Beiträge zur Entomofaunistik 24: 147–164 | Wien, Dezember 2023

Louse fly records from three bird ringing stations in eastern Austria from 2013 to 2022 (Diptera: Hippoboscidae)

Matthias Jentzsch*, Flora Bittermann**, Bernhard Paces***,
Matthias Schmidt***, Benjamin Seaman***, Lukas Strobl****
& Ruben Schreiter*****

Abstract

At three bird ringing stations in eastern Austria, a total of 298 louse flies of nine different species were collected between 2013 and 2022. These came from a total of 228 birds of 38 different species of predominantly passerine birds. The records of *Icosta minor* (Bigot in Thomson, 1858) and *Ornithomya chloropus* (Bergroth, 1901) are the only ones from Austria so far. Also, the numerous records of *Ornithoica turdi* (Latreille, 1812), which is more common in the Afrotropis, and the generally rare *Ornithophila metallica* (Schiner, 1864) are remarkable. In all species, females clearly outnumbered males. Comparing the most common reed warblers and tits, the smaller birds were more often parasitized by *Ornithomya fringillina* Curtis, 1836 and the larger ones by *Ornithomya avicularia* (Linnaeus, 1758). Phoresy with mites occurred in five louse fly species, with *O. turdi* showing the highest phoresy rate of 25%. In one case, two different louse fly species were found on a Common Blackbird at the same time. The monoxenous *Ornithomya biloba* (Dufour, 1827) lives on Barn Swallows, but was also found on a Eurasian Wryneck, a Sand Martin, a Common Kingfisher and a Eurasian Blackcap. Furthermore, the mammalian louse fly *Lipoptena cervi* (Linnaeus, 1758) was found on a Dunnock. In one case, the malformation of a wing was observed in *Ornithomya biloba*.

Key words: eastern Austria, louse flies, Hippoboscidae, *Icosta*, *Ornithoica*, *Ornithomya*, *Ornithophila*, *Lipoptena*, phoresy, parasitism, Passerines, malformation.

Zusammenfassung

Lausfliegen-Nachweise von drei Vogelberingungsstationen in Ostösterreich von 2013 bis 2022 (Diptera: Hippoboscidae). − In drei Vogelberingungsstationen im Osten Österreichs wurden in den Jahren 2013 bis 2022 insgesamt 298 Lausfliegen neun verschiedener Arten gesammelt. Diese stammten von insgesamt 228 Vögeln von 38 verschiedenen Arten. Dabei handelte es sich vorwiegend um Sperlingsvögel. Die Funde von *Icosta minor* (Bigot in Thomson, 1858) und *Ornithomya chloropus* (Bergroth, 1901) stellen die bislang einzigen Nachweise aus Österreich dar. Bemerkenswert sind ferner die zahlreichen Belege der in der Afrotropis häufigeren *Ornithoica turdi* (Latreille, 1812)

* Prof. Dr. Matthias Jentzsch, Hochschule für Technik und Wirtschaft Dresden, Fakultät Landbau/Umwelt/Chemie, Pilnitzer Platz 2, 01326 Dresden, Deutschland (*Germany*). E-Mail: matthias.jentzsch.2@htw-dresden.de

** Mag. Flora Bittermann, Felbigergasse 61/17, 1140 Wien, Österreich (*Austria*). E-Mail: Flora.bittermann@gmx.at

*** MSc MSc Bernhard Paces, Mag. Matthias Schmidt & Mag. Benjamin Seaman, Verein Auring, Forsthausgasse 33, 2273 Hohenau/March, Österreich (*Austria*). E-Mail: bernhard@paces.at, Matthias.Schmidt@libellen.at, benjamin.seaman@gmx.at

**** Lukas Strobl, Florianigasse 3, 3910 Zwettl, Österreich (*Austria*). E-Mail: lukas_strobl@gmx.net

***** Dr. Ruben Schreiter, HenControl, Thalheimer Straße 2, 09390 Gornsdorf, Deutschland (*Germany*). E-Mail: ruben.schreiter@htw-dresden.de

und der allgemein seltenen *Ornithophila metallica* (Schiner, 1864). Bei allen Arten überwogen die Weibchen gegenüber den Männchen deutlich. Im Vergleich der häufigsten Rohrsänger und Meisen wurden die jeweils kleineren Vögel öfter von *Ornithomya fringillina* Curtis, 1836 und die größeren von *Ornithomya avicularia* (Linnaeus, 1758) parasitiert. Milbenphoresie kam bei fünf Lausfliegen-Spezies vor, wobei *O. turdi* mit 25 % die höchste Phoresie-Rate aufwies. In einem Fall wurden auf einer Amsel zeitgleich zwei verschiedene Lausfliegen-Arten festgestellt. *Ornithomya biloba* (Dufour, 1827) lebt monoxen auf Rauchschwalben, wurde aber auch auf einem Wendehals, einer Uferschwalbe, einem Eisvogel und einer Mönchsgrasmücke angetroffen. Des Weiteren gelang der Nachweis der Säugetier-Lausfliege *Lipoptena cervi* (Linnaeus, 1758) auf einer Heckenbraunelle. In einem Fall wurde die Missbildung eines Flügels bei *Ornithomya biloba* festgestellt.

Introduction

The Hippoboscidae are a group of bloodsucking ectoparasites which live on birds and mammals and are classified as pupiparous dipterans. With their flattened, highly sclerotised bodies and their strong claws, the animals have adapted their way of life to the conditions on their hosts. Hippoboscidae are distributed all over the world. They comprise only 204 species (Büttiker 1994). In Austria, 16 species are considered to be native (Jentzsch & Königstein 2023).

Louse flies are carried by their hosts, but in turn serve as hosts and means of transport for feather flies and mites, a process known as phoresy. In this process, the phoronts preferentially attach themselves to bristles of the abdomen or to wing veins (Büttiker 1994).

With regard to the host specificity of louse flies, three groups can be distinguished: polyxenous, oligoxenous and monoxenous species. The polyxenous species are quite unspecific regarding their host choice, although certain niches can be detected. The respective louse fly species occur either on birds or on mammals. Transfers to the respective other species group are rare.

To sample louse flies, it is necessary to get close to their hosts. In the case of bird louse flies, this is most easily done during bird trapping for scientific bird ringing. In this context, louse flies were collected over several years at the bird ringing stations in Hohenau-Ringelsdorf (Lower Austria), at Lake Neusiedl (Burgenland) and at the Rudmannser Teich (Lower Austria). From Lake Neusiedl Kasparek & Walter (1986) already reported the detection of four louse fly species.

In this work, we present the results of louse fly sampling conducted between 2013 and 2022.

Material and methods

To catch birds, mist nets were used, which efficiently trap small to medium sized passerine birds. In general, the louse flies were collected during the ringing of the birds and thus assigned to their respective hosts. However, some flies already left their hosts during the birds' transport to the ringing station or escaped when trying to collect them from the birds. Therefore, louse flies were also collected from the cotton bags in which the birds were transported from the nets to the station, or caught at the

worktables and windows of the ringing stations. Therefore, not all louse flies could be assigned to a host species. In these cases, no host is given in the list of individual records presented below. Other louse flies already escaped during the removal of the birds from the mist nets and thus evaded further investigations. The successfully collected louse flies were transferred into 2 ml twist vials with 70% denatured ethanol and later identified using the identification key of Büttiker (1994). The sex was also determined and attention was paid to the occurrence of phoresy.

