

AN ANNOTATED CHECKLIST OF HAWK-MOTHS (LEPIDOPTERA: SPHINGIDAE) OF CROATIA WITH THEIR DISTRIBUTION AND COMMON NAMES

TONI KOREN*¹ & MARTINA ŠAŠIĆ²

¹Association Hyla, Zagreb, Croatia, Association Hyla, 10 000 Zagreb, Croatia

²Croatian Natural History Museum, Demetrova 1, 10000 Zagreb, Croatia

Koren, T. & Šašić, M.: An annotated checklist of hawk-moths (Lepidoptera: Sphingidae) of Croatia with their distribution and common names. Nat. Croat., Vol. 31., No. 2, 49-68, 2022, Zagreb.

The first checklist of hawk-moths (Sphingidae) of Croatia is presented. The checklist is based on the examination of museum collections and published records. So far, 22 species have been recorded in Croatia, of which two, *Hippotion celerio* (Linnaeus, 1758) and *Sphingoneopsis gorgoniades* (Hübner, 1819) have not been confirmed during recent studies, and their current occurrence in the country needs confirmation. For each species, a distribution map is provided comprising all the available published records as well as records from museum collections in Croatia. For all confirmed and two potential hawk moth species, suggested Croatian common names are provided.

Keywords: checklist, maps, fauna, entomological collections, Croatian Natural History Museum, Varaždin City Museum

Koren, T. & Šašić, M.: Popis ljljaka (Lepidoptera: Sphingidae) Hrvatske s rasprostranjenošću i narodnim imenima. Nat. Croat., Vol. 31., No. 2, 49-68, 2022, Zagreb.

Predstavljen je prvi popis ljljaka (Sphingidae) Hrvatske. Popis se temelji na pregledu muzejskih zbirki i objavljenih literaturnih nalaza. Do sada su u Hrvatskoj zabilježene 22 vrste, od kojih dvije vrste, *Hippotion celerio* (Linnaeus, 1758) i *Sphingoneopsis gorgoniades* (Hübner, 1819) nisu potvrđene tijekom recentnijih istraživanja te njihovu prisutnost u zemlji treba potvrditi. Za svaku vrstu daje se karta rasprostranjenosti koja sadrži sve dostupne objavljene literaturne nalaze, kao i nalaze iz muzejskih zbirki u Hrvatskoj. Za sve potvrđene i dvije potencijalne vrste ljljaka navedeni su nazivi na hrvatskom jeziku.

Ključne riječi: popis, karte, fauna, entomološke zbirke, Hrvatski prirodoslovni muzej, Gradski muzej Varaždin

INTRODUCTION

The hawk moths (Lepidoptera: Sphingidae) are a widely distributed family, present in every continent except Antarctica. They are medium to large moths with the exception of a few smaller species in the genera *Microsphinx* and *Sphingoneopsis*, they display robust hairy bodies and forewing sizes between 16 to 90 mm (PITTAWAY, 1993). Most species in Europe are nocturnal with some exceptions like *Macroglossum stellatarum* (Linnaeus, 1758) or the genus *Hemaris*, members of which are diurnal. The majority of species feed as adults and have a well-developed proboscis which is sometimes extre-

* corresponding author

mely long, even longer than their body. This enables them to collect nectar from flowers while in flight. They are fast and strong fliers, their wings being narrow and tapering down basally to enable such flight. Many hawk moth species are regular migrants reaching great distances, in a few examples even migrating between different continents (LERAUT, 2006). The caterpillars of hawk moths are usually easily recognizable due to their hairless body, large size and the presence of a curved horn on the eighth abdominal segment, missing, or reduced only in a few groups (SKINNER, 2009). Due to their size and usually easy identification, they have been used as models for studies of genetics, physiology and development, functional morphology, plant-herbivore interactions, pollination biology, biogeography, and habitat quality assessment studies (KAWAHARA *et al.*, 2009).

So far more than 1400 species and about 200 genera of Sphingidae have been described (KITCHING & CADIOU, 2000). In Europe, 40 species have been recorded so far (PITTAWAY, 1993; LERAUT, 2006; DE JONG *et al.*, 2014). While the general distribution across Europe has been known for some time (PITTAWAY, 1983, 1993) for most eastern European countries no checklists or recent overviews of species distribution or status exist. With the compilation of such a list, the basis for all future works on any other Lepidoptera family becomes easier. A good recent example is North Macedonia for which a detailed checklist was published using several museum collections and all the available literature (KRPAČ *et al.*, 2019).

For Croatia, no such comprehensive work was previously compiled, and only overviews were given for three hawk-moth species, *Hemaris croatica* (Esper, 1800) (KOREN *et al.*, 2011), *Proserpinus proserpina* (Pallas, 1772) (KOREN, 2019) and *Hyles vespertilio* (Esper, 1780) (KOREN *et al.*, 2022).

Here we present the first checklist of the hawk-moths of Croatia along with the distribution, and the proposed Croatian vernacular names for all species.

MATERIALS AND METHODS

All the available literature regarding Lepidoptera of Croatia was consulted to gain an overview of the distribution and more accurate occurrences of Sphingidae in the country. For each species, all references that mention the occurrence records of the species in the country are provided. Systematics are in accordance with Fauna Europaea (DE JONG *et al.*, 2014).

During the preparation of this manuscript several museum collections were consulted; the Košćec Collection, deposited in the Varaždin City Museum, and several Lepidoptera collections stored in the Croatian Natural History Museum in Zagreb. Of those, the largest is the Central Lepidoptera Collection, which contains material from the former collections of Grund (coll. Gru.), Gušić (coll. Guš.), Igalffy (coll. Igal.), Koča (coll. Koč.), Kozulić (coll. Koz.), Locke (coll. Loc.), Taborski (coll. Tab.), Valjavec (coll. Valj.). Aside from the Central Collection, three other collections were consulted: the Maretić Collection, the remaining material from the Igalffy Collection, and the Kučinić Collection. For each specimen, dates, and localities from the labels are presented.

All literature and museum records are georeferenced to the highest possible precision and marked on maps. The only exceptions are the old citations of wide and vaguely-defined areas like "Slavonia" or "Croatia". For each species, a distribution map is

provided with their presence in the three biogeographical regions of Croatia (continental, alpine, Mediterranean).

As Sphingidae are large, and usually easily recognizable moths, often noted by the general public, many species already have vernacular names. For others, names were given in connection with their ecology, biology, larval food plant, distribution or if possible, via translation from other European languages.

RESULTS AND DISCUSSION

A total of 22 Sphingidae species have been recorded in Croatia so far (Tab. 1). For each of them, available museum and literature records are provided, and if necessary, additional comments. For each species, a distribution map is provided (Figs 1-19).

Mimas tiliae (Linnaeus 1758)

Museum collections:

Central Collection: Bosiljevo (coll. Koz.), Cmrok (1.07.1908, 30.04.1913, 27.7.1915, 10.08.1917; coll. Guš.), Osijek (13.06.1892), Trnjani (21.05.1909; coll. Guš.), Trnovec (4.06.1938; coll. Igal.), Vinkovci (1899, 1908), Zagreb (25.06.1908, coll.Tab.; 13.05.1929, coll. Valj.; 1960, 1961, 1979, 1980).

Igalffy Collection: Zagreb (6.05.1976, coll. Igal.; 12.05.1980, 14.05.1980)

Košćec Collection Varaždin (16.08.1925, 16.06.1928, 28.07.1928, 9.06.1929, 4.08.1930, 6.08.1937, 25.05.1945, 28.07.1947, 23.05.1952, 20.04.1959, 24.08.1960)

Literature: MANN (1857, 1867, 1869), VUKOTINOVIĆ (1879), JURINEC (1884), ŠLOSER (1890), KOČA (1900), KOČA (1901), REBEL (1904), ABAFY-AIGNER (1910), REBEL (1912), GRUND (1918), STAUDER (1923), MLADINOV (1958), MLADINOV (1976), KOVAČEVIĆ & FRANJEVIĆ-OŠTRC (1978), KRANJČEV (1978), KRANJČEV (1985), WITT (1987), HABELER (2003), VIGNJEVIĆ *et al.* (2010), KOREN & LADAVAC (2013)

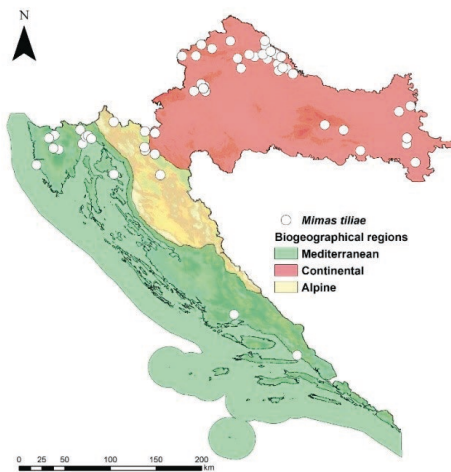


Fig. 1. The distribution of *Mimas tiliae* in Croatia based on literature data and museum collections.

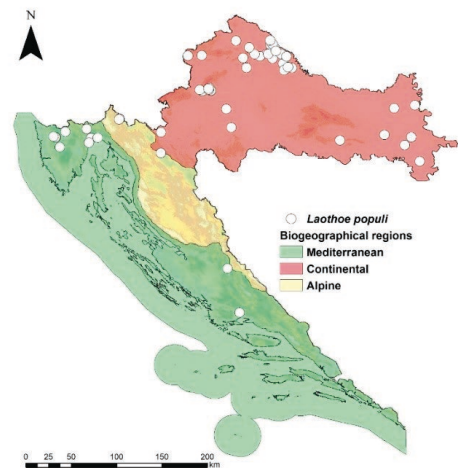


Fig. 2. The distribution of *Laothoe populi* in Croatia based on literature data and museum collections.

