A revised annotated checklist of louse flies (Diptera, Hippoboscidae) from Slovakia

Jozef Oboňa, Oldřich Sychra, Stanislav Greš, Petr Heřman, Peter Manko, Jindřich Roháček, Anna Šestáková, Jan Šlapák, Martin Hromada

Laboratory and Museum of Evolutionary Ecology, Department of Ecology, Faculty of Humanities and Natural Sciences, University of Presov, 17. novembra 1, SK – 081 16 Prešov, Slovakia
Department of Biology and Wildlife Diseases, Faculty of Veterinary Hygiene and Ecology, University of Veterinary and Pharmaceutical Sciences Brno, Palackého tř. 1946/1, CZ – 612 42 Brno, Czech Republic
Department of Entomology, Silesian Museum, Tyršova 1, CZ-746 01 Opava, Czech Republic
The Western Slovakia Museum, Múzejné námestie 3, SK – 918 09 Trnava, Slovakia
Faculty of Biological Sciences, University of Zielona Gora, Prof. Z. Szafrana 1, 65–516 Zielona Gora, Poland

Corresponding author: Jozef Oboňa (obonaj@centrum.sk)

Abstract
The list of all known locality and host records from the literature on louse flies from Slovakia are summarized, with the addition of new collection data. New locality data are provided for five species. Three species are added to the Slovakian list: Icosta minor (Bigot in Thomson, 1858), which was erroneously cited for Moravia instead of Slovakia in the previous checklist, and Ornithophila metallica (Schiner, 1864) and Ornithomya chloropus (Bergroth, 1901), which were overlooked from the last checklist. As a result, the louse fly fauna of Slovakia increases to 19 species: 12 autochthonous species and seven rare, non-native species only occasionally imported to Slovakia or migrating to the country with their hosts. This is by far the largest regional fauna of Hippoboscidae in Central Europe, and matches the richest southern European faunas. In total, 78 host-parasite associations concerning 46 bird-host species from eight orders and nine species of mammals, including humans, have been found from a literature review in Slovakia. Two host-parasite associations are reported from Slovakia for the first time: Ornithomya avicularia (Linnaeus, 1758) on Prunella modularis (Linnaeus, 1758) (Aves: Prunellidae) and Lipoptena fortisetosa Maa, 1965 on Homo sapiens Linnaeus, 1758 (Mammalia: Hominidae).
**Keywords**
Faunistics, literature review, louse flies, parasite-host associations

**Introduction**

Flies in the family Hippoboscidae, known as ‘louse flies’ or ‘keds’, belong among the Diptera and are a group of obligate parasites of mammals and birds (Rahola et al. 2011). All species are macrolarviparous, with females retaining the larva in the uterus until the end of the third instar; the three larval instars feed on secretions from the maternal accessory glands. The stage at which larviposition occurs represents a prepupal larva (e.g., Mehlhorn 2016). The larva (or pupa) is deposited in birds’ nests or on the hair of a mammalian host, but sometimes it is deposited on the ground by the female (e.g., Halos et al. 2004). Adults of both sexes are blood sucking and are known to act as vectors of many infectious agents, such as protozoa, bacteria, helminths, and possibly also viruses (e.g., Baker 1967, Kečera 1983, Halos et al. 2004, Liu et al. 2016, Skvarla and Machtinger 2019). Some species are host-specific, whereas others feed on a wide array of hosts (e.g., Ibáñez-Bernal et al. 2015, Mehlhorn 2016, Veiga et al. 2018).

Worldwide, more than 213 louse fly species are known (e.g., Maa 1963, Dick 2006, Rahola et al. 2011): 57 species from the Afrotropical region (e.g., Hutson and Oldroyd 1980, Oboňa et al. 2016), 26 from East Palaeartic Asia and Japan (e.g., Maa 1967, Mogi and Sawada 2002, Matyukhin et al. 2017), 9 from China, 8 from the eastern part of Russia (e.g., Soós and Hůrka 1986, Sun 1999), 6 from the Oriental and Australasian regions (e.g., Paramonov 1954, Amiot and Ji 2015, Farrow 2016), and 31 species have been reported from the Nearctic and Neotropical regions (e.g., Bequaert 1942, 1954, 1965, Savage et al. 2019).

From Europe, 30 species of Hippoboscidae are known (Petersen 2004, Pape et al. 2015). The species composition of the hippoboscid fauna in Slovakia is relatively well known; however, the investigation of Hippoboscidae in Slovakia is still far from complete. Scattered older published data on louse flies by Thalhammer (1899) and Brancsik (1910) are mentioned by Povolný and Rosický (1955). Subsequently, Povolný and Balát (1956), Dyk and Schanzel (1964), Čepelák (1974, 1982, 1985, 1986, 1987, 1988, 1992, 1993, 1994a, 1994b), Čepelák and Čepelák (1991), Chalupský and Macháček (1977), Chalupský (1980, 1986), Kištofík and Štefan (1980), Chalupský and Povolný (1983), Hubálek et al. (1988), Kištofík (1998), Kočišová et al. (2007), Roháček (1995, 2009), Straka (1981, 2001, 2005a, 2005b, 2010, 2011, 2016), Straka and Majzlán (2008, 2010, 2014, 2016), and Kočišová (2015) published additional information on the hippoboscid fauna of Slovakia. The most recent checklist of the family Hippoboscidae from Slovakia (Sychra 2009) comprised 16 species.

**Materials and methods**

Samples of Hippoboscini, Lipoptenini, and Ornithomyini came from unidentified material in the collections of the Laboratory and Museum of Evolutionary Ecology,
A revised annotated checklist of louse flies (Diptera, Hippoboscidae) from Slovakia

Department of Ecology, University of Presov (LMEE PO); of the Department of Entomology, Silesian Museum, Opava (SMOC); and of the Department of Biology and Wildlife Diseases, Faculty of Veterinary Hygiene and Ecology, University of Veterinary and Pharmaceutical Sciences Brno (VFU).

The material was identified using Povolný and Rosický (1955), Chalupský and Povolný (1983), Hutson (1984), Ducháč and Bádr (1998). The systematics and nomenclature follow Hutson and Oldroyd (1980), Kutty et al. (2010), Petersen et al. (2007), and Evenhuis et al. (2016).

Results

Tribe Hippoboscini

*Hippobosca equina* Linnaeus, 1758

**Published records:** Ladomirov (Ladomér), Rožňava (Rozsnyó), Slovenské Nové Mesto (S.A. Ujhely), Stropkov (Sztopók – Olyka) (Thalhammer 1899); Trnčín (Trëncsén) (Brancsik 1910, Chalupský 1986); Kečovo, Remetské Hámime, Rožňava (Povolný and Rosický 1955, Chalupský 1986); Bratislava, Kurinec, Staré Hory, Šasťin – Straže, Veľké Leváre (Kristófik and Štěfan 1980, Chalupský 1986); Královský Chlmec, Plešivecká planina (plain), Silica, Zádiel (Chalupský and Povolný 1983); Chřelák (Čepelák 1986); Dolné Štírany, Svoral, Žibrica (Čepelák and Čepelák 1991); Veľký Lysec (Čepelák 1992); Hunták (Čepelák 1993); Krivín (Čepelák 1994b); Bratislava-Lamač, Devínska Nová Ves, Horné Orešany, Jakubov, ostrov Kopač (island), Malacky, Štúrovo (Kristófik 1998); “Veľká Fatra” (Straka 2005b); Bábsky les (forest) (Straka and Majzlán 2010); Obúčná, Radzovce (Straka 2016); Burdov, Leliansky les (forest) (Straka and Majzlán 2016).

**Published host records:** main host: *Equus caballus* Linnaeus, 1758 (see Povolný and Rosický 1955, Kristófik and Štěfan 1980); occasional hosts: *Accipiter gentilis* (Linnaeus, 1758) (see Kristófik and Štěfan 1980), *Bos taurus* Linnaeus, 1758 (see Povolný and Rosický 1955, Chalupský and Povolný 1983), *Canis familiaris* Linnaeus, 1758 (see Povolný and Rosický 1955), *Capreolus capreolus* Linnaeus, 1758 (see Povolný and Rosický 1955, Chalupský and Povolný 1983), *Homo sapiens* Linnaeus, 1758 (see Povolný and Rosický 1955, Kristófik and Štěfan 1980, Kristófik 1998).

**Material examined:** Báb, 48°18’21.6”N, 17°53’16.5”E, 150 m a.s.l., 11.6.2007, 1 female, malaise trap, O. Majzlán leg. (LMEE PO); Drienovec, 48°37’04.4”N, 20°55’29.9”E, 200 m a.s.l., 1.10.2015, 1 female, from human, S. Greš leg. (LMEE PO); Kamenica nad Hronom nr. Štúrovo, 47°49’30”N, 18°43’03”E, 105 m a.s.l., 17.5.1984, 1 female, J. Roháček leg. (SMOC); Muránska planina NP, Poludnica res.-Suchý dol, 48°45’26”N, 20°02’32”E, 480 m a.s.l., 6.9.2011, 1 female (Fig. 1), sweeping over pasture meadow, J. Roháček leg. (SMOC); Muránska planina NP, Muráň castle env., 48°45’03”N, 20°02’54”E, 625 m a.s.l.; 4.5.2015, 1 male, sweeping undergrowth of steppe forest, J. Roháček leg. (SMOC); Cerová vrchovina PLA, Gemer-
Hippobosca longipennis Fabricius, 1805

Published records: Kečovo (Chalupský 1980, Chalupský and Povolný 1983, Chalupský 1986); Bábsky les (Straka and Majzlán 2010).