The nomenclature used for louse flies follows Müller (2021), while the nomenclature for birds follows Barthel & Krüger (2018).

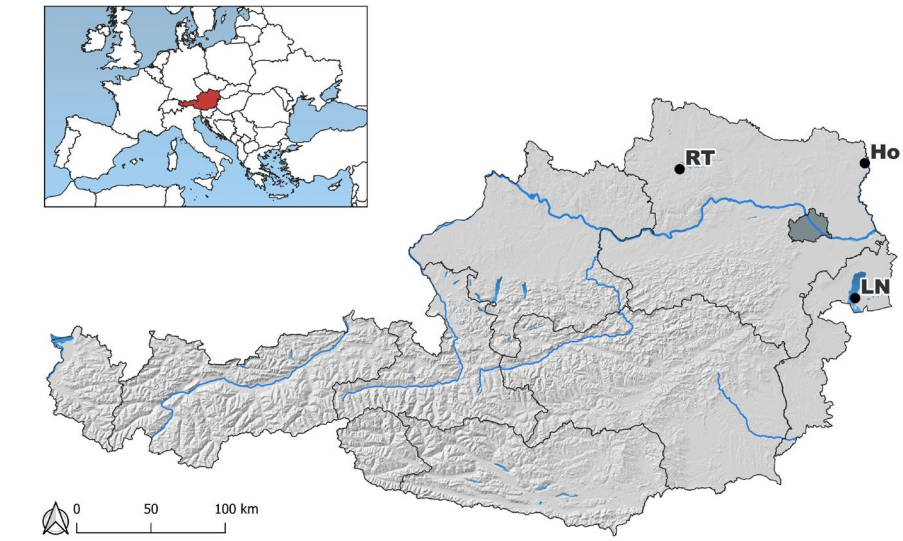
In order to investigate a possible preference of *Ornithomya fringillina* Curtis, 1836 and *Ornithomya avicularia* (Linnaeus, 1758) for bird species of different sizes, the frequently parasitized species Eurasian Blue Tit and Great Tit on the one hand and Eurasian Reed Warbler and Great Reed Warbler on the other hand were compared with regard to their louse fly infestation. Microsoft Excel® (version 2016, Microsoft Corporation, Redmond/USA) was used for data collection and preparation. Data were analysed with the programme IBM SPSS Statistics (Version 23, SPSS Inc., Chicago/USA). Within a bird species, the 95% confidence intervals (CI) were calculated for the detection rates of the encountered louse fly species using the bootstrapping method (n = 1000), which indicate statistically significant differences in the absence of overlap between the compared groups (Du Prel et al. 2009).

Study areas

Figure 1 shows the location of the three study areas.

Biological Station Hohenau-Ringelsdorf (Lower Austria) (Fig. 2): The Biological Station is operated by the local nature conservation association "Auring" and is located on the western edge of a strip of floodplain forest that accompanies the Morava River (48°34′59.8″ N, 16°54′29.9″ E). This river, which runs in north-south direction, serves as an important landmark for bird migration together with its accompanying floodplain forest (Zuna-Kratky et al. 2000). The nets are set up in former settling ponds of the local sugar factory in the immediate vicinity of the alluvial forest. They are up to one kilometre away from the Biological Station and are surrounded by a patchwork of wetland and dry ruderal vegetation.

Biological Station Lake Neusiedl (Burgenland) (Fig. 3): The Biological Station is a field station of the federal state Burgenland and is located on the eastern shore of Lake Neusiedl directly at the edge of the reed belt in the Lake Neusiedl – Seewinkel National Park near the village of Illmitz (47°46′8.8″ N, 16°45′58.2″ E). The reed belt of Lake Neusiedl is the largest contiguous reed area in Central Europe and is not only an important breeding area for many reed-dwelling bird species, but also an important stopover for migratory birds (Dvorak 2009). The mist nets are mostly located in the reed belt, but some are also set up in a nearby wooded area. The maximum distance from the station is about one kilometre.



Figs 1–2: (1) Location of the study areas (Ho = Biological Station Hohenau-Ringelsdorf, LN = Biological Station Lake Neusiedl, RT = Bird Ringing Station Rudmannser Teich, dark area = Vienna). (2) Biological Station Hohenau-Ringelsdorf, bird ringing station and the adjacent former settling ponds of the Hohenau sugar factory. / *(1) Lage der Beringungsstationen (Ho = Biologische Station Hohenau-Ringelsdorf, LN = Biologische Station Neusiedler See, RT = Vogelberingungsstation Rudmannser Teich, dunkel gekennzeichnetes Gebiet = Wien). (2) Ho, Vogelberingungsstation und die angrenzenden früheren Absetzbecken der Hohenauer Zuckerfabrik.* Source Fig. 1: geoland.at. © Fig. 2: B. Paces.

Figs 3–4: (3) Biological Station Lake Neusiedl, bird netting site. (4) Bird Ringing Station Rudmannser Teich, reed area with bird netting site. / *(3) Biologische Station Neusiedler See, Vogelnetz-Standort. (4) Vogelberingungsstation Rudmannser Teich, Schilfgebiet mit Vogelnetz.* © Fig. 3: F. Bittermann, Fig. 4: L. Strobl.

Bird Ringing Station Rudmannser Teich (Lower Austria) (Fig. 4): The ringing station is located on the southern shore of Rudmannser Teich (48°35′10.8″ N, 15°13′2.9″ E), a pond which is part of the Stifter Teiche European nature reserve. The ringing activities are focused on resting migrants, but breeding birds are also trapped. The mist nets are mainly located in the reeds, but some are also set up in a woody stand. None of the mist nets are more than 200 metres away from the station.

Results and discussion

298 louse flies of nine different species were recorded. Together with *Icosta ardea* (Macquart, 1835) and *Steneperyx hirundinis* (Linnaeus, 1758) known from earlier investigations at Lake Neusiedl (Kasparek & Walter 1986), the total number of registered species in the study areas is eleven.

The records of the different species between 2013 and 2022 at the different ringing stations are shown in Table 1.

Tab. 1: Louse fly species 2013–2022 (n = number, Ho = Hohenau-Ringelsdorf, LN = Lake Neusiedl, RT = Rudmannser Teich, ? = sex indeterminable). / *Lausfliegenarten 2013–2022 (n = Nummer, Ho = Hohenau-Ringelsdorf, LN = Neusiedler See, RT = Rudmannser Teich, ? = Geschlecht unbestimmt).*

Louse fly species	n_{Ho}	n_{LN}	n_{RT}	n_{total}	$n_{♂♂}$	$n_{♀♀}$	$n_{?}$	♂ : ♀	$n_{Phoresy}$	$\%_{Phoresy}$
Hippoboscinae										
Icosta minor	1			1	1	0	0	/	0	/
Ornithoica turdi	24	12		36	6	30	0	1:5	9	25
Ornithomya avicularia	66	25	1	92	10	82	0	1:8.2	9	9.8
Ornithomya biloba	25	42		67	18	47	2	1:2.3	13	19.4
Ornithomya chloropus		2		2	0	2	0	/	0	/
Ornithomya fringillina	16	48	12	76	6	70	0	1:11.7	2	2.3
Ornithophila metallica	16	1		17	4	13	0	1:3.2	1	5.9
Lipopteninae										
Lipoptena cervi		6		6	1	5	0	1:5	0	/
Lipoptena fortisetosa	1			1	1	0	0	/	0	/
n_{total}	**7**	**7**	**2**							

Individual records

Hippoboscinae

Icosta minor (Bigot in Thomson, 1858)

Biological Station Hohenau-Ringelsdorf: 1 ♂ (10.08.2020).