Laothoe populi* (Linnaeus, 1758)*Museum collections:**

Central Collection: Bosiljevo (coll. Koz.), Cmrok (16.07.1918, coll. Koz.), Đakovo (22.07.1893, coll. Guš.), Hrvatsko (13.06.1981), Trnovec (05.1959, 28.05.1978, coll. Igal.), Vinkovci (1.08.1902, coll. Guš.), Zagreb (7.06.1926, 19.07.1927, 20.04.1929, 15.07.1929, 18.08.1932, coll. Valj.; 1954, 12.08.1969, 9.06.1974)

Košćec Collection: Varaždin (24.05.1930, 6.06.1935, 10.06.1935, 5.07.1936, 3.06.1954)

Literature: MANN (1857, 1867, 1869), ŠLOSER (1870), VUKOTINOVIĆ (1879), JURINAC (1884), KOČA (1900, 1901), REBEL (1904, 1913), GRUND (1918), SCHAWERDA (1921), STAUDER (1923), MLADINOV (1958, 1983), KOVAČEVIĆ & FRANJEVIĆ-OŠTRC (1978), KRANJČEV (1985), HAFNER (1994), VIGNJEVIĆ *et al.*, (2010), KOREN & LADAVAC (2013), KOREN (2015)

Sphinx ligustri* Linnaeus, 1758*Museum collections:**

Central collection: Bosiljevo (coll. Koz.), Cmrok (4.06.1911, 4.06.1921; coll. Guš.), Vinkovci (1889, coll. Koč.; 20.07.1908, coll. Guš.), Zagreb (10.07.1925, 7.07.1926, coll. Valj.)

Other collections: Lička Plješevica/Kapela (5.07.1975, coll. Igal.)

Košćec Collection: Varaždin (21.08.1936, 5.06.1939, 17.05.1940)

Literature: MANN (1857, 1867, 1869), VUKOTINOVIĆ (1879), JURINAC (1884), WERNER (1895), KOČA (1901), ABAFI-AIGNER (1910), REBEL (1904, 1913, 1914), GRUND (1918), STAUDER (1923), MLADINOV (1958), KOVAČEVIĆ & FRANJEVIĆ-OŠTRC (1978), KRANJČEV (1985), WITT (1987), HABELER (2003), VIGNJEVIĆ *et al.* (2010), KOREN & LADAVAC (2013), KOREN (2018)

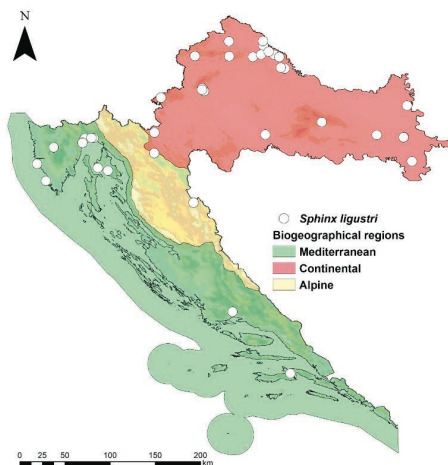


Fig. 3. The distribution of *Sphinx ligustri* in Croatia based on literature data and museum collections.

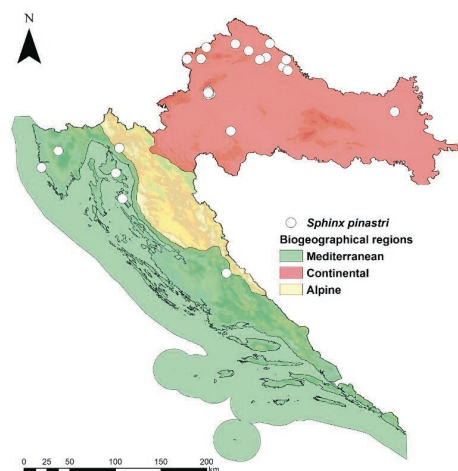


Fig. 4. The distribution of *Sphinx pinastri* in Croatia based on literature data and museum collections.

***Sphinx pinastri* Linnaeus, 1758**

Museum collections:

Central Collection: Cmrok (20.06.1910, 17.05.1913, 24.04.1915, 6.05.1915, 8.05.1917, coll. Guš.), Zagreb (29.07.1909, coll. Loc.; 8.05.1925, 22.05.1925, 11.06.1925, 29.07.1932, coll. Valj.), Trnovec (06.1917, 06.1956, 4.07.1958, 25.06.1959, coll. Igal.)

Košćec Collection: Varaždin (18.06.1937, 14.05.1959)

Other collections: Lička Plješevica/Kapela (7.07.1974, 4.07.1975, 6.07.1975, coll. Igal.); Trnovec (17.05.1970, 13.07.1974, coll. Igal.)

Literature: VUKOTINOVIĆ (1879), KOČA (1901), REBEL (1904), ABAFI-AIGNER (1910), GRUND (1918), STAUDER (1923), MLADINOV (1958), KOVAČEVIĆ & FRANJEVIĆ-OŠTRC (1978), KRANJČEV (1985), WITT (1987), HAFNER (1994), HABELER (2003), KOREN & LADAVAC (2013), KOREN (2018)

***Marumba quercus* (Denis & Schiffermüller, [1775])**

Museum collections:

Central Collection: Bosiljevo (coll. Koz.), Glina (20.06.1891, coll. Guš.), Macelj (06.1948, coll. Igal.), Trnjani (10.05.1910, coll. Koč.), Zagreb (3.05.1914, coll. Tab.; 3.07.1924, 6.06.1929, 12.07.1932, coll. Valj.; 06.1939)

Košćec Collection: Korčula (16.06.1981)

Literature: GEIGER (1873), VUKOTINOVIĆ (1879), ABAFY-AIGNER ET AL. (1896), KOČA (1901), GALVAGNI (1909), ABAFI-AIGNER (1910), REBEL (1904, 1913, 1914), GRUND (1918), STAUDER (1923), SCHWINGENSCHUSS & WAGNER (1925), SEYER (1938), MLADINOV (1958), BARTOL *et al.* (1964), BURGERMEISTER (1964), HABELER (1976), KOVAČEVIĆ & FRANJEVIĆ-OŠTRC (1978), Witt (1987), HAFNER (1994), HABELER (2003), KOREN & LADAVAC (2013)

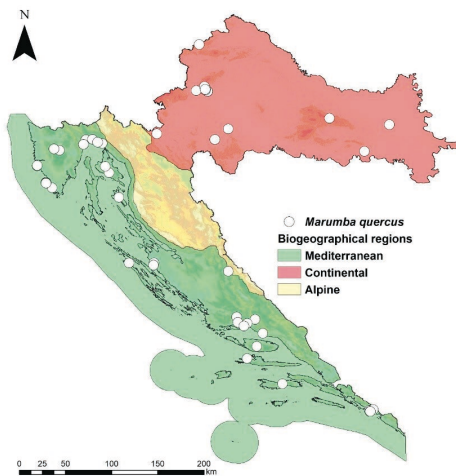


Fig. 5. The distribution of *Marumba quercus* in Croatia based on literature data and museum collections.

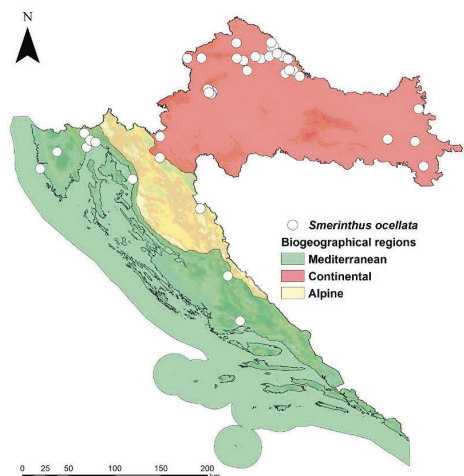


Fig. 6. The distribution of *Smerintus ocellata* in Croatia based on literature data and museum collections.

Smerinthus ocellata* (Linnaeus, 1758)*Museum collections:**

Central Collection: Trnovec (08.1957, coll. Igal.), Zagreb (17.05.1913, 27.05.1913, 3.05.1914, 1921, coll. Guš.; 9.05.1929, 28.06.1929, 2.05.1930, coll. Valj.)

Other collections: Lička Plješevica/Kapela (5.07.1975, coll. Igal.)

Košćec Collection: Varaždin (29.08.1925, 21.05.1929, 8.06.1929, 15.04.1931, 23.05.1931, 26.05.1932, 17.06.1932, 12.05.1934, 5.06.1940)

Literature: MANN (1857, 1867, 1869), ŠLOSER (1870), VUKOTINOVIĆ (1879), JURINAC (1884), KOČA (1900, 1901), REBEL (1904, 1913), ABAFI-AIGNER (1910), GRUND (1918), STAUDER (1923), KOVAČEVIĆ & FRANJEVIĆ-OŠTRC (1978), MLADINOV (1958), KRANJČEV (1978, 1985), WITT (1987), HAFNER (1994), VIGNJEVIĆ *et al.* (2010), KOREN & LADAVAC (2013), KOREN (2015, 2018)

Acherontia atropos* (Linnaeus, 1758)*Museum collections:**

Central Collection: Bosiljevo (coll. Koz.), Dubrovnik (10.09.1976), Đakovo (09.1902), Palagruža (4.05.1913, coll. Guš.), Trnovec (10.1940, 1.10.1940, coll. Igal.), Vinkovci (15.05.1900, coll. Koč.), Zagreb (28.09.1940, 18.08.1956)

Košćec Collection: Paukovec (7.09.1903); Varaždin (28.09.1929, 18.10.1931, 26.08.1936, 17.10.1936, 11.10.1938, 23.11.1938, 6.10.1940, 14.10.1940, 20.10.1940, 27.09.1943, 13.09.1951, 5.10.1960, 18.09.1961)

Literature: MANN (1857, 1869), BOHATSCH (1892), WERNER (1895), ŠLOSER (1870), VUKOTINOVIĆ (1879), JURINAC (1884, 1887), KOČA (1900, 1901), GALVAGNI (1909, 1921), ABAFI-AIGNER (1910), TÁBORSKY (1910), REBEL (1912, 1914), HOFBAUER (1916), GRUND (1918),

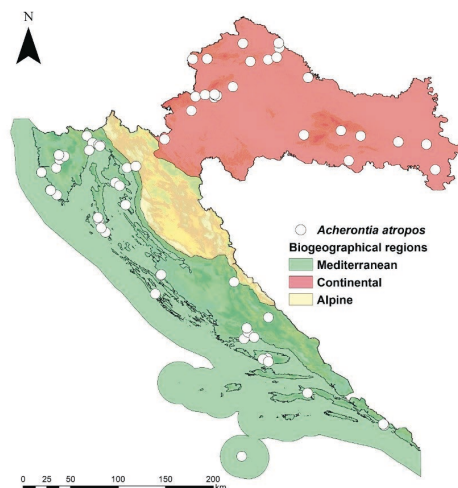


Fig. 7. The distribution of *Acherontia atropos* in Croatia based on literature data and museum collections based on literature data and museum collections.

