Catching of spiders in shallow subterranean habitats in the Czech Republic

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Abstract. Spiders occurring in soils and fissured rocks were investigated using pipe traps. Four microphthalmic species, namely Hahnia microphthalmus, Porhamma egeria, P. microps and P. cambridgei were collected. Hahnia microphthalmus is reported from the Czech Republic for the first time. The importance of collecting material by complex pipe traps (consisting of a perforated pipe and a set of removable cups) to record the depth distribution of spiders in subterranean habitats is stressed. The importance of the soil and fissure network formed by sandy marlrite bedrock and of alluvial soils for the life of subterranean spiders is documented.

Keywords: alluvial soil, microphthalmalmy, pipe traps, sandy marlrite, troglomorphism

For humans, caves are more accessible than other subterranean habitats. Much of what we know about subterranean biology comes from the study of caves, partly because of the adventure and excitement of visiting and exploring caves, which are certainly more exciting than visiting, for example, talus slopes (Culver & Pipan 2009). Terrestrial shallow subterranean habitats are formed in soil, rock mantled, with holes of 7 cm. Many small holes (5-7 mm diameter) are drilled along its surface, and a bottle containing preservation fluid (and bait) is lowered inside on a nylon cord. The pipes are installed vertically into holes in a suitable terrain. This kind of trap is a modification of a similar pipe used by Gers (1992). Barranco et al. (2013), Ortuño et al. (2013) and Jiménez-Valverde et al. (2015) used such traps to investigate invertebrates in stony slopes and river deposits in continental Spain; Nitzu et al. (2014) used a similar trap in Romania.

Schlick-Steiner & Steiner (2000) constructed a trap consisting of a perforated pipe and a set of removable plastic cups situated on a central-thread metal axis. Through this arrangement, the cups collect animals entering the tube through holes at particular depths. Using these complex pipe traps (with a length of 95 cm), Laška et al. (2011) studied the distribution of spiders in soil profiles and Rendoš et al. (2012) studied the distribution of invertebrates in limestone scree slopes. The design of perforation varies from a horizontal line of holes, to a network of holes up to horizontal cuttings accompanied by holes (Fig. 1a–c). The aim of this present study was to test the performance of pipe traps in soils and crevice systems.

Material and methods

Sampling. Six pipe traps (one per site) were deployed from 2013 to 2015, and were emptied twice a year. The plastic pipes have an inner diameter of 7 cm, and are perforated with a system of oblique cuts 5 mm wide (Fig. 1d). This design has been registered at the Czech Industrial Property Office under No. 36420. Plastic cups were mounted onto a metal-thread rod at...
10 cm distances and contained a mixture of 7% formalin and 5% glycerol, plus a few drops of detergent (Růžička 1988b). In the final version, we used plastic or brass components to avoid damage to material caused by rust. We installed these traps in excavated trenches in sandy marlite terrains, or in boreholes (15 cm in diameter) in lowland forests, the deepest reaching 160 cm below the surface. The free space around the trap was filled by excavated material or – in the case of boreholes – by a mixture of excavated material and artificial rubble (Keramzit) or starch-based packing peanuts.

Study sites. Traps were installed in sandy (arenaceous) marlite (SM) terrains, and in alluvial soils in lowland forests (AS) (Figs 2a–f).

SM-1. Jenišovice-Mravín (49.9446°N, 16.0522°E, 335 m a.s.l.). On the upper margin of a sandy marlite slope at the border between a deciduous forest and a lucerne field: 0–60 cm stony soil, 60–100 cm fissured rock (Fig. 2a). The pipe with ten cups at a depth of 10–100 cm operated from 25 October 2013 to 29 September 2015. The spider assemblage of adjacent open habitats was studied by Dolanský (2002).
SM-2. The same locality as SM-1, 50 m apart (49.9445°N, 16.0516°E, 315 m a.s.l.), at the lower margin of a sandy marlite slope covered by deciduous forest (Fig. 2b). The whole profile studied consisted of a clay soil. The pipe with nine cups at a depth of 40–120 cm operated from 25 October 2013 to 29 September 2015.

