J. Entomol. Res. Soc., 26(1): 93-112, 2024 *Research Article*
Doi: 10.51963/jers.v26i1.2547 *Online ISSN:2651-3579*

New Records of the Moroccan Soldier Flies (Diptera: Stratiomyidae) with the Description of the Male of *Oxycera flava* (Lindner, 1938)

Driss YIMLAHI[1]* Boutaïna BELQAT[2] Turgay ÜSTÜNER[3]
Paul L.TH. BEUK[4]

[1,2]Laboratory of Ecology, Systematics, Conservation of Biodiversity (LESCB), Department of Biology, Faculty of Sciences, CNRST Labeled Research Unit Nº18, Abdelmalek Essaâdi University, Tétouan, MOROCCO

[3]Selçuk University, Faculty of Science, Department of Biology, Campus Alaeddin Keykubat, Selçuklu, 42075 Konya, TURKEY

[4]Natuurhistorisch Museum Maastricht, de Bosquetplein 6-7, Nl-6211kj Maastricht, THE NETHERLANDS

e-mails: [1]yimlahi.1986@gmail.com; [2]bbelqat@uae.ac.ma [3]tustuner@selcuk.edu.tr [4]muscapaul@gmail.com;

ORCID IDs: [1]0009-0007-2331-7552; [2]0000-0003-2857-7699; [3]0000-0002-0604-2346 [4]0000-0001-6383-3905

*Corresponding author

ABSTRACT

New data about Moroccan soldier flies (Stratiomyidae) are presented in the present study that discusses 15 species. Six species are recorded as new to the fauna of Morocco, four of which, *Oxycera analis* Wiedemann in Meigen, 1822, *O. flava* (Lindner, 1938), *O. marginata* Loew, 18959, and *Chorisops tibialis* (Meigen, 1820) are new records for North Africa. *Oxycera morrisii* (Curtis, 1833) is recorded for the first time in Morocco. *Hermetia illucens* (Linnaeus, 1758) was recently reported based on a personal communication without details but is now also formally added. It adds a new subfamily to the Moroccan fauna, the Hermetiinae. Notes on taxonomy, distribution and biology of the species are added. The male of *O. flava* is described and illustrated.

Keywords: New records, Morocco, Rif Mountains, Palaearctic Region.

Yimlahi, D., Belqat, B., Üstüner, T., & Beuk, P.L.TH. (2024). New records of the Moroccan soldier flies (Diptera: Stratiomyidae) with the description of the male of *Oxycera flava* (Lindner, 1938). *Journal of the Entomological Research Society*, 26(1), 93-112.

Received: November 10, 2023 *Accepted: March 20, 2024*

INTRODUCTION

At present, the world fauna of Stratiomyidae consists of approximately 2700 recognized and described species belonging to approximately 400 genera (Woodley, 2001). Contributions to the knowledge of stratiomyids of Morocco are very fragmented and remain patchy; the first records were by Becker and Stein (1913) and further studies were those of Séguy (1930) and Lindner (1936-1938) who recorded species in their studies of the Diptera of Morocco or of the Palaearctic stratiomyids, respectively.

One single comprehensive study on the Moroccan stratiomyid fauna was published to summarize the knowledge in the first checklist of the soldier flies of Morocco (Yimlahi et al, 2017). It counted 33 species of which twelve were new additions to the list of Moroccan Stratiomyidae. Kettani and Woodley (2022) uncovered a few other records from the literature and set the total of Moroccan species at 40. With the present publication, another six species are added bringing the total to 46. However, the inventory of the Moroccan fauna is evidently not complete and new investigations are needed.

MATERIAL AND METHODS

The study is based on a total of 455 specimens (293 larvae, 79 males and 83 females) collected from 18 sampling sites in Morocco between 2014 and 2020. Adults were collected by sweep netting, trapped in a malaise tent or reared. The rearing of larvae and nymphs in the laboratory from substrates collected in the field was conducted using the technique employed by Afzan and Belqat (2016) which proved successful in obtaining adult specimens from larvae and nymphs of various Dipteran families, including Stratiomyidae, which are typically found buried in substrates. These substrates primarily consisted of silt, mosses, and submerged or partially submerged vegetation, collected from riverbeds, banks, and aquatic environments, and transported back to the laboratory in large containers. The experimental rearing protocol involved using basins and mesh screens, onto which the substrate was spread, and then covered with additional mesh to contain the emerging adults. We have also reared adults of *Hermetia*, both in the wild (Fig. 1) and in the laboratory, from larvae found in the litter (straw and plant food remains) of rabbits raised on a small farm. The specimens examined were collected in Chefchaouen, Ifrane, Khénifra, Tanger-Assilah, Larache, Tétouan, M'diq-Fnideq and Sidi Kacem Provinces. The specimens were sampled by the first and the second authors. All specimens are deposited in the insect collection of the Laboratory Ecology, Systematics, Conservation of Biodiversity in the Department of Biology, Faculty of Sciences of Tétouan, Abdelmalek Essaâdi University.

The list of sampling sites, with their coordinates and elevations, is presented in Table 1. Photographs of sampling localities showing Moroccan habitats of Stratiomyids are given.

The identifications were made using Séguy (1930), Rozkošný (1982, 1983) and Mason (2013). The nomenclature and the list of the species known from Morocco follow Woodley (2001).

Table 1. Sampling sites (in alphabetical order) with province and locality names, elevation (meters), and geographical coordinates (latitude/longitude).

Site	Province, locality	Geographical coordinates	Elevation (m)
Rif Mountains			
Aazafa	Tétouan, Beni Said	35°27.860'N/005°17.210'W	330
Aïn El Malâab	Chefchaouen, Parc National Talassemtane	35°05.509'N/005°09.443'W	1278
Daya Aïn Jdioui	Tanger-Assilah, Aïn Jdioui	35°34.074'N/005°55.499'W	5
Douar Kitane	Tétouan, Kitane	35°32.412'N/05°20.393'W	52
Douar Kouf	Allyene, M'diq-Fnideq	35°47.263'N/005°21.695'W	8
Golf Cabo Negro	Tétouan	35°64.8667'N/05°28.4266'W	2
Ksar Rimal	M'diq-Fnideq, Kabila	35°43.806' N/005°20.509'W	11
Larbaa Beni Hassan	Tétouan	35°19.1270'N/05°21.1840'W	608
Oued Aârate	Chefchaouen, Dardara	35°07.381'N/05°17.456'W	269
Oued El Kannar	Chefchaouen, Stehate	35°30.920'N/04°97.828'W	37
Oued Siflaou	Chefchaouen, Tougharine	35°11.609'N/005°18.402'W	278
Oued Tkaraâ	Larache, Jbel Bouhachem	35°16.063'N/05°25.829'W	959
Marabout Sidi Bouhadjel	M'diq-Fnideq, Restinga	35°43.596'N/005°24.517'W	77
Aïn Haouzi	Chefchaouen, Tougharine	35°11.213 'N/005°17.144'W	480
Middle Atlas Mountains			
Aïn Arougo	Khénifra	32°55.387'N/05°34.081'W	118
Cascade Aïn Vittel	Ifrane, Aïn Vittel	33°33.682'N/005°07463'W	1555
Mchacha Aïn Vittel	Ifrane, Aïn Vittel	33°33.206'N/05°06.722'W	1585
Rabat-Salé-Kénitra Region			
Douar Ouled Ammar	Khmiss Rmila, Sidi Kacem	34°24.969'N/06°06.083' W	14

Figure 1. Rearing. a) in the wild from larvae found in litter; b) in the laboratory from organic matter from a barn in Douar Kitane.