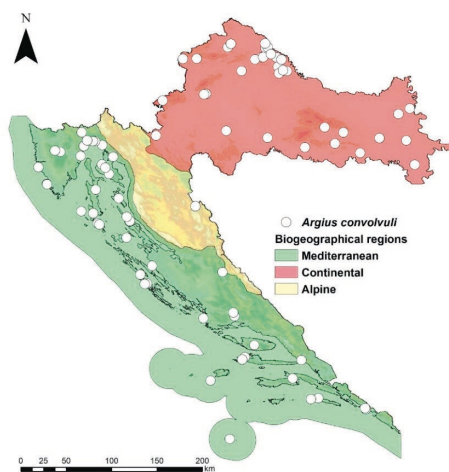


Fig. 8. The distribution of *Argrius convolvuli* in Croatia based on literature data and museum collections.

MÜLLER (1921), SCHAWERDA (1921), SCHWINGENSCHUSS & WAGNER (1925), STAUDER (1923), HAFNER (1930), MLADINOV (1958), BURGERMEISTER (1964), DANIEL (1971), KOVAČEVIĆ & FRANJEVIĆ-OŠTRC (1978), KRANJČEV (1978, 1985), WITT (1987), HABELER (2003), KOREN & LADAVAC (2013)

***Agrius convolvuli* (Linnaeus, 1758)**

Museum collections:

Central Collection: Bosiljevo (coll. Koz.), Caska VK93 (15.08.1960), Crikvenica (25.09.1966), Dubrovnik (3.09.1975, 16.09.1978), Đakovo (22.08.1897; 24.08.1909, coll. Guš.), Malinska (6.09.1973), Osijek (27.09.1897, coll. Koč.), Palagruža (4.05.1913, coll. Guš.), Stara Novalja (13.06.1958), Trnovec (09.1940, coll. Igal.), Trnjani (coll. Koč.; coll. Guš.), Zagreb (6.07.1914, 13.08.1917, coll. Guš.; 17.08.1924, 4.08.1931, coll. Valj.)

Other collections: Brseč/Golovik (10.1976, coll. Igal.), Nova Gradiška (08.1935), Lička Plješevica/Kapela (19.09.1974, coll. Igal.), Zagreb (07.1971)

Košćec Collection: Poljana (21.09.1966), Varaždin (26.09.1925, 27.09.1932, 17.09.1936, 27.09.1938, 3.10.1940, 16.05.1943, 14.09.1949, 28.10.1950, 10.10.1953, 25.09.1959, 28.09.1960, 25.07.1968)

Literature: GERMAR (1814, 1817), MANN (1857, 1869), JURINAC (1884), VUKOTINOVIĆ (1879), WERNER (1895), KOČA (1900, 1901), GALVAGNI (1902, 1909, 1921), REBEL (1904, 1912, 1914), ABAFI-AIGNER (1910), TÁBORSKY (1910), HOFBAUER (1916), GRUND (1918), SCHAWERDA (1920, 1921), STAUDER (1923), SCHWINGENSCHUSS & WAGNER (1925), HAFNER (1930), NOVAK (1940), MLADINOV (1958, 1968), BARTOL *et al.* (1964), BURGERMEISTER (1964), IGAŁFFY *et al.* (1965), MOUCHA (1965), DANIEL (1971), KOVAČEVIĆ & FRANJEVIĆ-OŠTRC (1978), KRANJČEV (1985), WITT (1987), HAFNER (1994), HABELER (2003), FUNDURULJA (2006), KAZIMIERCZAK (2009), VIGNJEVIĆ *et al.* (2010), KOREN & LADAVAC (2013), KOREN (2015, 2018)

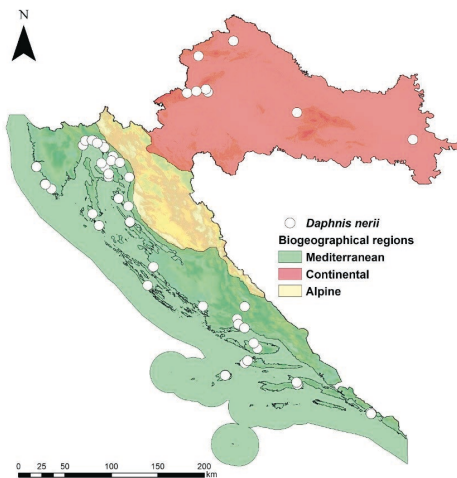


Fig. 9. The distribution of *Daphnis nerii* in Croatia based on literature data and museum collections.

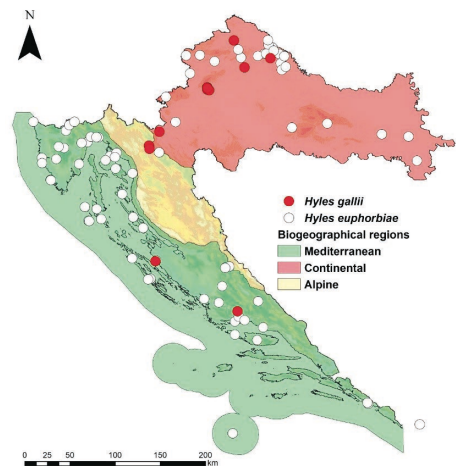


Fig. 10. The distribution of *Hyles euphorbiae* and *Hyles gallii* in Croatia based on literature data and museum collections.

Daphnis nerii* (Linnaeus, 1758)*Museum collections:**

Central Collection: Caska (24.08.1960, 25.08.1960), Crikvenica (5.07.1916, coll. Guš.), Kraljevica (1901, 1904, coll. Koč.), Sušak (coll. Koz.)

Košćec Collection: Varaždin (17.09.1926, 22.10.1926, 30.08.1930, 27.09.1937, 7.11.1926, 19.09.1940, 26.09.1940, 5.10.1940, 16.10.1946)

Literature: MANN (1869), VUKOTINOVIĆ (1879), WERNER (1895), ABAFY-AIGNER *et al.* (1896), KOČA (1901), REBEL (1904, 1913, 1914), GALVAGNI (1909), ABAFI-AIGNER (1910), HOFBAUER (1916), GRUND (1918), SCHAWERDA (1920, 1921, 1927), STAUDER (1923), SCHWINGENSCHUSS & WAGNER (1925), HAFNER (1930), NOVAK (1940), NEUSTETTER (1956), MLADINOV (1958, 1968), BARTOL *et al.* (1964), BURGERMEISTER (1964), IGAFFY *et al.* (1965), KOVAČEVIĆ & FRANJEVIĆ-OŠTRC (1978), WITT (1987), HABELER (2003), HARBICH (2003).

Hyles euphorbiae* (Linnaeus, 1758)*Museum collections:**

Central Collection: Bosiljevo (coll. Koz.), Caska (31.08.1960, 16.07.1962), Cmrok (4.07.1912, 7.07.1912, 17.07.1915, coll. Guš.), Đakovo (10.1809, coll. Guš.; 19.08.1909), Malinska (1.-6.09.1973, 2.07.1981), Susak (1.09.1962), Trnovec (07.1914, coll. Igal.), Unije (3.09.1963, 5.09.1963), Vinkovci (9.07.1888, coll. Koč.; 4.07.1905, coll. Guš.), Zagreb (18.07.1912, 28.07.1915, coll. Guš.), Zlatar (24.07.1922, coll. Valj.)

Other collections: Caska (17.08.1962), Unije (07.1967), Zagreb (1932, coll. Maretič; 16.06.1965, 10.07.1980)

Košćec Collection: Varaždin (23.07.1919, 21.07.1929, 17.06.1930, 15.08.1935, 14.06.1936, 9.07.1936, 30.05.1946)

Literature: MANN (1857, 1867, 1869), ŠLOSER (1870), VUKOTINOVIĆ (1879), JURINAC (1884), KOČA (1900, 1901), GALVAGNI (1902, 1909, 1921), REBEL (1904, 1912, 1913, 1914), ABAFI-AI-

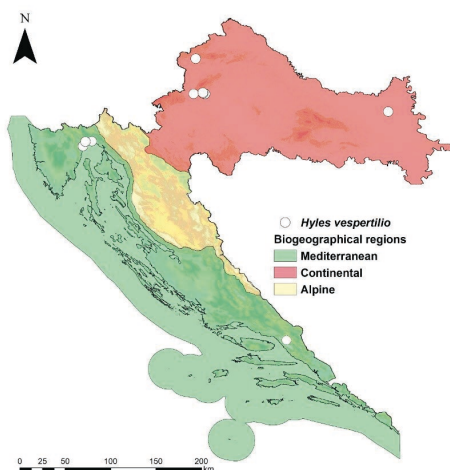


Fig. 11. The distribution of *Hyles vespertilio* in Croatia based on literature data and museum collections.

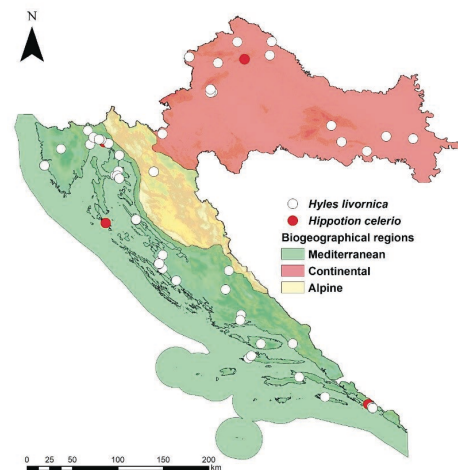


Fig. 12. The distribution of *Hyles livornica* and *Hippotion celerio* in Croatia based on literature data and museum collections.

