

New and interesting records of Diptera on glacial sand deposits in Silesia (NE Czech Republic). Part 3 – Acalyptratae 2

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Abstract: Additional records of 28 species of interest belonging to acalyptrate families *Lonchaeidae* (1 species), *Lauxaniidae* (2 species), *Chamaemyiidae* (9 species), *Agromyzidae* (16 species) and *Opomyzidae* (1 species) from glacial sand deposits in the Czech Silesia (NE Czech Republic) are presented and their association with sandy habitats discussed. A total of 25 species are recorded from the Czech Silesia for the first time, 15 are new additions to the fauna of Moravia of which 11 are also new for the whole of the Czech Republic. Six species (*Lauxaniidae* 1, *Agromyzidae* 5) are new additions to the Diptera fauna of Poland. *Leucopis cerasiphila* Gomolitzkaja & Tanasijtshuk, 1986 is recorded for the first time from Europe. None of the here reported species is classified as psammobiont but 8 species are considered psammophilous or probably psammophilous, viz. *Minettia longiseta* (Loew, 1847) (*Lauxaniidae*), *Leucopis kaszabi* Tanasijtshuk, 1970 (*Chamaemyiidae*), *Cerodontha* (*Xenophytomyza*) *leptophallus* Papp, 2016, *Hexomyza saroathamni* (Hendel, 1923), *Liriomyza dracunculi* Hering, 1932, *L. latigenis* (Hendel, 1920), *L. yasumatsui* Sasakawa, 1972 (*Agromyzidae*) and *Geomyza subnigra* Drake, 1992 (*Opomyzidae*). The conspicuous species diversity of *Chamaemyiidae* in Silesian glacial sand deposits is discussed.

Key words: *Diptera*, *Lonchaeidae*, *Lauxaniidae*, *Chamaemyiidae*, *Agromyzidae*, *Opomyzidae*, new records, psammophily, glacial sand deposits, Czech Republic (Moravia/Silesia)

Introduction

This study represents a supplement to a previous publication (Roháček *et al.* 2020) on interesting species of Diptera Acalyptratae found on glacial sand deposits in the Czech Silesia. This northeastern region of the Czech Republic is rich in glacial sand and gravel deposits due to the fact that the Pleistocene glaciations reached their southernmost limit in this area. In particular, the largest Saalian glaciation (ca 160 000 ya) resulted in the formation of huge sand beds (cf. Růžicka 2004; Růžicková *et al.* 2009; Nývlt 2011), which are at present largely covered by recent or subrecent Holocene layers of soil. However, the habitats with naturally exposed glacial sediments (natural outcrops of sands) are rather small and fragmentary in the area. Characteristically, exposed sandy habitats can be found in sand-pits, both active (currently mining sand) and abandoned. Although such habitats are rare in the study area these glacial sands support a distinctive ecosystem that is conspicuously different from those found on the more extensive agricultural or forestry landscapes in the vicinity (Roháček 2020; Roháček *et al.* 2020, 2021). These sandy ecosystems in turn support a characteristic fauna of Diptera.

Formerly, sand-loving two-winged flies have largely been associated with maritime areas where they inhabit coastal sand dunes (cf. Karl 1930, Krogerus 1932, Ardö 1957, Howe 2010, Nielsen *et al.* 2016, 2019). In contrast, the dipterous fauna of inland sandy habitats remains mostly undescribed. This project is a biodiversity study of Diptera on glacial sand deposits in Silesia designed to describe species composition of the local fly communities and to evaluate the degree of association of the recorded species to these inland sandy habitats.

The first data on some species of Diptera living in sand-pits in Silesia were presented by Roháček & Ševčík (2013) in the popular book Příroda Slezska (Nature of Silesia). The field work and subsequent research of obtained material of Diptera performed within the above

project yielded much more detailed information on sand-inhabiting flies. However, the results have only been partly published in studies mostly dealing with the faunistically more interesting species (Roháček 2015a, 2016a, 2020; Roháček *et al.* 2020, 2021).

The present study was conducted in nine localities in four parts of the Czech Silesia, viz. in the Jesenicko, Osoblažsko, Hlučínsko and Karvinsko regions (see map on Fig. 3) in 2013–2020. Material obtained previously (1995–1997, 2004) in a few sand-pits and allied sandy sites in the Hlučínsko and Osoblažsko regions (deposited in SMOC) has also been included.

A good deal of species of interest, including faunistic novelties, psammobiont or psamphilous, xerophilous and/or thermophilous species have been recorded during the above research. As in two similar previous studies (Roháček *et al.* 2020, 2021), this current study also includes faunistically important records, now from the acalyptrate families Lonchaeidae, Lauxaniidae, Chamaemyiidae, Agromyzidae and Opomyzidae. Some of species listed below represent first records from the Czech Republic, others are first from Moravia and the remaining from the Czech Silesia. In addition, several species are first records for Poland. We have attempted to obtain most detailed information on biology and distribution of each recorded species (both from the literature and personal experience and field work), and, based on these data, to classify their affinity to sandy habitats.

Material and methods

The material examined is deposited in the collection of the Silesian Museum, Opava, Czech Republic (SMOC) except for a few duplicates retained by the taxonomic experts involved in this study. The collected specimens were air-dried and mounted on pinned triangular cards in the course of the study but some of them were retained alive in plastic tubes for a while to be photographed by means of a digital camera (Canon EOS 60D) with a macro lens (Canon MP-E 65 mm 1–5×) and ring macro flash (Canon MR-14EX). After photography these specimens were killed and mounted for subsequent identification in the same way as the other specimens. Some voucher specimens were photographed by digital camera Canon EOS 5D Mark III with a Nikon CFI Plan 4×/0.10NA 30 mm WD or Nikon CFI Plan 10×/0.25NA 10.5 mm WD objective attached to Canon EF 70–200 mm f/4L USM zoom lens. The specimen photographed by means of the latter equipment was repositioned upwards between each exposure using a Cognisys StackShot Macro Rail and the final photograph was compiled from multiple layers (35) using Helicon Focus Pro 7.0.2. The final images were edited in Adobe Photoshop CS6. Where necessary, male genitalia or female postabdomina were examined after detachment and dissection of the whole abdomen. After examination, all parts were transferred to polymer microvials which were pinned below the respective specimens. Habitat photographs were taken in the field by digital cameras Canon EOS 60D and/or Sony NEX-7.

The historic region of Silesia (the Czech part of Silesia), as delimited in Příroda Slezska (see Fig. 3 and/or Roháček *et al.* 2013, map on pp. 10–12), is treated within (the historical country) Moravia in all checklists of Diptera of the Czech Republic and Slovakia, including the most recent one (Jedlička *et al.* 2009). To display its location, this region is depicted on a map of the Czech and Slovak Republics (see Fig. 2) used in Jedlička *et al.* (2009). Because the Czech Silesia has been considered a part of Moravia in these checklists the area under study is listed as “N Moravia” in the material examined below to be in conformity also with previous faunistic studies.

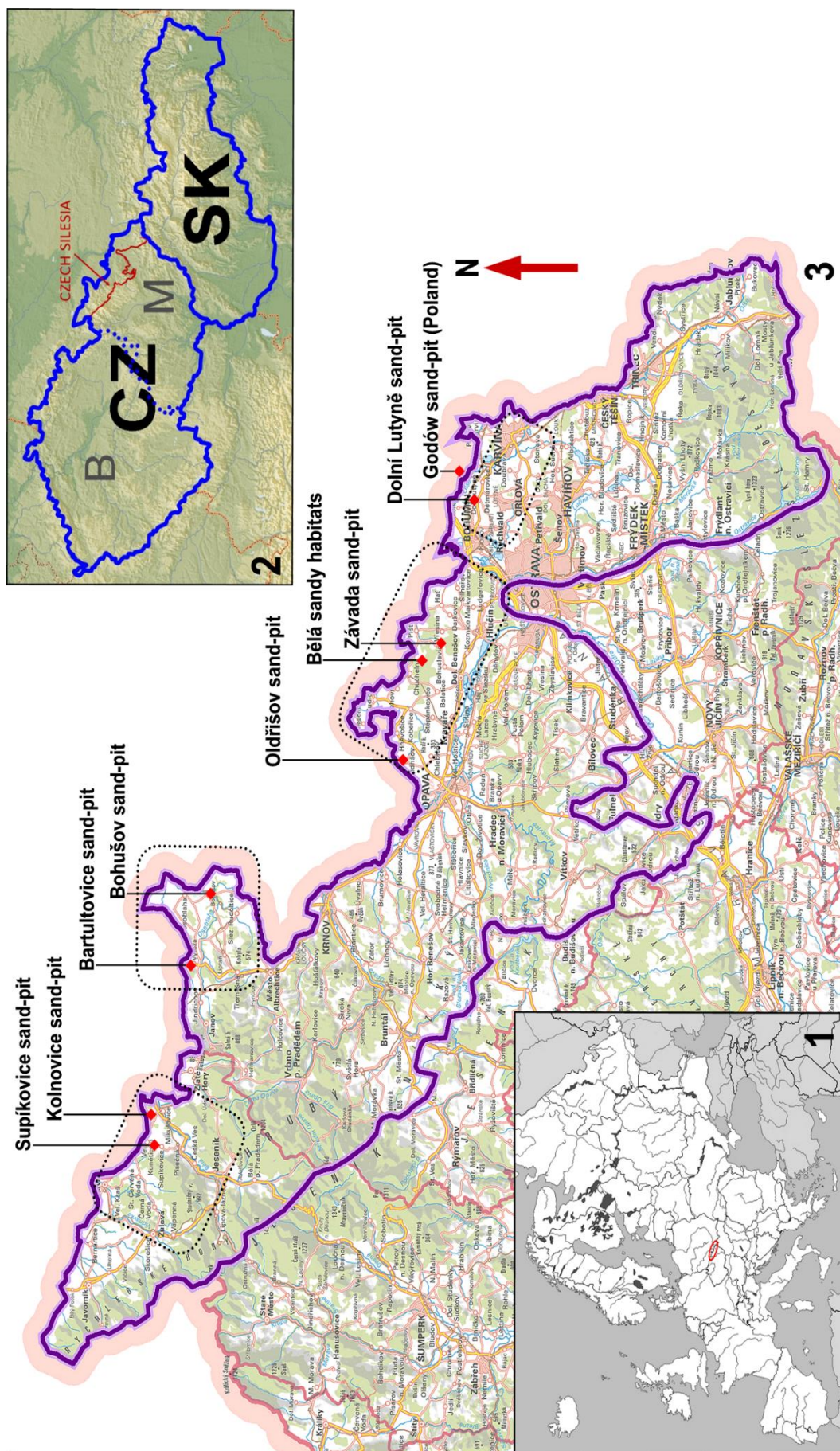
Localities under study. Field work was performed in 2013–2020 in four regions of the Czech Silesia (cf. Roháček *et al.* 2020, 2021) but in this study mainly the records from fieldwork in 2019 and 2020 are presented. Sand-pits were paired by proximity with one being actively utilized for sand extraction and the other left abandoned. A large abandoned sand-pit in Godów in S. Poland was also included in the project to complement the active sand-pit in Dolní Lutyně. The only sites with natural occurrence of glacial sand in the Czech Silesia (Bělá nr. Chuchelná, “Buben” sand-hill and Bělá nr. Chuchelná, natural outcrop of sand at holt) have also been included in the study (see below). For landscape photographs of all localities see Roháček (2020: figs 6–18). Localities are listed below according to these regions and arranged from west to east (see Fig. 3):

Jesenicko region:

- (1) **Supíkovice** 1.1 km NE, 50°18'22"N, 17°15'43"E, 380 m, large abandoned sand-pit;
- (2) **Kolnovice**, active sand-pit, two plots – Kolnovice 1 km SW, 50°18'55"N, 17°18'45"E, 385 m (C part) and Kolnovice 1.2 km WSW, 50°18'59"N, 17°18'35"E, 390 m (W part).

Osoblažsko region:

- (3) **Bohušov** 0.7 km S, 50°14'14"N, 17°42'58"E, 250 m, abandoned sand-pit;
- (4) **Bartultovice** 0.5 km SW, 50°16'13"N, 17°35'00"E, 315 m, small abandoned sand-pit.



Figs 1–3: Maps. **1** – location of the Czech Silesia in Europe (red ellipse); **2** – situation of the Czech Silesia within the Czech Republic and Moravia; **3** – Localities of glacial sand deposits under study. Abbreviations used in maps: B – Bohemia, CZ – Czech Republic, M – Moravia, N – north, SK – Slovak Republic. Study sites are in the regions marked by dotted lines: Jesenícko (Supíkovice, Kolnovice), Osoblažsko (Bartultovice, Bohušov), Hlučínsko (Oldřišov, Bělá, Závada), Karvinsko (Dolní Lutyně) and S. Poland (Godów). Map sources: Fauna Europaea (Fig. 1), <http://www.edvis.sk/diptera2009/mapCZSK.htm> (Fig. 2) and orig. (Fig. 3).

Hlučínsko region:

(5) **Oldřšov** 0.7 km N, sand-pit, 49°59'51"N, 17°57'48"E, 280 m, abandoned sand-pit;

(6) **Bělá** (nr. Chuchelná), three plots – Bělá 0.5 km E, 49°58'26"N, 18°09'05"E, 250 m (small abandoned sand-pit), Bělá 0.4 km NE, "Buben" sand-hill, 49°58'29"N, 18°09'01"E, 260 m (natural outcrop of sand) and Bělá 0.6 km N, 49°58'39"N, 18°08'49"E, 265 m (holt on natural outcrop of sand);

(7) **Závada**, active sand-pit, three plots – Závada 1.8 km SE, 49°56'19"N, 18°10'28"E, 260 m (SE part, partly recultivated), Závada 2 km S, 49°56'09"N, 18°10'04"E, 270 m (SW part, not excavated but regularly disturbed) and Závada 1.6 km S, 49°56'25"N, 18°09'56"E, 265 m (NW part, with active excavation).

Karvinsko region:

(8) **Dolní Lutyně** 1.2 km N, 49°54'34"N, 18°25'33"E, 210 m, active sand-pit with two artificial lakes after excavation.

S. Poland:

(9) **Godów** 1.3 km ESE, 49°55'13"N, 18°29'41"E, 230 m, large abandoned sand-pit (close to Czech-Polish borders).