Published host records: Canis familiaris (see Chalupský 1980, Chalupský and Povolný 1983).
Comments: A rare and non-native species in Central Europe, distributed in the Mediterranean and Afrotropical regions. Up until now, only two individuals have been recorded in Slovakia, in 1953 and 2007 (Chalupský 1980, Straka and Majzlán 2010). It is an ectoparasite of dogs; occasionally it can occur also on other predatory mammals or ungulates (Chalupský 1980). Occassionally, it can be imported via human activities (e.g., through breeding of particular species of mammal).

Hippobosca variegata Megerle, 1803

Published records: Gabčíkovo (Povolný and Rosický 1955, as H. maculata, Chalupský 1980, Chalupský 1986).

Published host records: Canis familiaris (see Povolný and Rosický 1955, Chalupský 1980).

Comments: A rare and non-native species in Central Europe, distributed in the Afrotropical region. The only record from Slovakia is from 1951. It is an ectoparasite of cattle and domestic equines (Povolný and Rosický 1955). It can be occasionally imported through human activities (e.g., through breeding of particular species of mammals).

Tribe Lipoptenini

Lipoptena cervi (Linnaeus, 1758)

Published records: Mníchova Lehota (Barátszabadi), Omšenie (Nagysziklás) (Brancsik 1910); Dlhá Ves, Timoradz (Povolný and Rosický 1955); Blatnická dolina (valley in Veľká Fatra) (Dyk and Schanzel 1964); Chlaba, Hlboké, Jovsa, Kamienka, Kúty, Lozorno (Kríštofík and Štefan 1980, Chalupský 1986); Gabčíkovo, Modrá, Nitra, Plášťovce, Plešivec, Podunajské Biskupice, Silická planina (plain), Šaštín – Stráže, Timoradza (Chalupský and Povolný 1983, Chalupský 1986); Burdov (Čepelák 1986); Tepoľčany, (Chalupský 1986); Hrášková Lúka (Čepelák 1987); Hrdovická (Čepelák 1988); Silická planina (plain) (Hubálek et al. 1988); Bartošov prameň (well), Dolné Štítare, Gáborka, Haranč, Hrnčiarovce, Hnuták (Čepelák and Čepelák 1991); Veľký Lysec (Čepelák 1992); Nebrová (Čepelák 1994a); Nové Mesto nad Váhom, Podunajské Biskupice, Stará Lesná, Šaštín – Stráže, Veľká Fatra – Gaderská dolina (valley) (Kríštofík 1998); Klín, Rozsutec (Straka 2001); Hrochoť – Beňova dolina (valley) (Roháček 2009); Žalostiná (Straka 2010); Vršatské bradlá (cliff), Záhorská Bystrica (Straka 2011); “Nitrické vrchy” (Straka and Majzlán 2014).

Published host records: main hosts: Capreolus capreolus (see Dyk and Schanzel 1964, Kríštofík and Štefan 1980, Chalupský and Povolný 1983, Kríštofík 1998); Cervus elaphus Linnaeus, 1758 (see Dyk and Schanzel 1964, Kríštofík and Štefan 1980, Chalupský and Povolný 1983, Hubálek et al. 1988); occasional hosts: Capra hircus Linnaeus, 1758 (see Povolný and Rosický 1955); Homo sapiens (see Kríštofík and Štefan 1980, Kríštofík 1998); Rupicapra rupicapra (Linnaeus, 1758) (see Kríštofík 1998); Turdus philomelos C. L. Brehm, 1831 (see Chalupský and Povolný 1983).
Material examined: Diviacka Nová Ves, 48°44'58.9"N, 18°29'29.5"E, 280 m a.s.l., 4.9.2012, 1 male, from a human, J. Oboňa leg. (LMEE PO); Drienovec, 48°37'04.4"N, 20°55'29.9"E, 200 m a.s.l., 1.10.2015, 2 males, 1 female, from human, S. Greš leg. (LMEE PO); Stará Lesná, 49°08'11.3"N, 20°17'47.5"E, 750 m a.s.l., 8.9.2017, 1 male, from human, P. Manko leg. (LMEE PO); Tvrdošín (Skorušické vrchy), 49°22'19.5"N, 19°31'57.4"E, 750 m a.s.l., 23.9.2017, 1 female, from human, J. Šlapák leg. (LMEE PO); Východná, 49°04’04.2”N, 19°53’57.0”E, 780 m a.s.l., 15.9.2017, 1 male, from car, A. Šestáková leg. (LMEE PO); Nová Sedlica env., 49°03’22.1”N, 22°31’03.1”E, 505 m a.s.l., 1.10.1997, 4 females, sweeping undergrowth of deciduous forest, J. Roháček leg. (SMOC); Muránska planina NP, Šiance res., top plateau, 48°46’11”N, 20°04’14”E, 1000 m a.s.l., 7.9.2011, 1 male, the same, 4.9.2012, 1 male, J. Roháček leg. (SMOC); Muránska planina NP, Pohronská Polhora 5.9 km E, Kučalach Mt., 48°44’51”N, 19°52’27”E, 1060 m a.s.l., 10.10.2014, 2 females, sweeping undergrowth of beech-fir forest, J. Roháček leg. (SMOC); Muránska planina NP, Šarkanica res., 48°42’45”N, 19°59’19”E, 580 m a.s.l., 29.9.2017, 1 female, sweeping undergrowth of deciduous forest in ravine, J. Roháček leg. (SMOC); Cerová vrchovina PLA, Gemerský Jablonec – Vodokáš 1 km N, 48°13’00”N, 19°59’42”E, 280 m a.s.l., 27.9.2017, 1 male, the same, 1.11.2017, 3 females, sweeping undergrowth of oak-beach forest (Fig. 2), J. Roháček leg. (SMOC).

Comments: A relatively frequent species in Central Europe, widespread in the Palaearctic region and introduced to the Nearctic region. It is an ectoparasite of Cervidae, and also attacks human beings (Krištofík 1998).

Lipoptena fortisetosa Maa, 1965

Published records: Rozhanovce (Kočišová et al. 2007).

Published host records: Capreolus capreolus (Kočišová et al. 2007).

Material examined: Bogliarka, 49°16’37.1”N, 21°08’52.3”E, 450 m a.s.l., 15.7.2017, 1 female, from human, P. Manko leg. (LMEE PO); Lažany, 49°02’20.2”N, 21°05’40.8”E, 380 m a.s.l., 7.2017, 17 males, 13 females, 21.6.2017, 1 female, 5.9.2017, 4 males, 2 females, all from human, P. Manko leg. (LMEE PO); Levočská (dolina) valley, 49°04’08.3”N, 20°36’17.5”E, 780 m a.s.l., 12.8.2017, 1 female, from a human, A. Šestáková leg. (LMEE PO); Magurka – Oravská Magura (Oravská priehrada), 49°23’19.6”N, 19°31’34.3”E, 850 m a.s.l., 29.7.2017, 1 male, 1 female, 650 m a.s.l., 17.7.2017, 1 male, all from human, J. Šlapák leg. (LMEE PO); Prešov env. (near “pri Kríži”), 48°59’57.0”N, 21°13’03.7”E, 300 m a.s.l., 9.9.2017, 1 male, from a human, J. Šlapák leg. (LMEE PO); Stráne pod Tatrami, 49°09’26.7”N, 20°21’59.9”E, 750 m a.s.l., 8.9.2017, 1 male, from a human, J. Šlapák leg. (LMEE PO); Tvrdosin (Skorušické vrchy), 49°22’19.5”N, 19°31’57.4”E, 700 – 750 m a.s.l., 7.2016, 1 female, 10.7.2017, 1 male, 22.7.2017, 1 male, 3 females, 26.7.2017, 1 male, 31.8.2017, 1 female, all from human, J. Šlapák leg. (LMEE PO); Cerová vrchovina PLA, Tachty 2.2 km SW, Gortva valley, 48°08’41”N, 19°54’51”E, 320 m a.s.l., 13.9.2018, 2 females, netted from forest margin vegetation, J. Roháček leg. (SMOC).
Comments: A relatively frequent species in Slovakia, distributed in the eastern Palearctic region. Previously often confused with *Lipoptena cervi*. *L. fortiseta* has a western boundary of distribution in Central Europe. It is an ectoparasite of Cervidae, and also attacks human beings (Ducháč and Bádr 1998). *Homo sapiens* is here newly recorded as a (common) host of *L. fortiseta* in Slovakia.
**Melophagus ovinus** (Linnaeus, 1758)

**Published records:** Štúrovo (Povolný and Rosický 1955); Silica (Povolný and Rosický 1955, Hubálek et al. 1988, Chalupský 1986); Hažín, Kóprová dolina (valley), Šahy (Chalupský and Povolný 1983, Chalupský 1986); Poprad (Kočišová 2015).

**Published host records:** main host: *Ovis aries* Linnaeus, 1758 (see Povolný and Rosický 1955, Chalupský and Povolný 1983, Hubálek et al. 1988); occasional hosts: *Canis familiaris* and *Homo sapiens* (see Povolný and Rosický 1955), and *Equus caballus* (Kočišová 2015).