GNER (1910), TÁBORSKY (1910), GRUND (1918), STAUDER (1923), SCHWINGENSCHUSS & WAGNER (1925), HAFNER (1930), MLADINOV (1958, 1968), LIPSCOMB (1961), BURGERMEISTER (1964), MLADINOV & HERMAN (1964), HABELER (1976), KOVAČEVIĆ & FRANJEVIĆ-OŠTRC (1978), KRANJČEV (1985), WITT (1987), HAFNER (1994), HABELER (2003), KOREN & LADAVAC (2013)

***Hyles gallii* (Rottemburg, 1775)**

Museum collections:

Central Collection: Bosiljevo (coll. Koz.), Zagreb (28.06.1908, coll. Guš.;10.08.1909, 2.09.1909, coll. Tab.)

Košćec Collection: Varaždin (11.06.1938, 30.05.1946)

Literature: MANN (1869), VUKOTINOVIĆ (1879), KOČA (1901), REBEL (1904), GALVAGNI (1909), GRUND (1918), STAUDER (1923), MLADINOV (1958), KOVAČEVIĆ & FRANJEVIĆ-OŠTRC (1978), KRANJČEV (1985)

***Hyles vespertilio* (Esper, 1780)**

Museum collections:

Central Collection: Bosiljevo (coll. Koz.), Zagreb (17.04.1908, 7.05.1909, coll. Guš.; 2.09.1909, coll. Tab.)

Literature: VUKOTINOVIĆ (1879), KOČA (1901), ABAFI-AIGNER (ABAFI-AIGNER, 1902) (1902), GRUND (1918), MLADINOV (1958), KOVAČEVIĆ & FRANJEVIĆ-OŠTRC (1978)

***Hyles livornica* (Esper, 1780)**

Museum collections:

Central Collection: Biograd n. m. (27.08.1961), Bosiljevo (coll. Koz.), Caska (4.07.1962, 5.07.1962), Cmrok (7.08.1908, coll. Guš.), Đakovo (28.08.1914), Križpolje (10.08.1894,

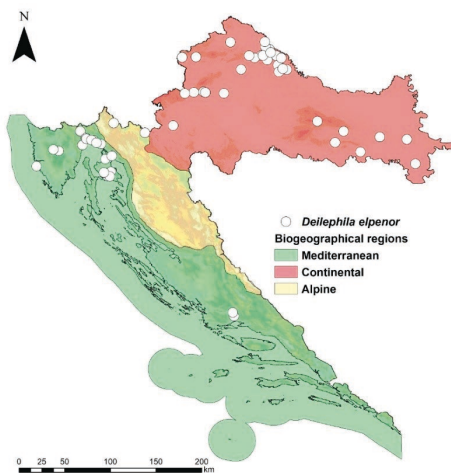


Fig. 13. The distribution of *Deilephila elpenor* in Croatia based on literature data and museum collections.

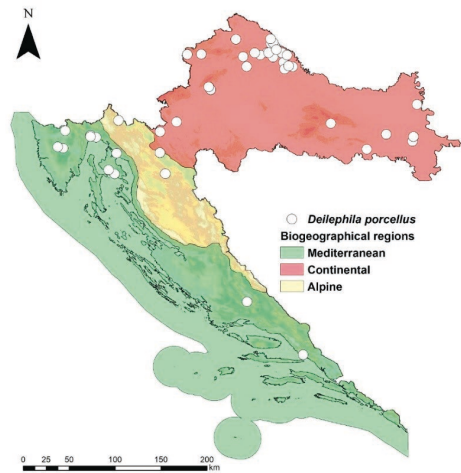


Fig. 14. The distribution of *Deilephila porcellus* in Croatia based on literature data and museum collections.

coll. Koč.), Trnovec (08.1918, 07.1928, 05.1958, coll. Igal.), Trnjani (10.08.1906, coll. Koč.), Vinkovci (10.06.1894, coll. Koč.; 16.06.1908, coll. Guš.), Zadar (2.07.1912, coll. Guš.), Zagreb (coll. Tab.; 4.07.1947), Zlatar (12.08.1923, coll. Valj.)

Other collections: Biokovo/Vošac (17.06.1990, 29.08.1990, coll. Kučinić), Crikvenica VL70 (23.07.1931)

Košec Collection: Varaždin (25.07.1928)

Literature: MANN (1857, 1869), VUKOTINOVIĆ (1879), WERNER (1895), ABAYFI-AIGNER ET AL. (1896), KOČA (1900, 1901), REBEL (1904, 1912), GALVAGNI (1909), ABAYFI-AIGNER (1910), GRUND (1918), STAUDER (1923), SCHWINGENSCHUSS & WAGNER (1925), MLADINOV (1958, 1968), BURGERMEISTER (1964), IGALFFY *et al.* (1965), DANIEL (1971), KRANJČEV (1985), WITT (1987), HAFNER (1994), HABELER (2003), KAZIMIERCZAK (2009), KOREN & LADAVAC (2013)

Hippotion celerio (Linnaeus, 1758)

Museum collections:

Central Collection: Sušak VL51 (coll. Koz.)

Literature: ŠLOSER (1870), VUKOTINOVIĆ (1879), GALVAGNI (1909), STAUDER (1923)

Deilephila elpenor (Linnaeus, 1758)

Museum collections:

Central Collection: Dugo Selo (07.1959, coll. Igal.), Đakovo (14.09.1914, 24.09.1914), Osilnica (19.07.1974, 23.07.1976), Sušak (coll. Koz.), Trnovec (08.1937, 07.1958, 2.07.1958, coll. Igal.), Trnjani (coll. Koč.), Vinkovci (23.06.1894, coll. Koč.), Zagreb (22.07.1909, coll. Tab.; 10.06.1909, 23.07.1909, 10.08.1917, 1918, coll. Guš.; 15.07.1925, 27.07.1925, coll. Valj.; 23.05.1959)

Košec Collection: Varaždin (25.06.1930, 20.06.1959)

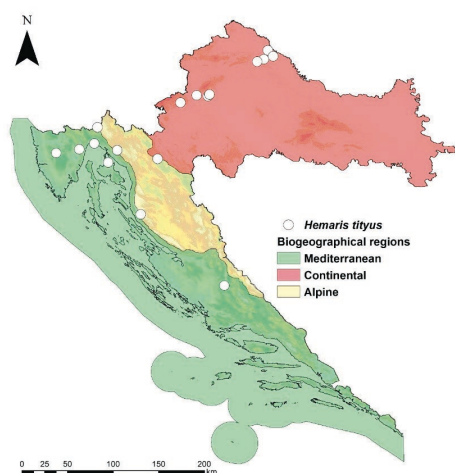


Fig. 15. The distribution of *Hemaris tityus* in Croatia based on literature data and museum collections.

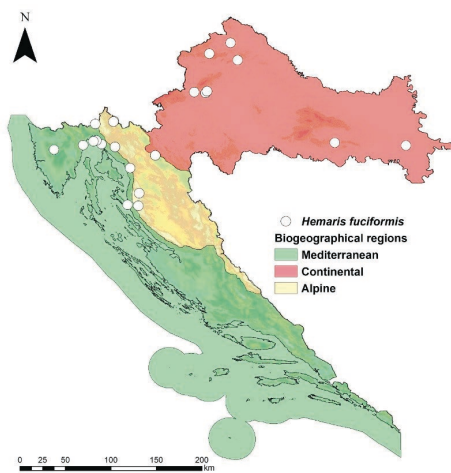


Fig. 16. The distribution of *Hemaris fuciformis* in Croatia based on literature data and museum collections.

Literature: MANN (1857, 1869), VUKOTINOVIĆ (1879), JURINAC (1884), KOČA (1900, 1901), REBEL (1904, 1912), ABAFI-AIGNER (1910), TÁBORSKY (1910), GRUND (1918), STAUDER (1923), MLADINOV (1958, 1976), BARTOL *et al.* (1964), KOVAČEVIĆ & FRANJEVIĆ-OŠTRC (1978), KRANJČEV (1985), WITT (1987), HABELER (2003), FUNDURULJA (2006), KOREN & LADAVAC (2013), KOREN (2018)

Deilephila porcellus (Linnaeus, 1758)

Museum collections:

Central collection: Bosiljevo (coll. Koz.), Cmrok (15.05.1909, coll. Guš.), Đakovo (24.08.1909; 20.07.1914, coll. Guš.), Trnovec (08.1914; 22.08.1918, 07.1928, coll. Igal.), Trnjani (21.08.1909, coll. Guš.), Vinkovci (06.1894, coll. Koč.; 9.06.1909, coll. Guš.), Zagreb (16.04.1906; 27.07.1925, coll. Valj.; 5.06.1910, 4.06.1911, coll. Tab.; 9.05.1974)

Košćec Collection: Varaždin (26.06.1930, 31.05.1946)

Literature: MANN (1857, 1867, 1869), ŠLOSER (1870), VUKOTINOVIĆ (1879), JURINAC (1884), KOČA (1900, 1901), REBEL (1904, 1912), ABAFI-AIGNER (1910), TÁBORSKY (1910), GRUND (1918), STAUDER (1923), MLADINOV (1958, 1976), KRANJČEV (1985), KOVAČEVIĆ & FRANJEVIĆ-OŠTRC (1978), HABELER (2003), VIGNJEVIĆ *et al.* (2010), KOREN & LADAVAC (2013), KOREN (2015, 2018), VELJKOVIĆ (2019)

Hemaris tityus (Linnaeus, 1758)

Museum collections:

Central Collection: Zagreb (11.05.1906, coll. Gru.)