Collecting methods. Specimens were collected by sweeping over sparse low vegetation or bare sand, netting of individually observed specimens and hand or aspirator collecting on flowering plants, decaying substrates and sandy ground.

Nomenclature. Botanical nomenclature follows that used in the Checklist of vascular plants of the Czech Republic (Danihelka *et al.* 2012). Nomenclature of flies follows the most recent catalogues, checklists, monographs and/or revisions of the groups recorded here.

Assessment of the affinity of species to sandy habitat. The affinity of a species to sand has been judged by the corresponding taxonomic expert based on his knowledge of the biology, autecology and distribution of the species. Four categories are differentiated according to the degree of association with sandy habitats:

(1) **psammobiont** – species strictly associated (including reproduction and entire life-cycle) with sandy habitats.

(2) **psammophilous** – species preferably associated with sandy habitats but also living in related xerothermic habitats like various types of xeric steppe and rocky grassland.

(3) **psammoneutral** – species with a wide habitat tolerance utilizing various habitats and successfully also living in habitats on sandy soils.

(4) **psammoxenous** – species coincidentally encountered in sandy habitats only by chance, not developing there.

These categories can be compared with those generally used in North Europe (e.g. Krogerus 1960) as follows: psammobiont = eucoenic (euzön), psammophilous = tychocoenic (tychozön), psammoneutral = acoenic (azön), psammoxenous = xenocoenic (xenzön).

Results

LONCHAEIDAE

***Protearomyia withersi* MacGowan 2014 – psammoneutral** (Fig. 5)

Material examined: CZECH REPUBLIC: N. Moravia: Bělá nr. Chuchelná 0.6 km N, holt, 49°58'39"N, 18°08'49"E, 265 m, sweeping *Cytisus scoparius* at forest margin, 11.v.2020, 1♂, J. Roháček leg., I. MacGowan det. (SMOC).

Biology: In the British Isles this species shows strong preference for ancient woodland sites and parkland containing veteran trees, although due to what we know of the larval preferences, this may be due more to the undisturbed pasture associated with these sites rather than the trees themselves (MacGowan & Reimann 2021). Swedish records include captures in heath and pasture habitat, mixed forest, broad-leaved deciduous forest and a beech forest (MacGowan & Reimann 2021)). In Germany it has been recorded in habitats ranging from swamp areas to xeric grasslands, including different types of woodland, pastures, roadsides and vineyards. *P. withersi* is a spring and early summer species with most adult records in May and June and has been found at altitudes up to 1600 m (MacGowan & Reimann 2021). The single specimen found during this study of sand-associated flies in Silesian sand deposits was swept from old bushes of broom (*Cytisus scoparius* L.) which occurred along the southern edge of the warm oak-pine holt (see Fig. 4) on old glacial sand dunes.

Distribution: Previously, *P. withersi* has been recorded from Andorra, France, Germany, Greece, Poland, Russia (Mordovia), Spain, Sweden, Switzerland and United Kingdom (England) (MacGowan & Reimann 2021). Consequently, it seems to be a widespread but hitherto overlooked species in the Western Palaearctic. First record from the Czech Republic.

Comments: In the last two decades it was realised that there were a number of cryptic species present within the Palaearctic *Protearomyia* and three of these, including *P. withersi*, were described in 2014 (MacGowan 2014). The status of the genus in the Palaearctic was reviewed by MacGowan & Reimann (2021). These species can mainly be recognized by structures of male terminalia; *P. withersi* is best diagnosed by claw-like apices of male cerci, see Fig. 5. With many of the adult records being linked to meadows or pasture habitats it would seem that feeding in the stems of herbaceous meadow plants is the most likely location for the larvae of this genus (MacGowan & Reimann 2021). Judging from previous habitat data (see above in Biology) the species is probably thermophilous but not particularly associated with sand habitat; therefore, it is classified here as psammoneutral.



Figs 4–5: Habitat and male terminalia of *Protearomyia withersi* MacGowan. **4** – habitat where the species was collected, forest margin with growth of *Cytisus scoparius* and adjacent sandy pasture meadow (Bělá holt, 11.v.2020); **5** – *P. withersi*, male terminalia, posterior view (the diagnostic claw-like apices of cerci are visible centrally). Photos by J. Roháček (4) and I. MacGowan (5).

LAUXANIIDAE

Callixania minor (Martinek, 1974) – ?psammoneutral

(Fig. 6)

Material examined: CZECH REPUBLIC: N. Moravia: Bartultovice 0.5 km SW, 50°16'13"N, 17°35'00"E, 315 m, abandoned sand-pit, sweeping over sand and vegetation on sand, 17.vi.2020, 1♂, J. Roháček leg. et det. (SMOC).

Biology: This thermophilous species seems to be a typical inhabitant of forest steppe habitats (Martinek 1974); also, Semelbauer (2016) reported about its common occurrence in xerothermic, warm and insolated localities in Slovakia (see also Semelbauer & Kozánek 2009). Its larvae were reared on rotting leaves up to the pupal stage (Semelbauer & Kozánek 2012). Also, in the Czech Republic its association with steppe and forest steppe habitats in the warmest areas of the country has been repeatedly confirmed (Martinek 1977, 1982, 1984, 1985, 1989; Dvořáková-Maršová *et al.* 2006). It is a spring species, with adults mainly occurring in III-V (Semelbauer 2016).

Only one male has been found during our study of Diptera on glacial sand deposits, in a small abandoned sand-pit (Fig. 7), which seems to indicate that sands are not its preferred habitat. However, Martinek (1974) included in the type series also specimens from S. Moravia (locality Bzenec-Prívov) collected on “steppe on sands in *Pinetum* region”.

Distribution: Although described in 1974 only from southern Slovakia and southern Moravia (Czech Republic) *C. minor* has subsequently been recorded from the majority of countries of temperate and southern Europe (cf. Merz 2013) but also from ranging throughout the Palaearctic as far as North Korea (for summary of its distribution see Li *et al.* 2019). In the Czech Republic, it has only been known from the warmest areas of Bohemia and Moravia (cf. Martinek 1977, 1982, 1984, 1985, 1989; Martinek & Barták 2001; Dvořáková-Maršová *et al.* 2005) but previously unrecorded from northern Moravia. First record from Silesia.

Comments: The species was formerly classified within the genus *Lauxania* Latreille, 1804 in the subgenus *Callixania* Papp, 1978. Recently, Semelbauer *et al.* (2021) have found this species to be unrelated to *Lauxania* (s. str.) species and therefore *Callixania* was elevated to genus. Although there are a few previous records of *C. minor* from sandy steppe, the species seems not to be more closely associated with sandy habitat and is, therefore, classified as probably psammoneutral.



Figs 6–7: *Callixania minor* (Martinek) and its habitat. **6** – *Callixania minor*, male, right sublateral (body length ca 2.7 mm); **7** – habitat where the species was collected, small abandoned sand-pit with rich herbaceous and shrubby vegetation (Bartultovice, 17.vi.2020). Photos by J. Roháček.



Figs 8–10: *Minettia longiseta* (Loew) and its habitat. 8 – *Minettia longiseta*, female, left lateral (body length ca 4.3 mm); 9 – same specimen, dorsal, cleaning its wings and showing the long setae on 3rd tergum of the abdomen; 10 – typical habitat of the species, a growth of *Cytisus scoparius* in central part of the active sand-pit Kolnovice (20.viii.2020). Photos by J. Roháček.

***Minettia longiseta* (Loew, 1847) – psammophilous**

(Figs 8, 9)

Material examined: CZECH REPUBLIC: N. Moravia: Kolnovice 1 km SW, 50°18'55"N, 17°18'45"E, 385 m, sand-pit C part, sweeping *Cytisus scoparius* on sand, 9.vii.2019, 1♂2♀; 6.viii.2019, 2♀ (1♀ PHOTO); 11.ix.2019, 3♂; Kolnovice 1.2 km WSW, 50°18'59"N, 17°18'35"E, 390 m, sand-pit W part, sweeping *Cytisus scoparius*,

20.viii.2020, 1♂; Bartultovice 0.5 km SW, 50°16'13"N, 17°35'00"E, 315 m, abandoned sand-pit, sweeping over sand and vegetation on sand, 6.viii.2019, 1♀; sweeping *Cytisus scoparius*, 20.viii.2020, 1♂1♀; Bělá nr. Chuchelná 0.6 km N, holt, 49°58'39"N, 18°08'49"E, 265 m, sweeping along sandy path and margin of oak-pine forest on sand, 11.vii.2019, 1♂; sweeping *Cytisus scoparius* at oak-pine forest margin on sand, 1.vii.2020, 1♂1♀; 13.viii.2020, 1♀, 12.viii.2021, 2♀ (PHOTO); POLAND: S. Silesia: Godów 1.3 km ESE, sand-pit, 49°55'13"N, 18°29'41"E, 230 m, sweeping over sand and vegetation on sand, 11.vii.2019, 1♀, all J. Roháček leg. et det. (SMOC).

Biology: Insufficiently known. Data from Portugal (Ebejer *et al.* 2019) revealed this species to be very common in a range of habitats including low vegetation near the seashore, vegetation on consolidated dunes, regenerating forest and scrub, damp mixed forests, pine forest, riparian woodland and *Mimosa* woods, from sea level to an altitude of 1015 m. Adults can be found from May to October in Portugal and probably for a shorter period in more northern latitudes. In Morocco, it was taken in mixed forest dominated by *Quercus suber*, but including *Populus nigra*, *Phillyrea latifolia*, *Salix alba*, *Nerium oleander*, *Lentiscus* sp., and *Crataegus* sp. (Ebejer & Kettani 2019). Although in Britain it is known from the south coast to Inverness at 57°N in Scotland (Collin 1948) *M. longiseta* obviously is a rather thermophilous species. All specimens recorded above have been netted from mature bushes of broom (*Cytisus scoparius*) growing on glacial sands (cf. Figs 4, 10) or from herbaceous vegetation near them (habitat somewhat resembling that on older vegetated dunes). Also, Kröber (1935) recorded this species from dunes in Amrum I. in northern Germany.

Distribution: This species was described from Sicily (Loew 1847) and is probably widespread in western and southern Europe (Portugal, Spain, Andorra, France (incl. Corsica), Great Britain, Ireland, Belgium, The Netherlands, Germany, Denmark, Switzerland, Italy (incl. Sicily) and Greece (mainland), see Merz (2013). However, records are absent from a number of more eastern European countries, including those of central Europe (the record from Slovakia in FaEu is erroneous, see Semelbauer 2016 and Semelbauer, pers. comm. 2021). In North Africa *M. longiseta* is known from Algeria, Tunisia and Morocco (Papp 1984; Ebejer & Kettani 2019). Based on the currently known distribution *M. longiseta* seems to be an Atlanto-Mediterranean species which may have its northeastern limit of distribution in central Europe. First records from the Czech Republic and Poland.

Comments: According to Merz (2004) *M. longiseta* can be best recognized by the combination of the dark 1st flagellomere, presutural dorsocentral seta always absent, dark sublateral pattern of scutellum and the female 3rd tergum short, bearing at the posterior margin medially 4-6 long and thick setae (see Figs 8, 9). However, the diversity of habitats (see above) would suggest that its larvae may develop in a variety of decaying plant matter rather than in association with a specific plant. It is possible that this may be a species complex and the apparent wide range of habitat and altitude reflects the cryptic species diversity. Due to its (almost exclusive) association with *Cytisus scoparius* on sands in Silesia it could be considered a psammophilous species (at least there), similarly as are *Micropeza lateralis* Meigen, 1826, *Calliopum geniculatum* (Fabricius, 1806), see Roháček *et al.* 2020) and *Hexomyza sarothamni* ((Hendel, 1923) (recorded below) co-occurring with it only in this specific habitat. Although *M. longiseta* have occasionally been recorded from coastal dunes (see above), usually another species, the rather mysterious *M. desmometopa* (de Meijere, 1907), has been reported as a typical (psammobiont) species from this habitat (cf. Karl 1930, Ardö 1957, von Tschirnhaus 2008, Howe 2010). However, the taxonomic status of *M. desmometopa* is unclear and is in need of a revision.

CHAMAEMYIIDAE

Chamaemyia hungarica Tanasijtshuk & Beschovski, 1991 – **psammoneutral** (Fig. 11)

Material examined: CZECH REPUBLIC: N. Moravia: Supikovice 1.1 km NE, 50°18'22"N, 17°15'43"E, 380 m, abandoned sand-pit, S part, sweeping over sand and vegetation on sand, 6.viii.2019, 3♂1♀; Bartultovice 0.5 km SW, 50°16'13"N, 17°35'00"E, 315 m, abandoned sand-pit, sweeping over sand and vegetation on sand, 11.ix.2019, 2♀; Oldřišov 0.7 km N, sand-pit, 49°59'51"N, 17°57'48"E, 280 m, sweeping over sand and vegetation on sand, 11.vi.2019, 1♂; all J. Roháček leg., M. J. Ebejer det. (SMOC).

Biology: Unknown. The species was described from a single sample of specimens (9♂ 18♀) collected near a small village in an agricultural area about 30 km southeast of Budapest at an altitude of about 130 m (Tanasijtshuk & Beschovski 1991). The only other record is one male swept from undergrowth of forest in the same country (Papp 2003). Adults have been recorded in V–IX. All specimens recorded above originate from abandoned sand-pits, all with relatively rich herbaceous vegetation with important graminoid component (Fig. 12).

Distribution: Hitherto only known from Hungary (Tanasijtshuk & Beschovski 1991; Papp 2003). New record for the fauna of the Czech Republic.

Comments: There are too few records (see above in biology) for this species to enable any conclusion to be reached about its possible ecology. Therefore, it is tentatively classified as a psammoneutral species.



Figs 11–13: *Chamaemyia hungarica* Tanasijtshuk & Beschovski, and habitats of Chamaemyiidae. **11** – *Chamaemyia hungarica*, male, voucher specimen from Supíkovice sand-pit (6.viii.2019), left lateral (body length ca 2.6 mm); **12** – habitat where this specimen was collected (same date); **13** – habitat of *Leucopis cinarophaga* Tanasijtshuk, young Scots pines in the active sand-pit Kolnovice (28.iv.2020). Photos by J. Roháček.