**Comments:** It is an ectoparasite of Bovidae, especially sheep (including lambs) (Chalupský and Povolný 1983). *Melophagus ovinus* is strongly affected by a decline of traditional horse and sheep farming in the monitored area (e.g., Bežák and Petrović 2006).

---

**Melophagus rupicaprinus** Rondani, 1879

**Published records:** Námestovo (Chalupský 1980, Chalupský 1986); Tatranská Kotlina (Chalupský and Povolný 1983, Chalupský 1986).

**Published host records:** *Ovis aries* (see Chalupský 1980), *Rupicapra rupicapra* (see Chalupský and Povolný 1983).

**Comments:** A relatively rare species in Central Europe. In Slovakia it is listed as endangered (EN) (Jedlička and Stloukalová 2001). Until now, only two records from 1951 and 1980 have been published from Slovakia (Chalupský 1980, Chalupský and Povolný 1983). It is an ectoparasite of mammals, collected mainly from *R. rupicapra* and, secondarily, sheep (Chalupský and Povolný 1983). *Rupicapra rupicapra* has an isolated population (*R. rupicapra* ssp. *tatrica*) in the Tatra Mountains in the north of the country, where *M. rupicaprinus* are found. Because it is isolated at the edge of its distribution range, this population of *M. rupicaprinus* is very vulnerable and like many other marginal populations, it could disappear rapidly and suddenly.

---

**Tribe Olfersiini**

**Crataerina pallida** (Olivier in Latreille, 1811)

**Published records:** no localities (Povolný and Rosický 1955); Banská Bystrica (Krištofík and Štefan 1980, Chalupský 1986); Vrútky (Straka 1981); Suchý (Čepelák 1985, Chalupský 1986); Bratislava (Krištofík 1998).

**Published host records:** *Apus apus* (Linnaeus, 1758) (see Povolný and Rosický 1955, Krištofík and Štefan 1980, Straka 1981, Krištofík 1998).

**Comments:** A frequent louse fly species in Central Europe, widespread in the Palaearctic region. A common ectoparasite of the bird species *Apus apus*, *Delichon urbicum* (Linnaeus, 1758) and (infrequently) of species from other birds, most frequently on young individuals (Krištofík 1998).
Even if the hosts are still widespread, their population density has declined over the past decades, and therefore the parasites will also suffer (BirdLife International 2018).

*ICA* *araeae* (Macquart, 1835)

**Published records**: Boheľov (Krištofík and Štefan 1980, Chalupský 1986).

**Published hosts**: *Ardea purpurea* Linnaeus, 1766 (Krištofík and Štefan 1980), *Ixobrychus minutus* (Linnaeus, 1766) (Krištofík and Štefan 1980).

**Comments**: A relatively rare species in Central Europe, widespread in the tropics and sub-tropics of the Old World. In Slovakia it is listed as vulnerable (VU) (Jedlička and Stloukalová 2001). Until now, only two records from 1977 have been published from Slovakia. *ICA* *araeae* is an ectoparasite of birds belonging to several different families; it is common on Ardeidae, and rarely found on species from other families (Krištofík and Štefan 1980). The host *Ardea purpurea* is mainly found in the SW part of the country, and although *Ixobrychus minutus* has a wider distribution, it is also more common in SW Slovakia. The rarity of this parasite in Slovakia is mainly due to its occurrence on the edge of its range (and hosts’ ranges) in the country.

*ICA* *minor* (Bigot in Thomson, 1858)

**Published records**: Patince (Chalupský and Macháček 1977, Chalupský 1986).

**Published host records**: *Passer montanus* (Linnaeus, 1758) (see Chalupský and Macháček 1977).

**Comments**: A relatively small, rare and non-native species in Central Europe, distributed in the Afrotropical region and the Mediterranean Basin. In Slovakia it was erroneously listed as vulnerable (VU) (Jedlička and Stloukalová 2001), even though it is not a native species in the country. An ectoparasite on various species of Passeriformes, less frequently found on species from other bird orders (Chalupský and Macháček 1977). The only known record from Slovakia is from 1974 (Chalupský and Macháček 1977, Chalupský 1980). It was mistakenly cited as occurring in the Czech Republic by Chalupský and Povolný (1987, 1997) and Sychra (2006, 2009).

*OLF* *aremennis* (Sahlberg, 1886)

**Published records**: “Slovakia” (Povolný and Balát 1956, as Lynchia palustris, Chalupský 1986).

**Published host records**: “eagle” (Povolný and Balát 1956).

**Comments**: A rare and non-native species in Central Europe, distributed mainly in the Nearctic and Neotropical regions. It is an ectoparasite of birds, mainly birds of prey (Chalupský 1980). The only known record from Slovakia is from 1904. That individual was originally misidentified as Ornithophila metallica by A. Wimmer (see Povolný and Balát 1956). Also, Povolný and Balát (1956) mentioned this specimen mistakenly under the name Lynchia palustris, which is in fact a synonym of Icosta albipennis from America (Chalupský 1980).
Ornithoica turdi (Olivier in Latreille, 1811)

**Published records:** Košice, Podunajské Biskupice (Povolný and Rosický 1955, Chalupský 1986); Podunajské Biskupice (Chalupský 1980, Chalupský and Povolný 1983).

**Published host records:** Emberiza citrinella Linnaeus, 1758 (see Povolný and Rosický 1955); Fringilla coelebs Linnaeus, 1758 and Sitta europaea Linnaeus, 1758 (see Povolný and Rosický 1955, Chalupský and Povolný 1983).

**Comments:** A relatively small species distributed in the Afrotropical region and southern Palaearctic, with a recent increase in records from Central Europe (Droz and Haenni 2011). In Slovakia, where it reaches the northernmost limit of its known distribution, it has been recorded only from a few individuals collected in 1953 (Povolný and Rosický 1955, Chalupský and Povolný 1983), and it was listed as vulnerable (VU) by Jedlička and Stloukalová (2001). It is an ectoparasite of birds, mainly small Passeriformes. It is less frequently found on species from other bird orders (Krištofík 1998).

Ornithophila metallica (Schiner, 1864)

**Published records:** Jakubov (Krištofík 1998).

**Published host records:** Saxicola rubetra (Linnaeus, 1758) (see Krištofík 1998).

**Comments:** A rare and non-native species in Central Europe, distributed in southern parts of the Palaearctic, Afrotropical, Oriental and Australasian regions. The only known record from Slovakia is from 1993 (Krištofík 1998). It was, however, overlooked and not listed in the most recent checklist (Sychra 2009). It is an ectoparasite of birds, mainly small Passeriformes but also species from other bird orders (Krištofík 1998).

Pseudolynchia canariensis (Macquart in Webb & Berthelot, 1839)

**Published records:** Devín (Povolný and Balát 1956, Chalupský 1986)

**Published host records:** Pandion haliaetus (Linnaeus, 1758) (Povolný and Balát 1956, Chalupský 1980).

**Comments:** A relatively rare and non-native species in Central Europe, widespread (subcosmopolitans) in the tropical and subtropical belts. In Slovakia it has been listed as vulnerable (VU) (Jedlička and Stloukalová 2001), despite not being a native species. An ectoparasite on species of many bird families but preferentially associated with Columbidae, including the domestic pigeon (Chalupský 1980). The only known record from Slovakia is from 1949 (Povolný and Balát 1956).

Stenepteryx hirundinis (Linnaeus, 1758)

**Published records:** Vyhne (Vihnye) (Thalhammer 1899); Trenčín (Trenčsén) (Brancsik 1910, Chalupský 1986); Devínska Nová Ves (Povolný and Rosický 1955, Chalupský 1986); Bratislava (Krištofík 1998).

**Published host records:** Delichon urbicum (see Povolný and Rosický 1955; Krištofík 1998); Hirundo rustica Linnaeus, 1758 (see Thalhammer 1899).
Comments: A frequent Central European species, widespread in the Palaearctic region. A common ectoparasite of the bird species Delichon urbicum, Hirundo rustica, Ptyonoprogne rupestris (Scopoli, 1769), Riparia riparia (Linnaeus, 1758), and (more rarely) of species from other bird species, most frequently found in nests (Krištofík 1998). Stenepteryx hirundinis might suffer from the decline of its hosts (BirdLife International 2018).

Tribe Ornithomyini

Ornithomya avicularia (Linnaeus, 1758)

Fig. 3

Published records: Snina (Szinha) (Thalhammer 1899); Súľov (Čepelák 1974), Bratislava, Čalovec, Čičov, Jarok, Lozorno, Plešivec, Sásra (Krištofík and Štefan 1980, Chalupský 1986); Kečovo, Šurany, Vtáčnik (Povolný and Rosický 1955, Chalupský and Povolný 1983, Chalupský 1986); Dražovce, Nitra (Čepelák and Čepelák 1991); Rača (Čepelák 1982, Chalupský 1986); Ivánka pri Dunaji, Nitra, Rača, Sládkovičovo (Chalupský 1986); Uličské Krivé (Roháček 1995); Bratislava, Brzotín, Gbelce, Kiarov, Kňažia, Kostolište, Košice – Šaca, Košická Nová Ves, Limbach, Mošj, Oravský Podzámok, Pavlovce nad Váhom, Pezinok, Plavecký Mikuláš, Podunajské Biskupice, Svätý Jur, Šiatská Bukovinka, Závod (Krištofík 1998); Bábsky les (Straka and Majzlán 2010).