Literature: ABAFI-AIGNER *et al.* (1896), ABAFI-AIGNER (1910), REBEL (1910), GRUND (1918), STAUDER (1923), MLADINOV (1958), BERRA (1982), KRANJČEV (1985), HAFNER (1994), HABELER (2003), KOREN & LADAVAC (2013)

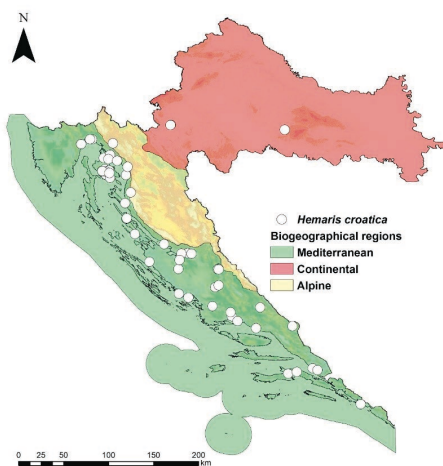


Fig. 17. The distribution of *Hemaris croatica* in Croatia based on literature data and museum collections.

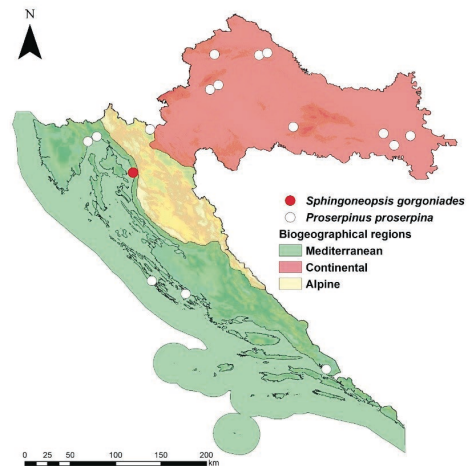


Fig. 18. The distribution of *Proserpinus proserpina* and *Sphingoneopsis gorgoniades* in Croatia based on literature data and museum collections.

Hemaris fuciformis* (Linnaeus, 1758)*Museum collections:**

Central Collection: Crni Vrh (5.06.1916, coll. Guš.), Hrvatsko (12.06.1976), Ivanščica (6.06.1918, coll. Valj.), Zagreb (06.1906, coll. Gru.; 8.05.1925, coll. Valj.)

Literature: MANN (1857, 1867, 1869), ŠLOSER (1870), VUKOTINVIĆ (1879), JURINAC (1884), REBEL (1904), ABAFI-AIGNER (1910), GRUND (1918), STAUDER (1923), KOČA (1925), MLADINOV (1958, 1978), KOREN & LADAVAC (2013)

Hemaris croatica* (Esper, 1800)*Museum collections:**

Central Collection: Caska (24.06.1960, 27.06.1960, 28.06.1960, 8.08.1960, 27.06.1962), Fužine (1913, coll. Tab.), Jablanac (29.07.1916, coll. Guš.), Kornić - Krk (31.07.1916, coll. Guš.), Starigrad (1.08.1922, coll. Guš.)

Other collections: Caska (26.06.1960)

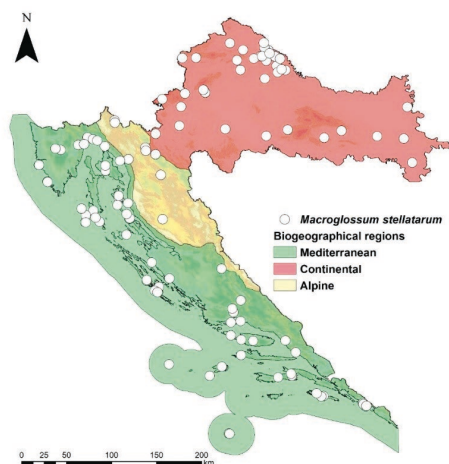
Literature: GERMAR (1814, 1817), MANN (1857, 1869), VUKOTINVIĆ (1879), WERNER (1895), ABAFY-AIGNER *et al.* (1896), DE LA NICHOLL (1899), ABAFI-AIGNER (1910), REBEL (1913), GRUND (1918), ZERNY (1920), SCHAWERDA (1921), STAUDER (1923), SCHWINGENSCHUSS & WAGNER (1925), SEYER (1938), BARTOL *et al.* (1964), BURGERMEISTER (1964), MLADINOV (1968), HABELER (1976), HAFNER (1994), HABELER (2003), KOREN *et al.* (2011)

Proserpinus proserpina* (Pallas, 1772)*Museum collections:**

Central Collection: Đakovo (30.08.1892), Vinkovci (14.06.1905, coll. Guš.; 10.07.1909, coll. Koč.), Kunjevci (23.05.1908, coll. Gušić)

Literature: MANN (1869), VUKOTINVIĆ (1879), BOHATSCH (1892), ABAFY-AIGNER *et al.* (1896), KOČA (1901), ABAFI-AIGNER (1910), GRUND (1918), STAUDER (1923), KRANJČEV (1985), KOREN (2019)

Comment: The distribution and the status of the species has been summarised in KOREN (2019). No further records known from Croatia since the publication of that work.

***Sphingoneopsis gorgoniades* (Hübner, 1819)**

Literature: ABAFI-AIGNER (1910), GRUND (1918), ZERNY (1933)

Fig. 19. The distribution of *Macroglossum stellatarum* in Croatia based on literature data and museum collections.

Macroglossum stellatarum* (Linnaeus, 1758)*Museum collections:**

Central collection: Biograd n.m. (29.08.1970), Bosiljevo (coll. Koz.), Caska (6.10.1955, 14.10.1955, 26.06.1960, 28.06.1960), Cmrok (24.04.1909, 5.05.1909, coll. Guš.), Đakovo, Hrvatsko (16.08.1975), Jablanac (4.10.1916, coll. Guš.), Lokrum (10.08.1969), Ogulin, Petrinja (7.09.1912, coll. Guš.), Srakani Veli (15.09.1961), Stara Novalja (12.10.1955), Trnovec (07.1958, coll. Igal.), Trsat (5.06.1916, coll. Guš.), Vinkovci (coll. Koč.), Zagreb (12.09.1912, 4.08.1915, 20.07.1916, coll. Guš.; 7.09.1912, 11.10.1923, coll. Valj.)

Other collections: Caska (26.06.1960); Jabuka (7.06.1979.); Kraljevica (07.1939); Vošac/Biokovo (23.07.1994, coll. Kučinić); Unije (Mladinov, 1967) gornji tok rijeke Kupe VL74 (Mladinov, 1976)

Literature: GERMAR (1814, 1817), MANN (1857, 1867, 1869), ŠLOSER (1870), VUKOTINOVIĆ (1879), JURINAC (1884), BOHATSCH (1892), WERNER (1895), KOČA (1900, 1901), ABAFI-AIGNER (1910), TÁBORSKY (1910), GALVAGNI (1902, 1909, 1921, 1935), REBEL (1910, 1912, 1914), PUSCHNIG (1914), HOFBAUER (1916), GRUND (1918), ZERNY (1920), SCHAWERDA (1921), STAUDER (1923), SCHWINGENSCHUSS & WAGNER (1925), HAFNER (1930), SZENTIVÁNY (1944), NEUSTETTER (1956), MLADINOV (1958, 1968, 1976), BARTOL *et al.* (1964), BURGERMEISTER (1964), DANIEL (1971), KOVAČEVIĆ & FRANJEVIĆ-OŠTRC (1978), KRANJČEV (1985), WITT (1987), WARING & THOMAS (1989), REINHARDT (1990), HAFNER (1994), HABELER (2003), FUNDURULJA (2006), KAZIMIERCZAK (2009), KOREN & BJELIĆ (2010), KOREN & LADAVAC (2013), KOREN & LAUŠ (2012), KOREN (2018), VELJKOVIĆ (2019)

Altogether 22 species have been, with certainty, recorded from Croatia (Tab. 1). As most Sphingidae are strong flyers and some are even migratory, the number of species per country in the wider surroundings of Croatia is more or less the same. The numbers of recorded species in the neighboring countries are as follows: 21 in Slovenia (CARNELUTTI, 1992), 19 in Bosnia & Herzegovina (HANJALIĆ & LELO, 2015), 2015), 17 in Hungary (VARGA & GYULAI, 2012), and 25 in North Macedonia (KRPAČ *et al.*, 2019).

Two species, *Hippotion celerio* and *Sphingoneopsis gorgoniades*, have not been recorded recently.

Hippotion celerio is an occasional migrant in Europe, arriving from tropical Africa and India to the western Palearctic region. In the Mediterranean, two or three migration-induced generations could occur between June and October (PITTAWAY, 2022). It was recorded in Croatia only four times (ŠLOSER, 1870; VUKOTINOVIĆ, 1879; GALVAGNI, 1909; STAUDER, 1923) and a single specimen is stored in the collections of CNHM in Zagreb. While the species can establish temporary populations in the warmer parts of the country, most probably along the coastline, the lack of recent records indicates it is only an irregular visitor to the area.

Sphingoneopsis gorgoniades is the smallest hawk-moth in Europe with a very sporadic and poorly understood distribution. In Europe, it occurs from Croatia, across Albania, Northern Macedonia, Greece, Bulgaria, Romania across southern Ukraine, and Crimea (PITTAWAY, 2022). In Croatia it was recorded from a single locality near Senj (Zenng), collected by Dobiasch (ABAFI-AIGNER, 1910; GRUND, 1918). A series of the species exists in the Natural History Museum, London, and one male is found in the Natural History Museum in Vienna (ZERNY, 1933). The authors of this work are not aware that the species has been recorded since the early 20th century in Senj or at any other locality

in Croatia. However, the area around Senj has not been a target of any recent lepidopterological surveys so it is not impossible that a population of the species still exists in the area. The nearest known populations are found in North Macedonia (KRPAČ *et al.*, 2019).

Aside from the 22 recorded species, two additional hawk-moths might still be expected; *Hyles hippophaes* (Esper, 1789) and *Hyles nicaea* (de Prunner, 1798).