***Chamaemyia submontana* Beschovski, 1994 – psammoneutral**

Material examined: CZECH REPUBLIC: N. Moravia: Bělá nr. Chuchelná 0.5 km E, sand-pit, 49°58'26"N, 18°09'05"E, 250 m, sweeping over sand & vegetation on sand, 11.v.2020, 1♂; Bělá nr. Chuchelná 0.4 km NE, „Buben“ sand-hill, 49°58'29"N, 18°09'01"E, 260 m, sweeping over sand & vegetation on sand, 13.viii.2020, 2♂; all J. Roháček leg., M. J. Ebejer det. (SMOC).

Biology: Unknown. Based on previous records, this species appears to be a predominantly montane species found among grasses adjacent to forested areas. In Switzerland it was taken at various locations between 1000 and 2200 m from mid June to early September (Beschovski & Merz 1998) and in Italy between 920 and 1900 m in late June (Ebejer unpublished data). However, the records from the Czech Republic, both those from southern Moravia (Papp *et al.* 2006) and those from sands listed above, are from low altitudes and not necessarily from forested sites.

Distribution: Hitherto only recorded from Switzerland (Beschovski & Merz 1998), Czech Republic (Papp *et al.* 2006), Hungary (Papp 2003) and Bulgaria (Beschovski 1994). In the Czech Republic it has been known only from the Podyjí NP in southern Moravia (Papp *et al.* 2006). First records from the Czech Silesia.

Comments: The limited available data indicate a much wider range of habitats and altitudes than formerly recorded for this species. Apparently, the presence of (hitherto unknown) preferred larval prey is a more important condition for the occurrence of this species than the habitat alone. Therefore, it is treated as a psammoneutral species.

***Chamaemyia sylvatica* Collin, 1966 – psammoneutral**

Material examined: CZECH REPUBLIC: N. Moravia: Supikovice 1.1 km NE, 50°18'22"N, 17°15'43"E, 380 m, abandoned sand-pit, S part, sweeping over sand and vegetation on sand, 27.v.2020, 1♀; 17.vi.2020, 1♀; Bohušov nr. Osoblaha 0.7 km S, 50°14'14"N, 17°42'58"E, 250 m, sand-pit, sweeping over sand and vegetation on sand, 17.vi.2020, 1♂; Bělá nr. Chuchelná 0.4 km NE, „Buben“ sand-hill, 49°58'29"N, 18°09'01"E, 260 m, sweeping over sand & sparse vegetation on sand, 13.viii.2020, 1♀; Bělá nr. Chuchelná 0.6 km N, holt, 49°58'39"N, 18°08'49"E, 265 m, sweeping along sandy path and margin of oak-pine forest, 1.vii.2020, 3♀; all J. Roháček leg., M. J. Ebejer det. (SMOC).

Biology: Insufficiently known, although reported from a number of countries. The type series was collected in lowland woods in Britain (Collin 1966). In Bulgaria it was collected in montane habitats at an altitude of 1000 m in one locality in early June and at another locality in early May at an estimated altitude (not given by the authors) between 300 and 600 m (Tanasijtshuk & Beschovski 1991). Both localities are forested with some open ground. In Poland it was collected near Krakow in mid July (Tanasijtshuk & Beschovski 1991). It was a common species in the French East Pyrenees at an altitude of 1035 m at a site also in open ground but within a forested area (M. J. Ebejer, unpublished data). It was reported from Israel at an altitude of about 450 m from vegetation near a “pond” in an arid area (Beschovski & Merz 1998). The above records from the Czech Republic show its occurrence in vegetation on sandy grounds, both in abandoned sand-pits and natural outcrops of glacial sands (at Bělá village).

Distribution: Widespread in the Palaearctic Region, with records from Great Britain, the Netherlands, Switzerland, Hungary, Poland, Bulgaria, Israel and Russian Far East (Gaimari 2013). First records from the Czech Republic.

Comments: There is little information on the habitat preference of this species and none on the preferred aphid prey of its larvae (see above in biology). The available data indicate no distinct preference to a definite habitat and, therefore, we consider it a psammoneutral species.

***Leucopis cerasiphila* Gomolitzkaja & Tanasijtshuk, 1986 – psammoneutral**

Material examined: CZECH REPUBLIC: N. Moravia: Kolnovice 1 km SW, 50°18'55"N, 17°18'45"E, 385 m, sand-pit C part, sweeping over sand and vegetation on sand, 28.iv.2010, 1♂; 27.v.2020, 1♀; 17.vi.2020, 3♂; 20.viii.2020, 1♂; Kolnovice 1.2 km WSW, 50°18'59"N, 17°18'35"E, 390 m, sand-pit W part, sweeping over sand and vegetation on sand, 28.iv.2020, 1♀; all J. Roháček leg., M. J. Ebejer det. (SMOC).

Biology: The larvae prey upon aphid colonies of *Aphidura bozhkoe* Narzikulov, 1958 on *Prunus verrucosa* Franch. (Tanasijtshuk 1986) but probably also on colonies of this aphid species attacking some other species of *Prunus* such as *P. erythrocarpa*, *P. fruticosa*, *P. incana*, *P. spinosa*, *P. tianschanica*, *P. triloba*, *P. ulmifolia*, *P. verrucosa* and *Prunus* sp. in Kyrgyzstan, Uzbekistan, Kazakhstan, Iran and Georgia (Nieto Nafria *et al.* 2013). On glacial sand deposits in the Czech Silesia this species has only been recorded from the active sand-pit at Kolnovice. Of the *Prunus* species listed above only *P. spinosa* occurs in this locality.

Distribution: Tajikistan, Turkmenistan (Tanasijtshuk 1986). First records from the Czech Republic and the whole of Europe.

Comments: *L. cerasiphila* was previously known only from Central Asia. This is surprisingly the first record from Europe, but given the presence of its aphid host across a wider geographic area it is likely to be a more widespread species. The species was originally recorded from xerothermic montane areas in Central Asia and, therefore, may have some affinity to xerophilous communities in sandy habitats. However, the lack of adequate information prevents its association with psammophilous element.

***Leucopis cinarophaga* Tanasijtshuk, 1962 – psammoneutral**

Material examined: CZECH REPUBLIC: N. Moravia: Kolnovice 1 km SW, 50°18'55"N, 17°18'45"E, 385 m, sand-pit C part, sweeping over sand and vegetation on sand, 28.iv.2020, 2♂ 3♀; J. Roháček leg., M. J. Ebejer det. (SMOC).

Biology: Larvae prey upon various aphid species of the genus *Cinara* Curtis, 1835 which attack a wide range of coniferous trees. Adults were mostly reared from *Cinara* spp. on pines (*Pinus* spp.) and on spruce (*Picea* sp.); Tanasijtshuk (1986) described the larva and the live-history of the species. The specimens recorded above were probably swept from very young Scots Pines (*Pinus sylvestris*) scattered in the active sand-pit at Kolnovice (Fig. 13).

Distribution: Italy, Northwest Russia, Sweden (Tanasijtshuk 1986); new record for the Czech Republic.

Comments: This species is certainly more widespread in Europe than reported up to now. Because host plants of the prey of *L. cinarophaga* grow in various habitats, its association with sands is unclear and, therefore, this *Leucopis* is tentatively treated as psammoneutral species.

***Leucopis kaszabi* Tanasijtshuk, 1970 – ?psammophilous (Figs 14, 15)**

Material examined: CZECH REPUBLIC: N. Moravia: Oldřišov 0.7 km N, sand-pit, 49°59'51"N, 17°57'48"E, 280 m, sweeping over sand and vegetation on sand, 3.vii.2019, 2♂ 2♀; 1.viii.2019, 6♂ 7♀ (1♂ PHOTO), all J. Roháček leg., M. J. Ebejer det. (SMOC, 1♂ 1♀ coll. Ebejer).

Biology: Tanasijtshuk (1986) reported this species as a predator of *Cryptosiphum artemisiae* Buckton, 1879 on a mugwort (*Artemisia* sp.) in Uzbekistan and also listed records from unnamed aphids on this plant in Germany and the Far East of Russia (Primor'e). This aphid species is known to form leaf galls on *Artemisia vulgaris*, a common plant on sandy habitats which also grows in the abandoned sand-pit (Fig. 16) from where *L. kaszabi* is recorded above.

Distribution: A transpalearctic species, known from Germany, Ukraine, Kazakhstan, Uzbekistan, Kyrgyzstan, Mongolia, Far East of Russia (Primor'e), cf. Tanasijtshuk (1986). First record from the Czech Republic. *L. kaszabi* appears to have a disjunct distribution, but this is likely to be a reflection of under reporting from the intervening countries.

Comments: Some species of *Artemisia* (including *A. vulgaris*) are common, widespread and frequently found among ruderal vegetation, most often in xeric habitats, including sands. Similarly to species of Agromyzidae associated with these plants (see below), *L. kaszabi* could also be considered a possible psammophilous species.

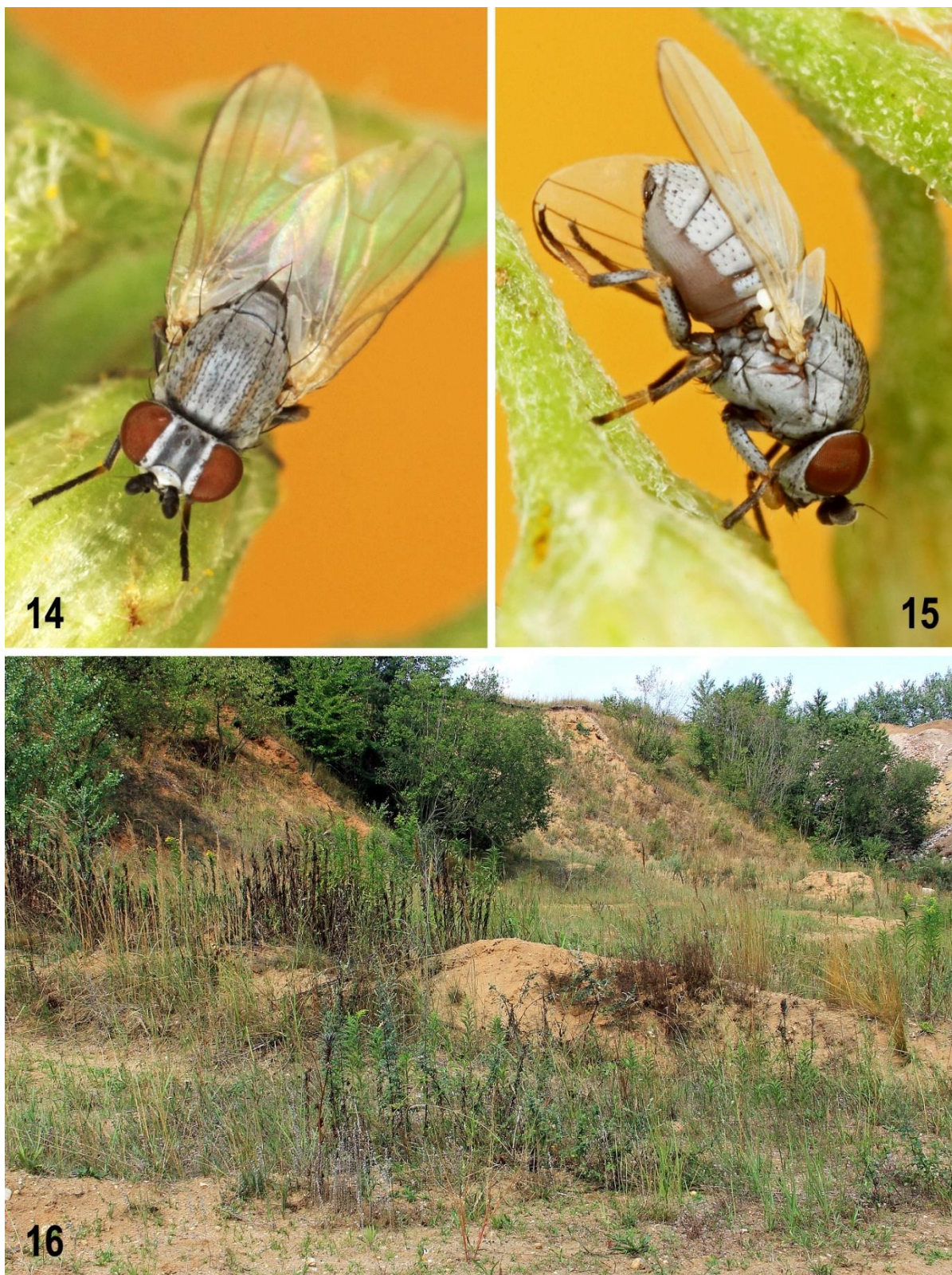
***Leucopis salicis* Tanasijtshuk, 1962 – psammoneutral**

Material examined: CZECH REPUBLIC: N. Moravia: Supíkovice 1.1 km NE, 50°18'22"N, 17°15'43"E, 380 m, abandoned sand-pit, S part, sweeping over sand and vegetation on sand, 27.v.2020, 1♂, J. Roháček leg., M. J. Ebejer det. (SMOC).

Biology: Eggs and larvae were found in colony of *Stomaphis* (*Parastomaphis*) *longirostris* (Fabricius, 1787) on Goat Willow (*Salix caprea*) in NW Russia, see Tanasijtshuk (1986) who also described these preimaginal stages. This aphid also attacks various other *Salix* and *Populus* species. However, in Sweden *L. salicis* was also reared from *Pterocomma* aphids also on *Salix caprea*, and, therefore, Tanasijtshuk (1986) considered it to be an oligophagous predator of aphids living on this species of *Salix*. Only a single male was found in an abandoned sand-pit although Goat Willow grows in most localities under study.

Distribution: Slovakia (Roháček 1995, 2009), Northwest Russia, Sweden, Georgia (Tanasijtshuk 1986). First record from the Czech Republic.

Comments: Little is known of the biology of this species. The host plants are very common and widely distributed as are the aphids which attack them. Unless the species is overlooked, the apparent paucity of records (and specimens) may be due to there being only one annual generation with a short flight period, heavy infestation with parasitoids or dependence on a stenotypic habitat. Inasmuch as the *Salix caprea* occurs in a wide variety of habitats *L. salicis* surely is not stenotopic for sands and is, therefore, classified as a psammoneutral species.



Figs 14–16: *Leucopis kaszabi* Tanasijtshuk and its habitat. **14** – *Leucopis kaszabi*, male, dorsal (body length ca 2.0 mm); **15** – same specimen, right lateral, cleaning its left wing; **16** – habitat of the species in abandoned sand-pit Oldřišov, with some mugwort (*Artemisia vulgaris*) plants in foreground (1.viii.2019). Photos by J. Roháček.