RESULTS

Faunistic Records

Subfamily Beridinae

Genus *Chorisops* Rondani, 1856

Chorisops tibialis (Meigen, 1820)

Material examined: Rif: Tétouan, Douar Kitane, 1♂, 9.10.2016-18.10.2016, 8♂, 6♀, 18.10.2016 -31.10.2016, 5♂, 4♀, 31.10.2016 -14.11.2016, Malaise trap. First record from North Africa.

World distribution: Euro-Mediterranean species, present in Austria, Belgium, Cyprus, Czech Republic, England, France, Hungary, Ireland, Israel, Italy, Germany, Greece, Netherlands, Poland, Romania, Slovakia, Spain, Switzerland, Wales and Yugoslavia (Woodley, 2001) and North Africa (present work).

This is the first record of *C. tibialis* from North Africa. It was collected in the Rif in Tétouan at an altitude of 52 m a.s.l.

Biology: Stubbs and Drake (2014) summarize the British data on the larvae of *C. tibialis* and associate them with rotting plant material (damp wood-mould in rot holes in trees and grass tussocks) and according to Handlirsch (1883), the larva was found in June among leaves. The flight period in Europe runs from the second half of May till late September and adults are often found in or near woodland (Stubbs & Drake, 2014).

Chorisops tibialis, a species of fly known for its summertime flight period in Europe, has been studied extensively for its ecological behavior. Lebard et al (2020) documented its presence in Europe until late September, suggesting the possibility of two annual generations.

In Morocco, our research conducted indicates a notable deviation from this pattern, with the species displaying activity later in the year, particularly from October to mid-November.

Subfamily Pachygastrinae

Genus *Pachygaster* Meigen, 1803

***Pachygaster atra* Panzer, 1798**

= *Nemotelus ater* Panzer, 1798

Material examined: Rif: Tétouan, Beni Said, Aazafa 1♀, 20.5.2018, sweep net. New localities for Morocco.

World distribution: Species of Turanic-European-Mediterranean distribution covering Europe (although its distribution seems to be limited in part also in the southern regions), the Middle East, Anatolia, the Balkan and the Caucasus (Woodley, 2001) and North Africa (Yimlahi et al, 2017) and Morocco (Aazafa) (New site).

Moroccan distribution: *P. atra* was collected in two localities within the Rif region, spanning two different provinces: Tétouan (Yimlahi et al, 2017) and Tangier-Assilah, where it was discovered at altitudes of 330 m and 778 m above sea level, respectively

Biology: Adults are often present locally on shrubs in the sun, at the edge of forests. Swarming has been recorded several times (Szilády, 1932; Piet, 1950; Verrall, 1909) and when mentioned the swarms consisted of males. The latter also noted a mass occurrence on *Pteridium aquilinum* in England. The main flight period ranges from May to August, but adults can be found as early as April and as late as September. Larvae have been found in moist soil among the fallen leaves of *Juglans regia*, the decaying leaves of *Verbascum, Salvia aethiopis* and others (Heeger, 1853; Dušek & Rozkošný, 1975).

In Morocco, the dates of collection of *P. atra* in Morocco fall within the flight period known from the literature, between April and May. The new locality is in a marshy

humid environment of a complex of stream and saline pond, on soil characterized by irrigated agriculture where plum tree is the main cultivated fruit tree.

Subfamily Hermetiinae

Genus *Hermetia* Latreille, 1804

Hermetia illucens (Linnaeus, 1758) (Figs 2-4)

Material examined: Rif: Tétouan, Douar Kitane, 13♂, 26 larvae, 1.7.2014, 20♀, 19 larvae, 17.7.2014, 1♂, 9♀, 104 larvae, 16.10.2015, 12 larvae, 24.5.2016, 19 larvae, 10.12.2016, 113 larvae. The adult collected by sweep net, 8♂, 14♀, 1.11.2015-17.12.2015, reared; Ksar Rimal, 1♀, 25.11.2018; Larbaa Beni Hassan, 1♂, 6.12.2020, sweep net; Chefchaouen, Dardara, Oued Aârate, 1♀, 10.7.2018, sweep net. Formally recorded from Morocco for the first time.

World distribution: Of almost cosmopolitan distribution, about between 45°N and 40°S, *H. illucens* is widespread in all zoogeographical regions. Apparently of American origin, it was spread worldwide through human activities. It should be noted that it was not recorded from North Africa until very recently when Koutsoukos and Kazilas (2021) added it to the Algerian list.

Only recently *H. illucens* was reported for Morocco based on a personal observation mentioned in Demetriou et al (2022), but no details were given. We here formally record *H. illucens* from Morocco for the first time and we thus add a new subfamily, the Hermitiinae, to the Moroccan stratiomyid fauna. It was collected in three localities in the provinces of Chefchaouen and Tétouan, in an altitudinal interval ranging from 11 m to 608 m.

Biology: Within its range *Hermetia illucens* is locally common on tree trunks and on garden plants in residential areas, and often seen resting on the walls and windows of houses (Callan, 1974). Larvae have been found in a wide range of decaying plant and animal materials; they are terrestrial scavengers (McFadden, 1967). European specimens have been collected from April 25 to November 8. Similarly, the Moroccan habitats where adults of *H. illucens* were found were particularly rich in decaying plant and manures. Males and females (Fig. 2a-b) were initially captured by sweep-netting. Larvae were found in manure (Figs. 3-4).

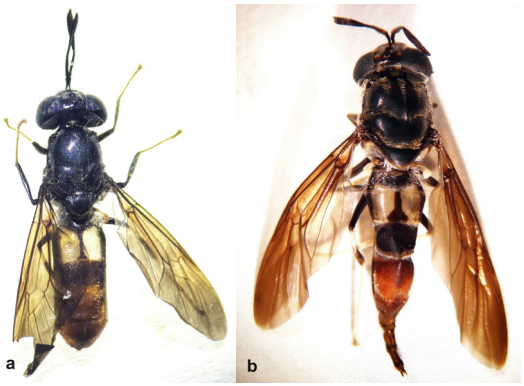

Figure 2. *Hermetia illucens* dorsal view; a) male, b) female.

Figure 3. Larvae of the black soldier fly, *Hermetia illucens*; in manure in Douar Kitane environment.