This is the first record for Austria (Jentzsch et al. 2021).

Ornithoica turdi (Latreille, 1812), Fig. 5

Biological Station Hohenau-Ringelsdorf: 2 ♀♀ (01.08.2020, Red-backed Shrike), 2 ♀♀ (07.08.2020, Yellowhammer, phoresy of mites), 1 ♀ (08.08.2020, Common Whitethroat), 1 ♂, 1 ♀ (09.08.2020), 1 ♂ (14.08.2020, Sedge Warbler, phoresy of mites), 1 ♀ (14.08.2020, Eurasian Tree Sparrow,

phoresy of mites), 1 ♀ (21.09.2020, Common Reed Bunting), 1 ♀ (01.08.2021, Red-backed Shrike), 1 ♂ (06.08.2021, Red-backed Shrike), 1 ♀ (08.08.2021, Red-backed Shrike), 1 ♀ (09.08.2021, Red-backed Shrike), 1 ♀ (13.08.2021, Red-backed Shrike), 1 ♂ (15.08.2021, Sedge Warbler), 1 ♀ (16.08.2021, Common Whitethroat), 3 ♀♀ (17.09.2021, Yellowhammer, all phoresy of mites), 1 ♂ (02.07.2022, Common Whitethroat), 1 ♀ (07.08.2022, Red-backed Shrike, phoresy of mites, Fig. 5), 1 ♀ (20.08.2022, Common Blackbird, phoresy of mites, specimen together with *Ornithomya avicularia*), 1 ♀ (21.08.2022, Red-backed Shrike).

Biological Station Lake Neusiedl: 1 ♀ (29.10.2020, Common Reed Bunting), 1 ♀ (17.10.2021), 1 ♀ (19.10.2021, Song Thrush), 4 ♀♀ (30.07.2022), 1 ♀ (01.08.2022, Savi's Warbler), 2 ♀♀ (05.08.2022), 1 ♂ (14.08.2022, Red-backed Shrike), 1 ♀ (04.10.2022, Common Chiffchaff).

Fig. 5: Mite phoresy in *Ornithoica turdi*. / *Milbenphoresie bei Ornithoica turdi*. © M. Jentzsch.

The small, polyxenous species, only 2.5 mm in size, occurs mainly in the Afrotropics and the southern Palaearctic (Bequeart 1953, Büttiker 1994) and arrivals in the more northerly parts of Europe were described by Maa (1966) as vagrants, occasionally introduced by migratory birds. Kock (2000) provides an overview of the findings published to date from the western Palaearctic, which include Germany, the Czech Republic, Slovakia and Hungary. The only finding from Austria so far was reported by Zittra et al. (2019) from Vienna.

Kock (2000) and Heddergott & Müller (2008) discussed the occurrences in connection with climate change and concluded at the time that there was no evidence for an effect of climate change on the occurrence patterns of this species. The findings from Lake Neusiedl and Hohenau-Ringelsdorf presented here can also be considered in this context. After all, they are unusually numerous and also distributed over some species that are no long-distance migrants (Common Reed Bunting, Eurasian Tree Sparrow, Song Thrush, Yellowhammer). In addition, the three years 2020, 2021 and 2022, in which many records in Austria occurred, were unusually warm and dry. It stands to reason that *O. turdi* is particularly frequently transported to Europe beyond the Mediterranean during such periods. However, the dates of discovery extend into October and it is not very likely that the louse flies still originate from the birds' spring migration. It is therefore possible that the (future) establishment of the species in more northerly areas of Europe is being initiated by climate change. Heddergott & Müller (2008) also assumed that *O. turdi* can have reproductive success in the western Palaearctic in climatically favourable years. However reliable scientific evidence for this assumption is lacking (Kock 2000, Heddergott & Müller 2008).

Ornithomya avicularia (Linnaeus, 1758)

Biological Station Hohenau-Ringelsdorf: 2 ♂♂ (17.08.2013, Great Reed Warbler), 1 ♀ (25.07.2014, Great Tit), 1 ♀ (25.07.2014, Great Tit), 1 ♂ (08.08.2014, Sedge Warbler), 1 ♀ (16.08.2015, Yellowhammer), 2 ♀♀ (17.08.2015, Great Reed Warbler), 1 ♀ (29.07.2016, Common Blackbird), 1 ♀ (08.08.2016, Song Thrush), 1 ♂ (12.07.2019, Common Blackbird), 1 ♂ (13.07.2019, Marsh Warbler), 1 ♂ (13.07.2019, Great Reed Warbler), 1 ♀ (15.07.2019, Common Whitethroat), 1 ♀ (19.07.2019, Common Blackbird), 1 ♀ (19.07.2019, Great Reed Warbler), 1 ♀ (20.07.2019), 1 ♀ (21.07.2019, Great Reed Warbler), 1 ♀ (22.07.2019), 1 ♀ (22.07.2019), 1 ♀ (22.07.2019, Great Reed Warbler), 1 ♀ (12.08.2019, European Greenfinch), 1 ♀ (16.08.2019, Common Reed Bunting), 1 ♀ (26.10.2019, Eurasian Blue Tit), 1 ♂, 1 ♀ (04.07.2020, Eurasian Wryneck), 1 ♀ (12.07.2020, Marsh Warbler, phoresy of mites), 1 ♀ (13.07.2020, Marsh Warbler), 1 ♀ (18.07.2020, Great Tit, phoresy of mites), 1 ♀ (19.07.2020, Eurasian Golden Oriole), 1 ♀ (26.07.2020, Sedge Warbler, phoresy of mites), 1 ♀ (27.07.2020, Great Tit), 1 ♀ (14.08.2020, Eurasian Reed Warbler), 1 ♀ (14.08.2020, Great Reed Warbler), 1 ♀ (15.08.2020, Common Chaffinch, phoresy of mites), 1 ♀ (19.09.2020, Yellowhammer), 1 ♂, 2 ♀♀ (04.07.2021, Great Tit), 1 ♀ (05.07.2021), 1 ♀ (09.07.2021, Common Grasshopper Warbler), 1 ♀ (12.07.2021, Yellowhammer), 1 ♀ (18.07.2021, European Green Woodpecker), 1 ♀ (23.07.2021, Great Reed Warbler), 1 ♀ (24.07.2021), 1 ♀ (24.07.2021, Great Tit), 1 ♀ (31.07.2021, Great Spotted Woodpecker), 1 ♀ (06.08.2021, Great Tit), 1 ♀ (01.07.2022, Eurasian Tree Sparrow), 1 ♀ (02.07.2022, Great Tit), 1 ♂, 2 ♀♀ (03.07.2022, Great Reed Warbler), 1 ♀ (11.07.2022, Sedge Warbler), 1 ♀ (15.07.2022, Eurasian Wryneck), 2 ♀♀ (15.07.2022, Great Reed Warbler), 1 ♀ (15.07.2022, phoresy of mites), 1 ♀ (16.07.2022), 1 ♀ (25.07.2022, Common Blackbird, phoresy of mites), 1 ♀ (20.08.2022, Common Blackbird, phoresy of mites; specimen together with *Ornithoica turdi*), 1 ♀ (09.09.2022, Barn Swallow), 1 ♀ (11.09.2022, Tree Pipit), 1 ♀ (07.10.2022, Common Reed Bunting), 1 ♀ (14.10.2022, Tree Pipit), 1 ♀ (21.10.2022, Dunnock).

