

First records of dendrolimnetic moth flies (Diptera: Psychodidae) from Slovakia

Prvónálezy dendrotelmových kútovek (Diptera: Psychodidae) zo Slovenska

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Abstract. The water-filled tree hole fauna of non-biting moth flies (Diptera: Psychodidae) of Slovakia is documented for the first time. The first records of *Lepiseodina tristis* (Meigen, 1830) and *Sciria advena* (Eaton, 1893) from Slovakia are noted. European tree hole Psychodidae species are reviewed, and the relevance of trapping methods is discussed.

INTRODUCTION

Water-filled tree holes, called dendrotelmata (Fig. 1), are small cavities in trees with lentic waters (e.g. Röhnert 1950; Kitching 1971, 2004) that are unique habitats because of extreme variation in chemical characteristics and other factors (frequent water loss, which alternates rapid flooding and also extreme variation in environmental characteristics (such as pH, temperature, conductivity and oxygen deficit (e.g. Walker et al. 1991; Léonard & Juliano 1995; Kitching 1971, 2004)). The organisms inhabiting dendrotelmata must be specially adapted to these extreme conditions, particularly the water loss. Dendrotelmata harbour, among other organisms, more or less specialized immature stages of Diptera and Coleoptera (Schmidl et al. 2008) that use them as breeding sites, and some species breed exclusively in such habitats (Yanoviak & Fincke 2005). Several species of non-biting moth flies (Diptera: Psychodidae) are also closely associated with water-filled tree holes (e.g. Feuerborn 1922, 1923; Mayer 1938; Röhnert 1950; Jung 1956; Mirouse & Vaillant 1960; Krivosheina & Mamaev 1967; Withers 1987, 1989a,b; Vaillant 1989, 1990). The larvae of these psychodids are detritus feeders inhabiting rotting wood or tree hole sediment. Some species are regular specialists inhabiting water-filled tree holes (e.g. Vaillant 1989, Kitching 2004).

The checklist of the psychodid fauna of Slovakia (Ježek 2009, Ježek et al. 2012) includes 101 species, but some of dendrotelmata inhabiting species (see text below) were not known until now from Slovakia.

MATERIAL AND METHODS

Tree holes sampling was carried out in the immediate vicinity of the village of Diviacka Nová Ves (district Prievidza, Hornonitrianska kotlina basin) at three localities:

Site 1: Vrbany env., Diviacka Nová Ves, an oak forest (old forest dominated by oak), northeast of the village, with 8 sampled oak tree holes, and 2 sampled birch tree holes, 320 m a.s.l., 48°45'25.1"N, 18°30'43.5"E, 7277.

Site 2: Diviacka Nová Ves, a beech forest (beech monoculture, with old trees at margins), west of the village, with 7 sampled beech tree holes and 1 sampled elm tree hole, 340 m a.s.l., 48°44'51.89"N, 18°28'57.5"E, 7276.

Site 3: Diviacka Nová Ves, an Old Jewish Cemetery, northwest of the village with 1 sampled apple tree hole, 1 cherry tree hole and 1 maple tree hole, 330 m a.s.l., 48°44'57.28"N, 18°29'20.5"E, 7276.

All the sampled tree holes were at heights up to 1.5 m (measured from the ground), with water capacity of 5–30 liters. More than 70 % of sampled tree holes completely lost water at least once a year.

For sampling, the following methods were used: individual sampling, yellow pan traps, larval rearing, and sweeping.

During individual sampling (IS) (from September 2010 to October 2012, at two-week intervals), adult individuals of Psychodidae were searched for within or in the proximity of tree holes. Specimens were stored in eppendorf tubes preserved with 75% ethanol.

Plastic containers (0.2 l, 6.5 cm in diameter and 8 cm high) filled with saline solution with a drop of detergent were used for yellow pan trapping. Containers were inserted into the bottom of monitored tree holes (with previously recorded occurrence of Psychodidae larvae). Following tree holes were selected for this type of sampling: 7 oaks, 3 beeches and 1 elm, 1 cherry and 1 maple. Yellow pan trap sampling began in March 2012, traps were checked at approximately 10 day interval until the end of May. Individuals of Psychodidae collected were thoroughly cleaned, and stored in eppendorf tubes with 75% ethanol.

