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Research article

Some winter active flies from snow and caves of Vârghiș, Romania

Olavi Kurina[1], Anna Dénes[2], Libor Dvořák[3], Kateřina Dvořáková[4], Jozef Oboňa[5], Jindřich Roháček[6], Peter Manko[7]

(1) Institute of Agricultural and Environmental Sciences, Estonian University of Life Sciences, Kreutzwaldi st 5-D, ES – 51 006 Tartu, Estonia, olavi.kurina@emu.ee; https://orcid.org/0000-0002-4858-4629
(2) Hungarian Department of Biology and Geology, Babes-Bolyai University, Clinicilor 5-7, Cluj Napoca RO – 400 006, Romania, en.denesanna@yahoo.com; https://orcid.org/0000-0002-8169-6016
(3) Tři Sekery 21, CZ–353 01 Mariánské Lázně, Czech Republic, lib.dvorak@seznam.cz; https://orcid.org/0000-0002-4712-3679
(4) Tři Sekery 21, CZ–353 01 Mariánské Lázně, Czech Republic, k.marsova@seznam.cz; https://orcid.org/0000-0002-1815-488X
(5) [Corresponding author] Department of Ecology, Faculty of Humanities and Natural Sciences, University of Prešov, 17. novembra 1, SK – 081 16 Prešov, Slovakia, jozef.obona@unipo.sk; http://orcid.org/0000-0002-1185-658X
(6) Slezské zemské muzeum, Nádražní okruh 31, CZ–746 01 Opava, Czech Republic, rohacek@szm.cz; https://orcid.org/0000-0003-3311-2087
(7) Department of Ecology, Faculty of Humanities and Natural Sciences, University of Prešov, 17. novembra 1, SK – 081 16 Prešov, Slovakia, peter.manko@unipo.sk; https://orcid.org/0000-0003-1862-9117

Abstract: This paper attempts to fill the gaps in knowledge about the biodiversity of some winter-active fly families from snowfields and caves in Vârghiș, Romania. A total of 15 fly species were recorded from caves and 9 species from snowfields. *Exechiopsis* (*Exechiopsis*) *pseudindecisa* Lastovka & Matile, 1974 and *Rymosia placida* Winnertz, 1863 from caves and *Mycetophila mitis* (Johannsen, 1912) (all Mycetophilidae) from snow represent the first records for Romania. Habitus photographs of these three species are provided.

Keywords: biodiversity, Bolitophilidae, Culicidae, faunistics, Heleomyzidae, Mycetophilidae, Sphaeroceridae, Trichoceridae

Introduction

In general, it can be stated that field surveys of insects are relatively rare in the winter months. Nevertheless, there are several studies that have addressed snow-active insects from several European countries (e.g. Hågvar & Greve, 2003; Soszyńska, 2004; Pavlov, 2006; Soszyńska-Maj & Klasa, 2009; Hågvar, 2010; Soszyńska-Maj, 2010; Soszyńska-Maj & Woźnica, 2016; Dvořák et al., 2022; etc.) and insects hibernating in caves (e.g. Košel & Horváth, 1996; Košel, 2009; Dvořák & Dvořáková, 2012; etc.). Also from the Romanian Carpathian area, there are several papers devoted to flies active on snow or in caves (e.g. Collart, 1940; Burghele-Bălăcesco, 1966; Motas et al., 1967; Boitan & Negrea, 2001; etc.).

Recently, there has been intense climate change (e.g. Musolin, 2007). Observations to date suggest that snow is becoming rarer in many regions of central and southern Europe (Arnell, 1999; Räisänen et al., 2004). Such climatic changes can have a fatal impact on a variety of organisms, including oligostenotermous winter-active insects.

Therefore, it is very important to carry out entomological research also in winter and to concentrate as much information as possible on the occurrence and distribution of winter-active insects. For this reason, in our paper we discuss the winter-

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active snow and cave dipteran fauna of an interesting and rare karst area in Vârghiș, Romania.