Biological Station Lake Neusiedl: 1 ♀ (10.08.2019, Common Snipe), 1 ♀ (25.09.2019, Moustached Warbler), 1 ♀ (06.10.2019, Common Blackbird, phoresy of mites), 1 ♀ (12.10.2019), 1 ♀ (17.10.2019, Common Reed Bunting), 1 ♀ (15.07.2020, Common Starling), 1 ♀ (04.09.2020, Great Reed Warbler), 1 ♀ (02.07.2021, Common Reed Bunting), 1 ♀ (02.07.2021, Common Blackbird), 2 ♀♀ (13.07.2021, Great Spotted Woodpecker), 1 ♀ (15.07.2021, Great Reed Warbler), 1 ♀ (15.07.2021, Great Tit), 1 ♂ (10.08.2021, Great Reed Warbler), 1 ♀ (12.08.2021, Great Reed Warbler, phoresy of mites), 1 ♀ (19.08.2021, Great Reed Warbler), 1 ♀ (31.08.2021, Savi's Warbler), 1 ♀ (29.07.2022, Great Reed Warbler), 1 ♀ (03.08.2022, Great Reed Warbler), 1 ♀ (10.08.2022, Eurasian Reed Warbler), 2 ♀♀ (26.08.2022, Great Reed Warbler), 1 ♀ (04.09.2022, Great Reed Warbler), 1 ♀ (04.09.2022), 1 ♀ (02.10.2022, Bearded Reedling).

Bird Ringing Station Rudmannser Teich: 1 ♀ (29.09.2021, Eurasian Penduline Tit).

The polyxenous species was the species found most frequently on a total of 29 bird species (Tab. 1, 2). Kasparek & Walter (1986) also most frequently detected *O. avicularia* on 12 bird species at Lake Neusiedl.

Ornithomya biloba (Dufour, 1827), Fig. 6

Biological Station Hohenau-Ringelsdorf: 1 ♂ (03.08.2014, Barn Swallow), 1 ♀ (09.07.2020, Barn Swallow), 1 ♂ (09.07.2020, Barn Swallow), 1 ♀ (26.07.2020, Barn Swallow, phoresy of mites), 1 ♀ (03.08.2020, Barn Swallow), 1 ♀ (07.08.2020, Common Kingfisher), 1 ♂ (11.08.2020, Barn Swallow, phoresy of mites), 2 ♀♀ (12.08.2020, Barn Swallow), 1 ♀ (02.09.2020, Barn Swallow, phoresy of mites), 1 ♀ (02.09.2020, Barn Swallow, phoresy of mites), 1 ♀ (03.07.2021, Barn Swallow), 1 ♂ (05.07.2021, Barn Swallow), 1 ♂ (06.07.2021, Barn Swallow), 1 ♀ (10.07.2021, Barn Swallow), 1 ♀ (10.08.2021, Barn Swallow), 1 ♂ (11.08.2021, Barn Swallow), 1 ♀ (28.08.2022, Barn Swallow), 1 ♀ (29.08.2022, Sand Martin), 2 ♀♀ (03.09.2022, Barn Swallow, both phoresy of mites), 1 individual (03.09.2022, Barn Swallow), 1 ♀ (03.09.2022, Barn Swallow), 1 ♀ (04.09.2022, Barn Swallow), 1 ♂ (09.09.2022, Barn Swallow), 1 ♀ (09.09.2022), 1 ♀ (09.09.2022, Barn Swallow), 1 ♀ (09.09.2022, Barn Swallow), 1 ♀ (10.09.2022, Barn Swallow), 1 ♂, 3 ♀♀ (10.09.2022, Barn Swallow), 1 ♀ (11.09.2022,

Fig. 6: Malformation of the skin of the right wing in *Ornithomya biloba*. / *Fehlbildung des rechten Flügels von Ornithomya biloba*. © M. Jentzsch.

Barn Swallow, phoresy of mites), 1 ♀ (11.09.2022, Eurasian Wryneck), 1 ♀ (11.09.2022, Barn Swallow, phoresy of mites), 1 ♂ (11.09.2022, Barn Swallow), 1 ♀ (11.09.2022, Eurasian Blackcap), 1 ♀ (18.09.2022, Barn Swallow), 1 ♀ (19.09.2022, Barn Swallow, phoresy of mites).

Biological Station Lake Neusiedl: 1 ♂, 1 ♀ (21.08.2021, Barn Swallow), 1 ♂, 3 ♀♀ (22.08.2021, Barn Swallow), 1 ♀ (26.08.2021, Barn Swallow), 1 ♀ (26.08.2021, Barn Swallow), 1 ♀ (27.08.2021, Barn Swallow), 1 ♀ (27.08.2021, Barn Swallow), 1 ♂, 2 ♀♀ (28.08.2021, Barn Swallow), 3 ♂♂, 1 ♀ (07.09.2021, Barn Swallow, phoresy of mites), 1 ♂ (09.09.2021, Barn Swallow), 1 ♂ (04.07.2022, Barn Swallow), 1 ♂, 1 ♀, 1 individual (27.07.2022, Barn Swallow), 1 ♀ (28.07.2022, Barn Swallow), 1 ♀ (04.08.2022, Barn Swallow), 1 ♀ (28.08.2022, Barn Swallow), 1 ♀ (29.08.2022, Barn Swallow), 1 ♀ (06.09.2022, Barn Swallow, wing with malformation, Fig. 6).

Ornithomya biloba is monoxenous on Barn Swallows (Büttiker 1994), which were also regularly parasitized with up to four louse flies occurring on one bird in the present study.

Ornithomya chloropus (Bergroth, 1901)

Biological Station Lake Neusiedl: 1 ♀ (23.09.2019, Tree Pipit), 1 ♀ (04.07.2021, Savi's Warbler).

This is the first record of the species for Austria. The common name Nordic Flat Fly describes the fact that the species is mainly found in northern Central Europe and Northern Europe. Those found further south are usually carried there on migrating birds (Büttiker 1994). This is probably also the case for the records presented here.

Ornithomya fringillina Curtis, 1836

Biological Station Hohenau-Ringelsdorf: 1 ♀ (17.08.2014, Marsh Warbler), 1 ♀ (19.08.2016, Yellowhammer), 1 ♀ (02.09.2016, European Goldfinch), 2 ♀♀ (19.08.2019, Red-backed Shrike), 1 ♀ (19.10.2019, Eurasian Blue Tit), 1 ♀ (24.08.2020, Eurasian Reed Warbler), 1 ♀ (04.07.2021), 1 ♀

(13.08.2021, Common Whitethroat), 1 ♀ (04.09.2021, Common Whitethroat), 1 ♀ (10.10.2021, Eurasian Blue Tit), 1 ♀ (22.10.2021, Great Tit), 1 ♀ (10.07.2022, Marsh Warbler), 1 ♀ (15.07.2022), 1 ♀ (24.07.2022, Red-backed Shrike), 1 ♀ (14.10.2022, Eurasian Tree Sparrow).