Published host records: Accipiter gentilis (Linnaeus, 1758), Acrocephalus arundinaceus (Linnaeus, 1758), A. melanopogon (Temminck, 1823), A. scirpaceus (Hermann, 1804), Anser anser (Linnaeus, 1758) (see Krištofík 1998); Anthus trivialis (Linnaeus, 1758) (see Krištofík and Štefan 1980; Krištofík 1998); Aquila pomarina C. L. Brehm, 1831 (see Krištofík 1998); Carduelis chloris (Linnaeus, 1758) (see Chalupský and Povolný 1983); Circus pygargus (Linnaeus, 1758), Coccothraustes coccothraustes (Linnaeus, 1758), Emberiza cia Linnaeus, 1766, Erithacus rubecula (Linnaeus, 1758) (see Krištofík 1998); Falco tinnunculus Linnaeus, 1758 (Krištofík and Štefan 1980); Ficedula albicollis (Temminck, 1815), Fringilla coelebs Linnaeus, 1758 (see Krištofík 1998); Homo sapiens (Krištofík and Štefan 1980); Lanius collurio Linnaeus, 1758, L. excubitor Linnaeus, 1758, Locustella luscinioides (Savi, 1824), Monticola saxatilis (Linnaeus, 1766), Oriolus oriolus (Linnaeus, 1758), Panurus biarmicus (Linnaeus, 1758) (see Krištofík 1998); Passer domesticus (Linnaeus, 1758) (see Krištofík and Štefan 1980); Passer montanus (Linnaeus, 1758) (see Krištofík 1998); Pernis apivorus (Linnaeus, 1758) (see Thalhammer 1899); Phoenicurus ochruros (S. G. Gmelin, 1774), Pica pica (Linnaeus, 1758) (see Krištofík 1998); Picus canus (J. F. Gmelin, 1788 (see Chalupský and Povolný 1983); Saxicola rubetra (Linnaeus, 1758) (see Krištofík 1998); Strix aluco Linnaeus, 1758 (see Chalupský and Povolný 1983); Turdus merula Linnaeus, 1758 (see Čepelák and Čepelák 1991; Krištofík 1998); Turdus pilaris Linnaeus, 1758 (see Krištofík 1998).

Material examined: Diviacka Nová Ves, 48°44′58.9″N, 18°29′29.5″E, 280 m a.s.l., 15.8.2012, 1 female, on a family house, J. Oboňa leg. (LMEE PO);
Drienovec, 48°37’04.4”N, 20°55’29.9”E, 200 m a.s.l., 15.9.2015; 1 female, from *Prunella modularis* (Linnaeus, 1758), S. Greš leg. (LMEE PO).

**Comments:** A frequent louse fly species in Central Europe, widespread in the Palaearctic region. A common ectoparasite of birds from the order Passeriformes and other orders, most frequently find in more individuals per host (Krištofík 1998). *Prunella modularis* is here recorded as a new host of *O. avicularia* in Slovakia.

**Ornithomya biloba** Dufour, 1827

**Published records:** Omšenie (Nagysziklás) (Brancsik 1910, as *Ornithomyia tenella*); Čaradská pustatina (Krištofík and Štefan 1980, Chalupský 1986); Humenné (Chalupský and Povolný 1983, Chalupský 1986); Bašovce, Bernolákov, Bodíky, Klúčovec, Podunajské Biskupice (Krištofík 1998).

**Published host records:** *Hirundo rustica* (see Krištofík 1998, Krištofík and Štefan 1980); *Riparia riparia* (see Chalupský and Povolný 1983).

**Material examined:** Gbelce, 47°51’29.4”N, 18°30’17.9”E, 120 m a.s.l., 21.4.2009, 1 male, 27.4.2009, 1 male, 28.4.2009, 1 male, 2.5.2009, 2 males, all from *Hirundo rustica*, O. Sychra leg. (VFU).
**Comments**: A Palaearctic species, common in Central Europe; its distribution range is incompletely known. It is an ectoparasite mainly of *Delichon urbicum*, *Hirundo rustica*, *Riparia riparia* and, less often, of species from other bird orders (Krištofík 1998).

**Ornithomya chloropus** (Bergroth, 1901)

**Published records**: Kalinovo, Košice (Povolný and Rosický 1955, Chalupský 1986).

**Published host records**: *Regulus regulus* (Linnaeus, 1758) (see Povolný and Rosický 1955); without host record (Chalupský 1986).

**Comments**: A Palaearctic species distributed in the northern and middle belts of the region. It is an ectoparasite mainly of Passeriformes, but also of species of other bird orders (Povolný and Rosický 1955). The only known record from Slovakia is from 1953, and it was “hidden” in the figure legend in Povolný and Rosický (1955). It was incorrectly doubted by Chalupský (1980) and was not listed in the last (Sychra 2009) or all previous checklists (Chalupský and Povolný 1987, 1997, Sychra 2006).

**Ornithomya fringillina** Curtis, 1836

**Published records**: Boheľov, Kamienka, Pilsko, Rovinka (Krištofík and Štefan 1980, Chalupský 1986); Kalinovo (Chalupský and Povolný 1983, Chalupský 1986); Brodské, Číčov, Gbelce, Jakobov, Oravský Podzámok, Svätý Jur (Krištofík 1998); Krasín (Straka 2005a); Lutovský Drieňovec (Straka and Majzlán 2008); “Nitrické vrchy” (Straka and Majzlán 2014).

**Published host records**: *Acrocephalus arundinaceus*, *A. schoenobaenus* (Linnaeus, 1758) (see Krištofík 1998); *Ardea purpurea* (see Krištofík and Štefan 1980); *Parus caeruleus* Linnaeus, 1758 (see Krištofík and Štefan 1980; Krištofík 1998); *Parus major* Linnaeus, 1758, *Riparia riparia* (see Krištofík and Štefan 1980); *Sitta europaea*, *Sylvia atricapilla* (Linnaeus, 1758) (see Krištofík 1998); *Troglodytes troglodytes* (Linnaeus, 1758) (see Krištofík and Štefan 1980).

**Comments**: A Palaearctic species distributed in the northern and middle belts of the region. It is an ectoparasite mainly of Passeriformes, but also parasitizes species of other bird orders (Krištofík 1998).

**Discussion**

We have critically evaluated all available data on the occurrence of the family Hippoboscidae in Slovakia, and published data are completed with new collection data and unpublished localities. We confirmed 19 species as recorded from the country, which has one of the richest hippoboscid faunas in Europe. Out of 19 total species, 12 are native. While seven species (*Crataerina pallida*, *Lipoptena cervi*, *L. fortisetosa*,
Ornithomya avicularia, O. biloba, O. fringillina, and Stenepteryx hirundinis) are widespread, three species (Icosta ardeae, Melophagus rupicaprinus, and Ornithomya chloropus) are known only from a few records, and the occurrence of the last two species (Hippobosca equina and Melophagus ovinus) is strongly affected by a decline of traditional horse and sheep farming in the monitored area (e.g., Bezák and Petrovič 2006). Species S. hirundinis and C. pallida might suffer from the decline of its hosts (BirdLife International 2018). Another seven species (Hippobosca longipennis, H. variegata, Icosta minor, Olfersia fumipennis, Ornithoica turdi, Ornithophila metallica, and Pseudolynchia canariensis) have been recorded from Slovakia based on very few records, due to occasional introduction with their hosts. These species can be introduced naturally due to migrating hosts (e.g., Icosta minor, Olfersia fumipennis, Ornithophila metallica, and Pseudolynchia canariensis) or imported together with domestic animals (e.g., Hippobosca longipennis, H. variegata).

Previous records of three species were omitted from the most recent checklist (Sychra 2009):

1) a single record of Icosta minor from Slovakia (Chalupský 1980; Chalupský and Macháček 1977) had been erroneously cited as being from Moravia (Czech Republic) in previous checklists (Chalupský and Povolný 1987, 1997; Sychra 2006, 2009);
2) Ornithophila metallica was reported from Slovakia by Kristoň (1998), and
3) Ornithomya chloropus (Bergroth, 1901) was reported from Slovakia by Povolný and Rosický (1955) in a note “hidden” in the illustration legend, but these records were omitted from all versions of the regional checklist (Chalupský and Povolný 1987, 1997; Sychra 2006, 2009), possibly due to Chalupský (1980), who doubted its occurrence in Slovakia.

Altogether, 78 host-parasite associations have so far been recorded for Slovakian Hippoboscidae (Table 2). The hosts of the 19 species of louse flies recorded in Slovakia belong to 46 species of birds from eight orders (Accipitriformes, Anseriformes, Apodiformes, Ciconiiformes, Falconiformes, Passeriformes, Piciformes, Strigiformes) and nine species of mammals, including humans. The host records of Prunella modularis for O. avicularia and Homo sapiens for L. fortisetosa are here recorded from Slovakia for the first time.

The species composition of the hippoboscid fauna of Slovakia is relatively well known, and is, in comparison with other European countries, unexpectedly diverse. In Table 1, a list of European hippoboscid faunas is given, based on Petersen (2004) and Pape et al. (2015) and supplemented with data from relatively recent regional checklists (Buettiker 1998, Chandler 1998, Muller 1999, Beuk 2001, Draber-Monko 1991, Pape et al. 1995, Papp 2001, Carles-Tolrà and Báez 2002, Sychra 2009, Pohjoismäki and Kahanpää 2014, present paper).

