

**UPDATED DISTRIBUTION OF *MILESIA CRABRONIFORMIS*
(FABRICIUS, 1775) AND *M. SEMILUCTIFERA* (VILLERS, 1789)
(DIPTERA: SYRPHIDAE: ERISTALINAE) IN BOSNIA AND
HERZEGOVINA, CROATIA AND SERBIA**

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Abstract – The members of the genus *Milesia* are large, wasp-mimic, saproxylic hoverflies. In Europe, only two species occur: *Milesia crabroniformis* and *M. semiluctifera*, but their distribution is still not sufficiently known, especially in eastern Europe. In the Balkans, Serbia is the country with the best-studied hoverfly fauna, while most of the other countries have significantly less studied fauna, including also Croatia and Bosnia and Herzegovina. This is also true for the genus *Milesia* for which, before this survey, most of the knowledge was based on a very limited dataset of mostly historical records. To update the distribution of the genus *Milesia* in the three mentioned countries, a detailed analysis of the literature was done, accompanied by the revision of the material stored in the National Museum of Bosnia and Herzegovina in Sarajevo and Croatian National History Museum in Zagreb, as well as additional specimens collected, photographed or observed in the period from 2018 to 2021 by the authors and using different citizen science platforms. After this survey, both species are present in all of the three mentioned countries, with *M. crabroniformis* being newly reported for Serbia and *M. semiluctifera* for Bosnia and Herzegovina. In addition, the records of *M. crabroniformis* from Croatia represent

the first ones after almost 70 years. Even after this survey, the records of both species are still scarce. However, as both species are rather large and colorful, they are good objects for amateur photographers. A good way to record them in the future would be targeted citizen science campaigns.

KEY WORDS: biodiversity, citizen science, fauna, hoverflies, Milesiini

Izveček – DOPOLNJENA RAZŠIRJENOST MUH TREPETAVK *MILESIA CRABRONIFORMIS* (FABRICIUS, 1775) IN *M. SEMILUCTIFERA* (VILLERS, 1789) (DIPTERA: SYRPHIDAE: ERISTALINAE) V BOSNI IN HERCEGOVINI, HRVAŠKI IN SRBIJI

Pripadniki rodu *Milesia* so velike saproksilne muhe trepetavke, ki posnemajo ose. V Evropi se pojavljata le dve vrsti: *M. crabroniformis* in *M. semiluctifera*, vendar njuna razširjenost še vedno ni dovolj poznana, zlasti v vzhodni Evropi. Na Balkanu je Srbija država z najbolje raziskano favno muh trepetavk, medtem ko ima večina drugih držav bistveno manj raziskano favno, vključno s Hrvaško in Bosno in Hercegovino. To velja tudi za rod *Milesia*, za katerega je pred to raziskavo večina znanja temeljila na zelo omejenem naboru podatkov, večinoma zgodovinskih zapisov. Za posodobitev razširjenosti rodu *Milesia* v treh omenjenih državah je bila opravljena podrobna analiza literature, revizija entomoloških zbirk shranjenih v Narodnem muzeju Bosne in Hercegovine v Sarajevu in Hrvaškem prirodoslovnem muzeju v Zagrebu, ter dodatnih zbranih ali fotografiranih osebkov, ki so jih v obdobju od 2018 do 2021 opazovali avtorji in z uporabo različnih platform državljanske znanosti. Po tej raziskavi sta obe vrsti prisotni v vseh treh omenjenih državah, pri čemer je *M. crabroniformis* prvič zabeležena v Srbiji in *M. semiluctifera* v Bosni in Hercegovini. Poleg tega so najdbe *M. crabroniformis* iz Hrvaške prve po skoraj 70 letih. Tudi po tej raziskavi so najdbe obeh vrst še vedno redke, vendar sta obe vrsti precej veliki in barviti, zato so primerki dobri objekti za amaterske fotografije. Dober način za njihovo beleženje v prihodnosti bi bile ciljno usmerjene državljanske znanstvene kampanje.

KLJUČNE BESEDE: biodiverziteteta, državljanska znanost, favna, muhe trepetavke, Milesiini

Introduction

The genus *Milesia* Latreille, 1804 comprises large, wasp-mimic hoverflies (Syrphidae), widespread in the Palaearctic, the Nearctic, the Afrotropical, and the Oriental region where reaches its greatest diversity (Van Veen, 2004; Speight, 2020). In Europe, only two species from this genus occur: *Milesia crabroniformis* (Fabricius, 1775) and *M. semiluctifera* (Villers, 1789).