***Leucopis steinbergi* Tanasijtshuk, 1965 – psammoneutral**

Material examined: CZECH REPUBLIC: N. Moravia: Kolnovice 1 km SW, 50°18'55"N, 17°18'45"E, 385 m, sand-pit C part, sweeping over sand and vegetation on sand, 27.v.2020, 1♂, J. Roháček leg., M. J. Ebejer det. (SMOC).

Biology: A predator of *Thecabius affinis* (Kaltenback, 1843) a gall-forming aphid on the early leaves of *Populus alba*, *P. nigra* and an *Ulmus* sp. (Tanasijtshuk 1986). Young plants of *Populus* (largely *P. tremula*) were seen in Kolnovice active sand-pit and also in most other localities under study.

Distribution: France, Austria, Hungary, European Russia, Kazakhstan, Uzbekistan (Tanasijtshuk 1986). New record for the Czech Republic.

Comments: The single record of this species suggests that it may be rare in the Czech Republic or at least in glacial sand localities studied. *L. steinbergi* apparently has no closer affinity to sandy habitats.

***Lipoleucopis praecox* de Meijere, 1928 – psammoneutral** (Figs 17, 19)

Material examined: CZECH REPUBLIC: N. Moravia: Kolnovice 1 km SW, 50°18'55"N, 17°18'45"E, 385m, sand pit C part, sweeping over sand and vegetation on sand, 18.iii.2020, 1♀, J. Roháček leg., M. J. Ebejer det. (SMOC).

Biology: The species is a predator of *Pineus pini* (Goeze, 1778) (Hemiptera, Sternorrhyncha, Adelgidae) that attacks pine (*Pinus sylvestris*), see Wilson (1938). Tanasijtshuk (1986) considered it monophagous on this aphid. The only specimen recorded above was swept from vegetation in an active sand-pit where pines occur (Fig. 18).

Distribution: Andorra, France, Great Britain, the Netherlands, Czech Republic, Hungary, Poland, Sweden, Finland (Papp *et al.* 2006; Gaimari 2013). In the Czech Republic, it has only been recorded from the Podyjí NP in S. Moravia (1♂ 1♀ from two localities). First record from Silesia.

Comments: This is probably a more widespread species in Europe than current records suggest. However, also the specimens recorded above are sparse. Papp *et al.* (2006) consider it a rare species. Its affinity to sandy habitats is uncertain, hence it is treated as a psammoneutral species.

General discussion on species of Chamaemyiidae found on glacial sand deposits

Some information on this topic was published as it related to the species of *Leucopis* previously recorded in part one of this study (Roháček *et al.* 2020). The biology of species of *Chamaemyia* is less well-known, but a few species have larvae that are predators of Pseudococcidae (Hemiptera, Sternorrhyncha) that live on grasses. Although the biology of none of the *Chamaemyia* species recorded above is known, it is likely to be similar.

Many species of *Leucopis* are predators on a several species of Aphidae, which in turn may be associated with a variety of plants, not necessarily within the same family. Others can be very prey specific, which in turn may be host plant specific. This point was raised as one explanation for the species recorded up to that time from the study of the fauna on glacial sand deposits (Roháček *et al.* 2020). It can be expected that those with an unrestricted biology would be found more widespread in Europe and in a greater diversity of habitats than those species with a more restricted and specific biology. Species that prey upon a single aphid, which attacks a limited range of host plants or even a single plant species, may have one generation per year and, for example, as in the case of *Leucopis bursaria* Rondani, 1847 (Raspi 2003) when infestation of the fly larvae by parasitoid hymenoptera is high, the following year this silver-fly species will be present in low numbers and not easily encountered. Interacting with these factors are the abiotic influences of season, humidity and altitude. In this study, the repeated sampling over a number of years and through an extended period within each calendar year has uncovered several more species of Chamaemyiidae many of which are new records for the country. These observations support the view that species populations fluctuate from year to year and although flight periods are probably short, these may appear prolonged when a species develops rapidly to produce sequential generations in a season. A corollary to this is that limited and sporadic sampling will easily miss a number of species. In this study, the diversity of species varied from one year to the next. Add the difficulty in identification of many species of Chamaemyiidae to the above considerations and the inevitable conclusion is that most species are probably more widespread in Europe and elsewhere than reported so far.



Figs 17–19: *Lipoleucopis praecox* de Meijere and its habitat. **17** – *Lipoleucopis praecox*, female, head (lateral) and thorax (dorsal) of the voucher specimen; **18** – habitat of this species, with pines surrounding a path in the active sand-pit Kolnovice (18.iii.2020); **19** – *L. praecox*, female, left lateral (body length ca 2.1 mm), voucher specimen collected in early spring (18.iii.2020) in this habitat. Photos by J. Roháček.

Despite all the factors listed above, the diversity of Chamaemyiidae found on glacial sands in the Czech Silesia is enormous in excess of that found in other previous large-scale studies of Diptera in the Czech Republic. The most detailed of them, viz. the study of the biodiversity

of Diptera in the Podyjí NP by M. Barták and collaborators yielded only 15 species of Chamaemyiidae (Papp *et al.* 2006) in the whole of the National Park although Malaise traps, emergence traps, yellow and white pan traps, car nets and sweeping were used in a number of localities for four years (Barták & Kubík 2006). This compares to the glacial sand localities in this study where as many as 26 species of Chamaemyiidae have been recorded (*Chamaemyia* 10, *Leucopis* 12, *Lipoleucopis* 1, *Neoleucopis* 2, *Parochthiphila* 1) at only nine localities and using only the single sweeping method of collection.

AGROMYZIDAE

Agromyza viciae Kaltenbach, 1872 – psammoneutral

Material examined: CZECH REPUBLIC: N. Moravia: Supíkovice 1.1 km NE, 50°18'22"N, 17°15'43"E, 380 m, abandoned sand-pit, S part, sweeping over sand and vegetation on sand, 27.v.2020, 1♂; J. Roháček leg., M. Černý det. (SMOC).

Biology: The larva forms a leaf mine on host plants, namely *Vicia cracca*, *V. dumetorum*, *V. grandiflora*, *V. sativa* and *V. sepium* (see Gibbs & von Tschirnhaus 2006).

Distribution: European species known from Andorra, Austria, Croatia (Černý 2018), Czech Republic, Estonia, France, Germany, Great Britain, Greece, Hungary (Papp & Černý 2015), Lithuania, Netherlands, Norway, Poland, Russia (Nartshuk & von Tschirnhaus 2017), Slovakia, Switzerland and Ukraine (Guglya 2016). *A. viciae* has been extremely rarely recorded from the Czech Republic. There are only three records from the country, one from S. Bohemia (Vráž near Písek, 1♂ collected near brook and 1♂ from meadow and wood, see Černý *et al.* 2013) and one from C. Bohemia (near Karlštejn, 5♂ collected in mixed forest, see Černý & Heřman 2015). The above record is the first from Moravia.

Comments: *A. viciae* is to be classified as psammoneutral due to its wide range of host species of the genus *Vicia*. These plants are not stenotopic and inhabit various open habitats from wet meadows and marshlands to dry damp ground and sandy embankments.

Aulagromyza flavoscutellata (Hendel, 1932) – psammoneutral

Material examined: CZECH REPUBLIC: N. Moravia: Supíkovice 1.1 km NE, 50°18'22"N, 17°15'43"E, 380 m, abandoned sand-pit, S part, sweeping over sand and vegetation on sand, 28.iv.2020, 1♂; J. Roháček leg., M. Černý det. (SMOC).

Biology: The host plants of *Aulagromyza flavoscutellata* are unknown.

Distribution: This European species has been recorded from Austria, Czech Republic, France, Germany and Poland. In the Czech Republic, the species has been known from northern and central Bohemia: Polabská nížina, Vysoká nad Labem, 1♀ on steppe (Černý & Vála 2005); near Karlštejn, 1♂ on forest clearing (Černý & Heřman 2015). The above record is the first from Moravia.

Comments: The host plant of *Aul. flavoscutellata* remains unknown and as this leaf-miner fly has been recorded from various types of habitat, it seems to belong to psammoneutral species.

Cerodontha (Poemyza) thunebergi Nowakowski, 1967 – psammoneutral

Material examined: CZECH REPUBLIC: N. Moravia: Supíkovice 1.1 km NE, 50°18'22"N, 17°15'43"E, 380 m, abandoned sand-pit, S part, sweeping over sand and vegetation on sand, 9.vii.2019, 1♂, 17.vi.2020, 1♂; Bohušov 0.7 km S, 50°14'14"N, 17°42'57"E, 250 m, abandoned sand-pit, sweeping over sand and vegetation on sand, 9.vii.2019, 1♂; POLAND: S. Silesia: Godów 1.3 km ESE, sand-pit, 49°55'13"N, 18°29'41"E, 230 m, sweeping over sand and vegetation on sand, 8.viii.2019, 1♂; all Roháček leg., M. Černý det. (SMOC).

Biology: Unknown.

Distribution: This species has been recorded from Belarus, Czech Republic, Finland, France, Germany, Hungary, Lithuania, Slovakia and Switzerland; also from Japan (Sasakawa 2005b). In the Czech Republic *C. (P.) thunebergi* is known from several localities from northern, central and southern Bohemia (Černý 1999; Černý *et al.* 2001, 2013) and also from central and southern Moravia (Černý 2001a, b; Černý & Vála 1996). The above records are the first from northern Moravia (Silesia) and also from Poland.

Comments: No more detailed biological data are available for *C. (P.) thunebergi* but great variability of the recorded habitats indicate that it is probably a psammoneutral species.

***Cerodontha (Poemyza) vladimiri* Černý in Černý & Merz, 2007 – psammoneutral**

Material examined: CZECH REPUBLIC: N. Moravia: Dolní Lutyně 1.2 km N, sand-pit, 49°54'34"N, 18°25'33"E, 210 m, sweeping over sand and vegetation on sand, 16.v.2019, 1♂; J. Roháček leg., M. Černý det. (SMOC).

Biology: Largely (including host plant) unknown.

Distribution: This species was first found in the wetland near Bílina (N. Bohemia, Czech Republic) and also recorded from Switzerland (Černý & Merz 2007). The first record from Moravia originates from steppe nr. Ječmeňské in S. Moravia (Černý 2013). The above record is the second from Moravia and the first from Silesia.

Comments: The species is to be classified as psammoneutral because it obviously has no distinct affinity to sandy habitats. It was recorded from wetland habitat in Bohemia, for the Swiss locality Biasca-Loderio, Ticino the habitat is unknown and both specimens from Moravia were found in dry habitats, viz. in steppe and sand-pit respectively.

***Cerodontha (Xenophytomyza) leptophallus* Papp, 2016 – psammophilous**

Material examined: CZECH REPUBLIC: N. Moravia: Bartultovice 0.5 km SW, 50°16'13"N, 17°35'00"E, 315 m, abandoned sand-pit, sweeping over sand and vegetation on sand, 17.vi.2020, 1♂; POLAND: S. Silesia: Godów 1.3 km ESE, sand-pit, 49°55'13"N, 18°29'41"E, 230 m, sweeping over sand and vegetation on sand, 13.vi.2019, 1♂; all J. Roháček leg., M. Černý det. (SMOC).

Biology: Largely unknown, see Papp & Černý (2016) and Roháček *et al.* (2020).

Distribution: The species was originally described from Hungary (Papp & Černý 2016) and recently also recorded from the Czech Republic and Spain (see Černý 2018). *C. (X.) leptophallus* has recently been found also on glacial sands in Silesia (from sand-pits Supíkovice and Závada), see Roháček *et al.* (2020). The above record from Bartultovice confirms its occurrence in Czech Silesia and that from Godów represents the first record of *C. (X.) leptophallus* from Poland.

Comments: *Cerodontha (X.) leptophallus* has hitherto been known from predominantly dry and sandy habitats and, therefore, it has been classified as a psammophilous species (Roháček *et al.* 2020). Both the above records seem to confirm this association by finding the species in sparse grassy vegetation on glacial sands.

***Chromatomyia scolopendri* (Robineau-Desvoidy, 1851) – psammoneutral (Fig. 20)**

Material examined: CZECH REPUBLIC: N. Moravia: Supíkovice 1.1 km NE, 50°18'22"N, 17°15'43"E, 380 m, abandoned sand-pit, S part, sweeping over sand and vegetation on sand, 16.x.2019; 1♀, J. Roháček leg., M. Černý det. (SMOC).

Biology: Larva forms a long greenish linear mine, frequently following a mid vein on the leaf of the host plants *Asplenium ceterach*, *A. ruta-muraria*, *A. septentrionale*, *A. scolopendrium* and *Polypodium vulgare* (see Spencer 1976, Ellis 2021).

Distribution: A Palearctic species in Europe known from Austria (Franz 1989), Belgium, Bulgaria (Buhr 1941), Croatia (Buhr 1941), Denmark, France, Germany, Great Britain, Ireland, Italy, Netherlands, Poland, Romania, Slovakia (Černý & Roháček 2020), Spain, Switzerland (Černý *et al.* 2021) but also recorded from Turkey (Civelek 2002) and Japan (Sasakawa & Matsumura 1998). First finding of mines of *C. scolopendri* on *Asplenium ruta-muraria* in the Czech Republic originates from Skalky, a locality near Štramberk (Zavřel 1953: 416). However, this record is not supported by reared or captured adults and, therefore, the above listed female from the abandoned sand-pit (Figs 21, 22) at Supíkovice represents the first confirmed occurrence of this species in the Czech Republic.

Comments: The host ferns of the genus *Asplenium* are found in diversity of habitats. Some grow in very wet and shaded environments while others can tolerate full sun in drier situations. Similarly, *Polypodium vulgare* inhabits umbraceous habitats on rocks, mossy scree slopes and wet humid soils, but also prospers on clay soils. For these reasons we can consider *Ch. scolopendri* most likely a psammoneutral species.