Material and methods

This research was conducted in February in Romania near village Vârghiș (Varghis), 550–650 m a.s.l.. The Varghis Gorge (Cheile Vârghișului) (in Hungarian Vargyas-szoros, in German Virghis Klamm) make up a protected area of national interest that corresponds to the Vârghiș Gorge Natural Reserve, lying on only 998 hectars and covering about 95% of the Cheile Vârghișului Natura 2000 site (ROSCI0036) (Grigore, 1989; Gheoca, 2016; NATURA 2000). The collection of insects was carried out in two different ecosystems:

Snow – snow areas along the river, 46°12′50.3″N 25°32′56.2″E, 2–3 February 2023, coll. by hand with entomological forceps. A more detailed description of individual snowfield is given below:

snow 1 – snow field near the Vârghiș Gorge Visitor Center, around 46°12′29.8″N 25°32′49.3″E;

snow 2 – snow field near the river (near the entrance to the gorge), around 46°12′47.8″N 25°32′53.9″E;

snow 3 – snow field in Gorge of Vârghiș, between 46°12′54.4″N 25°32′49.6″E and 46°13′16.3″N 25°32′23.8″E.

Cave – caves (Cheile Vârghișului), 46°13′08.6″N 25°32′41.2″E, 2–3 February 2023, coll. by aspirator and by hand with entomological forceps. A more detailed description of individual caves is given below:

cave 1 – Hotel Spelaeus locality – consisting of three small caves in the calcareous rock: two of them (cave No. 23 and Hotel Spelaeus cave – No. 24) with medium sized chambers (max 10 m length) which serve, microhabitats with stable temperature suitable for dipterans and one small cave with small opening, 03.02.2023, 46°13′05.4″N 25°32′38.0″E;

cave 2 – Lócsűr/Șura Cailor cave – No. 8 – with a total length of 300 m consisting of a wide opening, and a narrow side entrance, large chamber inside with constant temperature about 10°C, 02.02.2023, 46°13′09.9″N 25°32′41.3″E;

cave 3 – small, few metre long cave near the Orbán Balázs/barlang/Peștera Merești, without identity number, 02.02.2023, 46°13′07.7″N 25°32′42.3″E;

cave 4 – Orbán Balázs-barlang/Peștera Merești cave, No. 14 – the largest cave of the Vârghiș Gorge, with a total length of 1.5 km, collecting was performed only at the opening of the cave and in the first large chambers that have a higher temperature comparing to outside winter temperatures (other parts are not accessible due to barriers installed to protect hibernating bats), 02.02.2023, 46°13′06.4″N 25°32′41.3″E;

cave 5 – Albert cave, No. 1 – the entrance and first chambers of the cave, 03.02.2023, 46°13′15.2″N 25°32′27.9″E;

cave 6 – small, few metre long cave near Albert cave, without identity number, close to the riverbed 03.02.2023, 46°13′13.0″N 25°32′28.6″E;

cave 7 – the Vízkelet cave, No. 45 – the first part of the cave, with stable temperature about 10°C, including small side chambers, and narrow tunnels, until the point we reached the active part of the cave, 03.02.2023, 46°12′53.1″N 25°32′58.0″E.

Insects from the snow were collected by P. Manko, J. Oboňa, A. Dénes, and M. Pál by hand and insects from caves were collected by the same collectors by aspirator and by hand. All samples were placed in tubes with ethanol, then sorted under a stereomicroscope for identification by experts. Diptera identification was performed by specialists as follows: Culicidae L. Dvořák and J. Oboňa; Heleomyzidae K. Dvořáková; Bolitophilidae and Mycetophilidae O. Kurina; Sphaeroceridae J. Roháček; Trichoceridae J. Oboňa.

The material is deposited in the collections of the authors who identified it, or in the collections of the institutions to which they are affiliated.

Results and discussion

Culicidae

Culex sp.

Localities: cave 1, 10 ♀♀; cave 2, 34 ♀♀; cave 3, 28 ♀♀; cave 4, 33 ♀♀; cave 5, 16 ♀♀; cave 6, 2 ♀♀; cave 7, 3 ♀♀.

A common mosquito genus in caves. Adult females overwinter hibernating in basements, caves, and abandoned mines (Becker et al., 2010). The recent studies based on DNA analyses have shown unexpected diversity of *Culex* spp. in underground hibernaculas (Zittra et al., 2019, 2021).

Culiseta glaphyroptera (Schiner, 1864)

Localities: cave 1, 3 ♀♀; cave 2, 2 ♀♀; cave 4, 4 ♀♀; cave 5, 1 ♀; cave 7, 1 ♀.