The comparison of species richness of Hippoboscidae across Europe’s best studied countries for Diptera surprisingly showed that in Slovakia, the fauna of this group is
not only distinctly more diverse than in all surrounding Central European countries, but even comparable with the faunas of much larger and more southern countries, such as Spain or Italy (including their insular areas), which also comprise 19 species (Table 1). However, raising any hypotheses about a possible latitudinal pattern in hippoboscid species richness would require much more thorough data on the continental scale.

We have noted that a number of country occurrences are missing in Fauna Europaea (Petersen 2004, Pape et al. 2015) when compared with the above checklists, most markedly for Spain and its adjacent islands (seven species missing) and Great Britain (six species missing). In contrast, some species listed in Fauna Europaea are missing in national checklists: e.g., *I. minor* is present in Fauna Europaea for Italy (Petersen 2004, Pape et al. 2015) but is absent in the national checklist (Pape et al. 1995); similarly, *O. chloropus* is present in Fauna Europaea for Hungary but is missing in the checklist of this country (Papp 2001). The national checklist of Spain (Carles-Tolrà and Báez 2002) also includes the species *Crataerina nigriventris* Gil Collado, 1932, which was wrongly referred to as *C. nigriventris* (Strobl, 1906) although it was originally described by Gil Collado (1932). However, according to Schneider-Orelli (1937), it is only an aberrant form of *C. melbae* (Rondani, 1879) and, therefore, it is omitted from the list in Table 1.

Judging from the occurrences of Hippoboscidae in other European countries, the list of Slovak species of the family is obviously not yet complete, despite its richness. At least the following two species can be expected in Slovakia: *Crataerina melbae* and *Pseudolynchia garzettae* (Rondani, 1879), both of which parasitize bird species living in Slovakia and are known from Italy and Switzerland, and Great Britain and Italy, respectively (see Table 1). In addition, the introduction of additional, more exotic hippoboscid species, like *Olfersia spinifera* (Leach, 1817) (known from G. Britain) or *Ornithomya rupes* Hutson, 1981 (recorded from Switzerland) to Slovakia cannot be excluded. In conclusion, more than 20 species of louse flies can be expected to occur in Slovakia, including both native residents and sporadic introductions.

Several species of the family Hippoboscidae can interfere with human life and interests, as ectoparasites of some domestic animals, occasionally parasitizing also humans. These are mainly *Lipoptena cervi*, *L. fortisetosa*, and relatively rare species *Hippobosca equina* and *Melophagus ovinus*. Damage is caused by direct bloodsucking and the venomsaliva of the louse flies, which can lead to permanent loss of blood and to animal wasting (especially ovine wasting), reduced milk and wool production, damage to wool caused by the parasite's faeces, etc. (Hutyra and Marek 1952). A secondary consequence of ectoparasitism by keds is the constant discomfort and scratching by the parasitised host (Hase 1927). Louse flies are also known as possible vectors of various diseases (Baker 1967, Kečera 1983, Oyieke and Reid 2003, Halos et al. 2004, Reeves et al. 2006, Martinković et al. 2012). A few of the above-mentioned species, especially *L. cervi* and *L. fortisetosa*, may bite humans in forest environments.

In Slovakia, species of the family Hippoboscidae have not received sufficient attention, even though they are among the most abundant ectoparasites in some localities. Therefore, it is important to pay attention to this group and maintain an accurate
overview of the species living in our territory, including monitoring of the occurrence of non-native species migrating with their hosts or imported with domestic animals. From a wider perspective, verified and accurate information on the diversity and distribution of louse flies in Slovakia can contribute to knowledge of this parasitic group from a global point of view.

Table 1. Hippoboscid faunas of selected European countries (see Petersen 2004, Pape et al. 2015), supplemented with data from relative recent checklists.*

| Sciomyzidae | Spain inc. islands | Italy inc. islands | Switzerland | Great Britain | Czech Republic | Slovakia | Finland | Germany | Hungary | Poland | The Netherlands |
|-------------|-------------------|-------------------|-------------|--------------|---------------|---------|---------|---------|---------|--------|-----------------|
| Hippoboscini | *Hippobosca* | | | | | | | | | | |
| | equina | + | + | + | + | + | + | + | + | + | + |
| | longipennis | + | + | + | + | + | + | + | + | + | + |
| | variegata | + | + | + | + | + | + | + | + | + | + |
| Lipoptenini | *Lipoptena* | | | | | | | | | | |
| | arianae | + | + | + | + | + | + | + | + | + | + |
| | capreoli | + | + | + | + | + | + | + | + | + | + |
| | cervi | + | + | + | + | + | + | + | + | + | + |
| | couturiieri | + | + | + | + | + | + | + | + | + | + |
| | fortisetosa | + | + | + | + | + | + | + | + | + | + |
| Melophagus | *Melophagus* | | | | | | | | | | |
| | oceinu | + | + | + | + | + | + | + | + | + | + |
| | rupicapinus | + | + | + | + | + | + | + | + | + | + |
| Olfersiini | *Crataerina* | | | | | | | | | | |
| | acutipennis | + | + | + | + | + | + | + | + | + | + |
| | melbae | + | + | + | + | + | + | + | + | + | + |
| | obtusipennis | + | + | + | + | + | + | + | + | + | + |
| | pallida | + | + | + | + | + | + | + | + | + | + |
| Icosta | *Icosta* | | | | | | | | | | |
| | ardeae | + | + | + | + | + | + | + | + | + | + |
| | masonati | + | + | + | + | + | + | + | + | + | + |
| | minor | + | + | + | + | + | + | + | + | + | + |
| Olfersia | *Olfersia* | | | | | | | | | | |
| | humipennis | + | + | + | + | + | + | + | + | + | + |
| | spinifera | + | + | + | + | + | + | + | + | + | + |
| Ornithobica | *Olmithobica* | | | | | | | | | | |
| | turdi | + | + | + | + | + | + | + | + | + | + |
| Ornithophila | *Olmithophila* | | | | | | | | | | |
| | gastroi | + | + | + | + | + | + | + | + | + | + |
| | metallica | + | + | + | + | + | + | + | + | + | + |
| Pseudolynchia | *Pseudolynchia* | | | | | | | | | | |
| | canariensis | + | + | + | + | + | + | + | + | + | + |
| | garzettae | + | + | + | + | + | + | + | + | + | + |
| Stenepteryx | *Stenepteryx* | | | | | | | | | | |
| | hiirudinis | + | + | + | + | + | + | + | + | + | + |
| Ornithomyiini | *Ornithomyia* | | | | | | | | | | |
| | articulata | + | + | + | + | + | + | + | + | + | + |
| | biloba | + | + | + | + | + | + | + | + | + | + |
| | chloropus | + | + | + | + | + | + | + | + | + | + |
| | fringillina | + | + | + | + | + | + | + | + | + | + |
| | rupeae | + | + | + | + | + | + | + | + | + | + |
| number of species | 19 | 19 | 19 | 15 | 19 | 15 | 19 | 10 | 12 | 12 | 11 | 12 |