***Hexomyza sarothamni* (Hendel, 1923) – psammophilous (Figs 23, 24)**

Material examined: CZECH REPUBLIC: N. Moravia: Kolnovice 1.2 km WSW, 50°18'59"N, 17°18'35"E, 390 m, sand-pit W part, sweeping over flowering *Cytisus scoparius*, 27.v.2020, 4♂1♀; sweeping *Cytisus scoparius*, 17.vi.2020, 1♀; Kolnovice 1 km SW, 50°18'55"N, 17°18'45"E, 385 m, sand-pit C part, sweeping over sand and vegetation on sand, 17.vi.2020, 2♀; Bartultovice 0.5 km SW, 50°16'13"N, 17°35'00"E, 315 m, abandoned sand-pit, sweeping over sand and vegetation on sand, 17.vi.2020, 1♂; Bělá nr. Chuchelná 0.6 km N, holt, 49°58'39"N, 18°08'49"E, 265 m, sweeping along sandy path & margin of oak-pine forest, 11.v.2020, 1♂; 3.vi.2020, 5♂1♀ (1♂ 1♀ PHOTO); sweeping flowering *Cytisus scoparius*, 3.vi.2020, 5♂8♀ (2♀ PHOTO); all J. Roháček leg., M. Černý det. (SMOC).



Figs 20–22: *Chromatomyia scolopendri* (Robineau-Desvoidy). **20** – *Chromatomyia scolopendri*, female, (voucher specimen), left lateral (body length ca 3.3 mm); **21** – probable habitat of this species, overgrown slopes of sand-pit Supíkovice (16.x.2019); **22** – a general view (from the south) of the abandoned sand-pit Supíkovice, autumnal aspect (16.x.2019). Photos by J. Roháček.

Biology: The larvae form oval twig-galls on *Cytisus scoparius* (see Spencer 1966b: Fig. 70). This species possibly also occurs on *Genista aetnensis* from which Spencer reared a long series in April, 1964 at Sinofsi on Mt Etna, Sicily (Spencer 1966a, b). Spencer (1966b, 1990) had identified the species as *H. sarothamni* but later he questioned this (Spencer 1992). Only a future study of additional material reared from this plant may show if these specimens belong to *H. sarothamni* or to an as yet unnamed species.

Distribution: The European distribution of *H. sarothamni* was summarized by Papp & Černý (2015) as follows: Austria, Czech Republic, France, Germany, Great Britain, Greece, Hungary Netherlands, Portugal, Sicily? and Spain. The species has also been recorded from Cyprus (Černý & Vála 2006) and Israel (Černý 2009b). In the Czech Republic, this species has only been confirmed from southern Moravia from Zvěrkovice, district Třebíč (Černý & Vála 1996). The above records are the first from Czech Silesia.

Comments: *Hexomyza sarothamni* is treated here as a psammophilous species due to its feeding specialization on broom, *Cytisus scoparius*, which requires insolated and dry habitats, preferably on sandy ground. This plant is a frequent and common inhabitant of glacial sands in Silesia (cf. Figs 4, 10, 25). *Hexomyza sarothamni* belongs to a distinctive community of flies associated with broom, including for example *Micropeza lateralis* Meigen, 1826 (Micropezidae) and the lauxaniids *Calliopum geniculatum* (Fabricius, 1805) and *Minettia longiseta* (Loew, 1847), recorded above (see also Roháček *et al.* 2020).

***Liriomyza dracunculi* Hering, 1932 – psammophilous (Fig. 26)**

Material examined: CZECH REPUBLIC: N. Moravia: Kolnovice 1 km SW, 50°18'55"N, 17°18'45"E, 385 m, sand-pit C part, sweeping over sand and sparse vegetation on sand, 11.ix.2019, 1♂; Bělá nr. Chuchelná 0.5 km E, sand-pit, 49°58'26"N, 18°09'05"E, 250 m, sweeping over sand & sparse vegetation on sand, 23.iv.2020, 2♂; all J. Roháček leg., M. Černý det. (SMOC).

Biology: The larva of *L. dracunculi* forms an upper surface leaf mine on the host plants *Artemisia absinthium* and *A. campestris* (see Spencer 1976, 1990). These species occur also in sand-pits under study, including the small abandoned one at Bělá (Fig. 27).

Distribution: A West Palaearctic species described from Poland and recorded from Denmark, France (Černý 2009b), Germany, Greece (Černý 2011), Hungary (Papp & Černý 2017), Lithuania, Norway, European part of Russia (Strakhova *et al.* 2013), Switzerland, Sweden and Turkey (Civelek *et al.* 2007). Countries listed for *L. dracunculi* in Papp & Černý (2017) are incorrect! The above records from glacial sands are the first from the Czech Republic.

Comments: *Liriomyza dracunculi* is considered a psammophilous species owing to its trophic dependence on host plants of the genus *Artemisia* being associated with xerophilous and insolated habitats.

***Liriomyza latigenis* (Hendel, 1920) – psammophilous**

Material examined: CZECH REPUBLIC: N. Moravia: Bartultovice 0.5 km SW, 50°16'13"N, 17°35'00"E, 315 m, abandoned sand-pit, sweeping over sand and vegetation on sand, 9.vii.2019, 1♂; J. Roháček leg., M. Černý det. (SMOC).

Biology: The larva forms a leaf mine on *Senecio jacobaea* (see Spencer 1990). Considering its largely southern distribution (see below) it seems to be a thermophilous species.

Distribution: A rare species, hitherto known from the Czech Republic, France, Greece, Portugal (Černý *et al.* 2018), Romania (Papp & Černý 2017) and Spain; also recorded from Uzbekistan (Černý & Merz 2006). There is only a single record from the Czech Republic, viz. Havraníky in the Podyjí NP in southern Moravia (Černý *et al.* 2006). The above record is the second from the Czech Republic and the first from Silesia.

Comments: *L. latigenis* is a monophagous species on the host plant *Senecio jacobaea*, which grows on dry pastures, meadows, borders of fields, stony slopes and insolated margins of forests. This plant also occurs on xeric habitats along field paths, on railway banks, in abandoned pits and ruderalized areas, often on sandy grounds. For these reasons, *L. latigenis* is classified as a psammophilous species.

***Liriomyza obliqua* Hendel, 1931 – psammoneutral**

Material examined: POLAND: S. Silesia: Godów 1.3 km ESE, sand-pit, 49°55'13"N, 18°29'41"E, 230 m, sweeping over sand and vegetation on sand, 13.vi.2019, 3♂; J. Roháček leg., M. Černý det. (SMOC).

Biology: Unknown.

Distribution: A European species hitherto known from Austria, Bulgaria, Czech Republic, Germany, Hungary, Lithuania, Romania, Slovakia, Switzerland, and the former Yugoslavia. In the Czech Republic, it has only been known from a single locality in southern Moravia, viz. Ledové sluje in the Podyjí NP (Černý *et al.* 2006). First record from Poland.



Figs 23–25: *Hexomyza sarothamni* (Hendel). **23** – *Hexomyza sarothamni*, male, right lateral (body length ca 2.4 mm); **24** – same species, female on broom stem, left dorsolateral (body length ca 2.3 mm); **25** – habitat of the species, bushes of flowering *Cytisus scoparius* along a path at margin of oak-pine wood on sand-hill (Bělá-holt, 11.v.2020. Photos by J. Roháček.

Comments: Because of an entirely unknown biology, *Liriomyza obliqua* is tentatively placed among psammoneutral species. The above record is the first with any information on the habitat of the species.

***Liriomyza yasumatsui* Sasakawa, 1972 – psammophilous**

Material examined: CZECH REPUBLIC: N. Moravia: Oldřišov 0.7 km N, sand-pit, 49°59'51"N, 17°57'48"E, 280 m, sweeping over sand & vegetation on sand, 24.v.2019, 2♂; 11.vi.2019, 1♂; Bělá nr. Chuchelná 0.5 km E, sand-pit, 49°58'26"N, 18°09'05"E, 250 m, sweeping over sand & sparse vegetation on sand, 11.v.2020, 1♂; all J. Roháček leg., M. Černý det. (SMOC).

Biology: The host plant of *L. yasumatsui* is *Artemisia principes*, but this has only been confirmed for a population in Japan (Sasakawa 1994). In Europe, its biology and host plant(s) remain unknown, but it may be presumed that larvae probably mine in some species of the genus *Artemisia* also here.

Distribution: The European distribution of *L. yasumatsui* has been most recently summarized by Papp & Černý (2017): Czech Republic, France, Greece, Hungary, Switzerland. The species was originally described from Taiwan and subsequently recorded from Japan, China, North and South Korea, Uzbekistan and Europe. In the Czech Republic the species has been known only from two localities from southern and central Moravia (Havraníky in the Podyjí NP, 1♂, see Černý *et al.* 2006; Skalička, 1♂, see Černý 2019). The above records are the first from Czech Silesia.

Comments: Because of the presupposed association with *Artemisia* spp. (inhabiting largely dry and sunny localities) *L. yasumatsui* (European population) can be considered a psammophilous species.



Figs 26–27: *Liriomyza dracunculi* Hering and its habitat. **26** – *Liriomyza dracunculi*, male with detached abdomen, voucher specimen from Bělá sand-pit (23.iv.2020), left lateral (body length ca 1.4 mm); **27** — habitat of the species in small abandoned sand-pit at Bělá, vernal aspect with sprouting vegetation (23.iv.2020). Photos by J. Roháček.

***Melanagromyza tripolii* Spencer, 1957 – psammoneutral**

Material examined: POLAND: S. Silesia: Godów 1.3 km ESE, sand-pit, 49°55'13"N, 18°29'41"E, 230 m, sweeping over sand and vegetation on sand, 11.vii.2019, 1♂; J. Roháček leg., M. Černý det. (SMOC).

Biology: The larvae feed as internal stem-borers on *Aster tripolium* (= *Tripolium pannonicum*) (see Spencer 1957, 1972). However, this plant is a halophyte (associated with saline soils) and in the Czech Republic grows very rarely in southern Moravia where it is only known from two localities (PR Slanisko Dobré Pole and mainly NPR Slanisko at Nesyt pond nr. Sedlec, both in Břeclav district). However, because *M. tripolii* has also been captured in localities where the host plant (*A. tripolium*) does not occur, the larvae of this leaf-miner fly must have some other host plant(s) in addition.

Distribution: A rare Palaearctic species, in Europe known from the Czech Republic, Denmark, France, Germany, Great Britain, Hungary (Papp & Černý 2015), Italy, Netherlands, Slovakia, Spain, Switzerland (Černý & Bächli 2018), Ukraine. It was also recorded from Turkey, Uzbekistan (Nartshuk 2019) and Japan (Sasakawa 2005a). In the Czech Republic *M. tripolii* was encountered in several localities in Bohemia (Březno, Vysoká nad Labem, Jizerské hory Mts) and Moravia (Napajedla, Otrokovice – PP Na letišti), see Černý (2001a, 2009a); Černý & Vála (2005). First record from Poland.

Comments: Because of limited biological information *M. tripolii* is here tentatively classified as a psammoneutral species.

***Ophiomyia beckeri* (Hendel, 1923) – psammoneutral**

Material examined: CZECH REPUBLIC: N. Moravia: Kolnovice 1 km SW, 50°18'55"N, 17°18'45"E, 385 m, sand-pit C part, sweeping over sand and sparse vegetation on sand, 9.vii.2019, 1♂; Bartultovice 0.5 km SW, 50°16'13"N, 17°35'00"E, 315 m, abandoned sand-pit, sweeping over sand and vegetation on sand, 9.vii.2019, 1♂; 17.vi.2020, 1♂; Dolní Lutyně 1.2 km N, sand-pit, 49°54'34"N, 18°25'33"E, 210 m, sweeping over sand and vegetation on sand, 11.vii.2019, 1♀; POLAND: S. Silesia: Godów 1.3 km ESE, sand-pit, 49°55'13"N, 18°29'41"E, 230 m, sweeping over sand and vegetation on sand, 11.vii.2019, 1♂; all J. Roháček leg., M. Černý det. (SMOC).

Biology: The larva forms a whitish leaf mine on many host plants of the genera *Coreopsis*, *Crepis*, *Hypochoeris*, *Launaea*, *Leontodon*, *Picris*, *Sonchus* and *Taraxacum* (see Spencer 1990).

Distribution: This species is known from the Palaearctic, Afrotropical and Oriental Regions. It is widespread in Europe, more common in the Mediterranean area: Albania, Andorra, Austria, Belgium, Croatia (Černý 2018), Czech Republic, Dalmatia, Denmark, Finland, France, Germany, Great Britain, Ireland, Italy incl. Sicily, Liechtenstein (Černý 2018), Lithuania, Maltese Islands, Montenegro, Poland, Portugal incl. Madeira Islands, Russia (Nartshuk 2019), Slovakia, Spain incl. Balearic and Canary Islands, Sweden, Switzerland and Ukraine. In the Czech Republic it has been recorded from only two localities in Bohemia, viz. from Hořice v Podkrkonoší (Černý & Vála 1996) and Vráž near Písek (Černý *et al.* 2013). There is also an unpublished record from Moravia: Hluk, PP Babí hora, 48°57'18"N, 17°33'45"E, 325 m, 2.vii.2013, 1♂, sweeping vegetation in old orchard, M. Černý leg., coll. & det. This and the above records are the first from Moravia.

Comments: *O. beckeri* occurs in many and various habitats, not only in dry sandy areas, but also in humid meadows and shores of watercourses. Therefore, it is considered a psammoneutral species.

***Ophiomyia slovaca* Černý, 1994 – psammoneutral**

Material examined: CZECH REPUBLIC: N. Moravia: Dolní Lutyně 1.2 km N, sand-pit, 49°54'34"N, 18°25'33"E, 210 m, sweeping over sand and vegetation on sand, 25.iv.2019, 1♂; J. Roháček leg., M. Černý det. (SMOC).

Biology: The larva forms stem mine on *Lathyrus pratensis*, *Vicia angustifolia*, *V. cracca*, *V. villosa* and probably also *V. hirsuta* and *V. tetraspermum* (see Pakalniškis 1996).

Distribution: A West Palaearctic species, in Europe known from the Czech Republic, Finland (Haarto *et al.* 2019), Hungary (Papp & Černý 2015), Latvia, Lithuania, Slovakia, and Ukraine, also recorded from Cyprus and Turkey (Dursun *et al.* 2015). In the Czech Republic, it was first found in Moravia, in the locality Střelová hora – NPR Tabulová in the Pálava Biosphere Reserve (Černý & Vála 1999) and later also recorded from Otrokovice – PP Na letišti and from Havraníky in the Podyjí NP (Černý *et al.* 2006). In Bohemia it is only known from Vysoká nad Labem in the Polabská nížina lowland (Černý & Vála 2005). The above record is the first from Czech Silesia.