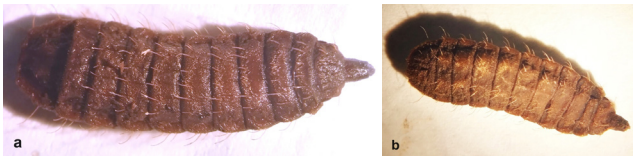

Figure 4. Larvae of the black soldier fly, *Hermetia illucens*; a) dorsal view, b) ventral view

Subfamily Sarginae

Genus *Chloromyia* Duncan, 1837

***Chloromyia formosa* (Scopoli, 1763)**

= *Musca formosa* Scopoli, 1763

Material examined: Rif: Tétouan, Douar Kitane, 6♂5♀, 5.3.2017-24.4.2017, reared; Chefchaouen, Tougharine: Oued Siflaou (Fig. 5a), 1♀, 9.5.2017, sweep net; Tétouan, Beni Said: Aazafa 4♂, 1♀ (Fig. 5b), 20.5.2018, sweep net. New localities for Morocco.

World distribution: Species of Holarctic distribution encompassing Europe, Asia and North America. It stretches from central Scandinavia to northern Africa and eastwards to eastern Siberia. Almost all local lists of European Stratiomyidae include it. In North Africa it is known from all three Maghreb countries: Algeria, Tunisia and Morocco.

Moroccan distribution: In recent years it was found in 5 localities, distributed in the provinces of Tétouan and Chefchaouen in a considerable large altitudinal interval ranging from 52 m to 828 m a.s.l.

Biology: Larvae have been found in garden soil, compost, heaps of rotting grass, under stones and often in manure (Laurence, 1953; Brindle, 1965; Stubbs & Drake, 2014) and hibernation takes place in the larval stage. Adults are present in low grasslands, on the leaves of shrubs and in similar situations, usually in sunny places (Chandler, 1975). In the Alps the species is known up to 2270 m a.s.l. (Bezzi, 1918; Keiser, 1947). The flight period is mainly from April to August.

In Morocco, *Chloromyia formosa* is found in a wide range of habitats. Males and females were trapped in our Malaise trap, already in March so it was collected earlier than cited in the literature. In our study area, *Chloromyia formosa* has been found both in forest habitats and open spaces where it colonizes both humid environments of lotic character, rivers and streams, as well as lentic environments and marshy lands.

As mentioned in the literature (Rozkošný, 1982), adults were also collected feeding on flowers, for example *Euphorbia helioscopia* (Fig. 6).

Figures 5. Moroccan habitat of *Chloromyia formosa*; a) Oued Siflaou, b) Oued Aazafa.


Figure 6. Moroccan habitat of *Chloromyia formosa* (Scopoli, 1763); Douar Kitane.

Subfamily Stratiomyinae

Tribe Oxycerini Enderlein, 1914

Genus *Oxycera* Meigen, 1803

Oxycera analis Wiedemann in Meigen, 1822

Material examined: Middle Atlas: Ifrane, Cascade Aïn Vittel (Fig. 7a), 2♂, 17.2.2016-21.4.2016, reared; Mchacha Aïn Vittel (Fig. 7b), 1♂, 17.2.2016-22.4.2016, reared. First record for North Africa.

World distribution: A relatively rare Palaearctic species, distributed in Europe, Turkey and eastern Transcaucasia (Woodley, 2001) and North Africa (present work).

Moroccan distribution: The authors collected *O. analis* in the Middle Atlas, in the province of Ifran at 1585 m a.s.l., the first record for North Africa. This discovery greatly expands the range of the species and this is now the southernmost record for the species.

Biology: Adults generally are caught around ponds, as well as in marshes along streams and rivers. In the French Alps larvae were found at altitudes of 300 m to 1950 m a.s.l. in hygropetric situations (Vaillant, 1951). The reported flight period was June 1 to July 17.

In Morocco, during our surveys we found larvae on mosses and other plants that line the limestone-rich surroundings of the Aïn Vittel waterfall and the stream Mchacha Aïn Vittel nearby, a region of a very humid climate. In the laboratory we succeeded in rearing three males from larvae that were buried in Mossy substrate collected at these sites.

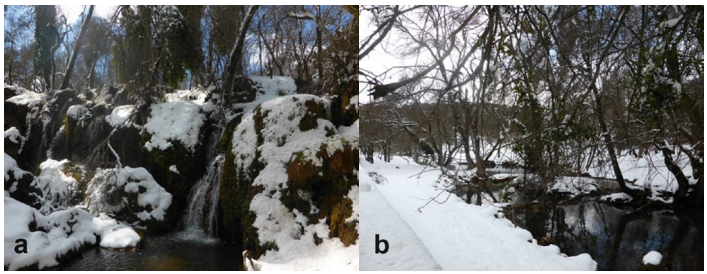

Figure 7. Habitat of *Oxycera pardalina* (Meigen, 1822) and *Oxycera analis* Wiedemann in Meigen, 1822 in Morocco: a) Cascade Aïn Vittel; b) Mchacha Aïn Vittel.

Oxycera flava (Lindner, 1938)

= *Heraclina flava* Lindner, 1938

Material examined: Rif: Chefchaouen, Stehate, Douar El Kannar (Fig. 8), 1♂, 1♀ (Figs. 9-11), 24.4.2015, sweep net. New record for North Africa, with the male described for the first time.

Comment: New record for North Africa. So far, only the female of *O. flava* was described (from Andalusia, Spain) and there were no published records of the male of this species. We now describe it here, based on material collected in the Rif Mountains.

Female (Fig. 10): Head completely yellow, but only a dot slightly ocellar triangle is black, and below the middle of the forehead is black (see Rozkosny, 1982). The antenna is the same in both sexes. Abdominal pattern with broadly yellow lateral edges extends from the lateral edges of tergum 1 to the last tergum. The female mesonotum with narrow transversal mesonotal stripes that are connected to one another in front of the transverse suture and fused anteriorly; the yellow pattern is absent in male. Notopleura with widely yellow bands in both sexes. Legs and wings are the same in both sexes.

Male (Fig. 11a-c): Body length: 6 mm, wing 5.0 mm.

Head (Fig. 9a) slightly broader than thorax in dorsal view. Vertex black. Ocellar tubercle and ocelli brown, eyes contiguous, brown. Occiput black, only vertex with yellow spot behind ocellar tubercle. Eyes with sparse, short brown hairs. Frons black. Face yellow, with broad silvery white bands along the eye margins. Postocular area slightly swollen in lower half, densely silvery-white pubescence, the pubescence extending to the lower corner of the eye and joining with broad silvery white bands along the eye margins on face. Antenna about half as long as head; scape and pedicel yellow, flagellum light brown, the last flagellomere is slender, dark and slightly longer than the remainder of the antennae. Proboscis yellow.