Several rearing containers were used for larval rearing in laboratory conditions (one container per tree species). Almost any container with rainwater and a small amount of leaf litter can function as an artificial tree hole. Tree hole analogues with varying degrees of realism can be constructed, for example, from plastic pots (e.g. Fincke 1992). We used plastic bottles crosscut in half (8 cm diameter) and 4 l canning jars closed by a Petri dish as a rearing units. Rearing containers were filled with wet tree hole sediment to one third of their height. Psychodidae larvae obtained from field research during individual sampling were placed into the rearing containers, which were subsequently closed. Rearing containers were monitored daily. Adult individuals that emerged from the substrate were stored in 75% ethanol in polyethylene eppendorf tubes.

The sweeping method was only used on site 1 (see "Material examined").

All specimens obtained were mounted in Canada balsam and identified to the lowest possible taxonomic level. Material is deposited in the NMPC (National Museum, Praha, Diptera collection). Identification and nomenclature is based on Pellerano (1967), Vaillant (1971–1983), Ibañez-Bernal (2008), Ježek (2009) and Ježek & van Harten (2009). Geomorphological units and grid mapping codes of DFS (Databank of the fauna of Slovakia) are cited according to Lučivjanská (1989).

The following abbreviations are used: IS – individual sampling, LR – larval rearing, SW – sweeping, YPT – yellow pan traps; NMPC – National Museum, Praha.

RESULTS

Paramormiini

Clogmia albipunctata (Williston, 1893)

Material examined. Slovakia occ., Prievidza district, Vrbany env., Diviacka Nová Ves, Rudnianska kotlina basin, 7277, **site 1:** 21.x.2011, IS, oak tree hole, 1 ♂, J. Oboňa leg., G. Kvifte det. et coll.; 29.ix.2012, IS, the same tree hole, 1 ♀; J. Oboňa leg., J. Ježek det., coll. NMPC.

Distribution. Circumtropical and circumsubtropical species. In Europe recorded from Belgium, Canary Islands, Czech Republic, France, Germany, Greece, Italy (incl. Sardinia), Madeira, the Netherlands, Slovakia, Slovenia and Spain (Ježek & Goutner 1995, Werner 1997, Boumans 2009, Boumans et al. 2009, Wagner 2011, Ježek et al. 2012, Oboňa & Ježek 2012). Invasive, often synanthropic species.

Lepiseodina tristis (Meigen, 1830)

Material examined. Slovakia occ., Prievidza district, Vrbany env., Diviacka Nová Ves, Rudnianska kotlina basin, 7277, **site 1:** 9.iv.2012, LR, 1 ♂; 2.v.2012, LR, 2 ♂♂; 8.v.2012, LR,



Fig. 1. Sampled site 1, oak water-filled tree hole.
Obr. 1. Vzorkovaná lokalita 1, dendrotelma na dube.



Fig. 2. Reared specimen of *Lepiseodina tristis* (Meigen, 1830), habitus (9.v.2012, from oak water-filled tree hole, site 1).
Obr. 2. Dochovaný jedinec *Lepiseodina tristis* (Meigen, 1830), habitus (9.V.2012, z dubovej dendrotelmy, lokalita 1).

1 ♂ 1 ♀; 9.v.2012, LR, 1 ♂ (Figure 2); 22.v.2012, LR, 1 ♀; 29.v.2012, LR, 1 ♂; 1.vi.2012, LR, 1 ♀; 12.vi.2012, LR, 1 ♀; 7.ix.2012, LR, 1 ♀, all from oak tree holes, 30.viii.2012, LR, 1 ♀; 5.ix.2012, LR, 1 ♂, both from birch tree holes; Diviacka Nová Ves, Strážovské vrchy hills, 7276, **site 2**: 8.v.2012, LR, 1 ♀; 17.v.2012, LR, 1 ♂, both from beech tree holes, 24.viii.2012, LR, 2 ♀♀; 25.viii.2012, LR, 1 ♂ 1 ♀; 27.viii.2012, LR, 1 ♀, all from elm tree hole; Diviacka Nová Ves, Strážovské vrchy hills, 7276, **site 3**: 21.viii.2012, LR, 1 ♂, maple tree hole, 19.viii.2012, LR, 1 ♀; 23.viii.2012, LR, 2 ♀♀; 8.ix.2012, LR, 2 ♀♀, all from cherry tree hole; all J. Oboňa leg., J. Ježek det.; all coll. NMPC.