Comments: *O. slovaca* is here treated as a psammoneutral species for it apparently has no close association with sandy habitats because it occurs in various types of environment where its host plants grow commonly.

***Ophiomyia vimmeri* Černý, 1994 – psammoneutral**

Material examined: CZECH REPUBLIC: N. Moravia: Kolnovice 1 km SW, 50°18'55"N, 17°18'45"E, 385 m, sand-pit C part, sweeping over sand and vegetation on sand, 17.vi.2020, 1♂; POLAND: S. Silesia: Godów 1.3 km ESE, sand-pit, 49°55'13"N, 18°29'41"E, 230 m, sweeping over sand and vegetation on sand, 8.viii.2019, 1♂; all J. Roháček leg., M. Černý det. (SMOC).

Biology: Hitherto unknown.

Distribution: A West Palaearctic species, in Europe known from Andorra, Croatia (Černý 2018), Czech Republic, France, Greece, Hungary (Papp & Černý 2015), Italy (Černý 2018), Liechtenstein (Černý 2018), Portugal (Černý *et al.* 2018), Slovakia, Spain, Switzerland, and Ukraine, but also recorded from Morocco (Černý & Merz 2006). In the Czech Republic, it was first found in the type locality (Halenkovice, distr. Zlín) and also in Hněvotín, distr. Olomouc (Černý 1994). Later, it has been confirmed in a number of localities in Moravia and also in Bohemia (CHKO Český kras, Bílina, Skalička etc.). The above record from Kolnovice is the first from Czech Silesia and that from Godów represents a new addition to the fauna of Poland.

Comments: *O. vimmeri* is classified as a psammoneutral species because it is also known from humid situations at watercourses and similar habitats (see Černý 2019).

***Phytobia cambii* (Hendel, 1931) – psammoneutral**

Material examined: CZECH REPUBLIC: N. Moravia: Kolnovice 1 km SW, 50°18'55"N, 17°18'45"E, 385 m, sand-pit C part, sweeping over sand and sparse vegetation on sand, 11.ix.2019, 1♂; Dolní Lutyně 1.2 km N, sand-pit, 49°54'34"N, 18°25'33"E, 210 m, sweeping vegetation on sandy lake shore, 16.v.2019, 1♀; all J. Roháček leg., M. Černý det. (SMOC).

Biology: Host plants are *Alnus glutinosa*, *Betula pendula*, *Carpinus*, *Corylus*, *Populus deltoides*, *P. euramericana*, *P. nigra*, *P. tremula*, *P. trichocarpa*, *Salix alba*, *S. caprea*, *S. cordata*, *S. fragilis*, *S. purpurea*, *S. triandra* and *S. viminalis* (see Černý *et al.* 2018).

Distribution: This species was recorded in Europe from Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Great Britain, Hungary, Ireland, Latvia, Lithuania, Netherlands, Norway (Winqvist *et al.* 2020), Poland, Portugal (Černý *et al.* 2018), Romania, Russia (North and Central European Territories), Slovakia, Sweden, Switzerland (Černý & Bächli 2018) and also from Japan, Kazakhstan (Černý 2018) and Russia (East Siberia). In the Czech Republic, its occurrence has only been documented from Bohemia: Bílina–Štěpánov (Černý *et al.* 2001), Vráž near Písek (Černý *et al.* 2013) and an unpublished record: Krkonoše Mts –Úpská jáma, 1100 m, 10.vii.-14.viii.2007, 1♂, Malaise trap, J. Vaněk leg., M. Barták coll., M. Černý det. The above records are the first from Moravia.

Comments: Owing to the relatively large spectrum of host plants (having various environmental and habitat demands) *P. cambii* is classified as a psammoneutral species.

OPOMYZIDAE

***Geomyza subnigra* Drake, 1992 – ?psammophilous**

(Fig. 28)

Material examined: CZECH REPUBLIC: N. Moravia: Oldřišov 0.7 km N, sand-pit, 49°59'51"N, 17°57'48"E, 280 m, sweeping over sand and vegetation on sand, 24.v.2019, 1♀; 4.ix.2019, 1♂ (PHOTO), J. Roháček leg., J. W. van Zuijlen det. (SMOC).

Biology: In Britain (Drake 1993) this species was found to be predominantly associated with dry and warm habitats like chalk grassland and scrub, coastal dunes, coastal shingle and suburban grassland. It was recorded from *Bromus* sp. but is more often associated with *Arrhenatherum elatius* and adults occur throughout the year and are abundant also in autumn and winter (overwintering stage) when occurring at roots of grass tussocks (Drake 1992, 1993). In Denmark *G. subnigra* was collected in an abandoned gravel pit and a coastal habitat (Gritsch 2015). There are also a few records from birch (Drake 1993) and damp deciduous lowland forest (van Zuijlen & Roháček 2006) once, even from a montane spruce wood (van Zuijlen & Roháček 2009). Despite rather thorough field work on the Silesian glacial sands this thermophilous species has only been found in the abandoned sand-pit at Oldřišov. Significantly, there is a rich community of grasses at this location (Figs 29, 30).

Distribution: *G. subnigra* was described by Drake (1992) from Great Britain (England and Scotland) and also from the Czech Republic (central Bohemia). Hitherto only known from a few countries of W. and C. Europe: Spain, France, Great Britain, the Netherlands, Germany, Czech Republic (van Zuijlen 2013) and Slovakia (van Zuijlen & Roháček 2009). In the Czech Republic it seems to be a rare and local species which was formerly misrecorded as *G. breviseta* Czerny, 1928 (Martinek 1976). There are only a few records from lowlands of C. and S. Bohemia (Drake 1992; Martinek 1994; van Zuijlen & Roháček 2006) and S. Moravia: Podyjí NP (van Zuijlen & Roháček 2006). First record from the Czech Silesia.



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Figs 28–30: *Geomyza subnigra* Drake and its habitat. **28** – *Geomyza subnigra*, male on grass stem, right dorsolateral (body length ca 2.6 mm); **29** – microhabitat of the species, tussocks of grasses on sand in abandoned sand-pit Oldřišov (24.v.2019); **30** – general view on sand-pit Oldřišov (from the east), vernal aspect with lush vegetation (24.v.2019). Photos by J. Roháček.

Comments: Previous data on habitat association of *G. subnigra* (see Drake 1992, 1993 in particular) indicate that this species may have an affinity to grasses on sandy ground (including coastal dunes) although it can live also in other xerothermic grassland with *Arrhenatherum elatius*, some other grasses and, rarely, in forests. Therefore, we can consider it as a probably psammophilous species.

Discussion and conclusions

As mentioned in the introduction the glacial sand deposits in the Czech Silesia developed during Pleistocene glaciations; they particularly originated from the two largest glaciations, the older Elsterian (ca 400 000 ya) and the younger Saalian (ca 160 000 ya), see Růžicková *et al.* (2001), Růžicka (2004) and Nývlt *et al.* (2011). Two main types of sand and gravel sediments are present in Silesia: (1) glaciofluvial sediments (mainly in Jesenicko and Osoblažsko regions) and (2) glaciolacustrine sediments (largely in Hlučínsko and Karvinsko regions), see Růžicková *et al.* (2001). Currently, sandy habitats in Silesia are mainly associated with active and abandoned sand-pits while natural outcrops of glacial sand are scarce. The latter have only been investigated in two small spots of non-cultivated land near the Bělá village (near Chuchelná): on a sandhill called “Buben” (see Roháček 2020: Fig. 6) and on northern slopes of another sandhill opposite to the southern margin of a holt at this village (Roháček 2020: Fig. 7). These hills of glaciolacustrine sand sediments were originally huge sand dunes on shores of a postglacial lake created by melting glaciers after the Saalian glaciation (Růžicková *et al.* 2001, Nývlt *et al.* 2011). On the other hand, sandy habitats created in sand-pits by sand excavation are larger (in active sand-pits) and more frequent in Silesia. Despite their contemporary reduced extent and insular character these glacial sand habitats have been presupposed to host specific psammophilous fauna and flora, including Diptera.

The results of our study of Diptera biodiversity on glacial sand habitats in the Czech Silesia confirmed this expectation. Hitherto, only a part of these results (dealing with most interesting species of several families) has been published. Apart from some lower Brachycera (Roháček *et al.* 2021), most published records dealt with Acalyptratae (Roháček 2015a, 2016a, Roháček *et al.* 2020). Despite this, records of 28 additional species of acalyptrate families are presented in this paper. They represent not only new additions to the dipterous fauna of the Czech Republic, Moravia or the Czech Silesia but also of Poland (records from abandoned sand-pit at Godów in southern Polish Silesia). The finding of *Leucopis cerasiphila* (Chamaemyiidae) in the Kolnovice active sand-pit is particularly interesting because this species has previously been only known from Tajikistan and Turkmenistan in Central Asia (see Tanasijtshuk 1986). However, this is not the first case of a species being found locally that previously had a remote distribution. Recently, *Medetera grunini* Negrobov, 1966 (Dolichopodidae), a species formerly only known from Kazakhstan, was recorded from two Silesian sand-pits (Roháček *et al.* 2021).

In this study we also recognized several more species with distinct affinity to sandy habitats. All these are classified as psammophilous (or probably psammophilous) and are additions to the current list of sand-loving Diptera hitherto recorded from sands in the Czech Silesia (cf. Roháček & Ševčík 2013, Roháček 2015a,b, 2016a,b, 2020, Roháček *et al.* 2020, 2021). Six species are considered distinctly psammophilous, viz. *Minettia longiseta* (Lauxaniidae), *Cerodontha (Xenophytomyza) leptophallus*, *Hexomyza sarothamni*, *Liriomyza dracunculi*, *L. latigenis*, *L. yasumatsui* (Agromyzidae) and two probably psammophilous, viz. *Leucopis kaszabi* (Chamaemyiidae) and *Geomyza subnigra* (Opomyzidae). All these species are associated (primarily or secondarily via their plant dependent prey) with plants which prefer to grow on sandy ground.

A formerly unknown phenomenon is discussed under Chamaemyiidae. Species of this family have larvae which prey on aphids (Aphidoidea) or mealybugs (Pseudococcidae) infesting various host plants (Tanasijtshuk 1986). For unknown reasons representatives of Chamaemyiidae were found to be unusually diverse in sandy habitats under study. This species

richness (and also abundance) can possibly be explained by a reduction of competitive parasitoid Hymenoptera in colonies of aphids on young plants emerging on sand in spring every year. However, this is only a hypothesis not supported by rearing data.

As in the previous studies on sand-inhabiting flies (see references above) this contribution also has shown that the insular glacial sand habitats (including those in sand-pits) act as important refugia for the sand-loving fauna as demonstrated recently by Roháček (2020). We believe that the accumulating information on dipterous assemblages forming an important component of this (in Silesia) unusual and extreme ecosystem may help to better evaluate processes of postglacial evolution of psammophilous insects on the southernmost limits of the Pleistocene glaciation in this region.

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References

- Ardö P. (1957): Studies in the marine shore dune ecosystem with special reference to the dipterous fauna. – *Opuscula Entomologica*, 14 (suppl.): 1-255.
- Barták M. & Kubík Š. (eds) (2006): *Diptera of Podyjí National Park and its Environs*. Česká zemědělská univerzita v Praze, Praha (2005), 432 pp.
- Beschovski V.L. (1994). Three new species of genus *Chamaemyia* Meigen, 1803 from Europe (Insecta: Diptera: Chamaemyiidae) – *Reichenbachia* 30(35): 203-209.
- Beschovski V.L. & Merz B. (1998). Contribution to the knowledge of the Chamaemyiidae (Diptera), with particular reference to the fauna of Switzerland. – *Mitteilungen der Schweizerischen entomologischen Gesellschaft* 71: 83-106.
- Buhr H. (1941): Dipteren-, insbesondere Agromyziden-Minen aus Südeuropa. – *Stettiner entomologische Zeitung* 102 (1): 73-119.
- Civelek H.S. (2002): New records of Agromyzidae (Diptera) from Western Turkey. – *Insecta Mundi* 16 (1-3): 49-55.
- Civelek H.S., Tonguc A., Ozgul O. & Dursun O. (2007): Contributions to the Turkish Agromyzidae Fauna from Anatolian Part of Turkey, with fifteen New Records (Insecta: Diptera). – *Mitteilungen des Internationalen Entomologischen Verein* 32 (3/4): 151-160.
- Collin J.E. (1948): A short synopsis of the British Sapromyzidae (Diptera). – *Transactions of the Royal entomological Society of London*, 99(5): 225-242.
- Černý M. (1994): Eight new species of *Ophiomyia* from Czech Republic and Slovak Republic (Diptera, Agromyzidae). – *European Journal of Entomology* 91: 455-476.
- (1999): Faunistic records. Agromyzidae. Pp. 200-207. In: Jedlička L. (ed.): *Dipterologica Bohemoslovaca* 9. – Slovak Entomological Society, Bratislava.
- (2001a): Agromyzidae (Diptera) of the Zlín district (Czech Republic). In: Chvála M. (ed.): *Dipterologica bohemoslovaca* 10. – *Acta Universitatis Carolinae-Biologica* 45 (2001): 31-40.
- (2001b): Příspěvek k poznání Agromyzidae (Diptera) Chráněné krajinné oblasti Bílé Karpaty. (A contribution to the knowledge of Agromyzidae (Diptera) of the Bílé Karpaty Protected Landscape Area). – *Sborník přírodovědného klubu v Uherském Hradišti* 6: 244-258. (in Czech, English summary).
- (2009a): Vrtalkovití (Diptera: Agromyzidae) Jizerských hor a Frýdlantska. Agromyzidae (Diptera) of the Jizerské hory Mts. and Frýdlant region (Northern Bohemia, Czech Republic). – *Sborník Severočeského Muzea – Přírodní Vědy, Liberec* 27: 115-140. (in Czech, English summary)
- (2009b): New faunistic data on the Agromyzidae (Diptera) from the West Palaearctic Region. – *Klapalekiana* 45: 9-21.
- (2011): Agromyzidae (Diptera) in the vicinity of the Kerkini Lake with descriptions of eight new species from Greece. – *Acta Entomologica Musei Nationalis Pragae* 51 (1): 299-347.