Thorax (Fig. 11b, c) black. Scutellum and scutellar spines yellow, length of scutellar spines about two-thirds the length of the scutellum. Postpronotal lobes yellow. Notopleura is broadly yellow from postpronotal lobe to the postalar callus. Subnotopleural stripes very broad and extending to the anepimeron, the upper margin of katepisternum and the upper margin of the meron. Legs yellow, but the fore tibia with a dark stripe on the dorsal surface and fore tarsi completely black; hind tibiae yellow with broad dark brown median ring; last three tarsal segments of mid and hind legs brown. Wing hyaline, R4 absent. Halters light yellow.

Abdomen (Fig. 11b, c) black with a broad undulating yellow margin Similar to that of female but not extending on to segments 1-2. Venter mainly yellow but sternites with brownish lateral patches at anterior margins.

Terminalia (Fig. 9a-d, 11b, c,) exposed, proctiger subtriangular, cerci elongate-oval, about 2-2.5 times as long as broad at middle; the epandrium is nearly equivalent in size to the proctiger at its midpoint. Genital capsule subquadrate, Median process of the synsternum separated with V-shaped indentation in the middle, which is not very deep. Gonostylus, the lower part of which is dilated, curves inward from the middle and gradually becomes thinner, ending in a pointed tip. The phallic complex is moderately short and broad, with parameres are separated and almost equal in length.

In males, distinguishing features between *Oxycera stigmosa* and *Oxycera flava* include the coloration of the flagellum and face. In *Oxycera stigmosa*, the flagellum of the antenna is black, whereas in *Oxycera flava*, it tends to be a lighter brown shade. Additionally, the face of *Oxycera stigmosa* is black, contrasting with the yellow face of *Oxycera flava*. Another distinguishing characteristic is observed in the spines of the scutellum: in *Oxycera stigmosa*, the spines are longer compared to the length of the scutellum, whereas in *Oxycera flava*, these spines are slightly shorter relative to the scutellum.

World distribution: This is only the third record of the species that until now was only known from Spain and France (Woodley, 2001) and recently from Corsica (Lebard & Hauser 2023). Consequently, this is also the first record for Morocco and thus North Africa. In the Rif it was collected in only one province (Chefchaouen), at an altitude of 37 m a.s.l.

Biology. The female *O. flava*, previously unknown, was collected along the El Kannar River (Fig. 8) in Morocco. This discovery offers the initial insights into the species' biology. The insect was found in the wet margins of the river's middle course, characterized by sand, pebbles, and moss-covered boulders. Adult activity appears limited to late April.

Figure 8. Moroccan habitat of *Oxycera flava* (Lindner, 1938): Oued El Kannar.

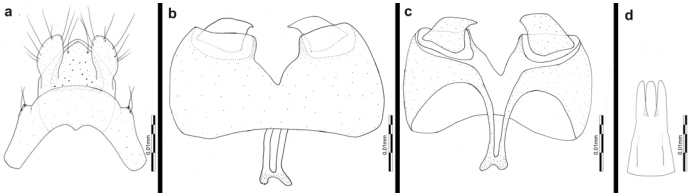

Figure 9. *Oxycera flava*, male genitalia. a) Epandrium, dorsal view; b) Synsternum, dorsal view; c) Synsternum,ventral view; d) Phallic complex. Scala bar: 0.01 mm.

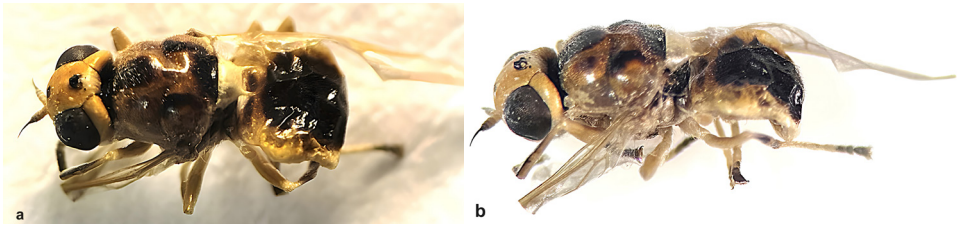

Figure 10. *Oxycera flava,* female: a) dorsal view; b) lateral view.

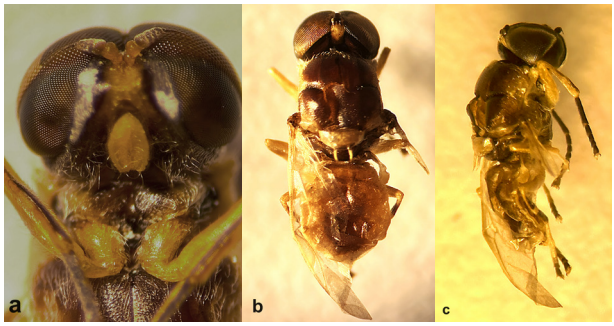

Figure 11. *Oxycera flava*, male a) ventral view of head; b) dorsal view; c) lateral view.

Oxycera marginata Loew, 1859

Material examined: Middle Atlas: Ifrane, Cascade Aïn Vittel (Fig. 7a), 2♀, 17.2.2016-20.4.2016, reared; Mchacha Aïn Vittel (Fig. 7b), 1♀, 17.2.2016-21.4.2016, reared. First record for North Africa.

World distribution: This species was only known from Europe, having a Western Mediterranean distribution (Iberian Peninsula and southern Italy, including Sicily) and recently from Corsica (Lebard & Hauser 2023). The species is recorded for the first time for the fauna of North Africa.

Moroccan distribution: *Oxycera marginata* was now collected at two localities in Ifrane (Middle Atlas).

Biology: So far the biology was unknown except that it was a species active in early summer with collecting dates ranging from the beginning of June to 27 July (Rozkošný, 1983).

In Morocco, we have collected substrate particularly rich in mosses and other plants from the torrential habitat of the waterfall of Aïn Vittel and that of the streams that flow from it (Mchacha Aïn Vittel). This substrate contained several larvae and we successfully reared this species in the laboratory, according to the protocol described in Materials and Methods section of the 2021 thesis of the first author (Yimlahi, 2021).

These aquatic ecosystems of high altitudes (higher than 1500 m a.s.l.), seem to be the preferred habitat of *O. marginata* but also of *O. analis*, since the preimaginal stages of the two species coexist perfectly.

Oxycera morrisii (Curtis, 1833)

Material examined: Middle Atlas: Ifrane, Cascade Aïn Vittel, 2♂, 17.2.2016-20.4.2016, reared; Mchacha Aïn Vittel, 1♂, 1♀, 17.2.2016-21.4.2016, reared; Aïn Arougo (Fig. 12), 1♀, 14.7.2016, sweep net. Recorded from Morocco for the first time.

World distribution: A western Palaearctic species, known from Europe, Algeria, Turkey and Israel.

Moroccan distribution*:* It is here recorded from Morocco for the first time. It was collected in two provinces in the Middle Atlas, Khénifra and Ifrane, at altitudes of 118 m and 1500-1585 m a.s.l., respectively.