Biological Station Lake Neusiedl: 1 ♀ (01.10.2019, phoresy of mites), 1 ♀ (04.10.2019, Eurasian Blue Tit), 1 ♀ (09.10.2019), 1 ♀ (11.10.2019, Eurasian Blue Tit), 1 ♀ (13.10.2019), 1 ♀ (14.10.2019, Coal Tit), 1 ♀ (20.10.2019), 1 ♀ (21.10.2019, Eurasian Blue Tit), 1 ♀ (22.10.2019, Coal Tit), 1 ♀ (22.10.2019, Eurasian Penduline Tit), 1 ♀ (24.10.2019, Eurasian Blue Tit), 1 ♀ (24.10.2019, Eurasian Blue Tit), 1 ♀ (13.08.2020, Red-backed Shrike, phoresy of mites), 1 ♀ (14.08.2020, Eurasian Reed Warbler), 1 ♀ (03.07.2021, Sedge Warbler), 1 ♀ (07.08.2021, Eurasian Reed Warbler), 1 ♀ (08.08.2021, Eurasian Reed Warbler), 1 ♀ (09.08.2021, Eurasian Reed Warbler), 1 ♀ (09.08.2021, Eurasian Reed Warbler), 1 ♀ (09.08.2021, Eurasian Reed Warbler), 1 ♀ (10.08.2021, Eurasian Reed Warbler), 1 ♀ (11.08.2021, Eurasian Reed Warbler), 1 ♀ (21.08.2021, Eurasian Reed Warbler), 1 ♀ (31.08.2021, Savi's Warbler), 1 ♀ (09.10.2021, Eurasian Blue Tit), 1 ♀ (20.10.2021, Eurasian Blue Tit), 1 ♀ (06.07.2022, Eurasian Reed Warbler), 1 ♀ (07.07.2022, Common Reed Bunting), 1 ♂, 1 ♀ (20.07.2022, Eurasian Reed Warbler), 1 ♂, 1 ♀ (28.07.2022, Bearded Reedling), 1 ♀ (29.07.2022, Sedge Warbler or Savi's Warbler), 3 ♀♀ (30.07.2022), 1 ♀ (02.08.2022, Great Reed Warbler), 1 ♀ (03.08.2022, Eurasian Reed Warbler), 1 ♀ (05.08.2022), 1 ♀ (05.08.2022, Eurasian Reed Warbler), 1 ♂ (15.08.2022, Eurasian Reed Warbler), 1 ♀ (15.08.2022, Eurasian Reed Warbler), 1 ♀ (01.09.2022, Eurasian Reed Warbler), 1 ♀ (15.09.2022, Eurasian Reed Warbler), 1 ♀ (27.09.2022, Goldcrest), 1 ♀ (01.10.2022, Eurasian Blue Tit), 1 ♀ (09.10.2022, Eurasian Blue Tit), 1 ♀ (20.10.2022, Eurasian Blue Tit).

Bird ringing Station Rudmannser Teich: 1 ♀ (07.08.2021, Eurasian Reed Warbler), 2 ♀♀ (25.08.2021, Eurasian Reed Warbler), 1 ♂ (26.08.2021, Eurasian Reed Warbler), 1 ♀ (26.08.2021, Marsh Warbler), 1 ♂ (05.09.2021, Eurasian Blue Tit), 1 ♀ (05.09.2021, Great Tit), 1 ♀ (23.09.2021, Common Chiffchaff), 1 ♂ (29.09.2021, Eurasian Penduline Tit), 1 ♀ (29.09.2021, Eurasian Penduline Tit), 1 ♀ (30.09.2021, Eurasian Blue Tit), 1 ♀ (04.10.2021, Eurasian Blue Tit).

The polyxenous species was the second most frequently found on a total of 18 bird species (Tab. 1, 2). Kasparek & Walter (1986) found 30 specimens of *O. fringillina* on 18 bird species at Lake Neusiedl.

Ornithophila metallica (Schiner, 1864)

Biological Station Hohenau-Ringelsdorf: 1 ♀ (23.08.2013, Red-backed Shrike), 1 ♀ (09.09.2013, Yellowhammer), 1 ♂ (25.07.2014, Red-backed Shrike), 1 ♀ (10.08.2014, Red-backed Shrike), 1 ♀ (12.08.2016, Bluethroat), 1 ♀ (19.08.2016, Common Reed Bunting), 1 ♀ (21.08.2016, Song Thrush), 1 ♀ (29.08.2016, Common Whitethroat), 1 ♀ (03.09.2016, Common Reed Bunting, phoresy of mites), 1 ♀ (22.07.2019, Common Starling), 1 ♂ (09.08.2019, Red-backed Shrike), 1 ♂ (27.06.2020, European Stonechat), 1 ♀ (27.06.2020, Sedge Warbler), 1 ♂ (09.07.2021, Eurasian Tree Sparrow), 1 ♀ (15.07.2022), 1 ♀ (30.07.2022, Eurasian Wryneck).

Biological Station Lake Neusiedl: 1 ♀ (15.08.2020, Barn Swallow).

This polyxenous species was found by Maa (1969) on 321 bird species. It is clearly rarer than *O. avicularia* and *O. fringillina*, but according to Büttiker (1994) more common in the Balkans and Eastern Europe. In the course of our work, 16 records were found at the two eastern ringing stations, which are closer to the Balkans. A historical finding by Bau (1909) is known from Austria. Red-backed Shrikes were most frequently registered as hosts. This bird species has already been documented as a host on the Iberian Peninsula by Bernal et al. (2022).

Lipopteninae

Lipoptena cervi (Linnaeus, 1758)

Biological Station Lake Neusiedl: 1 ♀ (20.10.2019, Human), 1 ♂ (24.10.2020, Human), 1 ♀ (17.10.2021, Human), 1 ♀ (17.10.2022, Dunnock), 1 ♀ (20.10.2022, Human), 1 ♀ (21.10.2022, Human).

Lipoptena fortisetosa Maa, 1965

Biological Station Hohenau-Ringelsdorf: 1 ♂ (24.09.2021, Human).

L. cervi and *L. fortisetosa* are louse flies that occur on mammals. Humans and rarely also birds are approached as deviant hosts. These records, even though most of them do not originate from birds, should be mentioned here for the sake of completeness.

Sex ratio of louse flies on birds in the study areas

When the louse flies of all study areas are combined according to the respective species, females outnumber males, sometimes by far (Tab. 1). Similar sex ratios were found in numerous other studies (e.g. Kasparek & Walter 1986, Labitzke & Jentzsch 2019, Konow & Jentzsch 2021), although larger series of *Ornithophila metallica* were only rarely available (Hohenau-Ringelsdorf and Lake Neusiedl, sex ratio 1 ♂ : 3.2 ♀♀, Tab. 1). Nartshuk & Matyukhin (2019) even found a sex ratio of 1 ♂ : 9 ♀♀ for this species in the eastern Palaearctic (n = 40).

Overall, the phenomenon is still not well studied. Schuurmans & Stekhoven (1954) provide the explanation that males live shorter due to lower nutrient availability and therefore generally die earlier than their female conspecifics. Females thus predominate in the course of the season. Büttiker (1994) states that adult males are often more mobile than females and can therefore escape more easily. Walter et al. (1990) noted that there are fluctuations in the number of individuals and sex ratios throughout the season in general.

Different louse fly species on one host

In a single case, two different louse fly species were documented on one host, in this case a Common Blackbird (0.4% of all birds with louse fly infestations). These were one female of *Ornithoica turdi* and one of *Ornithomya avicularia*. Meissner et al. (2020) reported three such cases among 91 birds with louse fly infestations (3.2%) from the Far East, where two different species were also found on a single host. Apparently, this is a very rare phenomenon overall and could indicate competition among the different louse fly species.

