Terrestrial arthropods inhabiting caves near Veľký Folkmar (Čierna hora Mts., Slovakia)

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The six most important caves in the surrounding of the Veľký Folkmar village, the Márnica Cave, the Predná veľká Cave, the Klenbová Cave, the Nová galéria Cave, the Cave Hoľa I, and the Zelená puklinová cave, were investigated for terrestrial arthropods during 2002. Invertebrates were collected by three types of pitfall traps differing in fixation solution (ethylalcohol, formaldehyde, ethylenglycol/beer; with exposition from March to June), by individual hand sampling (March - October) and by heat extraction of baits or organic materials. More then 1500 individuals of mites, pseudoscorpions, spiders, harvestmen, isopods, millipedes and centipedes were obtained and determined. The mites (especially Gamasida with 1062 individuals and 13 spp.) were the most abundant and diverse group. Spiders were also very rich in number of species (17 spp.). The mites *Archipteria coleoptrata, Belba clavigera, Damaeus gracillipes*, *Damaeus* cf. *tecticola, Oribellopsis cavatica, Liacarus subterraneus, Oribella* cf. *forsslundi* (Oribatida), *Parasitus loricatus* and *Uroobovella advena* (Gamasida), the spiders *Meta menardi, Metellina merianae, Porrhomma convexum*, and *P. egeria*, the opilionid *Mitostoma chrysomelas*, and the millipede *Trachysphaera costata* may be regarded as cavernicolous (eutroglophilous). The other species (Hexapoda excluded) are characterised as dwellers of forest soils and litter and penetrated into subterranean spaces more or less occasionally. The results showed that also the caves within a small karstic region can be inhabited by peculiar faunas which are worthy to study and to protect.

Keywords: Čierna hora Mts., cave fauna, eastern Slovakia, Arachnida, Oniscidea, Diplopoda, Chilopoda.

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Introduction

The geomorphologic unit Čierna hora Mts. is situated along the Hornád river, west from the town of Košice (East Slovakia) and belongs to the crystalic Western Carpathians. More then 61 caves and cavities are known from this area (Bella and Holúbek, 1999). However, the majority of them are short corridors or spaces. Preliminary investigations indicated a remarkable subsurface fauna.

Roubal (1929) published the first data on the cave fauna from this area. He found here and described the new cavernicolous carabid beetle *Duvalius machulkai*, later synonymised as *Duvalius bokori valyianus* (Bokor, 1922). Intensive research on arthropods in the most important caves in the Čierna hora Mts. started in 1997 and the results have been partially published. Krumpál (2000) published the occurrence of six epigeic species of pseudoscorpions, both at the entrances and in inner parts of some caves. The find of the palpigrade *Eukoenenia spelaea* (Peyerimhoff, 1902) in the cave Priepasťová jaskyňa pod Humencom (Kováč et al., 2002) proved, that also small caves (35 m) can be inhabited by troglobites. The cavernicolous woodlouse *Mesoniscus graniger* (Frivaldszky, 1865) was collected in four caves in the Čierna hora Mts. (Mlejnek and Ducháč, 2001, 2003). Although most of the 27 known millipede species prefered the suitable microclimate of the cave entrances of these caves (Mock, 2000b), their presence corresponded closely with the above-ground ecosystems. Three or four millipede species were classified as cavernicolous (troglophilous). Two of them were new for science (Mock, 2000b). The troglophilous fly *Bradysia forficulata* (Bezzi, 1914) was identified by Košel (2001) from the material collected in the Kysacká and Veľká ružínska caves. Košel (2000) recognized the karst of the Čierna hora Mts. as a separate zoogeographic region within the Gemer-Bükk-Spiš supraregion with very incomplete knowledge of its fauna.