This species has a relatively wide European distribution from southern Scandinavia to Greece and from Luxembourg to Ukraine (Robert et al., 2019; Huldén & Huldén, 2014; Zittra et al., 2021). Although usually noted as a rare mountain species, it has been found as a relatively common or very common species in underground refuges in the Czech Republic and Slovakia (Dvořák, 2012, 2014; Dvořák et al., 2020). On the other hand, this species seems to be really rare in some surrounding countries as documented in recent publications from, e.g., Hungary (Tóth & Kenyeres, 2012), Romania (Török et al., 2018), and Germany (Kampen et al., 2013).

Bolitophilidae

Bolitophila (*Bolitophila*) *saundersii* (Curtis, 1836)

Localities: cave 1, 1 ♀; cave 5, 1 ♀.

A Palaearctic species, widely distributed in Europe (Chandler, 2013). Larvae develop in terrestrial agarics (Jakovlev, 1994). Adults have been recorded in caves throughout Europe (Weber et al., 2007). It is one of the most commonly recorded *Bolitophila* species in the cave environment.

Heleomyzidae

Gymnomus caesius (Meigen, 1830)

Locality: snow 2, 1 ♂.

Not frequent, but a common European coprophagous species. Adults occur mainly in colder parts of year, and have been caught in traps set during winter (Preisler & Dvořáková, 2009). According to Soszyńska-Maj & Woźnica (2016) it is a very common species on snow in the Beskid Mountains in Poland.

Heleomyza (*Heleomyza*) *captiosa* (Gorodkov, 1962)

Localities: cave 1, 1 ♂; cave 2, 3 ♂♂, 3 ♀♀; cave 4, 7 ♂♂, 21 ♀♀; cave 6, 1 cf. 1 ♀; cave 7, 1 ♂, 1 ♀.

One of the most common species of Heleomyzidae in European caves (Papp, 1982; Dvořák & Dvořáková, 2012; etc). Some populations undergo their entire development inside the cave, but the species may also occur outdoors in the colder part of the year (Preisler & Dvořáková, 2009).

Scoliocentra (*Leriola*) *brachypterna* (Loew, 1873)

Locality: cave 4, 1 ♂.

A common European species, often found in caves. Larvae develop in the nests of birds and in the guano of bats (Woznica, 2004). In the colder part of the year it is found outdoors (Preisler & Dvořáková, 2009). Collart (1940) recorded it in Transylvanian caves.

Mycetophilidae

Allodia ornaticollis (Meigen, 1818)

Locality: snow 2, 1 ♂.

A common Holarctic species, widely distributed in Europe (Chandler, 2013, 2022). Larvae develop in fruiting bodies of several genera of macrofungi (Chandler, 2022) and adults are found in all types of forest ecosystems. The species has also been recorded from caves in Germany and Luxembourg (Weber et al., 2007; Plassmann & Weber, 2013). This species' name has a problematic identity (cf. Kjærandsen et al., 2007) and we follow here the interpretations by Zaitzev (2003) and Chandler (2022).

Allodia sp.

Locality: cave 7, 1 ♀.

Species of the genus *Allodia* can reliably be determined only based on the male terminalia. Thus, in most cases, females are determined at the genus level only.

Exechia dorsalis (Stæger, 1840)

Locality: snow 2, 1 ♂.

A common Palaearctic species, widely distributed in Europe (Chandler, 2013, 2022). Larvae are

mycophagous in many genera of macrofungi (Chandler, 2022). Recorded in caves in Germany and France (Weber et al., 2007).

Exechia fusca (Meigen, 1804)

Localities: cave 1, 1 ♂; snow 1, 6 ♂♂; snow 2, 1 ♂.

A very common Holarctic species, widely distributed and abundant in Europe (Chandler, 2013, 2022). Larvae are mycophagous in many genera of macrofungi (Chandler, 2022). It is one of the most frequent fungus gnat species recorded during the winter months in Europe. Adults have been often recorded on snow (Olavi Kurina, pers. obs.) and in caves in Europe (Weber et al., 2007).

Exechia sp.

Locality: snow 3, 2 ♀♀.

Species of the genus *Exechia* can reliably be determined only based on the male terminalia. Thus, in most cases, females are determined at the genus level only.

Exechiopsis (*Exechiopsis*) *intersecta* (Meigen, 1818)

Localities: cave 1, 1 ♂, 2 ♀♀; cave 2, 1 ♀; cave 4, 1 ♀; cave 5, 1 ♂, 1 ♀; cave 6, 2 ♂♂, 2 ♀♀.