H. hippophaes is an easily recognizable species, with the forewing mostly lacking the typical black marking present in similar species like *H. gallii* and *H. euphorbiae* while the median area is distinctly lighter in color. It is distributed from northern Spain and France to Germany, Italy, and the Black Sea coast (LERAUT, 2006). Again, the distribution on the maps also includes parts of Croatia (LERAUT, 2006). According to our data, it has never been recorded in the country. However, this species tends to wander, and individuals may turn up at great distances from known breeding grounds (PITTAWAY, 2022), so this possibility cannot be excluded. The typical habitat of the species is river islands and sand banks overgrown with *Hippophae rhamnoides*, its preferred host plant (PITTAWAY, 2022). *H. rhamnoides* was historically present in northern Croatia at several localities along the Drava River according to herbarium material that dates from the end of the 19th and the beginning of the 20th century (NIKOLIĆ & TOPIĆ, 2005; FRANJIĆ *et al.*, 2016). Due to the extensive hydro-technical interventions on the watercourse, natural habitats have been drastically altered along the Drava River, and the majority of known localities have been destroyed (NIKOLIĆ & TOPIĆ, 2005). Recently, the plant was rediscovered in one locality in Podravina with additional individuals planted in order to regenerate the colony (FRANJIĆ *et al.*, 2016). In neighboring Hungary, the *H. rhamnoides* is slightly more widespread but *H. hippophaes* has not been recorded so far (SÁFIÁN & HADARICS, 2005).

The second potential species, *Hyles nicaea*, is very similar to *H. euphorbiae*, but it is distinctly larger, with a wingspan of 70-80 mm in comparison with 58-65 mm in *H. euphorbiae* (LERAUT, 2006). Also, the hindwing in *H. nicaea* is more strongly marked with black. While in some publications the whole eastern Adriatic coastline is marked as part of the distribution range for this species (LERAUT, 2006; PITTAWAY, 2022), there are no known records from Croatia. The range of this species extends from Portugal and Spain, across southern Europe to Turkey, Georgia, Armenia, and Azerbaijan (PITTAWAY, 2022). The closest populations to Croatia are located in North Macedonia (KRPAČ *et al.*, 2019). According to PITTAWAY (2022), it is a local and scarce species, disappearing from known areas for many years and appearing in others. According to Pittaway (2022), the habitats are sunny, drained, stony limestone slopes with clumps of *Euphorbia* especially *Euphorbia nicaeensis* also present in Croatian flora. Thus, the species may also appear in Croatia.

On the vernacular names of Sphingidae of Croatia

With the growing interest of the local communities in amateur Lepidoptera surveys and citizen science data collection, there is also an increasing need and also a demand for the establishment of systematic lists of vernacular names for various insect groups. Sphingidae, being large and attractive moths are one of such groups for which names are needed. With the rise of open data platforms like Biologer (POPOVIĆ *et al.*, 2020), iNaturalist and others, citizen scientists contribute to data collection with accurately georeferenced photographs. However, the scientific community is not fulfilling its role in supporting the work of citizen scientists by establishing Croatian vernacular names.

As a minor contribution, we have prepared the list given below for all the recorded Sphingidae species as well as for the two potential ones (Tab. 1).

Sphingidae, play an important role in the entomology history of Croatia. This is particularly true of *H. croatica* as it has been for more than 20 years the symbol of the Croatian Entomological Society as well as of the journal *Entomologia Croatica*.

In the available literature, the most common name used for the family Sphingidae is "ljljci" (MLADINOV, 1976; KOREN & GOMBOC, 2017; DURBEŠIĆ *et al.*, 2018). Another name can be found on some internet sites "sumračnjaci", reflecting the crepuscular activity of many species. However, "ljljci" is a commonly used name throughout the literature and the general public.

For each species, common names have appeared in publications on only a few occasions. This is mostly because the papers at the beginning of the 20th century were

Tab. 1. List of hawk-moths present or potentially present (*) in Croatia with their English and Croatian vernacular names.

	Latin name	English name	Croatian name
1	<i>Hemaris croatica</i> (Esper, 1800)	Olive Bee hawkmoth	hrvatska golupka
2	<i>Hemaris fuciformis</i> (Linnaeus, 1758)	Broad-bordered bee hawk-moth	širokorubi bumbarasti ljljak
3	<i>Hemaris tityus</i> (Linnaeus, 1758)	Narrow-bordered bee hawk-moth	uskorubi bumbarasti ljljak
4	<i>Deilephila elpenor</i> (Linnaeus, 1758)	Large Elephant hawkmoth	veliki vinski ljljak
5	<i>Deilephila porcellus</i> (Linnaeus, 1758)	Small Elephant hawkmoth	mali vinski ljljak
6	<i>Hippotion celerio</i> (Linnaeus, 1758)	Silver-striped hawkmoth	srebrenoprugi ljljak
7	<i>Hyles euphorbiae</i> (Linnaeus, 1758)	Spurge hawkmoth	mlječkin ljljak
8	<i>Hyles gallii</i> (Rottemburg, 1775)	Bedstraw hawkmoth	broćikin ljljak
9	<i>Hyles hippophaes</i> (Esper, 1789)*	Seathorn hawk-moth	pasjetrni ljljak
10	<i>Hyles livornica</i> (Esper, 1780)	Striped hawkmoth	prugasti ljljak
11	<i>Hyles nicaea</i> (de Prunner, 1798)*	Mediterranean hawk-moth	sredozemni ljljak
12	<i>Hyles vespertilio</i> (Esper, 1780)	Bat hawkmoth	sivokrili ljljak
13	<i>Daphnis nerii</i> (Linnaeus, 1758)	Oleander hawkmoth	oleandrov ljljak
14	<i>Macroglossum stellatarum</i> (Linnaeus, 1758)	Hummingbird hawkmoth	obična golupka
15	<i>Proserpinus proserpina</i> (Pallas, 1772)	Willowherb hawkmoth	vrbolikin ljljak
16	<i>Sphingoneopsis gorgoniades</i> (Hübner, 1819)	Gorgon hawkmoth	gorgonin ljljak
17	<i>Laothoe populi</i> (Linnaeus, 1758)	Poplar hawkmoth	topolin ljljak
18	<i>Marumba quercus</i> (Denis & Schiffermüller, 1775)	Oak hawkmoth	hrastov ljljak
19	<i>Mimas tiliae</i> (Linnaeus, 1758)	Lime hawkmoth	lipin ljljak
20	<i>Smerinthus ocellata</i> (Linnaeus, 1758)	Eyed hawkmoth	okati ljljak
21	<i>Acherontia atropos</i> (Linnaeus, 1758)	Death's Head hawkmoth	mrtvačka glava
22	<i>Agrius convolvuli</i> (Linnaeus, 1758)	Convolvulus hawkmoth	slakov ljljak
23	<i>Sphinx ligustri</i> Linnaeus, 1758	Privet hawkmoth	kalinin ljljak
24	<i>Sphinx pinastri</i> Linnaeus, 1758	Pine hawkmoth	borov ljljak

mostly written in Hungarian (ABAFY-AIGNER *et al.*, 1896; ABAFI-AIGNER, 1910) or in German (GRUND, 1918). VUKOTINOVIĆ (1879) listed a vernacular name for each Lepidoptera species he recorded around Zagreb, including hawk-moths, with names being most probably translations from other languages adjusted for the easier use in Croatian. He lists a total of 21 species that he named as follows: *A. atropos* "smrtoglavac", *A. convolvuli* "slakar", *S. ligustri* "zimolezinar", *S. pinastri* "jelvar", *H. vespertilio* "šišmičar", *H. gallii* "brošikar", *H. euphorbiae* "mliečikar", *H. livornica* "vinikar", *H. celerio* "lozar", *D. elpenor* "slonar", *D. porcellus* "zlolepar", *D. nerii* "zlolepar", *M. tiliae* "lipar", *M. quercus* "hrastar", *S. ocellata* "očinar", *L. populi* "zubar", *P. proserpina* "vrboličar", *M. stellatarum* "zvjezdar", *H. tityus* "kušar", *H. fuciformis* "dronjar", *H. croatica* "hrvat". After the original publication these names were never used in the literature as far as we know, which has been confirmed by colleagues in oral communication. Indeed, many of them are not in the spirit of the modern Croatian language, although many similar names are actually used even today: e.g. 'mrtvačka glava' for *A. atropos*, 'mlječikin ljljak' for *H. euphorbiae*, 'hrvatska golupka' for *H. croatica* etc.

When available, we proposed these commonly known and used names, altogether for 17 out of the 22 species. For the remaining ones, new names were established with explanations follow.

Hemaris fuciformis and *H. tityus* were collectively called 'bumbarasti ljljci', but without distinction. Accordingly, we proposed new names based on their wing coloration, širokorubi bumbarasti ljljak for *H. fuciformis* due to the wide black wing border and uskokrili bumbarasti ljljak for *H. tityus* due to its thin black border on the wings. For *Sphingoneopsis gorgoniades* we proposed a translation of the English name Gorgon hawkmoth, "gorgonin ljljak". For *Hyles vespertilio* we proposed "sivokrili ljljak" meaning grey-winged hawkmoth, due to the predominantly grey forewings. *Hippotion celerio* was named "srebrenoprugi ljljak" meaning silver-striped hawkmoth due to the silver coloration of the forewings. In all other cases it was proposed that commonly used names become official names.

CONCLUSIONS

This work aims to be a baseline for future studies of Sphingidae in Croatia. While not all the existing literature may be presented in this work, a vast majority of references were consulted. In terms of species distribution, further field surveys, as well as the publication of existing data, will further contribute to the knowledge of this family in Croatia, but no major discoveries are to be expected. Still, the open question remains in respect to *Sphingoneopsis gorgoniades*, but to solve this, targeted field surveys are needed in the future.

ACKNOWLEDGEMENTS

The first author is grateful to Bruno Schmidt and Daria Kranželić for the immense help with the Lepidoptera database and Zotero references database that were irreplaceable for creating this work. The second author is grateful to dr. sc. Snježana Vujčić-Karlo for mentorship during the creation of the Checklist of Sphingidae of Croatia which was a part of Rector's Award.