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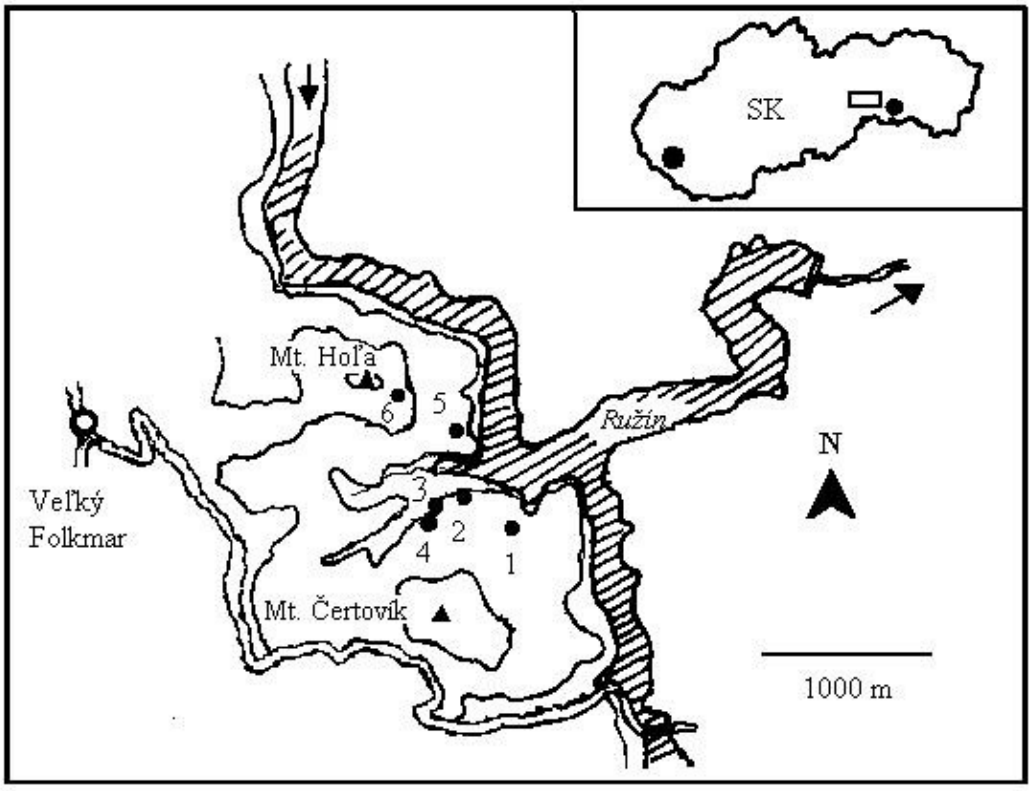

Fig. 1. Location of the caves near the village Veľký Folkmar: 1 – Márnica Cave, 2 – Predná veľká Cave, 3 – Klenbová Cave, 4 – Nová galéria Cave, 5 – Zelená puklinová Cave, 6 – Hoľa I Cave.

Inspired by these facts, we began in 2002 to study the subterranean arthropod fauna in the karst region on the right bank of the Hornád river, near the village Veľký Folkmar, up to then biospeleologically unexplored. Preliminary results regarding oribatid mites and harvestmen from these caves were already published in another papers (Ľuptáčik and Miko, 2003; Stašiov et al., 2003). In this contribution we summarize the first part of results focusing on Arthropoda, including Arachnida, Isopoda and Myriapoda.

Localities

The caves are situated in a small karstic region (2 x 0.5 km) situated between the village Veľký Folkmar and the Ružín water reservoir, in the westernmost part of the Čierna hora Mts., eastern Slovakia (Fig. 1). All 16 caves known in this area are located in the square 7192a (grid reference of the Databank of the Slovak Fauna - DFS). Most of the caves were studied by Zikmund in the years 1924-1925 and later identified and described by Erdös (1979), but these works exist only in manuscript. The entrances of all these caves are situated on the north- or east-facing slopes of the two adjacent hills, Čertovík (558.8 m a.s.l.) and Hoľa (618.4 m a.s.l.), in beech forests (*Fagetum, Acero-Fagetum*). The caves were created within the Jurassic crinoid limestone, except for the pseudocarstic Zelená puklinová Cave, representing a crack in the Palaeozoic biotitic granodiorites. There are no aquatic habitats at all of these caves. The following characteristics of the particular caves are given according to Erdös (1979), the altitudes were added by the authors:

1. Márnica Cave (48°50´52´´N, 21°03´35´´E), 48 m long, narrow entrance and horizontal passage, 340 m a.s.l.;
2. Predná veľká Cave (48°50´52´´N, 21°03´35´´E), 22 m, great entrance with vertical passages (+15 m), 400 m a. s. l.;
3. Klenbová Cave (48°50´52´´N, 21°03´35´´E), 43 m, great portal with spacious horizontal corridor, 420 m a. s. l.;
4. Nová Galéria Cave (48°50´52´´N, 21°03´35´´E), 14 m, low entrance leads into sole hall, 440 m a. s. l.;
5. Zelená puklinová Cave (48°51´03´´N, 21°03´30´´E), 20 m, fracture pseudocave, 355 m a. s. l.;
6. Cave Hoľa I. (48°51´17´´N, 21°03´00´´E), 45 m, horizontal corridor opened through two small entrances, upper entrance is in 580 m a. s. l. (this cave has been recently colonised by the badger - *Meles meles*).