Biology: Haliday (1857) found the larva among algae covering a dam of a watermill outlet that was continuously moistened by running water, and adults were found near places of larval development. Bertrand (1949) found the larvae among the wet moss in hygropetric situations, along with some other hygropetric larvae of Ceratopogonidae and Psychodinae. His collected material suggested a flight period between June 6 and July 25 but in the United Kingdom it was also found in August (Stubbs & Drake, 2014).

In Morocco, during our research an adult female was collected by sweeping herbaceous vegetation and rushes near a stream of Aïn Arougo, that also features the species larval habitat. The remainder of the material was obtained by rearing in the laboratory, at room temperature, from larvae living in the substrate of the Aïn Vittel waterfall (Fig. 7a) and that of Mchacha Aïn Vittel (Fig. 7b). It took a little over two months for the adults to hatch, from 17 February, the date of collection, until 20 April. As in the literature, the preimaginal stages of *O. morrisii* prefer slowly running water that is rich in algae and mosses.

Figure 12. Habitat of *Oxycera morrisii* in Morocco: Aïn Arougo.

Oxycera pardalina (Meigen, 1822)

Material examined: Rif: Chefchaouen, Stehate, Oued El Kannar, 1♀, 15.8.2016, sweep net. New localities for Morocco.

World distribution: Species with European-Mediterranean distribution that extends east to the Caucasus and west to Morocco (Oued El Kannar) (New site).

Moroccan distribution: Our earlier samples from the Rif, from the provinces of Tétouan and Chefchaouen, and from the Middle Atlas (Ifrane), were the very first

citations of the species from North Africa (Yimlahi et al, 2017). In Morocco, *Oxycera pardalina* exploits altitudes ranging between 37 m and 1585 m a.s.l.

Biology: According to Rozkošný (1983) the larvae prefer calcareous waters and usually are met in hygropetric conditions on wet stones and rocks and in wet moss in and near springs and streams. Vaillant (1951) found larvae in various sites from 200 to 2500 m a.s.l. in the Alps. Adults were collected on *Heracleum sphondylium* and *Saxifraga aizoides* (Keiser, 1947). The flight period runs from May to August (Rozkošný, 1983; Stubbs & Drake, 2014).

In our study area, that of previous (Yimlahi et al, 2017) and current studies, this species is found in a wide range of habitats, but always in environments with aquatic ecosystems of running water, from very fast running (waterfalls and upper wadis) to slow (lower rivers and streams). The substrates hosting the preimaginal stages of *O. pardalina* were amassed in beds, mostly dominated by rocks and pebbles, and rich in mosses and algae.

During our sampling we located this species in two geographical regions, the Rif (5 sites in 2 provinces) and the Middle Atlas (2 sites in the province of Ifrane), in a wide altitudinal interval, ranging from 50 m to 1674 m a.s.l. (Yimlahi et al, 2017). In the northern Moroccan region, the species also seems to frequent high-altitude forest habitats, where it was collected near a spring stream that crosses the Talassemtane fir forest characterized by the presence of boulders lined with mosses, pebbles, sand and silt in places.

When we reared material in the laboratory, the emergence of adults took 40-60 days. Adult emergence from material collected on February 17 in the Middle Atlas, was earlier and continued to April 20. In the Rif, on the other hand, for rearing experiments that began later, in April and May, the emergences were from the first fortnight of June onwards. The flight period in Morocco runs from the end of April to August, a wider range than reported in literature (see above), both starting earlier and ending later.

Oxycera trilineata (Linnaeus, 1767)

= *Hermione bucheti* Séguy, 1930

Material examined: Rif: Tanger-Assilah, Aïn Jdioui Daya, Aïn Jdioui, 1♂, 28.3.2019-18.5.2019, reared, 1♂, 28.3.2019-20.5.2019, reared. New localities for Morocco.

World distribution: The commonest species of the genus and known to be present throughout the Palaearctic region, from Western Europe (Mason et al, 2009), and Northern Africa to Central Asia (Hauser, 2014) and China. In Northern Africa, the species is known from Algeria, Morocco.

Morocco distribution: Tangier (Séguy, 1930), and new site Daya Aïn Jdioui (Yimlahi et al, 2017).

The new records, we collected larvae in the Rif at one site in Tangier-Assilah, at an altitude of 5 m a.s.l.

Biology: Larvae are found in a wide range of wet habitats, including banks of streams, pools, ponds, marshes, fens, seepages and springs (Rozkošný, 1983; Stubbs & Drake, 2014). In Algeria larvae were found in mud and among calcium carbonate

deposits on wet rocks up to 1200 m a.s.l. (Vaillant, 1952). Adults are usually mostly found near the larval habitat from early June to early September (Stubbs & Drake, 2014).

We ourselves spotted it on a small saline daya (depression of ground filled by overflow water from river), eutrophicated, invaded by duckweed and fed by a stream near the Atlantic coast, but at a very low altitude. We successfully reared the species in the laboratory. The collected substrate, brought back for this purpose, was loamy, rich in macrophytes and had been taken from the edges of a bog and a daya.

Tribe Stratiomyini Latreille, 1802

Genus *Odontomyia* Meigen, 1803

***Odontomyia limbata* (Wiedemann, 1822)**

= *Stratiomys limbata* Wiedemann *in* Meigen, 1822

Material examined: Rif: Chefchaouen, Parc National Talassemtane, Aïn El Malâab, 1♂, 2♀, 17.5.2014, 1♂, 4.7.2020. New localities for Morocco.

World distribution: Species of Western Mediterranean distribution. In North Africa, the species is known from three western Maghreb countries along the Mediterranean.

Moroccan distribution: it had been recorded from Tangier and the Middle Atlas (Becker & Stein, 1913; Séguy, 1930; Dušek & Rozkošný, 1962).

Presently, we can add seven sites for *Odontomyia limbata* (Yimlahi et al, 2017), considerably expanding its range in two provinces in the Rif (Chefchaouen and Larache), in a wide altitudinal range from 600 m to 1278 m a.s.l.

Biology: Until now, the specifics of the biology of *Odontomyia limbata* are unknown.

In Morocco, *O. limbata* is associated with aquatic environments of the lentic type. It was collected near peat bogs, ponds. We also collected it near lotic habitats (streams).

In the majority of these sites silt with sparse gravel, cobbles and some boulders was the dominant substrate. These sites were located between pine forests, oak forests and meadows.

The species was captured near a spring stream running over a limestone substrate through *Abies marocana* fir forest, the banks and coarse substrate of which were lined with moss in places.

Genus *Stratiomys* Geoffroy, 1762

***Stratiomys longicornis* (Scopoli, 1763)**

= *Hirtea longicornis* Scopoli, 1763

Material examined: Rif: Chefchaouen, Parc National Talassemtane: Aïn El Malâab 1♂, 17.5.2014, sweep net; Rabat-Salé-Kénitra Region: Douar Ouled Ammar (Fig. 13), 1♂, 10.6.2017, sweep net; Tétouan, Golf Cabo Negro, 1♀, 15.5.2020, hand hunting. New localities for Morocco.