Occurrence of *O. fringillina* and *O. avicularia* on selected bird species

In order to investigate a possible preference of the two louse fly species for bird species of different sizes, two pairs of frequently parasitized bird species of different sizes, which are closely related, were selected. Eurasian Blue Tit (small species) and Great Tit (large species) as well as Eurasian Reed Warbler (small species) and Great Reed Warbler (large species) were chosen.

Tab. 2: Number of birds per louse fly species (*L. c.* = *Lipoptena cervi*, *O. t.* = *Ornithoica turdi*, *O. a.* = *Ornithomya avicularia*, *O. b.* = *Ornithomya biloba*, *O. c.* = *Ornithomya chloropus*, *O. f.* = *Ornithomya fringillina*, *O. m.* = *Ornithophila metallica*). / *Anzahl der Vögel pro Lausfliegenart.*

Bird species	Common name	Number of birds per louse fly species						
		L. c.	*O. t.*	*O. a.*	*O. b.*	*O. c.*	*O. f.*	*O. m.*
Charadriiformes								
Gallinago gallinago (Linnaeus, 1758)	Common Snipe			1				
Coraciiformes								
Alcedo atthis (Linnaeus, 1758)	Common Kingfisher				1			
Passeriformes								
Acrocephalus arundinaceus (Linnaeus, 1758)	Great Reed Warbler			19			1	
Acrocephalus melanopogon (Temminck, 1823)	Moustached Warbler			1				
Acrocephalus palustris (Bechstein, 1798)	Marsh Warbler			3			3	
Acrocephalus schoenobaenus (Linnaeus, 1758)	Sedge Warbler		2	3			1	1
Acrocephalus scirpaceus (Hermann, 1804)	Eurasian Reed Warbler			2			21	
Anthus trivialis (Linnaeus, 1758)	Tree Pipit			2		1		
Carduelis carduelis (Linnaeus, 1758)	European Goldfinch						1	
Chloris chloris (Linnaeus, 1758)	European Greenfinch			1				
Cyanistes caeruleus (Linnaeus, 1758)	Eurasian Blue Tit			1			15	
Emberiza citrinella (Linnaeus, 1758)	Yellowhammer		2	3			1	1
Emberiza schoeniclus (Linnaeus, 1758)	Common Reed Bunting		2	4			1	2
Fringilla coelebs (Linnaeus, 1758)	Common Chaffinch			1				
Hirundo rustica (Linnaeus, 1758)	Barn Swallow			1	46			1
Lanius collurio (Linnaeus, 1758)	Red-backed Shrike		9				3	4
Locustella luscinioides (Savi, 1824)	Savi's Warbler		1	1		1	1	
Locustella naevia (Boddaert, 1783)	Common Grasshopper Warbler			1				

Bird species	Common name	Number of birds per louse fly species						
		L. c.	*O. t.*	*O. a.*	*O. b.*	*O. c.*	*O. f.*	*O. m.*
Luscinia svecica (Linnaeus, 1758)	Bluethroat							1
Oriolus oriolus (Linnaeus, 1758)	Eurasian Golden Oriole			1				
Panurus biarmicus (Linnaeus, 1758)	Bearded Reedling			1			1	
Parus major (Linnaeus, 1758)	Great Tit			9			2	
Passer montanus (Linnaeus, 1758)	Eurasian Tree Sparrow		1	1			1	1
Periparus ater (Linnaeus, 1758)	Coal Tit						2	
Phylloscopus collybita (Vieillot, 1817)	Common Chiffchaff		1				1	
Prunella modularis (Linnaeus, 1758)	Dunnock	1		1				
Regulus regulus (Linnaeus, 1758)	Goldcrest						1	
Remiz pendulinus (Linnaeus, 1758)	Eurasian Penduline Tit			1			3	
Riparia riparia (Linnaeus, 1758)	Sand Martin				1			
Saxicola rubicola (Linnaeus, 1766)	European Stonechat							1
Sturnus vulgaris (Linnaeus, 1758)	Common Starling		1					1
Sylvia atricapilla (Linnaeus, 1758)	Eurasian Blackcap				1			
Sylvia communis (Latham, 1787)	Common Whitethroat		3	1			2	1
Turdus merula (Linnaeus, 1758)	Common Blackbird		1	7				
Turdus philomelos (Brehm, 1831)	Song Thrush		1	1				1
Piciformes								
Dendrocopos major (Linnaeus, 1758)	Great Spotted Woodpecker			2				
Jynx torquilla (Linnaeus, 1758)	Eurasian Wryneck			2	1			1
Picus viridis (Linnaeus, 1758)	European Green Woodpecker			1				
Total birds		**1**	**24**	**72**	**50**	**2**	**61**	**16**
Total bird species	**38**	**1**	**11**	**29**	**4**	**2**	**18**	**12**

Tab. 3: Confidence intervals (CI) between frequency of *O. avicularia* and *O. fringillina* on common, closely related bird species 2013–2022 (n_B = number of birds, n_L = number of birds with louse flies). * Sizes according to Glutz von Blotzheim & Bauer (1991, 1993). / *Konfidenzintervalle (CI) der Häufigkeit von O. avicularia und O. fringillina auf häufigen, nahe verwandten Vogelarten 2013–2022 (n_B = Anzahl der Vögel, n_L = Anzahl der Vögel mit Lausfliegen). * Größen laut Glutz von Blotzheim & Bauer (1991, 1993).*

Host species	**Size in cm ***	**n_B**	**n_L**	**$n_{O.avicularia}$**	**$n_{O. fringillina}$**
Eurasian Blue Tit	12	5441	17	2	15
Prevalence (%)				0.037	0.276
95% CI				0.018–0.055	0.165–0.404
Great Tit	15	1983	10	9	1
Prevalence (%)				0.454	0.050
95% CI				0.252–0.656	0.000–0.101
Eurasian Reed Warbler	13	7730	23	2	21
Prevalence (%)				0.026	0.272
95% CI				0.000–0.052	0.168–0.375
Great Reed Warbler	19	914	20	19	1
Prevalence (%)				2.079	0.109
95% CI				1.313–2.845	0.000–0.218

Ornithomya fringillina infested the smaller European Blue Tits (percentage detection rate [95% confidence interval]: 0.28 [0.17−0.40] %) and Eurasian Reed Warblers (0.27 [0.17−0.38] %) significantly more often than *Ornithomya avicularia* (Eurasian Blue Tit: 0.04 [0.02−0.06] %; Eurasian Reed Warbler: 0.03 [0.00−0.05] %). In contrast, *O. avicularia* specimens were predominantly found on the larger Great Tits (0.45 [0.25−0.66] %) and Great Reed Warblers (2.08 [1.31−2.85] %) and were thus significantly more frequent on these bird species than *O. fringillina* (Great Tit: 0.05 [0.00−0.10] %; Great Reed Warbler: 0.11 [0.00−0.22] %). An overview of the absolute frequencies is given in Table 3.

Phoresy

Phoresy is a non-permanent, commensalistic interaction in which one organism (phoront) attaches itself to another (the host) solely for the purpose of travel. The transport of other animals, usually shaft lice or mites, has often been observed in louse flies (Büttiker & Cerny 1974, Walter 1989, White et al. 2017, Labitzke & Jentzsch 2019). Phoresy by mites (Acari) was found in our study on five louse fly species. The rate ranged from 2.3% for *Ornithomya fringillina* to 25% for *Ornithoica turdi* and 19.4% for *Ornithomya biloba* (Tab. 1). At the Helmestausee Berga-Kelbra in Germany, the values were roughly similar for *O. biloba* (22.6%) and slightly higher for *O. fringillina* (7.1%). There were too few records of *O. avicularia* for reliable statements, and *O. turdi* was not recorded there (Labitzke & Jentzsch 2019).