M. crabroniformis is a large, hornet mimicking hoverfly which mainly occurs in deciduous (mesophilic *Fagus*, thermophilous *Quercus*, and acidophilous *Quercus*) and evergreen oak (*Q. ilex*/*Q. suber*) forests. The range of this species includes the

Mediterranean region including islands, from northern France to Spain, the former Yugoslavia, Greece, Turkey, and North Africa, as well as some records from central Europe – Switzerland (Speight, 2020).

M. semiluctifera is smaller than *M. crabroniformis*, and can be easily separated from the latter by the black and yellow abdomen. It is a thermophilic species that mainly occurs in thermophilic and evergreen oak forests and *Castanea* forests. Its range includes the Mediterranean basin, Spain, southern France, Italy and Sicily, the former Yugoslavia, Bulgaria, Greece, Israel, Syria, Lebanon, some countries in central Europe, south-east Switzerland, Romania, Ukraine, Caucasus, and on to as far as Turkmenistan (Speight, 2020; Saab, 2021).

These two European species can be easily distinguished in the field or collected material using a key in Speight (2017): *M. crabroniformis* is very similar in general appearance to *Vespa crabro*, vertex entirely yellow-brown, dull, clypeus yellow-brown, posterior half of tergite 3 and often tergite 2 yellow-brown, female frons entirely yellow, in contrast to *M. semiluctifera* that is very different from *V. crabro*, smaller species, resembles Scoliidae wasps, vertex with black ocellar triangle, clypeus black, posterior half of tergite 3 and often tergite 2 black, female frons with median black stripe.

Milesia species are saproxylic hoverflies, but the ecology of these species is not well known. Radenković *et al.* (2013) listed *M. semiluctifera* as saproxylic species, and Speight (2020) noted that female *M. crabroniformis* has been observed ovipositing in the bark of old, living, largely hollow, and humus-full *Quercus* trees. Lower stages of development are not described for both species, although Matile and Leclercq (1992) described a puparium, which probably does not belong to *M. crabroniformis* but *Mallota cimbiciformis* (Speight, 2020).

As is the case with many Syrphidae species in the Balkans, their distribution is still not sufficiently known. Aside from Serbia and Slovenia in which a long tradition of syrphidological studies exist (e.g. De Groot & Govedič, 2008; Nedeljković *et al.* 2009; Radenković *et al.*, 2013; Van Steenis *et al.*, 2013; Tot *et al.*, 2018; Vujić *et al.*, 2018, etc.), other neighboring countries of the former Yugoslavia have a significantly less studied Syrphidae fauna. Accordingly, for most species, their distribution is not known or is in most cases based on very old literature records (e.g. Langhoffer 1919) and thus does not represent a good starting point for the assessments of the species' status or potential threats, which is very significant especially for saproxylic species (Reemer 2005). Here we present an updated distribution of both species of the genus *Milesia* in Croatia, Bosnia and Herzegovina (B&H), and Serbia.

Material and methods

The data set presented in this paper consists of newly gathered data on collected, photographed, or observed specimens in the period from 2018 to 2020; literature data and the data of the revised material stored in the National Museum of Bosnia and Herzegovina (NMBiH) in Sarajevo and the Croatian Natural History Museum

(CNHM) in Zagreb. The specimens in the collection of the NMBiH are mostly without collection date information, but they are part of the entomological collection of the Balkan Peninsula gathered by Viktor Apfelbeck and his associates between the 1880s and 1930s. Collected specimens were caught by an entomological net, prepared by a standard procedure, and stored in private collections of the first and the second authors, and the Dubrovnik Natural History Museum collection. At locality Ljubač, specimens were found trapped on yellow insect glue boards on *Ziziphus jujuba* tree during its flowering period. The distribution map was created in ArcGIS and includes new data, data from NMBiH and CNHM collection and published records from the available literature. Data on the specimens from the photographs were collected using Facebook groups of insect enthusiasts „Insekti Srbije (Insects of Serbia)” and „Koji je ovo pauk/kukac?”. Additionally, a large Syrphidae dataset, including the genus *Milesia*, was collected using four online databases, AlciPhron, bioluger.hr, bioluger.ba and iNaturalist (Popović et al., 2020, Vujić 2021).

Results and discussion

Both *Milesia* species that occur in Europe were registered in B&H, Croatia, and Serbia. For each species, available literature, as well as additional notes, are provided.

Milesia crabroniformis (Fabricius, 1775) (Fig. 1a)

Published records: **Bosnia and Herzegovina:** Glumac (1955a); **Croatia:** Strobl (1900).