World distribution: *S. longicornis* is widely distributed in the Palaearctic region, including Europe, Transcaucasia, North Africa, Central Asia, Mongolia and Russia. In North Africa, the species is known from Algeria, Tunisia, Egypt, Morocco (Badrawy, 2006).

Moroccan distribution: Séguy (1930) recorded the species from Casablanca. New records it was now netted in three localities (Chefchaouen: Aïn El Malâab, Cabo Negro and Sidi Kacem: Douar Ouled Ammar) at 1278 and 14 m a.s.l., respectively.

Biology: The larvae develop among aquatic vegetation in stagnant water in saline habitats, like ponds near the coast, salt marshes and saline inland habitats, while they can hibernate in wet earth (Rozkošný, 1982). Adults can be found on vegetation and flower-visiting near larval habitat. They were recorded from flowers of *Crataegus*, *Chaerophyllum*, *Artemisia*, *Evonymus*, *Ferulago* and *Petasites* (Schiner, 1855; Speiser, 1910; Szilády, 1932; Lindner, 1938; Weinberg, 1972). Foremost it appears to be a lowland species preferring highly saline habitats, active from mid-May to late August.

In Morocco, our findings on the biology of *S. longicornis* mostly corroborate data in the literature, although we did not capture them after June. The males were swept from herbaceous plants near stagnant water at low altitudes, for example at the Oued Sebou, Douar Ouled Ammar (Fig. 13). The female was hand-caught, early in the morning, whereas it was found resting on a motorcycle near a small lake in Cabo Negro.

Figure 13. Habitat of *Stratiomys longicornis* (Scopoli, 1763) in Morocco: Douar Ouled Ammar.

Subfamily Nemotelinae

Genus *Nemotelus* Geoffroy, 1762

Nemotelus cingulatus Dufour, 1852

= *Nemotelus consimilis* Becker, 1915

Material examined: Rif: Larache, Jbel Bouhachem, Oued Tkaraâ, 1♂, 1♀, 22.5.2017, sweep net; Aïn Haouzi, 1♀, 9.5.2017, sweep net. New localities for Morocco.

World distribution: A species of the Western Mediterranean, *N. cingulatus* is known to be present in Spain, southern France and North Africa.

In North Africa, it known from Tunisia (type locality Korbons [=Qurbus]; Becker, 1915), Algeria (Lindner, 1931), Morocco.

Moroccan distribution: (Rozkošný, 1983; Yimlahi et al, 2017), and new localities (Oued Tkaraâ and Aïn Haouzi) in the present work.

If we combine our previous (Yimlahi et al, 2017), and the current studies research we collected *N. cingulatus* again, at four sites ranging from 124 m to 959 m a.s.l.

Biology: Rozkošný (1983) recorded the flight period as April 26 to May 17 with adults being captured up to an altitude of 1000 m a.s.l. in Spain.

In Morocco, during our research we found the species flying a bit later (22 May) and in both lentic and lotic aquatic habitats. It was collected near peat bogs and ponds of the Daya Afrate. We also collected it in the upper reaches of Oued Tkaraâ in Jbel Bouhachem, running through an oak forest, and around Oued El Koub. These last two sites are characterized by the presence of boulders lined with moss, sand, pebbles and silt in places.

Nemotelus longirostris (Wiedemann, 1824)

Material examined: Rif: Chefchaouen, Tougharine, Oued Siflaou, 1♀, 9.5.2017, sweep net; Douar Kouf, 1♂, 1♀ (Fig. 14), 19.5.2019, sweep net. New localities for Morocco.

World distribution: Western Mediterranean species, known in Europe only from France and Spain, and in North Africa, from the three Maghreb countries: Algeria (Lindner 1931), Tunisia (Becker 1906) and Morocco.

Moroccan distribution: In our country, *N. longirostris* was mentioned in the Rif in Tangier (Wiedemann, 1824; Becker & Stein, 1913; Séguy, 1930), Fès (Lindner, 1931), and new localities (Oued Siflaou and Douar Kouf) in the present work.

We can now confirm the presence of *N. longirostris* in the Rif, but also in the province of Chefchaouen (a female in Tougharine) and in the province of M'diq-Fnideq (a male and a second female in Douar Kouf), at altitudes of 8 m and 480 m a.s.l., respectively.

Biology: There is no information on the biology of this species. It was only collected in May (Rozkošný, 1983; present data).

In Morocco, the adults were collected in environments, rich in vegetation with plants like *Anacyclus clavatus*, *Anacyclea radiatus*, *Pulicaria odora*, *Andryala integrifolia*, *Ficus carica*, *Olea europaea*, *Lavandula stochae* and *Dittrichia viscose*.

Figure 14. Moroccan habitat of *Nemotelus longirostris* (Wiedemann, 1824): Douar Kouf.

***Nemotelus nigrifrons* Loew, 1846**

= *Nemotelus tomentosus* Becker, 1906

Material examined: Rif: M'diq-Fnideq, Restinga, Marabout Sidi Bouhadjel 19.5.2019 (Fig. 15), 17♂6♀, sweep net. New locality for Morocco.

World Distribution: Widely spread in the Mediterranean, known from Europe (Italy) and North Africa: Algeria (Becker, 1906), Tunisia (Lindner, 1936-1938), Libya (Rozkošný, 1983).

Moroccan distribution: Morocco (Becker, 1906; Yimlahi et al, 2017), and new locality (Marabout Sidi Bouhadjel) in the present work.

Biology: There is no information on the biology of this species. It was collected between the end of April and 3 August (Rozkošný, 1983).

In Morocco, the species was encountered near aquatic environments of a lentic nature; most specimens were caught on vegetation growing around marshes with mud rich in organic matter and with dominance of *Typha* and rushes at the Marabout Sidi Bouhadjel (Fig. 15). However, specimens of this species have also been found in the vicinity of running waters (in lotic ecosystems).

Figure 15. Moroccan habitat of *Nemotelus nigrifrons* Loew, 1846: Marabout Sidi Bouhadjel.

DISCUSSION

Our study presents an extensive examination of Stratiomyidae specimens collected from various regions of Morocco between 2014 and 2020. The findings significantly contribute to the understanding of the distribution, biodiversity and Biology of these insects in Morocco.

The new findings given in this study enrich the number of Stratiomyidae with six species, raising this number to 46 species of soldier flies known from Morocco.