Microclimatic conditions in the caves

The air temperature and relative humidity were measured during two visits, on March 22 and June 16,

2002 by a digital thermo-hygrometer. The mean temperature in the deeper parts of the caves was 8.0 ºC (range 7.1-10.1 ºC), while at the entrances it was 10.5 ºC (6.0-16.8 ºC). The mean relative humidity in the rear parts of the caves was 90.0 % (80.5-98.5 %), while outside the caves it reached 67.0 % (47.0-84.0 %).

Methods

Invertebrates were collected within the caves using three different methods:

a) Hand-collecting during the visits (IS_1 - March 22, IS_2 – June 13, and IS_3 October 14 2002).

b) Pitfall traps of three types differing by fixation solutions and by diameter of openings: ethylalcohol traps (AT) with opening 10 mm in diameter, ethylenglycol-beer traps (EBT) with 26 mm in diameter and formaldehyde traps (FT) with 67 mm in diameter; exposed in various microhabitats in the caves as from March 22 till June 13 2002. In total, 4 AT, 8 EBT and 11 FT traps were exposed.

c) Exposition of organic baits (vegetable and chicken fat) nearby the exposed traps (March 22) collected on June 13 2002 and sampling of different organic materials such as rotten wood, humus, badger and marten faeces (OM+BE). Sampled materials were extracted in a Tullgren apparatus.

The arthropods were determined by the authors and are deposited in their collections. The harvestmen were identified by S. Stašiov (Banská Štiavnica, Slovakia).

Results and discussion

Invertebrate fauna sampled in the caves near Veľký Folkmar consists of lumbricids (3 ind.), gastropods (6 ind.) and arthropods (almost 3 700 ind.) (Fig. 2). Eudominant taxonomic groups were the Acari, Diptera, Coleoptera and Collembola. The Acari were the group with the highest species richness (Oribatida – 12 spp., Gamasida – 13 spp.), followed by Araneae (17 spp.), Diplopoda (7 spp.), Chilopoda (4 spp.), and 3 groups (Pseudoscorpiones, Opiliones and Isopoda) with 2 spp. only (Table 1). Hexapoda were not studied yet and Acari of the family Eupodidae (probably only 1 sp.) were not identified as well.

Comparison of the efficiency of the used sampling methods showed that extraction of organic material yielded the highest number of specimens.However, the highest species numbers of Arachnida, Isopoda, Diplopoda and Chilopoda were obtained by hand-collecting (IS_1+IS_2+IS_3 = 31 spp.) and by formaldehyde traps (FT = 29 spp.). Relative efficiency of pitfall trapping (average number of captured arthropods excl. Hexapoda per one trap) was highest in formaldehyde traps (51 ind.), followed by ethylenglycol-beer traps and ethylalcohol traps. Considering the quantity of all collected arthropods, the best results were obtained by ethylenglycol-beer traps (194 ind. trap^{-1} in average), attracting mainly flies and beetles, followed by formaldehyde traps (114 ind. trap^{-1}) and ethylalcohol traps (14 ind. trap^{-1}). The very low efficiency of ethylalcohol traps was probably due to white mould growing around their openings (Fig. 3). The repellent or attractant effects of particular fixation solutions on various arthropod groups are known and should be taken under consideration as well (Adis, 1979).

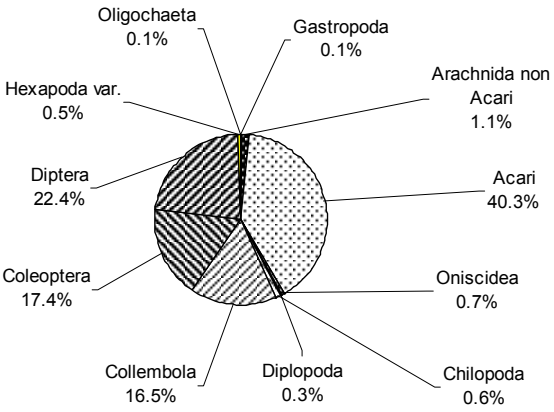

Fig. 2. Composition of the invertebrate fauna recorded in the caves near Veľký Folkmar.