SM-3. Kourov (50.2320°N, 13.6899°E, 515 m a.s.l.). Mixed forest on a sandy marlrite table hill, 15 m from a quarry wall: 0–70 cm stony soil, 70–140 cm fissured rock (Fig. 2c). The pipe with 14 cups at a depth of 10–140 cm operated from 1 November 2013 to 25 September 2015.

AS-1. Lednice (48.7867°N, 16.4848°E, 170 m a.s.l.). Lowland forest with rich herb and shrub vegetation (Fig. 2d): 0–90 cm clay soil. Fluctuating water table. The pipe with nine cups at a depth of 10–90 cm operated from 29 June 2014 to 17 May 2015.

AS-2. Znojmo (48.8466°N, 16.1033°E, 220 m a.s.l.). Lowland forest with rich herb and shrub vegetation (Fig. 2e): 0–70 cm sandy soil. The pipe with seven cups at a depth of 10–70 cm operated from 20 August 2014 to 11 May 2015.

AS-3. Pardubice (50.0458°N, 15.7727°E, 220 m a.s.l.). Lowland forest with rich herb and shrub vegetation (Fig. 2f): 0–60 cm alluvial soil, 60–160 cm sand. The pipe with 16 cups at a depth of 10–160 cm operated from 15 May 2014 to 23 September 2015.

Results and discussion

Spiders

In total, we captured 335 spider specimens belonging to 32 species (Appendix): 155 spiders belonging to 20 species at site SM-1 (Tab. 1), 44 belonging to 10 species at site SM-2 (Tab. 2), 118 belonging to 12 species at site SM-3 (Tab. 3), 7 belonging to 3 species at site AS-2 (Tab. 4), and 7 belonging to 3 species at site AS-3 (Tab. 5). Spiders were recorded down to a depth of 120 cm. Cicurina cicur was the most abundant species. Species that were clearly tied to surface habitats (e.g., *Agroeca cuprea*) were usually recorded only a few tens of centimetres deep. Some individual records can be considered as accidental, e.g., the record of *Linyphia hortensis* at a depth of 110 cm, due to the fact that it is a typical shrub layer inhabitant (*Buchar & Růžička* 2002). *Cicurina cicur*, *Mixoena blanda*, *Palliduphantes pallidus*, *P . alutacius* and *Syedra myrmicarum* were depigmented with reduced eyes and were clearly adapted to life in subterranean habitats. These species represent objects of our special interest.

**Habnia microphthalmalma**

Material: Jenišovice–Mravín (SM-2), 25 October 2013–18 April 2014 1♂; 28 April–29 September 2015, 1♂. This species is reported for the first time from the CZECH REPUBLIC. Posterior median eyes reduced (Fig. 3a). *Szita et al.* (1998) and *Hänggi & Staubi* (2012) found various stages of eye reduction in their material, and also differences in the form of the translucent copulatory ducts. The picture of the copulatory ducts of the epigyne of our specimens is in agreement with that of the type specimen (Fig. 3b; cf. *Snazell & Duffy* 1980: Fig. 3).

*Snazell & Duffy* (1980) described the species according to two records from Great Britain. *Hänggi & Staubi* (2012) summarized other records: three in Germany, one in Switzerland, and one in Hungary (Fig. 4). British specimens were collected in chalk grassland and in a field with a clay soil over-
lying chalk. Records in Germany were situated on sandstone and limestone bedrock (Sührig et al. 1998). The Hungarian locality was situated in an old field on loess (Szita et al. 1998).

All previous specimens were collected on the surface by pitfall traps, photoelectors or by sweeping. Snazell & Duffey (1980) conclude that some of the characteristics of the spider suggest a subterranean habitat. We document for the first time that *H. microphthalma* inhabits the soil at a depth of about 50-70 cm.

**Porrhomma cambridgei**


Pickard-Cambridge (1871) noted that the species "*Linyphia oblonga*" is characterized by "eyes very small". Based on the vulva structure, Millidge & Locket (1952) synonymized this microphthalmic form with *Porrhomma oblitum* (O. P.-Cambridge, 1871). Finally, Merrett (1994) removed it from synonymy with *P. oblitum* and revalidated it as a separate species *P. cambridgei* Merrett, 1994. It is clearly characterized by femora I and II without dorsal spines, a cephalothorax width < 0.58 mm, and reduced eyes. It has been recorded from Great Britain, Germany, Switzerland, northern Italy and the Czech Republic (Thaler et al. 2003).