In a previous study (Yimlahi et al, 2017) a checklist of soldier flies species recorded from the North African countries (Morocco, Algeria, Tunisia, Libya and Egypt) was presented, based on both literature records and material newly collected at that time in Morocco. Four subfamilies (Stratiomyinae, Sarginae, Nemotelinae, and Pachygasterinae), and twelve species from five genera were collected and recognized in Morocco. Six species: *Pachygaster atra* (Panzer, 1798), *Oxycera pardalina* (Meigen,

1822), *Nemotelus danielssoni* (Mason, 1989), *Oxycera terminata* (Meigen, 1822), *Nemotelus atriceps* (Loew, 1856) and *N. maculiventris* (Bigot, 1861) were reported for the first time in Morocco of which no less than four species (*P. atra*, *O. pardalina*, *O. terminata* and *N. danielssoni*) were new records for North Africa. The number of soldier flies known from Morocco was 40.

New data about Moroccan soldier flies (Stratiomyidae) are presented in the present study that discusses 15 species. Six species are recorded as new to the fauna of Morocco, four of which, *Oxycera analis* Wiedemann in Meigen, 1822, *O. flava* (Lindner, 1938), *O. marginata* Loew, 18959, and *Chorisops tibialis* (Meigen, 1820) are new records for North Africa. *Oxycera morrisii* (Curtis, 1833) is recorded for the first time in Morocco. *Hermetia illucens* (Linnaeus, 1758) was recently reported based on a personal communication without details but is now also formally added. It therefore now adds a new subfamily to the Moroccan fauna, the Hermetiinae. Notes on taxonomy, distribution and biology of the species are added. The male of *O. flava* is described and illustrated.

It is also important to note that in the previous study mentioned (Yimlahi et al, 2017), several species (*Pachygaster atra*, *Chloromyia formosa*, *Oxycera pardalina*, *Nemotelus cingulatus* and *Odontomyia limbata*) were referenced but without having studied their biology. In the present work, we provide detailed information about the biology of these species. Moreover, to enrich the content of this article, we have referenced both the previous collection sites and the current ones, providing a broader context for our discussion.

The inclusion of these new records enhances our understanding of the biogeography of Stratiomyidae in the Mediterranean region. The presence of species with Euro-Mediterranean distributions, such as *Chorisops tibialis* and *Chloromyia formosa*, highlights the biogeographical connections between North Africa and Europe.

The observed seasonal activity patterns of Stratiomyidae species in Morocco reveal minor variations compared to their counterparts in Europe. For example, the flight periods of certain species, such as *Chloromyia formosa* and *Oxycera pardalina*, appear to be influenced by climatic conditions, with activity extending into later months than reported in European populations.

The observed differences in the seasonal activity of *Chorisops tibialis* between Europe and Morocco raise intriguing questions about the factors driving these variations. One plausible explanation is the dissimilarity in climatic conditions between the two regions. Morocco's warmer climate, especially in late autumn, could provide favorable conditions for extended activity periods compared to the cooler European environment. Additionally, ecological factors such as host availability and habitat suitability might also play a role in shaping the seasonal behavior of *Chorisops tibialis* in different regions. This divergence in seasonal activity prompts an investigation into the potential influence of climatic variations between European and Moroccan environments.

The comprehensive faunistic records presented in this study significantly contribute to our knowledge of Stratiomyidae diversity and distribution in Morocco. The findings provide valuable baseline data for future research on the ecology, biogeography, and conservation of these important insects in North Africa.

CONCLUSION

Accounts of distribution and biology of 15 species of the Stratiomyidae of the Moroccan fauna are presented. *Chorisops tibialis, Oxycera analis, O. flava* and *O. marginata* are not only recorded from Morocco for the first time, but also from North Africa. *Oxycera morrisii* and *Hermetia illucens* are reported for the first time in Morocco. As a result of this work, the present number of soldier flies known from Morocco has been raised to 46. In general, the data we could obtain on the biology of species in Morocco is very similar to the known biological information from Europe except for some longer flight periods that might be the result of different climatological conditions in Morocco.

ACKNOWLEDGMENTS

We would like to thank Dr Younes El Harym (LESCB URL-CNRST N°18, FS, Abdelmalek Essaadi University, Tétouan, Morocco), for sharing with us the photo of *Chloromyia formosa* in its Moroccan habitat.

REFERENCES

Afzan H. & Belqat B. 2016. Faunistic and bibliographical inventory of the Psychodinae moth-flies of North Africa (Diptera, Psychodidae). *ZooKeys,* 558, 119-145. http://doi.org/10.3897/ zookeys.558.6593.

Badrawy, H.B.M. (2006). Taxonomic studies including numerical taxonomy of family: Stratiomyidae (Diptera: Brachycera) from Egypt, Thesis submitted in Partial Fulfilment of the Requirements for the Degree of M.Sc. in Entomology Science (Taxonomy), Department of Entomology, Faculty of Science, Ain Shams University, 252-254.

Becker, T. (1906). Die Ergebnisse meiner dipterologischen Frühjahrsreise nach Algier und Tunis. *Zeitschrift für systematische Hymenopterologie und Dipterologie*, 6(1), 1-16.

Becker, T. (1915). Dipteren aus Tunis in der Sammlung der Ungarischen National-Museums. *Annales Musei Nationalis Hungarici*, 13, 301-330.

Becker, T. & Stein, P. (1913). Dipteren aus Marokko. *Annuaire du Musée zoologique de l'Académie impériale des Sciences de St.-Pétersbourg,* 18, 62-95.

Bertrand, H. (1949). Note sur la capture aux environs de Paris de la larve de l'*Hermione morrisi* Meig. (Dipt. Stratiomyidae). *Bulletin de la Société Entomologique de France*, 54, 76-79.

Bezzi, M. (1918). Studi sulla ditterofauna nivale delle Alpi italiene. *Memorie della Società italiana di scienze naturali e del Museo civico di storia naturale di Milano*, 9, 1-164.

Brindle, A. (1965). Taxonomic notes on the larvae of British Diptera. - No. 23. The Geosarginae (Stratiomyidae). *Entomologist*, 98, 208-216.

Callan, E.M. (1974). *Hermetia illucens* L. (Dipt. Stratiomyidae), a cosmopolitan American species long established in Australia and New Zealand. *Entomologist's Monthly Magazine,* 109(1313-1315), 232-234

Chandler, P.J. (1975). An account of the Irish species of two winged flies (Diptera) belonging to the families of larger Brachycera (Tabanoidea and Asiloidea). *Proceedings of the Royal Irish Academy (B)*, 75, 81-110.

Demetriou, J., Kalaentzis, K., Kazilas, C., Kunz, G., Muller, B., Mostovski, M.B., & Koutsoukos, E. (2022). An "alien" species on the loose: new records and updated distribution of the black soldier fly *Hermetia illucens* in the Western Palearctic. *Bulletin of Insectology*, 75(1), 125-130.

Dušek, J. & Rozkošný, R. (1962). Revision mitteleuropaischer Arten der Familie Stratiomyidae (Diptera) mit besonderer Berücksichtigung der Fauna der CSSR III. *Acta Entomologica Bohemoslovaca*, 62, 24-60.

