Terrestrial isopods (Isopoda: Oniscidea) in and near the Zbrašov Aragonit Caves (Czech Republic)

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Abstract

Terrestrial isopod assemblages were studied in the Zbrašov Aragonit Caves National Nature Monument and in adjacent above-ground habitats, namely soil and stony debris as potential donor habitats for cave colonisation. In total, 15 species of terrestrial isopods were recorded. Only four of them were found in the caves. *Trachelipus rathkii* and *Armadillidium versicolor* represented trogloxenous species, the troglophilous *Cylisticus convexus* was the main inhabitant of debris, and *Androniscus dentiger* can be characterised as troglobiotic for the given cave system.

Keywords – *Androniscus dentiger*, MSS, stony debris, subterranean traps

Introduction

Caves are temporarily or permanently colonised by various invertebrate animals that generally inhabit above-ground soil and litter habitats. According to their affinity to life in caves, they are classified into three groups: troglobiotic species live strictly in caves, troglophilous species inhabit caves frequently but can also live outside the underground systems, and trogloxenous species are found only occasionally in caves but are not able to create vital populations there. The hotspots of biodiversity of troglobiotic species, including terrestrial isopods, in Europe are the south-western and south-eastern karst regions, in particular in France and the Balkan Peninsula (Slovenia) (Culver *et al.*, 2006).

Besides gradual dechitinization, depigmentation and loss of eyes, cave species of most arthropod groups are characterised by longer legs and longer setae. Endogeic species are typically smaller with shorter legs, antennae and setae (Ducarme *et al.*, 2004a). The origin of troglobionts is not well understood. It is supposed that they can spread along the MSS (*milieu souterrain superficiel*; Juberthie & Delay, 1981). Gentile and Sbordoni (1998) used genetic methods to study fluxes between soil and caves populations of the terrestrial isopod *Androniscus dentiger*. Results showed a high level of isolation of individual populations. Similarly, Ducarme *et al.* (2004b) assumed that endogeic and cave communities of mites were too dissimilar to suggest frequent migration.

Already a preliminary biospeleological survey of the Zbrašov Aragonit Caves National Nature Monument (the Hranice Karst system, NE Moravia, Czech Republic, 49°31´56´´N, 17°44´49´´E), a unique cave system with high mean temperatures of 14-16°C and high concentration of CO_2 in the lower corridor strata, showed that these caves are rich in invertebrate assemblages including frequent occurrence of terrestrial isopods. For a more complex evaluation of terrestrial isopod assemblages, and to shed light on the possibility of cave colonization by isopods from surrounding MSS (and vice-versa) and other above-ground habitats, the species composition of isopod assemblages in the Zbrašov Aragonit Caves, on surface areas nearby the cave openings and in different depths in stony debris above the cave system were investigated.

Material and Methods

Cave dwelling invertebrates were studied using pitfall trapping and hand sampling intensively in the years 2002-2003. To assess possible sources of cave colonization by epigeic assemblages, 6 pitfall traps were

Table 1. Vertical distribution of terrestrial isopods (numbers of individuals) based on the collected material in neighbouring surfaces, stony debris and the Zbrašov Aragonit Caves.

	Ligidium hypnorum (Cuvier, 1792)	*Androniscus dentiger* Verhoeff, 1908	*Androniscus roseus* (C.L. Koch, 1838)	*Hyloniscus riparius* (C.L. Koch, 1838)	*Trichoniscus pusillus* Brandt, 1833	*Haplophthalmus danicus* Budde-Lund, 1880	*Platyarthrus hoffmannseggii* Brandt, 1833	*Cylisticus convexus* (De Geer, 1778)	*Porcellium collicola* (Verhoeff, 19907)	*Protracheoniscus politus* (C.L. Koch, 1841)	*Trachelipus rathkii* (Brandt, 1833)	*Trachelipus ratzeburgii* (Brandt, 1833)	*Porcellio scaber* Latreille, 1804	*Armadillidium versicolor* Stein, 1859	*Armadillidium vulgare* (Latreille, 1804)
Above-ground (surface habitats)															
pitfall trapping	61	-	2	70	111	1	-	2	37	165	1	6	-	-	96
hand sampling	-	2	-	10	16	8	1	6	-	6	-	-	1	2	17
Stony debris															
30 cm depth (traps)	-	-	-	4	-	104	-	286	-	-	-	-	-	-	11
subterranean traps															
depth 5 cm	-	-	-	1	-	-	-	62	-	-	-	-	-	-	3
depth 15 cm	-	-	-	4	-	-	-	105	-	-	-	-	-	-	1
depth 25 cm	-	-	-	-	-	-	-	193	-	-	-	-	-	-	2
depth 35 cm	-	-	1	1	-	-	-	137	-	-	-	-	-	-	-
depth 45 cm	-	-	-	1	-	2	-	68	-	-	-	-	-	-	2
depth 55 cm	-	-	-	-	-	-	-	54	-	-	-	-	-	-	-
depth 65 cm	-	-	-	-	-	-	-	35	-	-	-	-	-	-	-
depth 75 cm	-	-	-	-	-	-	-	36	-	-	-	-	-	-	1
depth 85 cm	-	-	-	-	-	-	-	71	-	-	-	-	-	-	-
depth 95 cm	-	-	-	-	-	1	-	283	-	-	-	-	-	-	-
Caves (traps and hand sampling)	-	511	-	-	-	-	-	65	-	-	1	-	-	2	-
Total	61	513	3	94	127	146	1	1664	37	171	2	6	1	4	143