Unpublished records: **Croatia:** Šamarica (Zrinska gora), 7.1951 (CNHM); Istria, Pula, Ulica Marsovog polja, 44.85445 13.859466, 10.08.2020., 2♀1♂, leg. R. Maglić; Istria, Rovinj, Rovinj Aquarium, 45.085585 13.639807, 22.10.2021., 1♂, photo: I. Balković; **Serbia:** Banja Koviljača, 44.514498 19.160643, 15.09.2020., 1♀, photo: S. Maksimović.

Notes: New for the fauna of Serbia, so far registered in B&H and Croatia. The specimens collected in the territory of B&H are stored in the National Museum of Bosnia and Herzegovina in Sarajevo and these data are published by Glumac (1955a). Strobl (1900) noted that this species also occurs in Croatia, but the locality is noted as Dalmatia, a large region in southern Croatia. In the NMBiH collection, except for two specimens from Jablanica (Bosnia and Herzegovina), there is also one female specimen from Athos Mt. (Greece). A small number of records in all three countries indicate that *M. crabroniformis* is a rare, local, and probably endangered species and its habitats need to be protected. The records from Croatia (both from Istria Peninsula) represent the first findings of the species in the country after almost 70 years (specimen stored in CNHM from Šamarica (Zrinska gora) dates from 1951 (Strobl, 1900)). The specimens from Croatia were collected from *Foeniculum vulgare* inflorescences (specimens from Pula) or found while resting in business premises (specimen from Rovinj).

Milesia semiluctifera (Villers, 1789) (Fig. 1b)

Published records: **Croatia**: Franenfeld (1860), Strobl (1898), Strobl (1900), Strobl (1902), Langhoffer (1919), Glumac (1956a), Glumac (1956b), Leclercq (1961), Glumac (1972); **Serbia**: Glumac (1955b), Glumac (1972), Radenković (2008), Radenković *et al.* (2013), Vujić *et al.* (2018).

Unpublished records: **Bosnia and Herzegovina**: Domanovići, 1♂, leg. Wgth. (NMBiH); Jablanica, 1♂, leg. Wgth., 1♂, leg. Simmet (NMBiH); **Croatia**: Novi (Novi Vinodolski?), 1939 (CNHM); Island Srakane Vele, 15.9.1961, 2♂ (CNHM); Island Pag, 7.1962 (CNHM); Trnovec, 8.1964, leg. I. Igalffy (CNHM); Vozilići, 12.8.1973, 1♂; 21.8.1983, 1♂, leg. F. Perović (CNHM); Northern Velebit, Babrovača, 920 m, VK96, 16.7.1983, leg. F. Perović (CNHM); Istria, Pula, Valsaline, 44.848205 13.837752, 1.06.2018., 1♂, leg. R. Maglić; Istria, Pula, Valsaline, 44.847907 13.838804, 31.08.2019., 1♂, leg. R. Maglić; Dugopolje, 43.582772 16.571377, 06.07.2020., 1♂, leg. T. Koren; Dubrava, 43.478256 16.66417, 06.07.2020., 1♂, leg. T. Koren; Solin, 43.534712 16.496762, 08.07.2020., 1♀, photo: A. Gjeldum; Northern Velebit, west of Crnopac, 44.251825 15.831516, 21.7.2020., 1♂, photo: M. Doboš; Ploče-Šarić Struga, 43.051706 17.481038, 19.08.2020., 1♂, photo: D. Erak; Ostrovica, 43.947556 15.807997, 02.09.2020., 1♀, leg. T. Koren; Dubrovnik, Lapad peninsula, 42.663617 18.069753, 18.06.2021., 1♂, leg. M. Martinović; Ljubač, 42.722625 18.027798, 27.07.2021., 2♂, leg. M. Martinović; **Serbia**: Bela Palanka (as *Milesia splendida*) 1♀, leg. Hlf. (NMBiH); AP Kosovo, Kosovska Kamenica, Berivojce, 42.567737 21.582498, 27.08.2011., 1♀, photo: B. Milošević; Central Serbia: Suva planina Mt., Gornja Studena, 43.230075 22.103629, 12.07.2019., 1♂, photo: S. Stevčić; Suva planina Mt., Bojanine vode, 43.214829 22.124148, 24.07.2020., 1♀, leg. M. Đurić; Belgrade, Vrčin, 44.669507 20.631297, 13.07.2020., one specimen was observed by M. Vujić; Aleksinac, Bovan