A widespread European species (Chandler, 2013, 2022) but considered to be rather rare (Ševčík & Kurina, 2011). Larvae are mycophagous in fruiting bodies of *Tricholoma saponaceum* and *Mycena* sp. (Ševčík, 2010; Chandler, 2022). Adults have been recorded in caves throughout Europe (Weber et al., 2007).

Exechiopsis (*Exechiopsis*) *magnicauda* (Lundstrom, 1911)

Localities: cave 1, 21 ♂♂, 16 ♀♀; cave 2, 1 ♀; cave 3, 5 ♂♂, 7 ♀♀; cave 4, 1 ♀; cave 5, 4 ♂♂, 9 ♀♀; cave 6, 12 ♂♂, 7 ♀♀; cave 7, 5 ♂♂, 9 ♀♀.

A widespread but rather rare European species (Chandler, 2022). The biology of the species remains unknown. Adults have been recorded in caves in Germany, Luxembourg, Sweden, Romania, Czech and Slovak Republics (Kjærandsen, et al. 2007; Weber et al., 2007; Plassmann & Weber, 2013).

Exechiopsis (*Exechiopsis*) *pseudindecisa* Lastovka & Matile, 1974
(Fig. 1 A)

Localities: cave 1, 1 ♀; cave 4, 1 ♂, 1 ♀; cave 5, 1 ♂, 4 ♀♀; cave 6, 2 ♂♂; cave 7, 8 ♂♂, 4 ♀♀.

A Palaearctic species, widely distributed in Europe (Chandler, 2022). Biology is unknown. The species is very similar to *E.* (*E.*) *indecisa* (Walker, 1856), another widespread Palaearctic species, and the two species may have been confused in some earlier studies. Recorded in caves in Germany, Luxembourg, Slovakia, Norway and Estonia (Weber et al., 2004; Plassmann & Weber, 2013). New for Romania.

Mycetophila marginata Winnertz, 1863

Locality: snow 3, 1 ♂, 1 ♀.

A widespread Western Palaearctic species, common throughout Europe (Chandler, 2013, 2022). Larvae develop mainly in tree-living fungi (Chandler, 2022). Adults have been recorded in caves in Germany and Luxembourg (Weber et al., 2007; Plassmann & Weber, 2013).

Mycetophila mitis (Johannsen, 1912)
(Fig. 1 C)

Locality: snow 2, 1 ♂.

A Holarctic species, widely distributed in Europe (Chandler, 2022). Biology is unknown. Adults are described to prefer woodland and carr (Chandler, 2022) and have also been recorded in caves in Germany and Luxembourg (Weber et al., 2007; Plassmann & Weber, 2013). New for Romania.

Mycetophila sp.

Locality: snow 2, 1 ♀.

Species of the genus *Mycetophila* can reliably be determined only based on the male terminalia. Thus, in most cases, females are determined at the genus level only.

