EVANGELOS KOUTSOUKOS ^{a, b} - CHRISTOS KAZILAS ^{c, d}ADDRESSING DISTRIBUTIONAL SHORTCOMINGS THROUGH CITIZEN SCIENCE RECORDS: THE PRESENCE OF *HERMETIA ILLUCENS* (LINNAEUS, 1758) (DIPTERA STRATIOMYIDAE) IN ALGERIA^a Section of Ecology and Systematics, Department of Biology, National and Kapodistrian University of Athens, 15784 Athens, Greece^b Museum of Zoology, National and Kapodistrian University of Athens, 15784 Athens, Greece^c Naturalis Biodiversity Center, PO Box 9517, 2300 RA Leiden, The Netherlands^d Institute of Biology, Leiden University, Sylvius Laboratory, Sylviusweg 72, 2333 BE, Leiden, The Netherlands
Corresponding Author: Christos Kazilas; email: ckazilas@gmail.comKoutsoukos E., Kazilas C. - Addressing distributional shortcomings through citizen science records: the presence of *Hermetia illucens* (Linnaeus, 1758) (Diptera Stratiomyidae) in Algeria.

The black soldier fly, *Hermetia illucens* (Linnaeus, 1758) (Diptera: Stratiomyidae) is a polysaprophagous species originating from the Nearctic, that has been introduced to various countries throughout the world over the past decades. Even though, the fly has been recorded in several parts of the Mediterranean region and southern Africa, to this day its presence from northern Africa is only known from Morocco. The current study provides the first record of the black soldier fly from Algeria, based on photographic material and supplementing data which were extracted from citizen science observations. The provided material depicts the range expansion of the species throughout the coastal area of the country and provides new insight on the current distribution of the insect in the Mediterranean region, as well as in the continent of Africa. In addition, hypotheses on the possible introduction routes of the black soldier fly in the southwestern Mediterranean region are briefly discussed.

KEY WORDS: Algeria, alien species, black soldier fly, *Hermetia illucens*, Stratiomyidae.

INTRODUCTION

The translocation of species to areas beyond their natural adapted range has been a topic of increasing global concern over the years, due to the numerous ecological impacts that are closely tied to such events (RICCIARDI, 2007; KUEFFER, 2017). Even though there are known cases where the deliberate or unintentional introduction of an alien species did not have a substantial effect on the environment, economy or human health (FOXCROFT and DOWNEY, 2008), others have been identified as a growing threat to biodiversity and ecosystem services around the world (GANDHI and HERMS, 2010; BELLARD *et al.*, 2016). Thus, the study of this group of organisms remains essential and can be employed in identifying pathways of introduction and developing management plans to prevent their further spread.

A great number of insect species have been accidentally introduced and have consequently expanded their distribution in the Western Palearctic over the last years, such as the box tree moth, *Cydalima perspectalis* (Walker, 1859) (HADDAD *et al.*, 2020), and the feather-legged fly, *Trichopoda pennipes* (Fabricius, 1781) (KAZILAS *et al.*, 2020). The black soldier fly, *Hermetia illucens* (Linnaeus, 1758) is a polysaprophagous species of Nearctic origin, which is nowadays regarded as cosmopolitan (MARSHALL *et al.*, 2015). The presence of the fly is known from a large part of Europe, including various Mediterranean countries, such as Malta (LINDNER, 1936), Spain (PERIS, 1962), France (CHEVIN, 1986), Portugal (CARLES-TOLRÁ, 2001), Italy (MASON, 2013), and Greece (TSAGKARAKIS *et al.*, 2015). In Africa, the spe-

cies has been recorded from several localities in the central and southern part of the continent, namely: Madagascar (LECLERCQ, 1997; OLIVEIRA *et al.*, 2015), Burundi, Cameroon, Ivory Coast, Liberia (LECLERCQ, 1997), Guinea (LARDÉ, 1990), Ghana, Mali (DEVIC and MAQUART, 2015), South Africa (MARSHALL *et al.*, 2015) and Réunion island (INPN, 2019). In addition, MAQUART *et al.* (2020) reported additional sightings of the fly in Africa, which also included the countries of Ethiopia, Kenya, Namibia, Rwanda, Senegal, Tanzania and Uganda. Lastly, in the northern part of the continent, the presence of the *H. illucens* is known from Morocco (MAQUART *et al.*, 2020), while it has not yet been found in any other country of that region.