- (2013): Additional records of Agromyzidae (Diptera) from the West Palaearctic Region. – *Časopis Slezského zemského Muzea Opava (A)*, 62: 281-288.
- (2018): Additional new records of Agromyzidae (Diptera) from the Palaearctic Region. – *Acta Musei Silesiae, Scientiae Naturales* 67: 117-137.
- (2019): Příspěvek k faunistice minujících much vrtalkovitých (Agromyzidae, Diptera) z oblasti okolo Bečvy u Skaličky a Milotic nad Bečvou (střední Morava, Česká republika). A contribution to the faunistics of mining Agromyzidae (Diptera) from the Bečva River area near the villages of Skalička and Milotice nad Bečvou (central Moravia, Czech Republic). – *Acta Carpathica Occidentalis* 9 (2018): 33-52. (in Czech)
- Černý M., Andrade R., Gonçalves A. R. & von Tschirnhaus M. (2018): New records of Agromyzidae (Diptera) from Portugal, with an updated checklist. – *Acta Musei Silesiae, Scientiae naturales* 67: 7-57.
- Černý M. & Bächli G. (2018): New records of Agromyzidae (Diptera) from Switzerland and an updated checklist. – *Alpine Entomology* 2: 115-137.
- Černý M., Barták M. & Kubík Š. (2006): Agromyzidae. Pp. 285-300. In: Barták M. & Kubík Š. (eds): *Diptera of Podyjí National Park and its Environs. Česká zemědělská univerzita v Praze, Praha* (2005). 432 pp.
- (2013): Agromyzidae (Diptera) of Vráž nr. Písek (Czech Republic), Pp. 111-130. In: Kubík Š. & Barták M. (eds): *Workshop on biodiversity, Jevany. Česká zemědělská univerzita v Praze*, 436 pp. Printed version (ISBN 978-80-213-2423-7) + CD (ISBN 978-80-213-2424-4).
- Černý M. & Heřman P. (2015): Vrtalkovití (Diptera: Agromyzidae) Českého krasu (Leaf-miner flies (Diptera: Agromyzidae) of the Bohemian Karst (central Bohemia, Czech Republic)). – *Západočeské entomologické listy* 6: 50–65. Online: <http://www.zpcse.cz/entolisty/entolisty.html>, 12-10-2015.
- Černý M. & Merz B. (2006): New records of Agromyzidae (Diptera) from Palaearctic Region. – *Mitteilungen der Schweizerischen Entomologischen Gesellschaft* 79: 77-106.
- (2007): New records of Agromyzidae (Diptera) from the West Palaearctic Region, with an updated checklist for Switzerland. – *Mitteilungen der Schweizerischen Entomologischen Gesellschaft* 80: 107-121.
- Černý M. & Roháček J. (2020): New records of the Agromyzidae (Diptera) from Muránska planina National Park (Central Slovakia). – *Acta Musei Silesiae, Scientiae Naturales* 69: 97-140.
- Černý M. & Vála M. (1996): Faunistic records of Agromyzidae (Diptera) from the Czech and Slovak Republic. – *Časopis Slezského Muzea Opava (A)* 45: 157-169.
- (1999): Agromyzidae. In: Rozkošný R. & Vaňhara J. (ed.): *Diptera of the Pálava Biosphere Reserve of UNESCO, II. – Folia Facultatis Scientiarum Naturalium Universitatis Masarykianae Brunensis, Biologia* 100: 297-310.
- (2005): Faunistic records. Agromyzidae. Pp. 335-343. In: Kubík Š. & Barták M. (eds): *Dipterologica bohemoslovaca* 11. – *Folia Facultatis Scientiarum Naturalium Universitatis Masarykianae Brunensis, Biologia* 109 (2004): 346 pp.
- (2006): New records of Agromyzidae (Diptera) from Cyprus. Pp. 33-42. In: Kinkorová J. (ed): *Dipterologica bohemoslovaca* 13. – *Acta Universitatis Carolinae Biologica* 50: 158 pp.
- Černý M., Vála M. & Barták M. (2001): Agromyzidae. In: Barták M. & Vaňhara J. (eds.): *Diptera in an Industrially Affected Region (North-Western Bohemia, Bílina and Duchcov Environs), II. – Folia Facultatis Scientiarum Naturalium Universitatis Masarykianae Brunensis, Biologia* 105: 349-364.
- Černý M., von Tschirnhaus M. & Winqvist K. (2021): First records of Palaearctic Agromyzidae (Diptera) from 40 countries and major islands. – *Acta Musei Silesiae, Scientiae Naturales* 69(3): 193-229.
- Danihelka J., Chrtek J. Jr. & Kaplan Z. (2012): Checklist of vascular plants of the Czech Republic. – *Preslia* 84: 647-811.
- Drake C. M. (1992): Two new species of *Geomyza* with notes on the *combinata* group (Diptera: Opomyzidae). – *British Journal of Entomology and Natural History* 5: 143-153.
- (1993): A review of the British Opomyzidae (Diptera). – *British Journal of Entomology and Natural History* 6: 159-176.
- Dursun O., Civelek H. S., Barták M., Kubík Š., Yildirim E. M. & Černý M. (2015): Contributions to leafminer (Diptera: Agromyzidae) fauna and new records of plant pests and weeds in Turkey. – *Türkiye Entomoloji Dergisi (=Turkish Journal of Entomology)* 39(2): 159-169.
- Dvořáková-Marsová K., Martinek V., Barták M. & Kubík Š. (2006): Lauxaniidae. Pp. 260-265. In: Barták M. & Kubík Š. (eds): *Diptera of Podyjí National Park and its Environs. Česká zemědělská univerzita v Praze, Praha* (2005), 432 pp.
- Ebejer M.J., Andrade R. & Gonçalves A.R. (2019): The present state of knowledge of the Lauxaniidae of mainland Portugal (Diptera: Acalyptrata). – *Boletín de la Sociedad Entomológica Aragonesa (S.E.A.)* 64: 97-110.
- Ebejer M. J. & Kettani K. (2019): A review of the Moroccan species of Lauxaniidae (Diptera, Acalyptrata). – *Entomologists' Monthly Magazine* 155 (3): 139-150.

- Ellis W. N. (2021): Diptera, Agromyzidae. Plants Parasites of Europe, leafminers, galls and fungi. <https://bladmineerders.nl/parasites/animalia/arthropoda/insecta/diptera/brachycera/agromyzidae/> (accessed 29st November 2021).
- Franz H. (1989): Die Nordost-Alpen im Spiegel ihrer Landtierwelt. Eine Gebietsmonographie, umfassend: Fauna, Faunengeschichte, Lebensgemeinschaften und Beeinflussung der Tierwelt durch den Menschen. Universitätsverlag Wagner, Innsbruck. Band VI/2 Diptera Cyclorapha [sic!], 445 pp.
- Gaimari S. D. (2013): Fauna Europaea: Chamaemyiidae. In: Beuk P. & Pape T. (eds): Fauna Europaea: Diptera. Fauna Europaea version 2017.06, <https://fauna-eu.org> (accessed 20.vii.2021).
- Gibbs D. & von Tschirnhaus M. (2006): *Agromyza viciae* Kaltenbach, 1872 new for the British Isles and Norway with the first description of the male and a literature review. – *Studia Dipterologica* 12(2): 429-441.
- Gritsch W. (2015): Fund af *Geomyza subnigra* Drake 1992 (Diptera, Opomyzidae) – ny for den danske fauna. Records of *Geomyza subnigra* Drake 1992 – a new addition to the Danish fauna – *Entomologiske Meddelelser* 83(1): 35-38 (in Danish, English abstract).
- Guglya Y.A. (2016): A study of the fauna of leaf-miner flies of the subfamily Agromyzinae (Diptera: Agromyzidae) of Ukraine. Report 4. Thirteen new species for the fauna of Ukraine. – *The Kharkov Entomological Society Gazette* 24 (2): 17-24.
- Haarto A., Kakko I. & Winqvist K. (2019): Lisäyksiä Suomen Diptera-faunaan vuoden 2014 jälkeen. (Additions on the Finnish Diptera fauna after 2014). – *W-album* 22: 3-31. (In Finnish)
- Howe M.A. (2010): Chapter 4. The habitats of Diptera. Coastal sand dunes. Pp. 269–276. In Chandler P. (ed.): *A dipterist's handbook* (2nd Edition). The Amateur Entomologist Vol. 15, The Amateur Entomologist's Society, Brentwood, Essex, 525 pp.
- Jedlička L., Kúdela M. & Stloukalová V. (eds) (2009): Checklist of Diptera of the Czech Republic and Slovakia. Electronic version 2. <http://www.edvis.sk/diptera2009/mapCZSK.htm>
- Karl O. (1930): XI. e2. Thalossobionte [sic!] und thalassophile Diptera Brachycera. Pp. 33-84. In: Grimpe G. & Wagler E. (eds): *Die Tierwelt der Nord- und Ostsee* 14(11, e2), Akad. Verlagsgesellschaft, Leipzig.
- Kröber O. (1935): Dipterenfauna von Schleswig-Holstein und den benachbarten westlichen Nordseegebieten. 2. Teil: Diptera Brachycera: Pyrgotidae bis Milichiidae nebst weiteren Beiträgen zum I. Teil (Bd. 22, 1930) und zum III. Teil (Bd. 23, 1931). – *Verhandlungen des Vereins für naturwissenschaftliche Heimatforschung zu Hamburg* 24(1933-1935): 45-88.
- Krogerus R. (1932): Über die Ökologie und Verbreitung der Arthropoden det Triebssandgebiete an den Küsten Finnlands. – *Acta Zoologica Fennica* 12: 1-308.
- (1960): Ökologische Studien über nordische Moorarthropoden. – *Commentationes Biologicae* 21(3): 1-238.
- Li W., Qi L. & Yang D. (2019): Four species of the genus *Lauxania* Latreille 1804 (Diptera, Lauxaniidae) from China. – *Oriental Insects* 54(3): 1-16.
- Loew H. (1847): Dipterologisch Beiträge. Dritter Theil. Ueber die europäischer Arten der Gattung Sapromyza. – *Jahresbericht des Naturwissenschaftlichen Vereines zu Posen* 1846: 25-44.
- MacGowan I. (2014): Three new species of *Protearomyia* McAlpine, 1962 (Diptera; Lonchaeidae) with a key to males of the Palearctic species. – *Zootaxa* 3796(2): 337-348.
- MacGowan I. & Reimann A. (2021): A new species of *Protearomyia* (Diptera, Lonchaeidae) with a review of the genus in the Palearctic. – *Zootaxa* 4966(4): 487-493.
- Martinek V. (1974): New European species *Lauxania minor* sp. n. and redescription of species *Lauxania cylindricornis* (Fabr.) (Diptera, Lauxaniidae). – *Biológia (Bartislava)* 29(8): 609-617.
- (1976): Příspěvek k poznání výskytu druhu čeledi Heleomyzidae, Opomyzidae a Lauxaniidae (Diptera, Acalyptrata) v oblasti státní přírodní rezervace Kopeč. Contribution to the knowledge of distribution of species of the families Heleomyzidae, Opomyzidae and Lauxaniidae (Diptera, Acalyptrata) in the state nature reserve Kopeč. – *Bohemia centralis, Praha*, 5: 172-175 (in Czech, English summary).
- (1977): Druhy čeledi Lauxaniidae (Diptera), zastoupené ve sbírkách Moravského muzea v Brně. Species of the family Lauxaniidae (Diptera) represented in the collections of the Moravian Museum in Brno. – *Časopis Moravského Muzea, Vědy Přírodní* 62: 71-86 (in Czech, English summary).
- (1982): Discovery of some new species of Diptera – Acalyptrata in the fauna of Czechoslovakia. – *Folia Scientiarum Naturalium Universitatis Purkynianae Brunensis* 23(7), *Biologia* 74: 75-81.
- (1984): Nížinné biotopy u Lysé nad Labem a výskyt některých dvoukřídlých (Diptera, Acalyptrata), zvláště teplomilných. Lowland biotopes near Lysá nad Labem and occurrence of some, mainly thermophilous Diptera, Acalyptrata. – *Bohemia centralis, Praha* 13: 225-237 (in Czech, English summary).
- (1985): Příspěvek k poznání rozšíření některých dvoukřídlých (Diptera – Acalyptrata) na jižní Moravě. Contribution to the knowledge of the distribution of some Diptera – Acalyptrata in southern Moravia. – *Acta Scientiarum Naturalium Musei Moraviae occidentalis, Třebíč* 14: 41-59 (in Czech, English summary).
- (1989): Rozšíření některých méně známých dvoukřídlých (Diptera – Acalyptrata) ve středních Čechách. The distribution of some less known Diptera – Acalyptrata in Central Bohemia. – *Bohemia centralis* 18: 161-188 (in Czech, English summary).