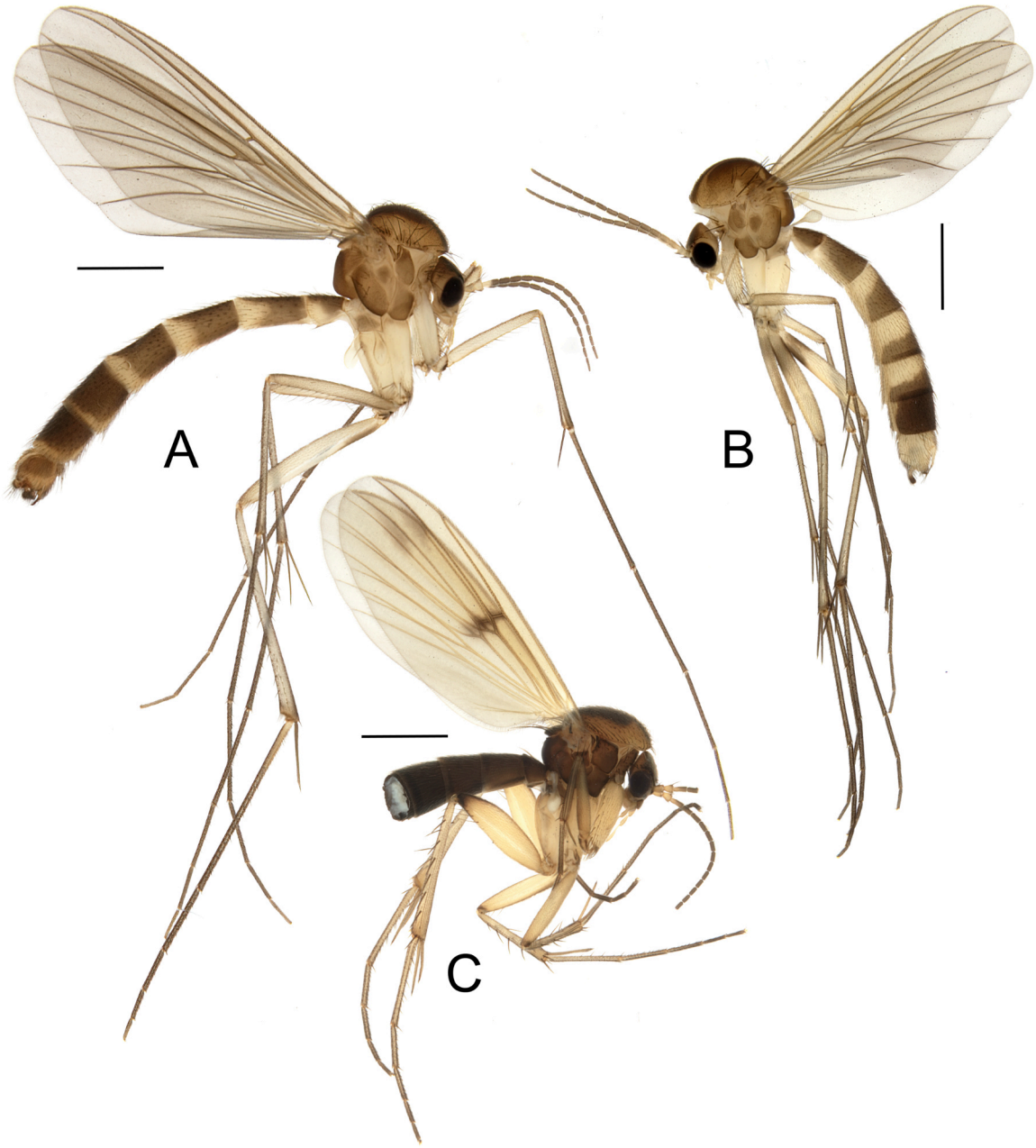

Fig. 1. Habitus of the species representing new country records. A – *Exechiopsis* (*Exechiopsis*) *pseudindecisa* Lastovka & Matile, 1974; B – *Rymosia placida* Winnertz, 1863; C – *Mycetophila mitis* (Johannsen, 1912), terminalia detached. Scale bars = 1 mm.

Phronia biarcuata (Becker, 1908)

Localities: snow 2, 3 ♂♂, 1 ♀; snow 3, 1 ♀.

A Holarctic species, widely distributed in Europe (Kjærandsen et al., 2007; Chandler, 2022). Biology is unknown. Adults have been recorded in German caves (Weber et al., 2007).

Rymosia affinis Winnertz, 1864

Localities: cave 1, 1 ♂, 1 ♀; cave 2, 1 ♂, 1 ♀; cave 4, 2 ♂; cave 7, 1 ♀.

A Palaearctic species, widely distributed in Europe (Chandler, 2022). According to Chandler (2022), the species prefers broad-leaved woodland

and has been reared from several species of terrestrial agarics. Adults have been recorded in caves throughout Europe (Weber et al., 2007).

Rymosia fasciata (Meigen, 1804)

Localities: cave 1, 4 ♂♂, 1 ♀; cave 2, 4 ♂♂, 1 ♀; cave 3, 1 ♀; cave 4, 1 ♀; cave 5, 3 ♂♂, 3 ♀♀.

A widely distributed European species (Chandler, 2013, 2022). Larvae develop in terrestrial agarics (Chandler, 2022). Adults have been recorded in caves throughout Europe (Weber et al., 2007). It is the most commonly recorded *Rymosia* species in the cave environment.

Rymosia placida Winnertz, 1863
(Fig. 1 B)

Localities: cave 3, 1 ♂; cave 5, 1 ♂.

A Palaearctic species, widely distributed but rather rare in Europe (Ševčík & Kurina, 2011; Chandler, 2022). It has been reared from ascomycete species *Trichoderma alutaceum* (Ševčík, 2010). Adults have been recorded in caves in Germany, Luxemburg and Norway (Weber et al., 2007; Plassmann & Weber, 2013). New for Romania.