Distribution. Austria, Belgium, Britain, Czech Republic, France (incl. Corsica), Germany and Ireland (Ježek 2009, Wagner 2011). **New species for the fauna of Slovakia.**

Sciria advena (Eaton, 1893)

Material examined. Slovakia occ., Prievidza district, Diviacka Nová Ves, Strážovské vrchy hills, 7276, **site 2**: 2.v.2012, LR, elm tree hole, 2 ♂♂; Vrbany env., Diviacka Nová Ves, Rudnianska kotlina basin, 7277, **site 1**: 19.v.2012, SW, 1 ♂, J. Oboňa leg., J. Ježek det.; all coll. NMPC.

Distribution. Czech Republic, Germany, Great Britain and Ireland (Ježek 2009, Wagner 2011). **New species for the fauna of Slovakia.**

Psychodini

Psychodocha cinerea (Banks, 1894)

Material examined. Slovakia occ., Prievidza district, Vrbany env., Diviacka Nová Ves, Rudnianska kotlina basin, 7277, **site 1**: 3.ix.2012, IS, oak tree holes, 1 ♂ 3 ♀♀, J. Oboňa leg., J. Ježek det., coll. NMPC. Diviacka Nová Ves, Strážovské vrchy hills, 7276, **site 3**: 15.v.2011, LR, apple tree hole, 4 ♂♂ 1 ♀, J. Oboňa leg., G. Kvifte det. et coll.

Distribution. Austria, Azores, Belgium, Bosnia and Herzegovina, Bulgaria, Canary Islands, Cyprus, Czech Republic, Denmark, Finland, France, Germany, Great Britain, Greece, Hungary, Ireland, Italy (incl. Sardinia), Madeira, the Netherlands, Norway, Poland, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland and Turkey (Ježek & Yağci 2005, Krek 1985, Wagner 2011). Cosmopolitan synanthropic species.

Psychodula minuta (Banks, 1894)

Material examined. Slovakia occ., Prievidza district, Vrbany env., Diviacka Nová Ves, Rudnianska kotlina basin, 7277, **site 1**: 25.v.2012, YPT, oak tree hole, 1 ♀; Diviacka Nová Ves, Strážovské vrchy hills, 7276, **site 3**: 25.v.2012, YPT, maple tree hole, 1 ♀, J. Oboňa leg., J. Ježek det., coll. NMPC.

Distribution. Holarctic species, in Europe recorded from Austria, Belgium, Britain, Bulgaria, Cyprus, Czech Republic, Denmark, France, Germany, Greece, Hungary, Ireland, Italy (incl. Sardinia), Madeira, the Netherlands, Norway, Romania, Slovakia, Slovenia, Spain (incl. Balearic Islands) and Switzerland (Wagner 2011).

DISCUSSION

The fauna associated with water-filled tree holes (dendroctelmata) including the family Psychodidae, has been poorly known in Europe. Though adults of non-biting moth flies from this

habitat are quite well known (see Table 1), identification of the immature stages remains quite difficult (see e.g. Krivosheina & Mamaev 1967). In order to get a reliable identification, it is therefore recommended to rear larvae to the adult stage (e.g. Vaillant 1989). Four methods of sampling (Table 2) were used in our study, but only the rearing method provided satisfactory results. The lack of knowledge of dendrolimnetic moth flies may be a direct result of the use of inappropriate sampling methods e.g. Diestelhorst & Lunau (2001). Standard yellow pan traps are ineffective for trapping tree hole inhabitants. Many specialized tree hole inhabitants appear to be active mainly late in the afternoon, early in the morning and the evening (e.g. Speight 1987, Klausnitzer 2009, Oboňa & Starý 2013), therefore conventional sampling methods are apparently ineffective. As shown by the present study, only the rearing method is satisfactory for obtaining tree hole non-biting moth flies (see also in Feuerborn 1922, 1923; Mayer 1938; Jung 1956; Mirouse & Vaillant 1960; Vaillant 1989, 1990). This may be in part a result of atypical activity of dendrolimnetic psychodids. Therefore, it is necessary to design and test new improved trapping methods.