REFERENCES

- ABAFI-AIGNER, L., 1902: A horvát-szlavonországi lepke-fauna. *Rovartani lapok* 9(3), 58–61.
- ABAFI-AIGNER, L., 1910: Adelék Magyar Tengermellék, Horvátország és Dalmácia lepkefaunájához. *Rovartani lapok* 17(55–57), 71–105.
- ABAFY-AIGNER, L., PÁVEL, J. & UHRYK, F., 1896: Fauna Regni Hungariae. Ordo Lepidoptera. *Regia Societas Scientiarum Naturalium Hungarica* 3, 1–82.
- BARTOL, B., BARTOL, V. & MICHELLI, S., 1964: Beitrag zur Kenntnis der Makrolepidopterenfauna der adriatischen Insel Krk (Veglia). *Nachrichtenblatt der Bayerischen Entomologen* 13(4), 33–59.
- BERRA, M., 1982: Velebit. I spedizione del Giornale italiano di Entomologia. *Giornale italiani di Entomologia* 1, 43–47.
- BOHATSCH, O., 1892: Beiträge zur Lepidopteren-Fauna Slavoniens. *Wiener Entomologischen Vereines* (2), 31–50.
- BURGERMEISTER, F., 1964: Makrolepidopteren aus dem Raume Dubrovnik (Süddalmatien, FVR Jugoslawien). *Zeitschrift der Wiener Entomologischen Gesellschaft* 49, 137–152.
- CARNELUTTI, J., 1992: Rdeči seznam ogroženih metuljev (Macrolepidoptera) v Sloveniji. *Varstvo narave* 17, 61–104.
- DANIEL, F., 1971: Wanderfalter in Rovinj - Südstrien 1970. *Atalanta* 3(5), 310–311.
- DURBEŠIĆ, P., STANIĆ KOŠTROMAN, S., ŠERIĆ JELASKA, L. & MAĐARIĆ, B., 2018: Entomologija – znanost o kukcima. Sveučilišni udžbenik. Fakultet prirodoslovnih, matematičkih i odgojnih znanosti Sveučilišta u Mostaru Mostar.
- FRANJIĆ, J., HORVAT, G. & KRSTONOŠIĆ, D., 2016: New localities and syntaxonomic characteristics of sea buckthorn (*Hippophaë rhamnoides* L., Elaeagnaceae) in Croatia. *Šumarski list* 140(3–4), 111–115.
- FUNDURULJA, D., 2006: Studija o utjecaju na okoliš Centra za gospodarenje otpadom Splitsko-dalmatinske županije u Lećeveci.pdf.
- GALVAGNI, E., 1902: Beiträge zur Kenntniss der Fauna einiger dalmatinischer Inseln. *Verhandlungen zoologisch-botanischen Gesellschaft in Wien* 52, 362–388.
- GALVAGNI, E., 1909: Die zoologische Reise des Naturwissenschaftlichen Vereines nach Dalmatien im April 1906. 13. Lepidoptera (Beiträge zur Kenntnis der Lepidopterenfauna der Adriatischen Inseln). Sonder-Abdruck aus den Mitteilungen des Naturwissenschaftlichen Vereines an der Universität Wien. 7, 154–254.
- GALVAGNI, E., 1921: Nachtrag zur Kenntnis der Schmetterlingsfauna Lussins. *Verhandlungen zoologisch-botanischen Gesellschaft in Wien* 72, 84–89.
- GALVAGNI, E., 1935: Ergänzung zur Kenntnis der Schmetterlings-fauna von Hvar (Lesina). Sonder-Abdruck aus den Mitteilungen des Naturwissenschaftlichen Vereines an der Universität Wien 84, 118–121.
- GEIGER, V., 1873: Beitrag zur Schmetterlingskunde Dalmatiens. *Verhandlungen der zoologisch-botanischen Gesellschaft in Wien* 23, 167–168.
- GERMAR, E. F., 1814: Reise durch Österreich und Tyrol nach Dalmatien und Ragusa. Leipzig.
- GERMAR, E. F., 1817: Reise nach Dalmatien und in das Gebiet von Ragusa. F. A. Brockhaus Leipzig und Altenburg.
- GRUND, A., 1918: Beiträge zur kroatischen Lepidopteren-Fauna. Beitrag C. Lepidopteren der Umgebung von Zagreb (Agram). *Glasnik Hrvatskog prirodoslovnog društva* 30, 59–71.
- HABELER, H., 1976: Beitrag zur Lepidopterenfauna Dalmatiens. *Acta entomologica Jugoslavica* 12(1–2), 67–86.
- HABELER, H., 2003: Die Schmetterlinge der Adria-Insel Krk. Eine ökofaunistische Studie. Delta Druck, Verlag Heinz Peks Graz.
- HAFNER, I., 1930: Prirodoslovna istraživanja sjevernodalmatinskog otočja. I Dugi i Kornati. Lepidoptera. *Jugoslavenska akademija znanosti i umjetnosti, zasebno izdanje* 16, 45–62.
- HAFNER, I., 1994: Verzeichnis der bei Knin gesammelten Schmetterlinge (Lepidoptera). *Natura Croatica* 3(2), 119–184.
- HANJALIĆ, J. & LELO, S., 2015: Hrvatska golupka, *Hemaris croatica* (Esper, 1800) (Lepidoptera: Sphingidae), nova vrsta u fauni leptira Bosne i Hercegovine. *Udruženje za inventarizaciju i zaštitu životinja* 11, 29–34.
- HARBICH, H., 2003: Sphingidae 2002. *Atalanta* 34(3/4), 375–380.

- HOFBAUER, L., 1916: Entomologische Herbsttage in Dalmatien. Zeitschrift des Österreichischen Entomologischen Vereins **1**, 26–27.
- IGALFFY, K., MLADINOV, L. & PAVLETIĆ, J., 1965: Contribution à l'étude de la faune de l'île de Pag. Rapports et Procès des réunions de la C.I.E.S.M.M. **18**(2), 531–533.
- DE JONG, Y., VERBEEK, M., MICHELSEN, V., BJØRN, P. de P., LOS, W., STEEMAN, F., BAILLY, N., BASIRE, C., CHYLA-RECKI, P., STILOUKAL, E., HAGEDORN, G., WETZEL, F., GLÖCKLER, F., KROUPA, A., KORB, G., HOFFMANN, A., HÄUSER, C., KOHLBECKER, A., MÜLLER, A., GÜNTSCH, A., STOEVE, P. & PENEV, L., 2014: Fauna Europaea – all European animal species on the web. Biodiversity Data Journal **2**, 1–35.
- JURINAC, A. E., 1884: 188. Dodatak: Leptiri velikaši (makrolepidoptera) okolice Varažd. Izvješće Kralj. Velike Gimnazije u Varaždinu. Brzotiskom Platzera sina Varaždin. p. 1–3.
- JURINAC, A. E., 1887: Prilog fauni zapadne Slavonije. Glasnik Hrvatskoga Naravoslovnoga Društva **2**, 21–29.
- KAWAHARA, A. Y., MIGNAULT, A. A., REGIER, J. C., KITCHING, I. J. & MITTER, C., 2009: Phylogeny and Biogeography of Hawkmoths (Lepidoptera: Sphingidae): Evidence from Five Nuclear Genes. PLoS ONE **4**(5), e5719.
- KAZIMIERCZAK, J., 2009: Moths and butterflies (Lepidoptera) found in the area of the Mljet National Park – results of the research performed in 2006. Natura Croatica **18**(2), 443–447.
- KITCHING, I. J. & CADIOU, J.-M., 2000: Hawkmoths of the world: an annotated and illustrated revisionary checklist (Lepidoptera:Sphingidae). Natural History Museum, Cornell University Press London, Ithaca.
- KOČA, GJ., 1900: Prilog fauni gore Papuka i njegove okoline. Glasnik Hrvatskoga Naravoslovnoga Društva **12**(1–3), 100–134.
- KOČA, GJ., 1901: Prilog fauni leptira (Lepidoptera) Hrvatske i Slavonije. Glasnik Hrvatskoga Naravoslovnoga Društva **13**, 1–67.
- KOREN, T., 2018: Diversity of moths (Lepidoptera: Heterocera) in the surroundings of the Bednja River, Varaždin County, Northern Croatia. Natura Croatica **18**(1), 111–141.
- KOREN, T., 2019: The distribution of Willowherb Hawkmoth *Proserpinus proserpina* (Pallas, 1772) (Lepidoptera, Sphingidae) in Croatia. Acta Entomologica Slovenica **27**(1), 51–57.
- KOREN, T. & BJELIĆ, M., 2010: New data about butterflies and moths (Insecta: Lepidoptera) of Kornati islands, Croatia. Entomologia Croatica **14**(3–4), 45–52.
- KOREN, T. & LAUŠ, B., 2012: The first faunistic records of butterflies from two small Adriatic islands, Olib and Šćedro, Croatia. Entomologia Croatica **16**(1–4), 115–124.
- KOREN, T. & LADAVAC, L., 2013: Diversity of Macroheterocera (except fam. Noctuidae [sensu novo] and fam. Geometridae) of central Istria, Croatia. Natura Croatica **22**(1), 73–94.
- KOREN, T. & GOMBOC, S., 2017: Noćni leptiri Krapinsko-zagorske županije. Javna ustanova za upravljanje zaštićenim dijelovima prirode Krapinsko-zagorske županije Zagreb.
- KOREN, T., KULIJER, D., MARTINOVIĆ, M., LAUŠ, B. & KRANŽELIĆ, D., 2022: New records of the Bat Hawkmoth, *Hyles vespertilio* (Esper, 1780) (Lepidoptera: Sphingidae) in Croatia, Bosnia and Herzegovina and Serbia. Acta Entomologica Serbia **27**, 1–11.
- KOREN, T., BJELIĆ, M., PEROVIĆ, F., ŠAŠIĆ, M., MIHOČI, I. & KUČINIĆ, M., 2011: Distribution of the olive bee hawk moth, *Hemaris croatica* (Esper, 1800) (Lepidoptera, Sphingidae) in Croatia. Entomologia Croatica **15**(1–4), 255–264.
- KOVAČEVIĆ, Ž. & FRANJEVIĆ-OŠTRC, M., 1978: Značaj faune Macrolepidoptera u šumama SR Hrvatske s biocenološkog i biogeografskog stanovišta. Vol. 35. Šumarski institut Jastrebarsko Zagreb.
- KRANJČEV, R., 1985: Odnos faune makrolepidoptera prema prirodnim i antropogenim staništima Podravine i podravskih pijesaka (I). Podravski zbornik **11**, 200–226.
- KRPAČ, V., ZEQRİ, R., KUČINIĆ, M., ABDIJA, X., BEADINI, N., KRPAČ, M., DARCEMONT, C., LEMONNIER – DARCEMONT, M., KRSTESKA, V., LAZAREVSKA, S. & ČERNILA, M., 2019: Contribution to the fauna of the hawk moth family (Lepidoptera, Sphingidae) in the Republic of North Macedonia. Natura Croatica **28**(1), 107–130.
- LERAUT, P., 2006: Saturnids, Lasiocampids, Hawkmoths, Tiger Moths. *Moths of Europe*. Vol. 1. NAP Editions Verrières-le Buisson.
- LIPSCOMB, C. G., 1961: Yugoslavia revisited. Entomologist's record and journal of Variation **73**, 141–146.
- MANN, J., 1857: Verzeichnis der im Jahre 1853 in der Gegend von Fiume gesammelten Schmetterlinge. Wiener entomologische Monatschrift **1**(6), 139–189.