We and Růžička et al. (2011, sub. *P. aff. myops*) captured this species in sandy marlite terrain and in alluvial soils at a depth of 35–120 cm. Thaler et al. (2003) collected this species on tree bark in the Bohemian Karst and we also obtained several specimens from conglomerate terrain and from karst caves.

**Porrhomma egeria**


**Concluding remarks**

The importance of shallow subterranean habitats for the evolution of subterranean life is well known (Růžička 1999, Gia-chino & Vailati 2010, Růžička et al. 2013, Culver & Pipan 2011).
2014) and has been repeatedly documented in recent years. Using pipe traps, Deltshev et al. (2011) collected spiders in soils down to the depth of 80 cm in the Bulgarian mountains. Zanberella relicta (Kratiochv, 1935), described from a cave in Montenegro, was recorded, which represents the first record of the family Anapidae in Bulgaria. Gilgado et al. (2015) collected the troglobal millipede Typhlopsychrosoma baeticaense (Mauriès, 2013), known from caves, in mountain scree and concluded that some subterranean species might have surprisingly wide distribution areas, and that study of shallow subterranean habitats will surely improve our knowledge on subterranean biodiversity.

There is a wide spectrum of sedimentary rocks containing variable amounts of clay and silt designated as marl or marl-rite. Their properties depend on mineralogical composition and diagenesis. In the Alicante region (Spain), the marl offers no suitable instances for a subterranean fauna, and marl layers constitute physical barriers to the movement of subterranean animals (Ortuño et al. 2013, Gilgado et al. 2015). On the other hand, in the Czech Republic, the indurated sandy marlrite forms a fissure network. This fissure network, together with soils originating from this bedrock, constitutes a subterranean habitat that seems to be very suitable for the subterranean fauna, according to our findings.

In subterranean biology, there is a common idea that alluvial plains are barriers to subterranean faunas, and that they do not have suitable spaces (Uéno 1987). However, this depends on the size of the sand and gravel grains. Christian (1998) recorded a subterranean palpigrade Eukoenenia austriaca (Hansen, 1926) (usually found in caves) in the bottom substrate of the tombs of St. Stephen's Cathedral in Vienna. These catacombs were dug down to the Pleistocene gravel of the Danube river. Gilgado & Ortuño (2015) recorded a subterranean zygentomid Coelotinia maggi (Grassi, 1887) (usually found in surface habitats, ant nests and caves) in a subsoil gravel layer in an alluvial plain in northern Spain. We collected subterranean spiders in three different alluvial plains. These findings suggest the possibility that alluvial deposits might represent 'connectors' between other subterranean habitats, at least for some subterranean animals. Moreover, in the locality AS-1, we collected not only the subterranean spider Portobonna cambridgei at a depth of 30–80 cm, but also a pale subterranean Niphargus sp. at a depth of 0–90 cm. Crustaceans thus migrated into soil horizons from shallow aquatic interstitial habitats at the time of flooding.

The modified space around the pipe can represent an artificial corridor through which invertebrates can migrate in a vertical direction. Nevertheless, the vertical distributions of spiders are clearly species-specific as also documented by Laika et al. (2011). In both cases of the common occurrence of P. microps and P. cambridgei (our site SM-2 and Růžička et al. 2011), the smaller species P. cambridgei occupies deeper soil horizons.

On the other hand, the soil structure is destroyed during installation of the traps, and fine crevices are closed. The reconstruction of the network of voids can take several years, as we infer by the catching of the first adults of P. egeria after two years of investigation.

Finally, we would like to recommend the use of complex pipe traps, which enables precise documentation of the depth distribution of species. We would like to emphasize that to document the occurrence of troglobal invertebrates, data on the subterranean habitat (not only data on surface habitat, e.g. plant associations) are important.

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