countries bordering the Mediterranean basin, as well as Central European countries and the Balkans. Although the species is rather thermophilic, it has spread as far north as the eastern Czech Republic (Roháček & Hora, 2013) suggesting that it has the potential to withstand the unfavourable climate, especially in manure piles where the heat is produced by bacterial activity.

Adults of BSF can be easily recognized, especially by the white and translucent spots on the abdomen. Although this very characteristic can vary in size and shape, it is always present. Therefore, citizen science can be of the essence in reporting the spreading trajectories of BSF in the region, as well as shaping the possible introduction scenarios. Although invasive, BSF is generally considered a beneficial species, especially in waste management and as a protein-rich food source (Li et al, 2011; Wang & Shelomi, 2017), and it has even been released in nature as a biological agent against the house fly (Skuhravá et al., 2010). Although black soldier flies are generally harmless to humans, they have been known to cause occasional myiasis in people (Rozkošný, 1982).

The species' synanthropic behaviour, quick dispersal, and adaptability to varying temperature ranges have led to its cosmopolitan distribution that is becoming increasingly pronounced over the last few decades. This raises significant concerns about its potential impact on local fauna and the ecosystem in general and emphasizes the scarcity of data regarding their role in new environments.

It is therefore of great importance to gather more detailed information about the current distribution and monitor its interaction with autochthonous fauna through both citizen science and extensive ecological studies.

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