- MANN, J., 1867: Schmetterlinge gesammelt im J. 1866 um Josefthal in der croat. Militärgrenze. Verhandlungen der zoologisch-botanischen Gesellschaft in Wien **17**, 63–76.
- MANN, J., 1869: Lepidopteren gesammelt während dreier Reisen nach Dalmatien in den Jahren 1850, 1862 und 1868. Verhandlungen der zoologisch-botanischen Gesellschaft in Wien **19**, 371–388.
- MLADINOV, L., 1958: Popis noćnih leptira (Noctua) Zagreba i okolice. Vol. 1. Hrvatski narodni zoološki muzej Zagreb.
- MLADINOV, L., 1968: Fauna leptira Jadranskog otoka Unije. Biološki glasnik **20**, 151–164.
- MLADINOV, L., 1976: Lepidoptera iz doline gornjeg toka rijeke Kupe II. Bombyces i Sphingides. Acta entomologica Jugoslavica **12**(1–2), 89–99.
- MLADINOV, L., 1978: Prvi dodatak poznavanju faune Macrolepidoptera iz doline gornjeg toka rijeke Kupe. Acta entomologica Jugoslavica **14**(1–2), 63–67.
- MLADINOV, L. & HERMAN, Č., 1964: Polimorfizam gusjenica *Celerio euphorbiae* L. Biološki glasnik **17**, 1–5.
- MOUCHA, J., 1965: Tagfalter-fauna der Insel Brač (Lepidoptera). Acta faunistica entomologica Musei Nationalis Pragae **11**(106), 265–275.
- MÜLLER, H., 1921: Vier Wochen auf der Insel Brazza. Entomologischer Anzeiger **1**(4–6), 17–18.
- NEUSTETTER, H., 1956: Sammelreisen nach Dalmatien (Jugoslavien). Entomologisches Nachrichtenblatt **3**(3), 4–8.
- DE LA NICHOLL, B. M., 1899: Butterfly hunting in Dalmatia, Montenegro, Bosnia and Herzegovina. The Entomologist's Record and Journal of Variation **11**(1), 1–8.
- NIKOLIĆ, T. & TOPIĆ, J., 2005: Crvena knjiga vaskularne flore Hrvatske. Državni zavod za zaštitu prirode Zagreb.
- NOVAK, P., 1940: Gli insetti dannosi in Dalmazia Aestratto dal bollettino della soc. Adriatica di scienze naturali Trieste. Vol. 38.
- PITTAWAY, A. R., 1983: An annotated checklist of the western Palaearctic Sphingidae (Lepidoptera). Entomologist's Gazette **34**, 67–86.
- PITTAWAY, A. R., 2022: Sphingidae of the Western Palaearctic (including Europe, North Africa, the Middle East, western Siberia and western Central Asia). Downloaded from <https://tpittaway.tripod.com/sphinx/list.htm> on 5 January 2022.: A.R. Pittaway.
- PITTAWAY, T., 1993: The Hawkmoths of the Western Palearctic. Harley Books, Colchester UK.
- POPOVIĆ, M., VASIĆ, N., KOREN, T., BURIĆ, I., ŽIVANOVIĆ, N., KULIJER, D. & GOLUBOVIĆ, A., 2020: Biologer: an open platform for collecting biodiversity data. Biodiversity Data Journal **8**.
- PUSCHNIG, K., 1914: Zum Dundowalde. Deutsche Entomologische Zeitschrift **1**(1–2).
- REBEL, H., 1904: Studien über die Lepidopterenfauna der Balkanländer. II. Teil. Bosnien und Herzegovina. Annalen des Naturhistorischen Museums in Wien **19**, 97–377.
- REBEL, H., 1910: Lepidopteren aus dem Gebiete des Monte Maggiore in Istrien. XXI. Jahresbericht des Wiener entomologischen Vereines 97–110.
- REBEL, H., 1912: Lepidopteren aus dem Gebiete des Monte Maggiore in Istrien. I. Nachtrag. Jahresberichte Wiener entomologischer Verein **22**, 227–240.
- REBEL, H., 1913: Studien über die Lepidopterenfauna der Balkanländer, III. Teil. Sammelergebnisse aus Montenegro, Albanien, Mazedonien und Thrazien. Annalen des K.K. Naturhistorischen Hofmuseums **27**, 281–334.
- REBEL, H., 1914: Über die Lepidopterenfauna von Brioni grande. Jahresbericht des Wiener entomologischen Vereines **24**, 181–201.
- REINHARDT, R., 1990: Beitrag zur Tagfalterfauna der mitteldalmatinischen Adriaküste (Lepidoptera, Papilionoidea). Nachrichten des entomologischen Vereins Apollo. Neue Folgen **11**(2), 113–117.
- SÁFIÁN, S. & HADARICS, T., 2005: *Hyles vespertilio* (Esper, 1779), new to the Lepidoptera fauna of Hungary (Lepidoptera: Sphingidae). Folia Entomologica Hungarica Rovartani Közlemények **66**, 245–251.
- SCHAWERDA, K., 1920: Lepidopteren-Ausbeute aus der Gegend von Lovrana und Monte Maggiore. Zeitschrift des Österreichischen Entomologischen Vereines **5**, 10–11, 20–21, 28, 36, 43.
- SCHAWERDA, K., 1921: Beiträge zur Lepidopterenfauna der kroatischen Küste und Neubeschreibungen. Deutsche Entomologische Zeitschrift **35**, 111–138.
- SCHAWERDA, K., 1927: Beitrag und Nachtrag zur Lepidopterenfauna der Dalmatischen Inseln, beziehungsweise der Insel Lussin. Verhandlungen der Zoologisch-Botanischen Gesellschaft **77**, 79–81.

- SCHWINGENSCHUSS, L. & WAGNER, F., 1925: Beitrag zur Macro-Lepidopteren-Fauna Süddalmatiens insbesondere der Umgebung Gravosa's. Zeitschrift des Österreichischen Entomologischen Vereins **10–12**, 53–71, 78–82, 116–119.
- SEYER, H., 1938: Einige Erlebnisse von meiner Jugoslawienfahrt und der Fang einer neuen *Papilio podalirius* L. - Monstrosität (*partitus*?). Entomologische Rundschau **55**(54), 629–657.
- SKINNER, B., 2009: Colour identification guide to moths of the British Isles: Macrolepidoptera. Apollo Books Stenstrup, Denmark.
- ŠLOSER, J. K., 1870: Kalnička gora sa svoje prirodopisne znamenitosti. Rad Jugoslavenske akademije znanosti i umjetnosti **11**, 146–227.
- STAUDER, H., 1923: Die Schmetterlingsfauna der illyro-adriatischen Festland- und Inselzone (Faunula Illyro-Adriatica). Zeitschrift für wissenschaftliche Insektenbiologie Berlin **18**(1/2, 3/4, 5/7, 8/9, 10/11, 12), 10–18, 58–68, 106–114, 187–202, 253–267, 317–327.
- SZENT-IVÁNY, J., 1944: Lepkefaunasztkaiés Oekologiaimegfigyelések a Magyar Nemzeti Múzeum Albrecht Kir. Herceg Biológiai Állomása Környékén. Albertina: Veröffentlichungen der Erzherzog Albrecht biol. Station des ung. Nat. Museums. **1**, 135–148.
- TÁBORSKY, V., 1910: Eine grössere Sammeltour im slavischen Süden. Entomologische Zeitschrift **23 & 24**(224 & 230), 224 & 230; 18–19 & 24–25.
- VARGA, Z. & GYULAI, P., 2012: Magyarország nagylepkei = Macrolepidoptera of Hungary. Heterocera Press Budapest.
- VELJKOVIĆ, M., 2019: Contribution to the knowledge of butterfly and moth fauna (Insecta: Lepidoptera) of Gornje Plavnice, Bjelovar, Croatia – result of a one year photographic study. Natura Croatica **28**(2), 345–358.
- VIGNJEVIĆ, G., ZAHIROVIĆ, Ž., TURIC, N. & MERDIĆ, E., 2010: Moths (Lepidoptera: Heterocera) of Kopački rit Nature Park - Results of preliminary research. Entomologia Croatica **14**(3–4), 17–32.
- VUKOTINOVIĆ, L., 1879: Fauna leptirah u okolišu Zagrebačkom. Jugoslavenska akademija znanosti i umjetnosti Zagreb.
- WARING, P. & THOMAS, R., 1989: Butterflies of the Yugoslavian island of Mljet. 19 August - 2 September 1988. The Bulletin of the Amateur Entomologists' Society **48**, 147–149.
- WITT, T. J., 1987: Lepidopterologische Sammelergebnisse der Reisen Franz Daniels nach Istrien in den Jahren 1965 mit 1971 (Lepidoptera, Bombyces et Sphinges). Entomofauna **8**(28), 413–440.
- ZERNY, H., 1920: Beitrag zur Kenntnis der Fauna Dalmatiens. Zoologische Jahrbücher **42**, 195–204.
- ZERNY, H., 1933: Lepidopteren aus dem nördlichen Libanon. Deutsche Entomologische Zeitschrift **47**, 60–109.