* Spain incl. islands (Carles-Tolrá and Báez 2002), Italy incl. islands (Pape et al. 1995), Switzerland (Büttiker 1998), Great Britain (Chandler 1998), Czech Republic and Slovakia (Sychra 2009, present paper), Finland (Pohjoismäki and Kahanpää 2014), Germany (Müller 1999), Hungary (Papp 2001), Poland (Draber-Monko 1991) and The Netherlands (Beuk 2001).
| Parasite sp.                  | Hosts       | Order        | Family         | Species                                      |
|-----------------------------|-------------|--------------|----------------|----------------------------------------------|
| Hippobosca equina           | Aves        | Accipitriformes | Accipitridae  | Accipiter gentilis                          |
|                             | Mammalia    | Carnivora    | Canidae        | Canis familiaris                            |
|                             |             | Cetartiodactyla | Bovidae       | Bos taurus                                  |
|                             |             | Cetartiodactyla | Cervidae      | Capreolus capreolus                         |
|                             |             | Perissodactyla | Equidae        | Equus caballus                              |
|                             |             | Primates     | Hominidae      | Homo sapien                                 |
| Hippobosca longipennis      | Mammalia    | Carnivora    | Canidae        | Canis familiaris                            |
| Hippobosca variegata        | Mammalia    | Carnivora    | Canidae        | Canis familiaris                            |
| Lipoptena cervi             | Mammalia    | Carnivora    | Canidae        | Canis familiaris                            |
|                             |             | Cetartiodactyla | Bovidae       | Bos taurus                                  |
|                             |             | Cetartiodactyla | Cervidae      | Capreolus capreolus, Cervus elaphus         |
|                             |             | Primates     | Hominidae      | Homo sapien                                 |
| Lipoptena fortisetosa       | Mammalia    | Carnivora    | Canidae        | Canis familiaris                            |
| Melophagus ovinus           | Mammalia    | Carnivora    | Canidae        | Canis familiaris                            |
|                             |             | Cetartiodactyla | Bovidae       | Bos taurus                                  |
|                             |             | Cetartiodactyla | Cervidae      | Capreolus capreolus, Cervus elaphus         |
|                             |             | Perissodactyla | Equidae        | Equus caballus                              |
|                             |             | Primates     | Hominidae      | Homo sapien                                 |
| Melophagus rupicaprinus      | Mammalia    | Carnivora    | Canidae        | Canis familiaris                            |
| Crataerina pallida          | Aves        | Apodiformes  | Apodidae       | Apus ater                                   |
| Icosta ardeae               | Aves        | Passeriformes | Hirundinidae   | Anela purpurea                              |
|                             | Aves        | Passeriformes | Ardeidae       | Isolobrychus minutus                        |
| Icosta minor                | Aves        | Passeriformes | Emberizidae    | Emberiza citrinella                         |
| Ornithica turdi             | Aves        | Passeriformes | Fringillidae   | Fringilla coelebs                           |
|                             | Aves        | Sittidae     | Sitta europaea |                                              |
| Ornithophila metallica      | Aves        | Passeriformes | Muscicapidae   | Saxicola rubetra                            |
| Pseudolynchia canariensis    | Aves        | Passeriformes | Pandionidae    | Pandion haliaetus                           |
| Steneopteryx hirundinis      | Aves        | Passeriformes | Hirundinidae   | Delichon urbica, Hirundo rustica            |
| Ornithomya avicularia       | Aves        | Passeriformes | Accipitridae   | Accipiter gentilis, Aquila pomarina, Circus pygargus, Pernis apivorus |
|                             |             | Anatidae     | Anseriformes   | Anser anser                                 |
|                             |             | Falconiformes | Falconidae     | Falco tinnunculus                           |
|                             |             | Prunellidae  | Prunella modularis |                                               |
|                             |             | Acrocephalidae | Acrocephalus arundinaceus, A. melanopogon, A. scirpaceus | |
|                             |             | Corvidae     | Pica pica      |                                              |
|                             |             | Emberizidae  | Emberiza cia   |                                              |
|                             |             | Fringillidae | Carduelis chloris, Coocinchara coccinchara, Fringilla coelebs | |
|                             |             | Laniidae     | Lanius collaris, L. excubitor                 |                                              |
|                             |             | Locustellida | Locustella luscinoides                        |                                              |
|                             |             | Motaellidae  | Anthus trivialis                               |                                              |
|                             |             | Muscicapidae | Erithacus rubecula, Ficedula albicollis, Phoenicurus ochruros, Saxicola rubetra | |
|                             |             | Oriolidae    | Oriolus oriolus                                 |                                              |
|                             |             | Paradisornithidae | Panurus biarmicus |                                             |
|                             |             | Passeridae   | Passer domesticus, P. montanus                  |                                              |
|                             |             | Turdidae     | Monticola saxatilis, Turdus merula, T. pilaris |                                              |
| Ornithomya biloba            | Aves        | Passeriformes | Hirundinidae   | Hirundo rustica, Riparia riparia             |
| Ornithomya chloropus         | Aves        | Passeriformes | Sylvidae       | Regulus regulus                             |
| Ornithomya fringillina       | Aves        | Passeriformes | Acrocephalidae | Acrocephalus arundinaceus, A. schoenobaenus  |
|                             |             | Paridae      | Parus cataractus                                 |                                              |
|                             |             | Hirundinidae | Riparia riparia                                |                                              |
|                             |             | Sittidae     | Sitta europaea                                  |                                              |
|                             |             | Sylvidae     | Sylvia atricapilla                              |                                              |
|                             |             | Troglydytiidae | Troglydytes troglodytes                         |                                              |
|                             |             | Pelecaniformes | Ardeidae | Antha parpurea                             |                                              |
Acknowledgements

We would especially like to thank the editor and anonymous reviewers for providing constructive comments that helped improve the manuscript, and M Deml (Morávka, Czech Republic) for permission to use his macrophotograph of *Ornithomyia avaicularia*. This study was supported by the Slovak Research and Development Agency under contract No. APVV-16-0411, VEGA 1/0977/16 and by the Research Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic, project ITMS: 26110230119. J Roháček’s study was financially supported by the Ministry of Culture of the Czech Republic by Institutional financing of long-term conceptual development of the research institution (the Silesian Museum, MK000100595).

References

Amiot C, Ji W (2015) New host record for *Ornithomyia variegata* (Diptera: Hippoboscidae) in New Zealand with a review of previous records in Australasia. Notornis 62: 47–50.
Baker JR (1967) A review of the role played by the Hippoboscidae (Diptera) as vectors of endoparasites. Journal of Parasitology 53(2): 412–418. https://doi.org/10.2307/3276603
Bequaert JC (1942) A monograph of the Melophaginae, or Kedflies, of sheep, goats, deer and antelopes (Diptera, Hippoboscidae). Entomologica Americana, N. Ser. 22: 1–220.
Bequaert JC (1954) The Hippoboscidae or louse-flies (Diptera) of mammals and birds. Part II. Taxonomy, evolution and revision of American genera and species. Entomological Society of America, 24–26.
Bequaert JC (1965) Familia Hippoboscidae. A Catalog of the Diptera of America north of México. United States Department of Agriculture, Agriculture handbook 276, 1696 pp.
Beuk PLTh (2001) Family Hippoboscidae. In: Beuk PLTh (Ed) Checklist of the Diptera of the Netherlands, http://www.diptera-info.nl/news.php?fam=Hippoboscidae [date accessed: 12/04/2018]
Bezáková P, Petrovič F (2006) Agriculture, landscape, biodiversity: scenarios and stakeholder perceptions in the Poloniny National Park (NE Slovakia). Ekołógia (Bratislava) 25(1): 82–93.
BirdLife International (2018) IUCN Red List for birds. http://www.birdlife.org [11/04/2018]
Brancsik K (1910) A Trenčínvármezgete palalí Dipterák felsorolása [List of Diptera found in Trenčín county]. Trenč. Várm. Termész. Eg. Trenčsén 31–33(1908–1910): 127–158.
Büttiker W (1998) 100. Hippoboscidae. In: Merz B, Bächli G, Haenni J-P, Gonseth Y (Eds) Diptera – checklist. Fauna Helvetica, Vol. 1, Centre de cartographie de la faune & Schweizerische Entomologische Gesellschaft, Neuchatel, 330–331.
Carles-Tolrá M, Báez M (2002) Hippoboscidae. In Carles-Tolrá Hjorth-Andersen M (Ed.) Catálogo de los Diptera de España, Portugal y Andorra (Insecta). Monografías SEA, vol. 8, Sociedades Entomológica Aragonesa, Zaragoza, 208.
Čepelák J (1974) Skupiny vyšších much (Diptera, Brachycera) z území Súlovských skál. Súlovske skaly. Monografia vlastivedného zborníka Považia 1: 359–362.
A revised annotated checklist of louse flies (Diptera, Hippoboscidae) from Slovakia

Čepelák J (1982) Niektoré skupiny vyšších dvojkrídlovcov Malých Karpát (Diptera, Brachycera) II. Some groups of higher flies of the Malé Karpaty (Diptera, Brachycera) II. Biológia, Bratislava 37: 599–607.

Čepelák J (1985) Přehled nálezov dvojkrídlovcov (Diptera) z oblasti štátnej prírodnej rezervácie Suchý v Malej Fatre. Survey of Diptera finds from the State Nature Reserve Suchý in Malá Fatra. Ochrana prírody 6: 163–187

Čepelák J (1986) Vyššie dvojkrídlovce (Diptera, Brachycera) Štátnej prírodnej rezervácie Kováčovské kopce. Higher dipterans (Diptera, Brachycera) of the State Nature Reserve Kováčovské kopce. Ochrana prírody 7: 127–148

Čepelák J (1987) Vyššie dvojkrídlovce (Diptera, Cyclorrhapha, Schizophora) Hraškovej lúky a jej okolia. I. Höhere Zweiflügler (Diptera, Cyclorrhapha, Schizophora) der Hraškova Lúka und ihrer Umgebung. I. Rosalia 3 (1986): 193–209.

Čepelák J (1988) Ďalší príspevok k poznaniu vyšších dvojkrídlovcov (Dipt., Brachycera) ŠPR Hrdovická v CHKO Ponitrie. Weiterer Beitrag zur Kenntnis der höheren Zweiflügler (Dipt., Brachycera) der Staatlichen Naturschutzreservation Hrdovická im Naturschutzgebiete Ponitrie. Rosalia 5: 153–164.

Čepelák J (1992) Vyššie dvojkrídlovce (Diptera, Cyclorrhapha) z oblasti Veľkého Lysca. Höhere Zweiflügler (Diptera, Cyclorrhapha) aus dem Gebiete Velký Lysec. Rosalia 8: 191–198.

Čepelák S (1993) Výsledky orientačných zberov dvojkrídlovcov (Diptera) na vybraných lokalitách pohoria Tribeč. Ergebnisse der Orientations-Abfänge der Zweiflügler (Diptera) an den ausgewählten Lokalitäten im Tribeč Gebirge. Rosalia 9: 173–180.

Čepelák J (1994a) Blick and die Zusammensetzung der Fauna der höheren Zweifluglern der Umgebung der Gemeinde Červený Kameň (Diptera, Brachycera). In: Jedlička L (Ed.) Dipterologica Bohemoslovaca, Vol. 6, 25–32.