Phoresy is commonly described as a form of zoochorous transport in which the host is not damaged (Roth 1968, Schwerdtfeger 1968). Bequaert (1952) and Fain (1965)

assume that the mite females feed on the haemolymph of the louse flies, which would make it a case of hyperparasitism. Even in the exclusive case of transport, however, it can be assumed that the host likely suffers at least some energetic disadvantages in the case of heavy infestation or due to the small size difference to its phoronts (cf. Fig. 5).

Teratology

In one case, the malformation of a wing was observed in *Ornithomya biloba* (Fig. 6). The skin of the wing had a blister-like expansion at the edge, which was turned over and adhered to the adjacent wing surface, resulting in a double layer of the wing in the area of the malformation. Random deviations from the bilateral symmetry of paired structures are called fluctuating asymmetry in zoology (Van Valen 1962), but are rare in nature (Swaddle et al. 1994, Achazi 2010). They are interpreted as a consequence of the influence of genetic, mechanical or environmental stressors.

Birds as hosts

In total, information about bird hosts is available for seven of the nine detected louse fly species. Louse flies were found on 228 birds of 38 different species (Tab. 2). The hosts examined were predominantly passerine birds, which is due to the bird trapping method at the stations considered here.

The fact that polyxenous louse flies, whose host selection is quite unspecific, were found on numerous different bird species, is not surprising. The host bird species lists available in the literature are hardly manageable with regard to possible first records of host species. On the other hand, louse flies are relatively rarely found on waders. In this respect, the finding of *Ornithomya avicularia* on a Common Snipe at the Biological Station Lake Neusiedl is remarkable. Walter et al. (1990) also described such a record in Germany.

Species which are usually monophagous can regularly be found on atypical bird species, such as *Ornithomya biloba*, which lives on Barn Swallows, but was found on a Eurasian Wryneck, a Sand Martin, a Common Kingfisher and a Eurasian Blackcap. Conversely, other louse fly species are rarely found on Barn Swallows, but this was the case for a specimen of the quite rare *Ornithophila metallica* at Lake Neusiedl (Maa 1969). Walter (1986) also found *O. metallica* on Barn Swallows in Malaysia and Northern Germany. However, it must be kept in mind that – especially at ringing sites with a high number of caught birds – louse flies may leave their original host in the bird bags and then choose another bird which is later transported in the same bag. It is possible that some of the exceptional louse fly records can be explained this way.

The first record of the louse fly *Lipoptena cervi* on a Dunnock, though it commonly parasitizes mammals, is remarkable. It is known that representatives of the genus are occasionally found on birds (e.g. Walter 1990, Knauthe & Jentzsch 2019, Jentzsch 2022). However, it is rather unlikely that blood ingestion occurs there (as well as in the case of false approaches to humans).

Büttiker (1994) and Kasparek & Walter (1986) assume that *Ornithomya avicularia* parasitizes larger birds and *Ornithomya fringillina* prefers smaller birds. However, there is also rare evidence of both species occurring on much larger birds. In the present study, this phenomenon was found in European Blue Tits compared to the larger Great Tits and in Eurasian Reed Warblers compared to the larger Great Reed Warblers. The smaller species were statistically significantly more often parasitized by *O. fringillina*, while *O. avicularia* was found significantly more frequently on the larger Great Tits and Great Reed Warblers (Tab. 3). Lehikoinen et al. (2021) studied larger series of both species in Finland and found a significant preference of *O. fringillina* for smaller species and for hosts breeding in forest habitats. *Ornithomya avicularia*, according to the study by these authors, prefers hosts that nest openly on trees and avoids species that nest on the ground. *Ornithomya fringillina*, on the other hand, shows a weak preference for host species nesting in caves and avoids species nesting on woody plants, while both species equally infest birds from wet habitats. While it can be assumed that the birds studied in Finland are mainly local breeding birds, this might be less pronounced at Lake Neusiedl and its surrounding area as a hotspot of bird migration. This assumption is therefore only partially transferable and is not in line with this study, for example, when analysing the cavity-nesting bird species (here: tits, sparrows, woodpeckers: 16 birds with *O. avicularia* to 18 birds with *O. fringillina*). In our dataset, only the relatively large woodpeckers are parasitized by *O. avicularia*, which again supports the finding that *O. avicularia* prefers larger bird species.

Acknowledgements

Thanks to all members, supporters and the board of the nature conservation association "Auring", who have made the long-term operation of the Biological Station Hohenau-Ringelsdorf possible, as well as to the Biological Station Lake Neusiedl, the Neusiedler See – Seewinkel National Park and the Austrian Ornithological Institute (AOC), who have financed and thus enabled bird ringing activities at the Biological Station Lake Neusiedl over the last three years. Moreover, the Biological Station Lake Neusiedl has also provided accommodation for all involved people. We also want to thank all the ringing assistants who worked at the Biological Stations Hohenau-Ringelsdorf and Lake Neusiedl during the survey years. Heinrich Frötscher, Gilbert Hafner, Martina Hillbrand, Christine Hoffmann, Michael Hupfer, Charel Klein, Barbara Kofler, Clara Machowetz, Niklas Meisenzahl, Martin Rössler, Tobias Schernhammer, Christian Schulze, Katharina Traxler and Barbara Waringer actively contributed louse flies for this study. Furthermore, we are grateful to Sören Knipper, HTW Dresden, who helped with the identification of the louse flies. Finally, our thanks go to Mike Heddergott, Luxembourg National Museum of Natural History, for reviewing the manuscript.

References

Achazi R.K. 2010: Der Tschernobyl-GAU – Die Wirkung ionisierender Strahlung auf Tiere, Pflanzen und Ökosysteme. Pp. 119–152. – In: Mez L., Gerhold L. & De Haan G. (Hrsg.): Atomkraft als Risiko. Analysen und Konsequenzen nach Tschernobyl. – Internationaler Verlag der Wissenschaften, Frankfurt (Main), 277 pp.

Barthel P.H. & Krüger T. 2018: Artenliste der Vögel Deutschlands. – Vogelwarte 56: 171–203.

Bau A. 1909: Beitrag zur Kenntnis der Dipteren Vorarlbergs. – Jahresbericht des Landes-Museums-Vereins für Vorarlberg 47: 295–325.

Bequaert J.C. 1952: The Hippoboscidae or louse-flies (Diptera) of mammals and birds. Part I. Structure, physiology and natural history. – Entomologica Americana 32: 1–209.

Bequeart J.C. 1953: The Hippoboscidae or louse-flies (Diptera) of mammals and birds. Part I. Structure, physiology and natural history. – Entomologica Americana (N.S.) 33: 211–442.

Bernal L., Hidalgo J.C. & Talabante C. 2022: Insect ectoparasites of the Red-backed Shrike *Lanius collurio* in the Iberian Peninsula. – Ornis Hungarica 30: 189–193. DOI: 10.2478/orhu-2022-0015

Büttiker W. 1994: Die Lausfliegen der Schweiz (Diptera, Hippoboscidae). Mit Bestimmungsschlüssel. – CSCF, Neuchâtel, 117 pp.