From the above recorded moth flies, only *Lepiseodina tristis* and *Sciria advena* can be included in the group of species associated with dendrotelmata (Vaillant 1989). These psychodids hibernate in tree holes as larvae or eggs, as shown by the numbers of immature stages recorded during the winter months. *Lepiseodina tristis* was present in all of the sampled tree species, except apple tree (Table 3). The other non-biting moth flies probably occupy this habitat periodically, but are not able to survive for an entire season. Every extreme variation event in this environment may cause immediate death of non-specialized Psychodidae, especially their immature stages. *Clogmia albipunctata* (Williston, 1893), *Psychodocha cinerea* Banks, 1894 and *Psychodula minuta* Banks, 1894 recorded in our study are classified as dendrolimnetophiles or dendrolimnetoxenes. These species, and e.g. also *Tinearia alternata* (Say, 1824), are able to colonize this environment (Vaillant 1989), but not to survive long-term (e.g. Röhner 1950, Kitching 2004). *Lepiseodina rothschildi* (Eaton, 1912) is known to be a tree holes inhabitant, but, although suspected, its occurrence in Slovakia was not confirmed in this work.

The water-filled tree hole ecosystem can be considered as an ecotone, representing the aquatic, terrestrial and wood ecosystems (Oboňa & Svitok 2012). Thus, presence of some aquatic or terrestrial species, e.g. *Pneumia trivialis* (Eaton, 1893) in water-filled tree holes is possible (cf. Vaillant 1989), but their occurrence is rather more incidental than regular and their long term survival in this type of habitat is unlikely.

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SÚHRN

Fauna kútoviek (Diptera: Psychodidae), ktoré boli zaznamenané v dendrotelmách (vodou naplnených dutinách stromov) zo Slovenska, je po prvýkrát zdokumentovaná. Nové záznamy 2 druhov, *Lepiseodina tristis* (Meigen, 1830) a *Sciria advena* (Eaton, 1893), sú prezentované. Celkový počet druhov čeľade Psychodidae sa s vyššie uvedenými prvonáležmi pre Slovensko zvyšuje zo 101 na 103 druhy. Európska fauna kútoviek dendroteliem, ako aj vhodnosť odchytových metód, je v krátkosti diskutovaná. Dendrotelmy, ako pomerne časté ale prehliadané ekosystémy, skrývajú ešte nesporné veľa zaujímavých druhov bezstavovcov (nie len kútoviek, ale i mnoho iných čeľadí dvojkrídlovcov (Diptera)) a je len otázkou času, kedy budú zaznamenané.

Table 1. Review of Psychodidae species recorded in European water-filled tree holes.
Tabuľka 1. Prehľad druhov čeladových Psychodidae zaznamenaných v európskych dendroelmach.