Rymosia tolleti Burghele-Balacesco, 1965

Locality: cave 2, 1 ♂.

A widespread but rare Central European species, with all known records from the cave environment (Kurina et al., 2023). This record has been published in a separate paper (Kurina et al., 2023) with detailed figures of male terminalia, DNA barcode, and discussion of the species' identity.

Tarnania dziedzickii (Edwards, 1941)

Localities: cave 2, 2 ♂♂; cave 3, 1 ♂; cave 5, 5 ♂♂, 3 ♀♀; cave 6, 1 ♂; cave 7, 1 ♂.

A Western Palaearctic species, widespread in Europe (Kjærandsen, 2006; Chandler, 2022). Larvae develop in terrestrial agarics (Jakovlev, 1994; Chandler, 2022). Adults have been recorded in caves throughout Europe (Weber et al., 2007).

Tarnania fenestralis (Meigen, 1818)

Localities: cave 1, 2 ♂♂, 6 ♀♀; cave 2, 4 ♂♂, 2 ♀♀; cave 3, 1 ♂; cave 4, 1 ♂, 1 ♀; cave 5, 2 ♂♂, 1 ♀; cave 6, 1 ♂; cave 7, 1 ♂, 2 ♀♀.

A Palaearctic species, widespread in Europe (Kjærandsen, 2006; Chandler, 2022). Larvae develop in terrestrial agarics (Jakovlev, 1994; Ševčík, 2010; Chandler, 2022). Adults have been recorded in caves throughout Europe (Weber et al., 2007). It is the most commonly recorded *Tarnania* species in the cave environment.

Trichonta sp.

Locality: snow 3, 1 ♀.

Species of the genus *Trichonta* can reliably be determined only based on the male terminalia. Thus, in the majority of cases, females are determined at the genus level only.

Sphaeroceridae

Crumomyia notabilis (Collin, 1902)

Localities: snow 2, 1 ♂.

It is a typical psychrophilic species that usually inhabits underground habitats (mammal burrows, caves, mines) where its larvae develop in various decaying organic matter (Roháček, 1991). This Euro-Siberian species leaves underground spaces only in the cold season of the year, and therefore, adults (including gravid females) can often be found on snow (for a review of previous records see Dvořák et al. (2022)). Hågvar & Greve (2003) and Dvořák et al. (2022) recorded *C. notabilis* as the most frequently occurring species of Sphaeroceridae on snow in winter.

Note: There is only one previous record of (probably) *C. notabilis* from Romania, by Ursu (1982, as *Copromyza* (*Crumomyia*) *glacialis*) from Ciudanoviţ (SW Romania). Inasmuch as the identification by Ursu (l. c.) remains uncertain the species is definitely confirmed from Romania only now.

Trichoceridae

Trichocera (*Saltrichocera*) *regelationis* (Linnaeus, 1758)

Localities: cave 1, 1 ♂; cave 7, 1 ♂.

One of the most abundant species widely distributed in the Holarctic Region, and known also from North Africa (Morocco) (Driauach et al., 2015; Krzemińska, 2021). Adults occur during autumn, winter and spring months (Krzemińska & Brunhes, 1991). This species is also known from caves (Petrašiūnas & Weber, 2013).

Trichocera (*Trichocera*) *hiemalis* (De Geer, 1776)

Locality: snow, 1 ♂.

A relatively common snow-active species, it occurs from early autumn to late spring (Krzemińska & Brunhes, 1991; Hågvar, 2010; Dvořák et al., 2022).

Conclusions

A total of 28 taxa and 23 species from the families Culicidae, Bolitophilidae, Heleomyzidae, Mycetophilidae, Sphaeroceridae and Trichoceridae were recorded in this study. More than 400 specimens belonging to 15 species (Culicidae 1 sp., Bolitophilidae 2 spp., Heleomyzidae 2 spp., Mycetophilidae 9 spp. and Trichoceridae 1 sp.) were collected from the caves. From snow, we recorded less than 30 individuals belonging to 9 species (Heleomyzidae 1 sp., Mycetophilidae 6 spp., Sphaeroceridae 1 sp. and Trichoceridae 1 sp.).

Three of the recorded species from the family Mycetophilidae (namely *Exechiopsis* (*E.*) *pseudindecisa, Mycetophila mitis, Rymosia placida*) have been recorded for the first time for Romania (for the list of Romanian species see Kolcsár & Salmela (2017)).

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