Čepelák S (1994b) Sammelergebnisse der Zweifluglern (Diptera, Brachycera) an den Lokalitäten Štiavnické vrchy und Hronská pahorkatina. Dipterologica Bohemoslovaca 6: 33–37.

Čepelák J, Čepelák S (1991) Niektoré čeľade dvojkrídlovcov (Diptera) Zobora. Certain families of Diptera in Zobor. Zobor 2: 245–278.

Chalupský J (1980). Hippoboscidae – Klošovití. In Chvála M (Ed.) Krejsající moučky a střečci. Fauna ČSSR, 22, Academia, Praha, 447–478.

Chalupský J (1986) Hippoboscidae. In Čepelák J (Ed.) Diptera Slovenska II., Veda, Bratislava, 201–202.

Chalupský J, Macháček P (1977) A find of Icosta minor [Bigot, 1858] [Diptera, Hippoboscidae] in Central Europe. Folia Parasitologica 24: 372.

Chalupský J, Povolný D (1983) Additional notes to a list of Czechoslovak Hippoboscidae (Diptera). Acta Universitatis Agriculturae Brno, Facultas Agronomica 31: 137–141.

Chalupský J, Povolný D (1987) Hippoboscidae. In: Ježek J (Ed.) Enumeratio insectorum bohemoslovakie. Check List of Czechoslovak Insects II (Diptera). Acta faunistica entomologica Musei Nationalis Pragae, Vol. 18, 287–288.

Chalupský J, Povolný D (1997) Hippoboscidae. In: Chvála M (Ed.) Check list of Diptera (Insecta) of the Czech and Slovak Republics. Karolinum, Charles University Press, Prague, 107.
Chandler P (1998) Hippoboscidae. In: Chandler P (Ed) Checklists of insects of the British Isles (New Series). Part 1: Diptera. Handbooks for the identification of British insects. Vol. 12. Royal Entomological Society, London, 162.

Dick CW (2006) Checklist of World Hippoboscidae (Diptera: Hippoboscoidea). Field Museum of Natural History, Chicago.

Draber-Monko A (1991) Hippoboscidae. In: Razowski J (Ed.) Wykaz zwierząt Polski. Checklist of animals of Poland. Vol. 2. Ossolineum, Wrocław-Warszawa-Kraków, 266.

Droz B, Haenni J-P (2011) Une mouche pupipare nouvelle pour la faune de Suisse (Diptera, Hippoboscidae). Entomolo Helvetica 4: 59–63.

Ducháč V, Bádr V (1998) Několik poznámek k druhu Lipoptena fortisetosa (Diptera: Hippoboscidae) (Several remarks of the species Lipoptena fortisetosa (Diptera: Hippoboscidae). východočeský sborník přírodovědného práce a studie 6: 117–122.

Dyk V, Schanzel H (1964) Cudzopasníci jelenej zvery v Blatnickej doline (velká Fatra) Vlast. Zbor. Považia 6: 276–281.

Evenhuis NL, Pape T, Pont AC (2016) Nomenclatural studies toward a world list of Diptera genus-group names. Part V: Pierre-Justin-Marie Macquart. Zootaxa 4172(1): 1–211. https://doi.org/10.11646/zootaxa.4172.1.1

Farrow R (2016) Insects of South-Eastern Australia: An Ecological and Behavioural Guide. CSIRO Pub., 288 pp. https://doi.org/10.1071/9781486304752

Gill Collado J (1932) Notas sobre Pupiparos de España y Marruecos del Museo de Madrid (Dipt. Pupip.). Eos 8: 29–41.

Halos L, Jamal T, Maillard R, Girard B, Guillot J, Che mol B, Vayssier-Taussat M, Boulouis HJ (2004) Role of Hippoboscidae flies as potential vectors of Bartonella spp. infecting wild and domestic ruminants. Applied and Environmental Microbiology 70(10): 6302–6305. https://doi.org/10.1128/AEM.70.10.6302-6305.2004

Hase A (1927) Beobachtungen über das Verhalten, den Herzschlag sowie den Stech und Sau gakt der Pferdelausflieg Hippobosca equina L (Dipt. Pupipara). Zeitschrift für Morphologie und Ökologie der Tiere 8: 187–240. https://doi.org/10.1007/BF00464884

Hubálek Z, Mittermayer T, Halouzka J, Černý V (1988) Isolation of “exotic” Bhanja virus (Bunyaviridae) from ticks in the temperate zone. Archives of virology 101(3): 191–197. https://doi.org/10.1007/BF01311000

Hutson AM (1984) Keds, flat-flies and bat-flies. Diptera, Hippoboscidae and Nycteribiidae. – Handbooks for the Identification of British Insects 10(7): 1–40.

Hutson AM, Oldroyd H (1980) Family Hippoboscidae. In: Crosskey RW (Ed.) Catalogue of the Diptera of the Afrotropical Region. British Museum (Natural History), London, 766–771.

Hutyra FV, Marek UJ (1952) Spezielle Pathologie und Therapie der Haustiere. 9. Aufl. Gustav Fischer, Jena.

Ibáñez-Bernal S, González-García F, Santiago-Alarcon D (2015) New bird host records for Ornithoctona fusciventris (Diptera: Hippoboscidae) in Mexico. The Southwestern Naturalist 60(4): 377–381. https://doi.org/10.1894/0038-4909-60.4.377

Jedlička L, Stloukalová V (2001) Červený (ekosozoológický) zoznam dvojkrídlovcov (Diptera) Slovenska. In: Baláž D, Marhold K, Urban P (Eds) Červený zoznam rastlín aživočíchov Slovenska. Ochrana prírody, Banská Bystrica, Supplementum 20: 139–142.
Kečera J (1983) Incidence and some ecological aspects of avian trypanosomes in Czechoslovakia. Folia Parasitol (Praha) 30(3): 209–222.

Kočišová A (2015) Druhová skladba dvojkrídlcov (Diptera) potenciálnych vektorov patogénov v chovoch koní (The species composition of the Diptera ns (Diptera) as potential vectors of pathogens in horsebreeding). In: Hamerlík L, Dobríková D, Stoklada J (Eds) The 8th Central European Dipterological Conference: conference abstracts (Kežmarské Žlaby, 28th–30th September, 2015). Belianum, Banská Bystrica, 61–63.

Kočišová A, Lazar P, Letková V, Goldová M, Ciberej J, Čurlík J, Lukešová D (2007) The species composition of the blood sucking Diptera (Tabanidae, Simuliidae) and Pupipara in deer breeding farm in East Slovakia. In Book of Abstracts; 2nd International Symposium “Game and Ecology”; Plitvice Lakes National Park October 17th to 20th October 2007. Zagreb (Croatia): University of Zagreb, Faculty of Veterinary Medicine; Department for Game Biology, Pathology and Breeding, 21–22.

Krištofík J (1998) Louseflies (Diptera, Hippoboscidae) in the collections of František Balát. Acta Musei Moraviae, Scientiae biologicae 83: 137–140.

Kutty SN, Pape T, Wiegman BN, Meier R (2010) Molecular phylogeny of the Calyptratae (Diptera: Cyclorrhapha) with an emphasis on the superfamily Oestroidea and the position of Mystacinobiidae and McAlpine’s fly. Systematic Entomology 35: 614–635. https://doi.org/10.1111/j.1365-3113.2010.00536.x

Liu D, Wang YZ, Zhang H, Liu ZQ, Wureli HZ, Wang SW, Tu ChCh, Chen CF (2016) First report of Rickettsia raoultii and R. slovaca in Melophagus ovinus, the sheep ked. Parasites & vectors 9(1): 600. https://doi.org/10.1186/s13071-016-1885-7

Maa TC (1963) Genera and species of Hippoboscidae: types, synonymy, habitats and natural groupings. Pacific Insects Monograph 6: 1–186. https://doi.org/10.1093/jmedent/1.1.4

Maa TC (1967) A synopsis of Japanese Diptera Pupipara. Pacific Ins. 9: 727–60.

Martinković F, Matanović K, Rodrigues AC, Garcia HA, Teixeira MM (2012) Trypanosoma (Megatrypanum) melophagium in the sheep ked Melophagus ovinus from organic farms in Croatia: phylogenetic inferences support restriction to sheep and sheep keds and close relationship with trypanosomes from other ruminant species. Journal of Eukaryotic Microbiology 59(2): 134–144. https://doi.org/10.1111/j.1550-7408.2011.00599.x

Matyukhin AV, Artem’yev AV, Panov IN (2017) Parazitologicheskiye issledovaniya ptits: mukhi-krovososki (Hippoboscidae: Ornithomyinae) Karelii. Trudy Karel’skogo nauchnogo tsentra Rossiyskoy akademii nauk 7.

Mehlhorn H (2016) Hippoboscidae. Encyclopedia of Parasitology 1252–1252. https://doi.org/10.1007/978-3-662-43978-4_3942

Mogi M, Sawada I (2002) Records of Hippoboscidae, Nycteribiidae and Streblidae (Diptera) from Japan. Medical entomology and zoology 53(Supplement 2): 141–165. https://doi.org/10.7601/mez.53.141

Müller J (1999) Hippoboscidae. In: Schumann H, Bährmann R, Stark A (Eds) Checkliste der Dipteren Deutschlands. Studia dipterologica, Supplement 2. Ampyx Verlag, Halle (Saale), 155–156.
Oboňa J, Zeegers T, Wamiti W, Njoroge N (2016) Additions to the checklist of the louse flies (Diptera: Hippoboscidae) of Kenya. African Entomology 24(2): 393–397. https://doi.org/10.4001/003.024.0393

Oyieke FA, Reid G (2003) The mechanical transmission of *Trypanosoma evansi* by *Haematobia minúta* (Diptera: Muscidae) and *Hippobosca camelina* (Diptera: Hippoboscidae) from an infected camel to a mouse and the survival of trypanosomes in fly mouthparts and gut (a preliminary record). Folia Veterinaria 47(1): 38–41.