exposed for 15 months in 2004-2005 in habitats nearby the cave bore and in two other sites, where the cave system evidently communicates with the surface. Additionally, terrestrial isopods were individually sampled by hand from the surface habitats above the caves and nearby the cave entrances. Because debris are often typical biotopes above the caves, connecting the above-ground soil strata and MSS with below-ground habitats, three pitfall traps were dug into the soil-debris profile (ca 30 cm) for 15 months in 2004-2005 and repeatedly sampled. In 2005, three special subterranean deep traps (Schlick-Steiner & Steiner, 2000) were used for catching invertebrates that inhabit deeper soil and debris layers. These traps caught invertebrates every 10 cm from 5 cm to the depth of 95 cm.

Results and Discussion

In total, 15 species of terrestrial isopods were found in above-ground, debris and cave habitats (Table 1). Isopod assemblages differed between above-cave sites, with *Protracheoniscus politus*, *Trichoniscus pusillus*, *Armadillidium vulgare*, *Hyloniscus riparius*, and *Ligidium hypnorum* predominating. Among these five species, *Cylisticus convexus* was very abundant in debris at all depths but particularly so at 95 cm

(Table 1). *Haplophthalmus danicus*, otherwise rare in upper soil and litter strata, was also very abundant at 30 cm depth. Caves were colonised by only four isopod species. Two of them, *Armadillidium versicolor* and *Trachelipus rathkii*, were found closest to the cave openings only; they evidently represent trogloxenous species. *Armadillidium versicolor* was typified as chazmatophilous species (inhabiting cave openings) in Slovak caves, too (Gulička, 1985; Mock *et al.*, 2004). *Cylisticus convexus* was frequently found over the entire cave system; it should be considered troglophilous. This finding is in accordance with Vandel (1962), who reported about its distribution in caves and subterranean environment. Frankenberger (1940) found one animal with weaker pigmentation and less ommatidia, too. *Androniscus dentiger* was widely distributed in all parts of the studied cave system, and was represented by both sexes and ovigerous females. Except for two specimens, sampled individually at the cave bore, this species was missing from above-ground and debris sites. Therefore, *A. dentiger* is troglobiotic species for the given cave system. *A. dentiger* is generally considered a troglophilous species, distributed mainly in caves of the Mediterranean and frequently recorded in synanthropic habitats (including greenhouses) throughout Europe, North Africa and North America (e.g., Schmalfuss, 2003; Meyer, 1996). As the previous records of this species in the former Czechoslovakia come exclusively from greenhouses (Flasarová & Flasar, 1965), the permanent population found in the Zbrašov Aragonit Caves represents the first record in a natural environment. Recently, *A. dentiger* was found in a Slovakian cave (Mock & Papáč, 2007).

The population of *A. dentiger* in the Zbrašov Aragonit Caves seems to be isolated, just as Italian cave populations are genetically isolated from epigeic ones (Gentile & Sbordoni, 1998). No evidence on migration of this species between cave system and MSS is available. It is evident that a classification with respect to the affinity to caves is better suited for the population rather than the species level. Epigeic and troglobiotic populations are known in *T. pusillus*, too (Cobolli Sbordoni *et al.*, 1997).

The presence of *C. convexus* in both debris and caves suggests that this species is able to colonise and inhabit subterranean systems continually from MSS down to caves. According to its long antennae, uropods and legs (c.f. Ducarme *et al.*, 2004a), *C. convexus* should be considered a cave-dweller rather than a soil-dweller. Morphology and body size of *A. dentiger* can be considered adaptations to the cave environment, too, as *A. dentiger* is bigger than the sympatric congener *Androniscus roseus* inhabiting the upper soil layers.

Low numbers of troglobiotic isopod species are characteristic for most of European caves. Gulička (1985) found 22 species of terrestrial isopods in the Western Carpathians, with only one troglobiotic species (*Mesoniscus graniger*). Among 9 species of woodlice recorded from Eastern Rhodope caves, only 2 were troglobiotic (Beron *et al.*, 2004). Caruso (1982) found 30 species of terrestrial isopods in the caves of Sicily including only 6 troglobionts; each of them was recorded in another cave. Eighteen caves with the highest numbers of troglobiotic species worldwide harbour 0-4 troglobiotic terrestrial isopods (Culver & Sket, 2000). Similarly low numbers of troglobiotic species of terrestrial isopods (1-2) are known from both Ukrainian (Vargovich, 2004) and North American (Schultz, 1970) caves, too.

The presence of troglobiotic populations of *A. dentiger* in the Zbrašov Aragonit Caves represents its northernmost occurrence in natural habitats in Central Europe, probably made possible by more favourable conditions than in other caves of this latitude (e.g., higher temperature with less fluctuations). This finding may prove significant with respect to both faunistics and the evolution of the European cave and soil invertebrate fauna.

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