- (1994): Further finds of new species of Diptera Acalyptrata on the territory of Czecho-Slovakia and nomenclatorial corrections in some species. Pp. 95-102. In: Jedlička L. (ed.): *Dipterologica bohemoslovaca* 6, Slovak Entomological Society, Bratislava, 123 pp.
- Martinek V. & Barták M. (2001): Lauxaniidae. In: Barták M. & Vaňhara J. (eds): *Diptera in an Industrially Affected Region (North-Western Bohemia, Bílina and Duchcov Environs)* II. – *Folia Facultatis Scientiarum Naturalium Universitatis Masarykianae Brunensis, Biologia* 105: 307-312.
- Merz B. (2004): Revision of the *Minettia fasciata* species-group (Diptera, Lauxaniidae). – *Revue Suisse de Zoologie* 111(1): 183-211.
- (2013): Fauna Europaea: Lauxaniidae. In: Beuk P. & Pape T. (eds): *Fauna Europaea: Diptera Brachycera. Fauna Europaea version 2017.06*, <https://fauna-eu.org> (accessed 2nd December 2021).
- Nartshuk E. P. (2019): Leafminer flies (Diptera: Agromyzidae: Agromyzinae) of the fauna of Russia and other countries of the Palearctic. – *Caucasian Entomological Bulletin* 15(2): 405-411.
- Nartshuk E. P. & von Tschirnhaus M. (2017): Leafminer flies (Diptera: Agromyzidae) of the fauna of Russia and adjacent countries: The genus *Agromyza* Fallén. – *Studia dipterologica* 22(2) (2015): 215-232.
- Nielsen B. O., Nielsen L. B. & Toft S. (2016): Epigaeic Diptera Nematocera from the coastal sand dunes of National Park Thy, Denmark. *Entomologiske Meddelelser, København* 84: 1-34
- (2019): Epigaeic Diptera Brachycera from the coastal sand dunes of National Park Thy, Denmark. *Entomologiske Meddelelser, København* 87: 19-40.
- Nieto Nafria J.-M., Mier Durante M.-P. & Remaudiere G. (2013): The genus *Aphidura* (Hemiptera, Aphididae) in the collection of the Muséum national d'Histoire naturelle of Paris, with six new species. – *ZooKeys* 318: 1-33.
- Nývlt D, Engel Z. & Tyráček J. (2011): Chapter 4. Pleistocene glaciation in Czechia. Pp. 37–45. In Ehlers J., Gibbart P. L. & Hughes P. D. (eds): *Quaternary Glaciations – extent and chronology: a closer look*. Elsevier, Amsterdam, 1108 pp.
- Pakalniškis S. (1996): On the bionomics and knowledge of Agromyzidae (Diptera) feeding on plant stems. – *Ekologija (Vilnius)* 3: 19-24.
- Papp L. (1984): Family Lauxaniidae. Pp. 193-217. In: Soós Á. & Papp L. (eds): *Catalogue of Palearctic Diptera. Vol. 9: Micropezidae–Agromyzidae*, Akadémiai Kiadó, Budapest, 460 pp.
- (2003): Further additions and corrections to the Hungarian Checklist. – *Folia Entomologica Hungarica* 64: 309-339.
- Papp L., Barták M. & Kubík Š. (2006): Chamaemyiidae. Pp. 266-269. In: Barták M. & Kubík Š. (eds): *Diptera of Podyjí National Park and its Environs. Česká zemědělská univerzita v Praze, Praha* (2005), 432 pp.
- Papp L. & Černý M. (2015): Agromyzidae (Diptera) of Hungary. Volume 1. Agromyzinae. Pars Ltd, Nagykovácsi, Hungary 2015: 416 pp.
- (2016): Agromyzidae (Diptera) of Hungary. Volume 2. Phytomyzinae I. Pars Ltd, Nagykovácsi, Hungary 2016: 385 pp.
- (2017): Agromyzidae (Diptera) of Hungary. Volume 3. Phytomyzinae II. Pars Ltd, Nagykovácsi, Hungary 2017: 427 pp.
- Raspi A. (2003): On the identity of *Leucopis (L.) bursaria* and description of a new species: *Leucopis (L.) spirothecae* (Diptera Chamaemyiidae). – *Bollettino della Società entomologica italiana* 135(2): 101-108.
- Roháček J. (1995): Chamaemyiidae. Pp. 129-130. In: Roháček J., Starý J., Martinovský J. & Vála M. (eds): *Diptera Bukovských vrchov. Diptera of the Bukovské Hills. SAŽP - Správa CHKO a BR Východné Karpaty, Humenné*, 232 pp. (in Slovak, English summary)
- (2009): Chamaemyiidae. Pp. 206-208. In: Roháček J. & Ševčík J. (eds): *Diptera of the Poľana Protected Landscape Area - Biosphere Reserve (Central Slovakia). SNC SR, Administration of the PLA – BR Poľana, Zvolen*, 340 pp.
- (2015a): *Tetanops myopina* Fallén, 1820, a psammophilous species of Otitinae (Diptera: Ulidiidae) found in a sandpit in the northeastern part of the Czech Republic. – *Acta Musei Silesiae, Scientiae Naturales* 64: 1-10.
- (2015b): Psammophilous flies (Diptera) on glacial sand deposits in Silesia (Czech Republic). P. 33. In Hamerlík L., Dobříková D. & Stoklasa J. (eds): *The 8th Central European Dipterological Conference: conference abstracts (Kežmarské Žľaby, 28.-30. September 2015)*. Belianum, Banská Bystrica, 79 pp.
- (2016a): Acalyptrate flies (Diptera) on glacial sand deposits in the Hlučínsko region (NE Czech Republic): most interesting records. – *Acta Musei Silesiae, Scientiae Naturales* 65: 33-46.
- (2016b): Čelnice *Tetanops myopina* – moucha z doby ledové ve Slezsku [*Tetanops myopina* – a fly from Ice Age in Silesia]. – *Naše příroda* 2016(4): 38-41 (in Czech).
- (2020): Sand-pits as refugia of flies (Diptera) associated with glacial sands in Silesia (Czech Republic) – preliminary results. Pp. 160-187. In Jarošová L. & Tyranová J. (eds): *Krajina a lidé [Landscape and people]. Recenzovaný sborník z mezinárodního odborného workshopu. Konaný dne 20. 10. 2020 v Opavě, Slezské zemské muzeum, Opava*, 244 pp. Available at http://atlas-slezska.cz/workshop/02_krajina/02_krajina_a_lide_sbornik.pdf

- Roháček J., Barták M., Čelechovský A., Grootaert P., Kanavalová L., Mazánek L. & Pollet M. (2020): New and interesting records of Diptera on glacial sand deposits in Silesia (NE Czech Republic). Part 2 – Brachycera except for Schizophora. – *Acta Musei Silesiae, Scientiae Naturales* 70(1): 1-32.
- Roháček J., Černý M., Ebejer M. J. & Kubík Š. (2020): New and interesting records of Diptera on glacial sand deposits in Silesia (NE Czech Republic). Part 1 - Acalyptratae. – *Acta Musei Silesiae, Scientiae Naturales* 69(1): 1-19.
- Roháček J. & Ševčík J. (2013): Dvoukřídli (Diptera). Pp. 263-283. In Roháček J., Ševčík J. & Vlk P. (eds): *Příroda Slezska [Nature of Silesia]*. Slezské zemské muzeum, Opava, 480 pp. (in Czech).
- Roháček J., Ševčík J. & Vlk P. (eds) (2013): *Příroda Slezska [Nature of Silesia]*. Slezské zemské muzeum, Opava, 480 pp. (in Czech, with English abstract & summary)
- Růžička M. (2004): The Pleistocene glaciation of Czechia. Pp. 27-34. In Ehlers J. & Gibbard P. L. (eds): *Quaternary Glaciations – Extent and Chronology. Part I: Europe. Developments in Quaternary Science. Vol. 2*. Elsevier B. V., Amsterdam, 475 pp.
- Růžičková E., Růžička M., Zeman A. & Kadlec J. (2009): Quaternary clastic sediments of the Czech Republic. Textures and structures of the main genetic type. *Český geologický ústav, Praha*, 68 + 92 pp.
- Sasakawa M. (1994): Notes on the Japanese Agromyzidae (Diptera), 3. *Liriomyza*-miners on *Artemisia* spp. (Asteraceae). – *Japanese Journal of Entomology* 62 (1): 55-64.
- (2005a): Notes on the Japanese Diptera Part 3. – *Japanese Journal of Entomology (N.S.)*, 8(3): 75-78. In Japan.
- (2005b): Notes on the Japanese Agromyzidae (Diptera), 5. Japanese species of the genus *Cerodontha* Rondani, with the description of five new species. – *Scientific Reports of Kyoto Prefectural University, Human Environment and Agriculture* 57: 47-64.
- Sasakawa M. & Matsumura T. (1998): Agromyzidae (Diptera) in Insect Museum, National Institute of Agro-Environmental Sciences, with the description of seven new species. – *The Bulletin of the National Institute of Agro-Environmental Sciences* 13: 1-17.
- Semelbauer M. (2016): Fauna Slovenska. Lauxaniidae – tieňovkovité (Diptera, Cyclorrhapha). [Fauna of Slovakia, Lauxaniidae (Diptera, Cyclorrhapha)]. Veda, Bratislava, 183 pp. (in Slovak)
- Semelbauer M., Dvořáková K. & Kočišek J. (2021): Comparative morphology of female terminalia of *Calliopum* Strand, 1928, *Lauxania* Latreille, 1804 (Diptera, Lauxaniidae) and allies. – *Biologia* 76: 3355-3369.
- Semelbauer M. & Kozánek M. (2009): Lauxaniidae of Slovakia, faunistic notes and seasonal dynamics of selected species. – *Folia Faunistica Slovaca* 16(1): 35-36.
- (2012): Morphology of preimaginal stages of *Lauxania* and *Calliopum* (Diptera: Lauxaniidae). – *Zootaxa* 3346: 1-28.
- Spencer K. A. (1957): Notes on the British species of *Melanagromyza* Hendel (Diptera: Agromyzidae), with the description of four new species, and also of three new species from Germany. – *Proceedings of the Royal Entomological Society, London (B)* 26: 179-188.
- (1966a): Some Agromyzidae from Sicily. – *Entomologist's Monthly Magazine* 101: 172-177.
- (1966b): A revision of European species of the genera *Melanagromyza* Hendel and *Hexomyza* Enderlein, with a supplement on the genus *Ophiomyia* Braschnikov. – *Beiträge zur Entomologie* 16: 3-60.
- (1972): Diptera Agromyzidae. Handbooks for the Identification of British Insects 10 (5g). Royal Entomological Society of London, 136 pp.
- (1976): The Agromyzidae (Diptera) of Fennoscandia and Denmark. *Fauna Entomologica Scandinavica*, Vol. 5 Part 1 (1-304), Part 2 (305-606). Scandinavian Science Press Ltd., Klampenborg, 606 pp.
- (1990): Host Specialization in the World Agromyzidae (Diptera). *Series Entomologica* 45. Kluwer Academic Publishers, 444 pp.
- (1992): Flycatcher. Memoirs of an amateur entomologist. SPB Academic Publishing. The Hague. 414 pp.
- Strakhova I.S., Yefremova Z.A., von Tschirnhaus M. & Yegorenkova E.N. (2013): Komplex parazitoidov (Hymenoptera, Eulophidae) miniruyushchikh mukh agromizid (Diptera, Agromyzidae) v Srednem Povolzh'e. Parasitoid complex (Hymenoptera, Eulophidae) of mining flies (Diptera, Agromyzidae) in the middle Volga river basin. – *Zoologicheskii Zhurnal* 92(5): 553-561. (in Russian, with English summary).
- Tanasijtshuk V.N. (1986): [Silver-flies (Chamaemyiidae)]. *Fauna of the USSR, New Series* 134, Dipterans. Volume 14. Zoological Institute of the Russian Academy of Sciences, Nauka Publishers, St. Petersburg, 335 pp. [in Russian].
- Tanasijtshuk V.N. & Beschovski V.L. (1991): A contribution of the *Chamaemyia* species (Diptera, Chamaemyiidae) from Bulgaria and some East European countries. – *Acta Zoologica Bulgarica* 41: 18-25.
- Tschirnhaus M. von (2008): Die acalyptraten Fliegen der Ostfriesischen Inseln (Diptera: Schizophora, „Acalyptratae“). Kritisches Artenverzeichnis anhand von Literaturdaten, Neufunden und unter Mitarbeit von Fachkollegen. – *Schriftenreihe Nationalpark Niedersächsisches Wattenmeer* 11: 373–390.
- Wilson F. (1938): Notes on the insect enemies of *Chermes* with particular reference to *Pineus pini*, Koch and *P. strobi*, Hartig. – *Bulletin of Entomological Research London* 29: 373-389.

- Winqvist K., Černý M. & Andersen T. (2020): Twenty species of Agromyzidae (Diptera) from Hedmark and Finnmark not previously recorded from Norway. – Norwegian Journal of Entomology 69: 125-131.
- Zavřel H. (1953): Minující hmyz na Kotouči a v okolí Štramberka I. [Mining insects on Kotouč Mt. and in the environs of Štramberk I.] – Přírodovědecký sborník Ostravského kraje 14: 416-422 (in Czech).
- Zuijlen J. W. A. van & Roháček J. (2006): Notes on the Opomyzidae (Diptera) of the Czech Republic and Slovakia, with two new synonyms in *Geomyza* Fallén. – Časopis Slezského zemského Muzea (A) 55: 125-130.
- (2009): Opomyzidae. Pp. 236-237. In: Roháček J. & Ševčík J. (eds): Diptera of the Pořana Protected Landscape Area – Biosphere Reserve (Central Slovakia). SNC SR, Administration of the PLA – BR Pořana, Zvolen, 340 pp.

Author contributions. J. Roháček conceptualized the study, performed the field work, designed the manuscript, treated Lauxaniidae and Opomyzidae and wrote all general parts of this paper; co-authors identified material and prepared sections on the families as follows: M. Černý (Agromyzidae), M. J. Ebejer (Lauxaniidae and Chamaemyiidae) and I. MacGowan (Lonchaeidae).

Nové a zajímavé nálezy dvoukřídlých (Diptera) na ložiskách glaciálních písků ve Slezsku (SV České republiky). Část 3 – Acalyptratae 2

Studie prezentuje další zajímavé nálezy celkem 28 druhů akalyptrátů z čeledi *Lochaetidae* (1 druh), *Lauxaniidae* (2 druhy), *Chamaemyiidae* (9 druhů), *Agromyzidae* (16 druhů) a *Opomyzidae* (1 druh) zaznamenaných při výzkumu fauny dvoukřídlých na písčích ledovcového původu v českém Slezsku. Z nich 25 je poprvé hlášeno z tohoto území, 15 je nových pro území Moravy a 11 z nich je také nových pro území celé České republiky. Šest druhů (*Lauxaniidae* 1, *Agromyzidae* 5) je poprvé zaznamenáno pro území Polska. Nález druhu *Leucopis cerasiphila* Gomolitzkaja & Tanasijtshuk, 1986 v písčinně Kolnovice je dokonce prvním na evropském kontinentu; tento druh byl dosud znám jen ze Střední Asie. Je diskutována a hodnocena afinita všech prezentovaných druhů k písčitém biotopům. Žádný z nich sice není psamobiontní ale 8 druhů je klasifikováno jako psamofilní nebo alespoň pravděpodobně psamofilní, viz *Minettia longiseta* (Loew, 1847) (*Lauxaniidae*), *Leucopis kaszabi* Tanasijtshuk, 1970 (*Chamaemyiidae*), *Cerodontha (Xenophytomyza) leptophallus* Papp, 2016, *Hexomyza sarothamni* (Hendel, 1923), *Liriomyza dracunculi* Hering, 1932, *L. latigenis* (Hendel, 1920), *L. yasumatsui* Sasakawa, 1972 (*Agromyzidae*) a *Geomyza subnigra* Drake, 1992 (*Opomyzidae*). Rovněž je diskutována enormně vysoká diverzita zástupců čeledi *Chamaemyiidae*, kterých bylo na glaciálních písčích ve Slezsku zjištěno neuvěřitelných 26 druhů.

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