| species / druh | original or often used combinations of names / pôvodné alebo často používané kombinácie názovov | mentioned in papers / uvádzané v publikáciách |
|---|--|--|
| <i>Trichomyia urbica</i> Curtis, 1839 | <i>Trichomyia urbica</i> Haliday, 1839 in Curtis (1839) | Curtis (1839), Withers (1989a,b) |
| <i>Clogmia albipunctata</i> (Williston, 1893) | <i>Psychoda albipunctata</i> Williston, 1893 | Vaillant (1989), Ježek et al. (2012) |
| <i>Lepiseodina rothschildi</i> (Eaton, 1912) | <i>Clogmia rothschildi</i> (Eaton, 1912) | Jung (1956), Vaillant (1989) |
| <i>Telmatoscopus rothschildi</i> Eaton, 1912 | <i>Telmatoscopus rothschildi</i> Eaton, 1912 | |
| <i>Clogmia tristis</i> (Meigen, 1830) | <i>Clogmia tristis</i> (Meigen, 1830) | Thienemann (1934), Röhner (1950), Mironov & Vaillant (1960), Vaillant (1989) |
| | * <i>Pericomafagicavatica</i> Feuerborn, 1922 | |
| | <i>Psychoda tristis</i> Meigen, 1830, | |
| <i>Paramormia (Phyllotelmatoscopus) acuta</i> (Krek, 1971) | <i>Duckhousiella acuta</i> Krek, 1971 | Vaillant (1989) |
| <i>Sciria achena</i> (Eaton, 1893) | <i>Pericomaadhena</i> Eaton, 1893 | Vaillant (1989) |
| | <i>Telmatoscopus advenus</i> (Eaton, 1893) | |
| <i>Sciria seguyi</i> (Vaillant, 1990) | <i>Telmatoscopus seguyi</i> Vaillant, 1990 | Vaillant (1990) |
| <i>Telmatoscopus laurencei</i> Freeman, 1953 | <i>Telmatoscopus laurencei</i> Freeman, 1953 | Vaillant (1989) |
| <i>Psychodocha cinerea</i> (Banks, 1894) | <i>Psychoda cinerea</i> Banks, 1894 | Vaillant (1989) |
| <i>Tinearia alternata</i> (Say, 1824) | <i>Psychoda alternata</i> Say, 1824 | Vaillant (1989) |
| <i>Chlytocerus (Boreocytiocerus) xylophyllus</i> Vaillant, 1983 | <i>Chlytocerus xylophyllus</i> Vaillant, 1983 | Vaillant (1989) |
| <i>Pneumia canescens</i> (Meigen, 1804) | <i>Psychoda canescens</i> Meigen, 1804 | Mayer (1938) |
| <i>Pneumia trivialis</i> (Eaton, 1893) | <i>Satchelliella canescens</i> (Meigen, 1804) <i>Pericomatrivialis</i> Eaton, 1893 | Vaillant (1989) |
| | <i>Satchelliella trivialis</i> (Eaton, 1893) | |

* *Pericomafagicavatica* Feuerborn, 1922 is probably a synonym of *Lepiseodina tristis* (Meigen, 1830); the ends of the male antenna fully match with Fig. 1, p. 21 in the original description, however, the type material is apparently lost.

* *Pericomafagicavatica* Feuerborn, 1922 je pravdepodobne synonymum *Lepiseodina tristis* (Meigen, 1830); koniec samičieho tykadia plne zodpovedá s obr. 1, na strane 21 v originálnej práci, avšak, typový exemplár sa pravdepodobne stratil.

Table 2. Psychodidae specimens collected in our study (2011–2012) by different sampling methods (numbers indicate number of individuals recorded). IS = individual sampling; YPT = yellow pan traps; LR = larval rearing; SW = sweeping.

Tabuľka 2. Psychodidae vzorky zozbierané v tejto práci (2011–2012) podľa rôznych metód odchytu (číslo udáva počet zaznamenaných jedincov). IS = individuálny odchyt; YPT = žlté misky; LR = chov lariev; SW = smýkanie.

| Species / Collecting method | IS | YPT | LR | SW |
|-----------------------------|----|-----|----|----|
| <i>Clogmia albipunctata</i> | 2 | | | |
| <i>Lepiseodina tristis</i> | | | 26 | |
| <i>Sciria advena</i> | | | 2 | 1 |
| <i>Psychodocha cinerea</i> | 4 | | 5 | |
| <i>Psychodula minuta</i> | | 2 | | |

Table 3. Psychodidae specimens collected in Slovakia (2011–2012) and separated per studied tree holes. AP = apple tree; BE = beech; BI = birch; EL = elm; CH = cherry tree; MA = maple; OA = oak.

Tabuľka 3. Psychodidae vzorky zbierané zo Slovenska (2011–2012) a rozdelené podľa skúmaných dendroliem. AP = jabloň; BE = buk; BI = breza; EL = brest; CH = čerešňa; MA = javor; OA = dub.

| Species / Sampled tree holes | AP | BE | BI | EL | CH | MA | OA |
|------------------------------|----|----|----|----|----|----|----|
| <i>Clogmia albipunctata</i> | | | | | | | 2 |
| <i>Lepiseodina tristis</i> | 2 | 2 | 5 | 5 | 1 | 11 | |
| <i>Sciria advena</i> | | | | 2 | | | |
| <i>Psychodocha cinerea</i> | 5 | | | | | | 4 |
| <i>Psychodula minuta</i> | | | | | 1 | 1 | |