Büttiker W. & Cerny V. 1974: Phoresie bei Hippobosciden (Diptera) von Säugetieren und Vögeln in der Schweiz. – Mitteilungen der Schweizerischen entomologischen Gesellschaft 47: 319–326.

Dvorak M. 2009: Important Bird Areas. – Die wichtigsten Gebiete für den Vogelschutz in Österreich. – Naturhistorisches Museum Wien, Wien, 576 pp.

du Prel J.-B., Hommel G., Röhrig B. & Blettner M. 2009: Konfidenzintervall oder p-Wert? Teil 4 der Serie zur Bewertung wissenschaftlicher Publikationen. – Deutsches Ärzteblatt 106(19): 335–339. DOI: 10.3238/arztebl.2009.0335

Fain A. 1965: A review of the family Epidermoptidae Trouessart parasitic on the skin of birds (Acarina). – Koninklijke Vlaamse Academie van België voor Wetenschappen en Kunsten 84: 1–176.

Glutz von Blotzheim U.N. & Bauer K.M. 1991: Handbuch der Vögel Mitteleuropas. Band 12. Passeriformes (Teil 3). Teil 1. Sylviidae. – Bauer, Wiesbaden, 626 pp.

Glutz von Blotzheim U.N. & Bauer K.M. 1993: Handbuch der Vögel Mitteleuropas. Band 13. Passeriformes (Teil 4). Teil 1. Muscicapidae – Paridae. – Bauer, Wiesbaden, 808 pp.

Heddergott M. & Müller F. 2008: Erneuter Nachweis von *Ornithoica turdi* (Latreille, 1812) in Deutschland (Diptera: Hippoboscidae). – Studia dipterologica 15: 297–300.

Jentzsch M., Knipper S. & Schreiter R. 2021: First record of the louse fly *Icosta minor* in Austria, including information on the host choice and entire distribution of the species (Diptera, Hippoboscidae). – Biharean Biologist 15: 102–107.

Jentzsch M. 2022: Funde von Lausfliegen auf einheimischen Greifvögeln und Eulen in Deutschland – eine Übersicht. – Beiträge zur Jagd- und Wildforschung 47: 315–321.

Jentzsch M. & Königstein M. 2023: Hippoboscidae (Insecta: Diptera). Checklisten der Fauna Österreichs, No. 11. – Biosystematics and Ecology, zum Druck angenommen.

Kasparek M. & Walter G. 1986: Die Lausfliegen-Fauna der Durchzügler und Brutvögel des Neusiedlersee-Gebietes (Diptera: Hippoboscidae). – Zeitschrift für angewandte Zoologie 73: 345–355.

Knauthe C. & Jentzsch M. 2019: Die Lausfliegenfauna des Freistaates Sachsen (Diptera, Hippoboscidae). – Entomologische Nachrichten und Berichte 63: 189–196.

Kock D. 2000: *Ornithoica turdi* (Latreille, 1812) neu in der Fauna Deutschlands und ihre Phänologie in der westlichen Paläarktis. – Senckenbergiana Biologica 80: 155–158.

Konow S. & Jentzsch M. 2021: Vögel als Wirte von Lausfliegen in Sachsen-Anhalt, Thüringen und Niedersachsen. – Apus 26: 45–51.

Labitzke V. & Jentzsch M. 2019: Lausfliegenerfassungen während der Vogelberingung am Helmestausee Berga-Kelbra (Diptera, Hippoboscidae). – Vogelwarte 57: 73–81.

Lehikoinen A., Pohjola P., Valkama J., Mutanen M. & Pohjoismäki J.L.O. 2021: Promiscuous specialists: Host specificity patterns among generalist louse flies. – PLOS ONE DOI: 10.1371/journal.pone.0247698

Maa T.C. 1966: The genus *Ornithoica* Rodani (Diptera: Hippoboscidae). – Pacific Insects Monograph 10: 1–186.

Maa T.C. 1969: Studies in Hippoboscidae (Diptera). Part 2. Synopses of the genera *Ornithophila* and *Ornithoctona* with remarks of their habitat diversification (Diptera: Hippoboscidae). – Pacific Insects Monograph 20: 1–23.

Meissner B.R., Rodríguez-Vera F., Hawlitschek O., Heim W. & Jentzsch M. 2020: Incidence of louse flies on birds from the Russian Far East (Diptera: Hippoboscidae) and investigation of the status of some taxa by DNA barcoding. – Russian Entomological Journal 29: 327–335. DOI: 10.15298/rusentj.29.3.14

Müller J. 2021: Aktualisierte und kommentierte Checkliste der Lausfliegen (Diptera: Hippoboscidae). – Studia dipterologica 24(2017): 55–61.

Nartshuk E.P. & Matyukhin A.V. 2019: The Louse Flies *Ornithophila metallica* (Schiner, 1864) and *O. gestroi* (Rondani, 1878) (Diptera, Hippoboscidae): Distribution and association with birds in the Palaearctic. – Entomological Review 99: 504–507. DOI: 10.1134/S0013873819040092

Roth B. 1968: Das Phänomen der Phoresie. – Entomologische Nachrichten 12: 7–10.

Schuurmans Stekhoven J.H. 1954: Biologische Beobachtungen an *Stenepteryx hirundinis* L. (Diptera Pupipara). – Zeitschrift für Parasitenkunde 16: 313–321.

Schwerdtfeger F. 1968: Demökologie. Struktur und Dynamik tierischer Populationen. – Paul Parey, Hamburg, Berlin, 448 pp.

Swaddle J.P., Witter M.S. & Cuthill I.C. 1994: The analyses of fluctuating asymmetry. – Animal Behavior 48: 986–989.

Van Valen L. 1962: A study of fluctuating asymmetries and sexual selection. – Evolution 16: 125–142.

Walter G. 1986: Zum Vorkommen der Lausfliege *Omithophila metallica* (Schiner, 1864) (Diptera: Hippoboscidae) in der Bundesrepublik Deutschland. – Beiträge zur Naturkunde Niedersachsens 39: 244–245.

Walter G. 1989: Phoresie und Hyperparasitismus bei *Ornithomya* (Diptera, Hippoboscidae) in der Bundesrepublik Deutschland. – Angewandte Parasitologie 30: 43–46.

Walter G. 1990: Dipteren (Diptera: Cyclorrapha) als Ektoparasiten von Vögeln in der Bundesrepublik Deutschland. – Die Vogelwarte 35: 231–242.

Walter G., Kasparek M. & Tschirnhaus M. 1990: Zur Lausfliegenfauna (Diptera: Hippoboscidae) der Vögel in der Bundesrepublik Deutschland. – Ökologie der Vögel 12: 73–83.

White P.S., Morran L. & De Roode J. 2017: Phoresy. – Current Biology 27(12): R578–R580. DOI: 10.1016/j.cub.2017.03.073

Zittra C., Schoener E.R., Wagner R., Heddergott M., Duscher G.G. & Fuehrer H.-P. 2019: Unnoticed arrival of two dipteran species in Austria: the synanthropic moth fly *Clogmia albipunctata* (Willison, 1893) and the parasitic bird louse fly *Ornithoica turdi* (Olivier in Latreille, 1811). – Parasitology Research 119: 737–740. DOI: 10.1007/s00436-019-06563-9

Zuna-Kratky T., Kalivodová E., Kürthy A., Horal D. & Horák P. 2000: Die Vögel der March-Thaya-Auen im österreichisch-slowakisch-tschechischen Grenzraum. – Distelverein, Deutsch Wagram, 285 pp.