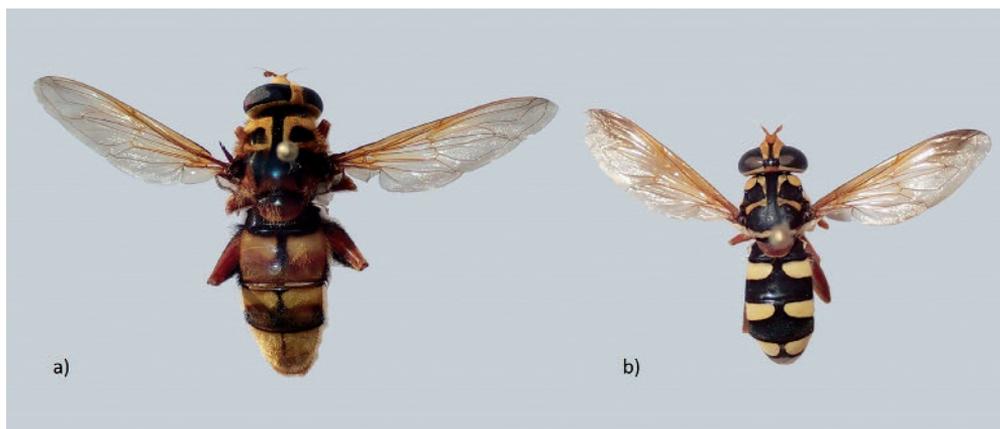


Fig. 1. a) Habitus of male *Milesia crabroniformis* from Pula, Croatia; b) Habitus of female *Milesia semiluctifera* from Dugopolje, Croatia. Photo: T. Koren.

Slika 1. a) Habitus samca *Milesia crabroniformis* iz Pulja, Hrvatska; b) Habitus samice *Milesia semiluctifera* iz Dugopolja, Hrvatska. Photo: T. Koren.

Lake (Bovansko jezero), 43.654581 21.721485, 13.07.2021., 1♂, photo: S. Milojković.

Notes: So far registered in Croatia and Serbia, but in available literature not mentioned for Bosnia and Herzegovina. In the collections of NMBIH, six specimens of *M. semiluctifera* were found, four from B&H and Serbia that are listed above and two male specimens from Herceg Novi (Montenegro) collected by Apfelbeck in 1913. In Serbia, this species was found mainly in the southern part of the country (except one specimen from Vrčin, in Belgrade surrounding). The specimen from Vrčin was observed at the edge of the thermophilous Turkey oak (*Quercus cerris*) forest, during a rest on oak leaves. In Croatia, this species was newly registered at nine localities in Istria and Dalmatia, also at hot and dry habitats.

Although new data are presented in this paper, both *Milesia* species are still registered only from a small number of localities in all three countries. *M. semiluctifera* was registered at more localities than *M. crabroniformis*, but always with a smaller number of individuals. *M. crabroniformis* was during this survey registered at four new localities, one in Serbia and B&H and two in Croatia (Fig. 2). However, only records from Croatia and Serbia are recent, while the latter represent the first records for the country. Both species co-occur only at two localities, one in Croatia (city of Pula) and one in B&H (Jablanica).

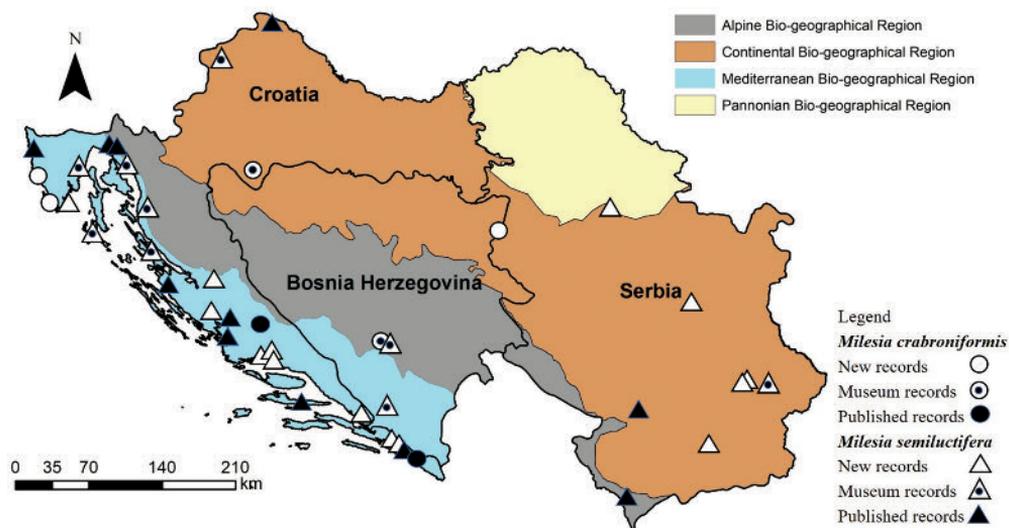


Fig. 2. Distribution of two species of the genus *Milesia* in Croatia, Bosnia, and Herzegovina, and Serbia with Biogeographical regions.