Dušek, J. & Rozkošný, R. 1975. Revision mitteleuropäischer Arten der Familie Stratiomyidae (Diptera) mit besonderer Berücksichtigung der Fauna der CSSR. VI. Unterfamilie Pachygasterinae. *Acta entomologica bohemoslovaca,* 72(4), 259-271.

Haliday, A.H. (1857). On some remaining blanks in the natural history of the native Diptera. Additional note on the metamorphosis of some species of Diptera, hitherto undescribed, or unknown but imperfectly. *Natural History Review*, 4, 177-196, pl.1.

Handlirsch, A (1883). Beitrage zur Biologie der Dipteren. Verhandlungen der Zoologisch-Botanischen Gesellschaft in Wien, 33, 243-246.

Hauser, M. (2014). Order Diptera, family Stratiomyidae. Further records and the description of a new species. *Arthropod Fauna of the United Arab Emirates,* 5, 695-703.

Heeger, E. (1853). Beitrage zur Naturgeschichte der Insecten. *Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften. Mathematisch-naturwissenschaftliche Classe*, 10, 161-178.

Keiser, F. (1947). Die Fliegen des Schweizerischen Nationalparks und seiner Umgebung. Pars I: Brachycera Orthorhapha. *Ergebnisse der wissenschaftlichen Untersuchungen des Schweizerischen Nationalparks (Neue Folge)*, 2(18), 1-198, 4 pls.

Kettani, K. & Woodley, N. (2022). Stratiomyidae. Pp. 162-165 in: Kettani, K., et al. Catalogue of the Diptera (Insecta) of Morocco - an annotated checklist, with distributions and a bibliography. *ZooKeys*, 1094, 1-466.

Koutsoukos, E. & Kazilas, C. (2021). Addressing distributional shortcomings through citizen science records: the presence of *Hermetia illucens* (L. 1758) (Diptera Stratiomyidae) in Algeria. *Redia*, 104, 69-73.

Laurence, B.R. (1953). Some Diptera bred from cow dung. Entomologist's Monthly Magazine, 89, 281-283.

Lebard, T., Haenni, J., & Martinez, M. (2020). Note sur la présence de Chorisops tunisiae (Becker, 1915) en France et de *Chorisops masoni* Troaino & Toscano, 1995 en France et en Espagne (Diptera, Stratiomyidae). *Revue Française d'Entomologie Générale,* 2(5-6), 94-106.

Lebard, T. & Hauser, M. (2023). Liste des Stratiomyidae de Corse avec une espèce nouvelle pour la faune de France (Diptera). *Revue Française d'Entomologie Générale,* 5(2), 19-28.

Lindner, E. (1931). Einige von Dr. Erich Schmidt und Prof. Dr. Franz Werner in Algerien und Marokko gesammelte Dipteren (Stratiomyidae, Rhagionidae, Nemestrinidae). *Sitzungsberichte der Gesellschaft Naturforschender Freunde zu Berlin*, 1931, 203-206.

Lindner, E. (1936-1938). *Die Fliegen der palaearktischen Region. Band IV. Stratiomyiidae.* E. Schweizerbart'sche Verlagsbuchhandlung (Erwin Nagele), Stuttgart, 1-218.

Lindner, E. (1938). *Lasiopa krkensis*, spec. nov. (Dipt., Stratiomyiidae). *Konowia,* 17(1), 5-7.

Mason, F. (2013). Updated Italian checklist of soldier flies (Diptera, Stratiomyidae). *ZooKeys,* 336, 61-78.

Mason, F., Rozkošný, R., & Hauser M. (2009). A review of the soldier flies (Diptera: Stratiomyidae) of Sardinia. *Zootaxa*, 2318, 507-530.

McFadden, M.W. (1967). Soldier fly larvae in America north of Mexico. *Proceedings of the United States National Museum*, 121, 1-72.

Piet, D. (1950). Massavlucht van *Pachygaster atra* Panz. (Dipt. Stratiomyidae). *Entomologische Berichten, Amsterdam,* 13(303), 141.

Rozkošný, R. (1982). *A biosystematic study of the European Stratiomyidae (Diptera)*. Vol 1. W. Junk, The Hague, Boston, London, 401 pp.

Rozkošný, R. (1983). *A biosystematic study of the European Stratiomyidae (Diptera)*. Vol. 2. W. Junk, The Hague, Boston, London, 431 pp.

Schiner, I.R. (1855). Diptera Austriaca. II. Die österreichischen Stratiomyden und Xylophagiden. *Verhandlungen der Zoologisch-Botanischen Gesellschaft in Wien*, 5, 613 682.

Séguy, E. (1930). Contribution à l'étude des Diptères du Maroc. *Mémoires de la Société des Sciences Naturelles du Maroc,* 24, 5-206.

Speiser, P. (1910). Blütenbesucher auf *Petasites spurius*. *Zeitschrift für wissenschaftliche Insektenbiologie*, 6, 25.

Stubbs, A.E. & Drake M. (2014). *British soldierflies and their allies*. Second edition. British Entomological and Natural History Society, Reading, 528 pp.

Szilády, Z. (1932). Dornfliegen oder Notacantha. *Die Tierwelt Deutschlands*, 26, 1-39.

Vaillant, F. (1951). Les larves d'*Hermione*. *Travaux du Laboratoire d'Hydrobiologie et de Pisciculture de l'Université de Grenoble*, 1951, 23-28.

Vaillant, F. (1952). Les larves d'*Hermione* d'Algérie(Diptères Stratiomyiidae). *Bulletin de la Société d'Histoire Naturelle de l'Afrique du Nord*, 43, 8-15.

Verrall, G.H. (1909). Stratiomyiidae and succeeding families of the Diptera Brachycera of Great Britain. *British Flies,* 5, 1-790.

Weinberg, M. (1972). Ord. Diptera (Brachycera): Stratiomyidae, Tabanidae, Asilidae, Therevidae, Conopidae et Sciomyzidae): L'entomofaune du 'grind' de Caraorman, delta du Danube. *Travaux du Museum d'Histoire Naturelle Grïgore Antipa'*, 12, 207-215.

Wiedemann, C.R.G. (1824). *Munus rectoris in Academia Christiana Albertina aditurus Analecta entomologica ex Museo Regio Havniensi maxime congesta profert iconibusque illustrat.*. Kiliae [= Kiel], 60 pp.

Woodley, N.E. (2001). *A world catalog of the Stratiomyidae (Insecta: Diptera)*. Backhuys Publishers. Leiden, 473 pp.

Yimlahi, D., Üstüner, T., Zinebi, S., & Belqat, B. (2017). New records of the soldier flies of Morocco with a bibliographical inventory of the North African fauna (Diptera, Stratiomyidae). *ZooKeys,* 709, 87-125.

Yimlahi, D. (2021). Les Diptères Stratiomyidae du Maroc (Insecta: Diptera): Taxonomie, Biodiversité, Atlas de répartition et Intérêts. Thèse Nationale. Université Abdelmalek Essaadi, Faculté des Sciences, Tétouan, 39-422 pp.