Even though the black soldier fly appears to have been established in various parts of the world, it still has not been recognized as a pest (FURMAN *et al.*, 1959) or a threat to the native species in the introduced areas (MAQUART *et al.*, 2020). The species has been observed in rice fields of Northern Italy in the past (GOIDANICH, 1939), but no evidence of damage to plants has been documented. On the contrary, the ability of the larva of *H. illucens* to consume decaying organic matter has deemed this species as a commercially important bioconverter (GAO *et al.*, 2019). The fly is also of particular interest for its applications in house fly infestation and manure control (SHEPPARD, 1983; SHEPPARD *et al.*, 1994), production of food supplements (NEWTON *et al.*, 1977; BONDARI and SHEPPARD, 1981) and composting (LANDER *et al.*, 2015).

Herein we present the first record of *H. illucens* for Algeria, extending its known distribution range in Africa.

Fig. I – Individuals of *Hermetia illucens* photographed in situ from three localities in Algeria: Annaba (1), El Biar (2), Bir El Djir (3). Photos by S. Samy (1), A. Andaloussi (2) and S. Kernane (3).

MATERIALS AND METHODS

The present publication is based entirely on citizen science records, which were extracted from the iNaturalist online platform. All records were obtained after personal communication with their respective observer and identified based on species diagnoses of (ROZKOŠNÝ, 1982; OLIVEIRA *et al.*, 2016; DUZELL, 2019; LESSARD *et al.*, 2019). In order to avoid errors in species determination, we only included photographic material of sufficient quality, thus excluding a few vague observations from the current study.

RESULTS

Apart from its distinct morphological features, the fact that *H. illucens* is the only representative of the ge-

nus *Hermetia* in the Palearctic region was taken into consideration (ROZKOŠNÝ and NARTSHUK, 1988; WOODLEY, 2001; STÄHLS *et al.*, 2020), thus further confirming the accurate identification of the presented records.

A total of three citizen science records of the occurrence of *H. illucens* in Algeria are presented:

Annaba (36.91534°, 7.761994°), 28.v.2020, S. Samy, 2 individuals in copula (iNaturalist) (<https://www.inaturalist.org/observations/47610018>) (Fig. I, 1).

Bir El Djir, Oran (35.723778°, -0.560600°), 18.x.2018, S. Kernane, 1 individual (iNaturalist) (<https://www.inaturalist.org/observations/24207025>) (Fig. I, 3).

El Biar, Algiers (36.773554°, 3.043631°), 22.vi.2020, A. Andaloussi, 1 individual (iNaturalist) (<https://www.inaturalist.org/observations/50534522>) (Fig. I, 2).

Fig. II – Physical map of the southwestern Mediterranean, where *Hermetia illucens* has been recorded. The red dots represent the new records of the fly from Algeria, while the red shaded areas indicate the countries where the presence of the species is already known.

DISCUSSION

The time period of the presented observations, which exceeds two consecutive years, suggests that *H. illucens* has formed established populations in the studied areas. All of the aforementioned records are distributed throughout the Mediterranean part of Algeria (Fig. II), in large cities that have commercial ports, which could support the hypothesis of an accidental introduction through maritime trade routes, possibly from another Western Mediterranean country such as Morocco, Malta, Italy, France, Spain or Portugal. Alternatively, the Black soldier fly could have actively dispersed to Algeria from Morocco throughout northwestern Africa, while a central African origin is less likely, given that the southern part of the country is covered by the Sahara desert. However, a genetic analysis of these populations is necessary in order to determine their exact origin, since a combination of these two scenarios is also possible.

The presence of *H. illucens* in North Africa is also confirmed by Fauna Europaea, although after personal communication with Dr. Thomas Pape, detailed distributional records of the species' presence in the region could not be found. The presence of Black soldier fly in Algeria could be subject to further research, especially on field, in order to ascertain the exact distribution of the species in North Africa and especially on the coastal areas of Tunisia,

Libya and Egypt, thus concluding if the species has a continuous spread throughout the southern Mediterranean.

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