Pape T, Beuk P, Pont A, Shatalkin A, Ozorov A, Woźnica A, Merz B, Bystrowski C, Raper C, Bergström C, Kehlmaier C, Clements D, Greathead D, Kameneva E, Nartshuk E, Petersen F, Weber G, Bächli G, Geller-Grimm F, Van de Weyer G, Tschorsnig H, de Jong H, van Zuijlen J, Vaňhara J, Roháček J, Ziegler J, Majer J, Hůrka K, Holston K, Rognes K, Greve-Jensen L, Munari L, de Meyer M, Pollet M, Speight M, Ebejer M, Martinez M, Carles-Tolrá M, Földvári M, Chvála M, Barták M, Evenhuis N, Chandler P, Cerretti P, Meier R, Rozkosny R, Prescher S, Gaimari S, Zatwarnicki T, Zeegers T, Dikow T, Korneyev V, Richter V, Michelsen V, Tanasijtshuk V, Mathis W, Hubenov Z, de Jong Y (2015) Fauna Europaea: Diptera – Brachycera. Biodiversity Data Journal 3: e4187. https://doi.org/10.3897/BDJ.3.e4187

Pape T, Richter V, Rivosecchi L, Rognes K (1995) Diptera Hippoboscoidea, Oestroidea. In: Minelli A, Ruffo S, La Posta S (Eds) Checklist delle specie della fauna italiana. Fascicolo 78, Calderolini, Bologna, 36 pp.

Papp L (2001) Hippoboscidae. In: Papp L (Ed.) Checklist of the Diptera of Hungary. Hungarian Natural History Museum, Budapest, 477–479.

Paramonov SJ (1954) XL.I. Notes on Australian Diptera (XIII–XV). Annals and Magazine of natural History 7(76): 275–297. https://doi.org/10.1080/00222935408651729

Petersen FT (2004) Fauna Europaea: Hippoboscidae. In: Pape T (Ed.) Fauna Europaea: Diptera, Brachycera. Fauna Europaea version 2.6. http://www.faunaeure.org [Retrieved 13.02.2017]

Petersen FT, Damgaard J, Meier R (2007) DNA taxonomy: How many DNA sequences are needed for solving a taxonomic problem? The case of two parapatric species of louse flies (Diptera: Hippoboscidae: *Ornithomya* Latreille, 1802). Arthropod Systematics and Phylogeny 65(2): 119–125.

Pohjoismäki J, Kahanpää J (2014) Checklist of the superfamilies Oestroidea and Hippoboscoidea of Finland (Insecta, Diptera). In: Kahanpää J, Salmela J (Eds) Checklist of the Diptera of Finland. ZooKeys 441: 383–408. https://doi.org/10.3897/zookeys.441.7252

Povolný D, Balát F (1956) Doplněk znalostí československých klošovitých (Hippoboscidae – Diptera). Folia zoologica 5: 390–393.

Povolný D, Rosický B (1955) Faunisticko-bionomický nástin klošovitých (Hippoboscidae, Diptera) z území ČSR. Zoologické a entomologické listy 4: 5–20.

Rahola N, Goodman SM, Robert V (2011) The Hippoboscidae (Insecta: Diptera) from Madagascar, with new records from the “Parc National de Midongy Befotaka”. Parasite 18: 127–140. https://doi.org/10.1051/parasite/2011182127

Reeves WK, Nelder NP, Cobb KD, Dasch GA (2006) *Bartonella* spp. in deer keds, *Lipoptena mazamae* (Diptera: Hippoboscidae), from Georgia and South Carolina, USA Journal of Wildlife Diseases 42: 391–396. https://doi.org/10.7589/0090-3558-42.2.391
Roháček J (1995) Hippoboscidae. In: Roháček J, Starý J, Martinovský J, Vála M (Eds) Diptera Bukovských vrchov. Diptera of the Bukovské hills. SÁŽP – Správa CHKO a BR Východné Karpaty, Humenné, 193.

Roháček J (2009) Hippoboscidae. In: Roháček J, Ševčík J (Eds) Diptera of the Polana Protected Landscape Area – Biosphere Reserve (Central Slovakia). SNC SR, Administration of the PLA – BR Polana, Zvolen, 285.

Savage J, Borkent A, Brodo F, Cumming JM, Curler G, Currie DC, deWaard JR, Gibson JE, Hauser M, Laplante L, Lonsdale O, Marshall SA, O’Hara JE, Sinclair BJ, Skevington JH (2019) Diptera of Canada. In: Langor DW, Sheffield CS (Eds) The Biota of Canada – A Biodiversity Assessment. Part 1: The Terrestrial Arthropods. ZooKeys 819: 397–450. https://doi.org/10.3897/zookeys.819.27625

Schneider-Orelli O (1937) Ueber die Alpenseglerparasiten Crataerina milbae Rond. und Crat. pallida Latr. Mitteilungen der Schweizerischen Entomologischen Gesellschaft 17: 4–20.

Skvarla MJ, Machtinger ET (2019) Deer Keds (Diptera: Hippoboscidae: Lipoptena and Neoli-poptena) in the United States and Canada: New State and County Records, Pathogen Records, and an Illustrated Key to Species. Journal of Medical Entomology 56(3): 744–760. https://doi.org/10.1093/jme/tjy238

Soós Á, Húrka K (1986) Family Hippoboscidae. In: Soós Á, Papp L (Eds) Catalogue of Palaeartic Diptera, vol 11. Akademiai Kaido, Budapest, 215–226.

Straka V (1981) Entomologické zaujímavosti v zbierkach Turčianského múzea Andreje Kmeťa. Z minulosti a prítomnosti Turca 5: 177–179.

Straka V (2001) Dvojkrídlovce (Diptera) v Národnjej prirodnej rezervácii Rozsutec v Národnom parku Malá Fatra. Naturae tutela 6: 81–100.

Straka V (2005a) Dvojkrídlovce (Diptera) Prírodnjej pamiatky Krasín v Bielych Karpatoch. Naturae tutela 9: 79–86.

Straka V (2005b) Súčasné poznatky o faune dvojkrídleho hmyzu (Diptera) Veľkej Fatry. Zborník SNM. Prirodné vedy, ročník LI: 67–70.

Straka V (2010) The Flies (Diptera) of the Žalostiná massif in the Protected Landscape Area Biele Karpaty Mts (West Slovakia). Naturae tutela 14(1): 55–73.

Straka V (2011) K poznaniu dvojkrídlovcov (Diptera) širšieho okolia Vršateckých bradiel. Naturae tutela 15(1): 39–63.

Straka V (2016) Fauna dvojkrídleho hmyzu (Diptera) v oblasti Cerovej vrchoviny na Južnom Slovensku. Naturae tutela 20(2): 149–173.

Straka V, Majzlán O (2008) Dvojkrídlovce (Diptera) prírodnej rezervácia Lutovský Dreieňovec v južnej časti Strážovských vrchov. Rosalia 19: 183–202.

Straka V, Majzlán O (2010) Dynamics of the flies abundance (Diptera) in the National Nature Reserve Bábsky les near Nitra (South Slovakia). Rosalia 21: 167–184.

Straka V, Majzlán O (2014) Dvojkrídlovce (Diptera) Nitrických vrch v južnej časti Strážovských vrchov. Naturae tutela 18/1: 79–105.

Straka V, Majzlán O (2016) Dvojkrídlovce (Diptera) pohoria Burda. Ochrana prirody 27: 89–125.

Sun X (1999) Family Hippoboscidae. Flies of China 2: 2256–2265.
Sychra O (2006) Hippoboscidae Samouelle, 1819. In: Jedlička L, Stloukalová V, Kúdela M (Eds) Checklist of Diptera of the Czech Republic and Slovakia. Electronic version 1. [CD-ROM] http://zoology.fns.uniba.sk/diptera2006

Sychra O (2009) Hippoboscidae Samouelle, 1819. In: Jedlička L, Kúdela M, Stloukalová V (Eds) Checklist of Diptera of the Czech Republic and Slovakia. Electronic version 2. [CD-ROM] http://zoology.fns.uniba.sk/diptera2009

Thalhammer J (1899) Ordo Diptera. Fauna regni Hungariae, III. Animalium Hungariae hucusque cognitorum enumeratio systematica. Edidit regia societas scientiarum naturalium Hungarica. Akadémiai Kiadó, Budapest, 76 pp.

Theodor O (1965) Lipoptena parvula n. sp., eine neue Art aus der Tschechoslowakei (Diptera, Hippoboscidae). Acta Entomologica Musei Nationalis Pragae 37: 275–278.

Veiga J, De Oña P, Salazar B, Valera F (2018) Defining host range: host-parasite compatibility during the non-infective phase of the parasite also matters. Parasitology 146(2): 1–7. https://doi.org/10.1017/S0031182018001233