Slika 2. Razširjenost dveh vrst rodu *Milesia* na Hrvaškem, v Bosni in Hercegovini ter Srbiji z biogeografskimi regijami.



Fig. 3. Habitat of *Milesia semiluctifera* at Dugopolje, Croatia. The species was observed feeding on *Sambucus ebulus* flowers. Photo: T. Koren.

Slika 3. Habitat vrste *Milesia semiluctifera* v Dugopolju na Hrvaškem. Vrsta je bila opažena, kako se hrani na cvetovih *Sambucus ebulus*. Foto: T. Koren.

In respect to the habitats the species were observed in, both preferred warmer, usually karstic areas. *M. semiluctifera* was found in hot and dry habitats, which is especially seen in Croatia where the species is confined to coastal areas (Figs. 2, 3). In Serbia, this species also inhabits hot and dry habitats (Fig. 4) and is marked as extremely rare (Radenković, 2008). The data from NMBiH collection are the first and only data for *M. semiluctifera* in Bosnia and Herzegovina, and these specimens were collected at localities in Jablanica and Domanovići, both in Herzegovina, Neretva River valley, the warmest and driest region in the country. Four different Bio-geographical Regions stretch through B&H, Croatia, and Serbia (Alpine, Continental, Mediterranean, and Pannonian) (Fig. 2), and both *Milesia* species were registered in the first three. Both are absent from the Pannonian bio-geographical region in the surveyed countries, but present in Hungary (the entire territory of Hungary is in this region) (Tóth, 2011). Although the largest number of data present-

ed here originate from the Adriatic coast (Mediterranean biogeographical region), the presence of these species in other regions, almost exclusively at hot and dry habitats, indicates a pronounced thermophilicity of both *Milesia* species, at least in B&H, Croatia, and Serbia.

A good method for finding the species in its areal is by looking at the flowering plants in dry areas, as the species commonly visit them. It was noted that specimens visit flowers of *Convolvulus arvensis* at Suva planina Mt. (Serbia) and *Sambucus nigra*, *Eryngium* sp. and *Thymus* sp. in Croatia. The *Ziziphus jujuba* flowers might also be attractive to this species, given that two specimens were found trapped on insect glue boards attached to a tree.

Given that both *Milesia* species are saproxylic, conservation of forest habitats and especially old, living trees are very important for their long-term survival.



Fig. 4. Habitat of *Milesia semiluctifera* at Gornja Studena, Suva planina Mt., Serbia. The species was observed feeding on *Convolvulus arvensis* flowers. Photo: S. Stevčić.

Slika 4. Habitat vrste *Milesia semiluctifera* v Gornji Studeni, Suva planina, Srbija. Vrsta je bila opažena, kako se hrani na cvetovih *Convolvulus arvensis*. Foto: S. Stevčić.

However, adults are usually found in more open areas, including grasslands, indicating that these habitats are also necessary for their life cycle. As the ecology of these two *Milesia* species is poorly known, future surveys should be aimed at getting an insight into their biology as well as determining the main threatening factors to their survival. Reemer (2005) found out that good forest management, including an increased area of forest with old, large, and very large trees, the increase in age of forests and more natural approach towards ill and dead trees most probably can play a very important role in increasing and conservation of saproxylic syrphid's populations. According to the IUCN, LC (Least Concern) status and stable population trend have been assessed for both species, but we believe that these species are more endangered in the Balkans, especially due to habitat loss (e.g. deforestation, spreading of invasive and allochthonous plants, intensive urbanization, tourism development) (Pennards, 2021a, Pennards, 2021b).

An important thing to note is that a part of the new data presented in this paper were collected using online citizen science databases (e.g. Alciphron, biologer.ba and biologer.hr) and Facebook groups. Lately, citizen science is becoming an extremely important tool also in eastern Europe which is used in monitoring species as well as discovering and collecting data about all groups of organisms. It proved to be a very useful tool for early registration of spreading invasive insect species that are easily recognizable like *Cacyreus marshalli* and *Hierodula tenuidentata* (Milojković *et al.* 2021; Vujić *et al.* 2021), but also discovering new species for science such as *Drosera magnifica* and *Hoya amicabilis* (Gonella *et al.* 2015; Rahayu & Rodda 2019). Accordingly, the citizen science approach can be used also to gather additional data for more easily recognizable Syrphidae species as is the case with the genus *Milesia*. This should ensure that in the future, we have at least a better understanding of their distribution and habitat preferences.

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