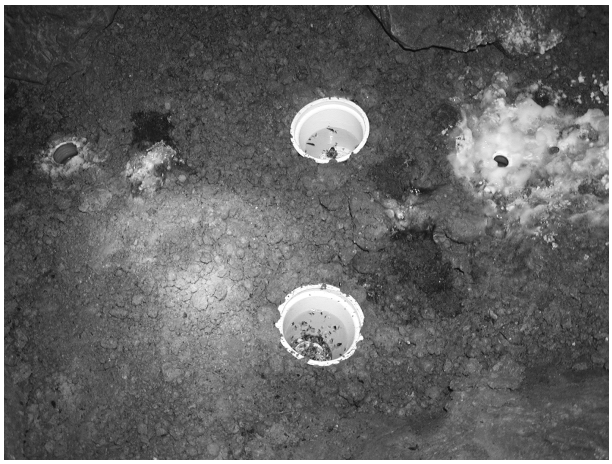

Fig. 3. Three types of pitfall traps exposed inside the Klenbová Cave; one ethylenglycol-beer trap on the left, two formaldehyde traps in the middle, and an ethylalcohol trap on the right. The surface around the ethylalcohol trap is covered with mould. Photo: P. Ľuptáčik.

The close relation with subterranean ecosystems was confirmed in 15 taxa (26 % of all taxa determined). These invetrebrates prefer subterranean conditions, foraging and reproducing there, but they inhabit also surface microsites (forest litter, stony debris, wood cavities etc.). They are classified as eutroglophiles. This frequently used category is being applied to the heterogeneous group of animals with “intermediate” biological features between troglomorphic and surface forms (Gnaspini and Hoenen, 1999). The Klenbová Cave was the richest in eutroglophilous forms (9 spp.).

This cave possessed also the highest diversity with 30 recorded species (Table 1). The rest of the arthropod fauna represented surface forms temporally migrating into subterranean habitats from various sites in the immediate surrounding. Caves may represent seasonal ecological refuges (habitat with optimal conditions) for them. Although the microclimate of the short caves is dynamic when compared to the long caves, they have much smaller fluctuations of climatic factors than the surrounding above-ground habitats. The temperature ranges closely around the mean annual temperature (7-8 ºC) and the relative air humidity within the caves is mostly higher than outside, without dramatic fluctuations during day and season (Růžička, 1999; Vandel, 1965).

The oribatid mites were represented by 12 species. Of those *Achipteria coleoptrata, Belba clavigera, Damaeus gracilipes*, *Damaeus* cf. *tecticola, Gemmazetes cavatica, Liacarus subterraneus,* and *Oribella* cf. *forsslundi* are cavernicolous. The diversity of oribatids in these caves was surprisingly higher than of other Slovak or Central European caves (Ľuptáčik and Miko, 2003). The gamasid mites *Parasitus loricatus* and *Uroobovella advena* are typical components of the Slovak cave fauna (Fenďa and Košel, 2000). The mite *U. advena* is considered as guanobiotic. A minor part of the fauna was formed by mites known as nidicoles of small mammals (*Haemogamasus nidi, Cyrtolaelaps mucronatus, Proctolaelaps pygmaeus Vulgarogamasus remberti*) and birds (*Androlaelaps casalis*, *P. pygmaeus*), and by mites phoretic on insects (*Poecilochirus carabi, Uroseius tragheardi*). Some of them (e.g. *C. mucronatus, V. remberti*) often colonise caves (Fenďa and Košel, 2000). Two specimens of *Ichoronyssus* sp. represent obligatory bat ectoparasites.

The surprisingly rich spider fauna was represented mainly by epigeic forest species. The spiders *Meta menardi, Metellina merianae* and *Tegenaria silvestris* are typical dwellers of the short caves and cave entrances in Slovakia (Košel, 1996; Svatoň, 2000). Two species of the genus *Porrhomma* (*P. convexum* and *P. egeria*) are troglophiles colonising deeper subterranean habitats. They are probably under the process of subterranean evolution (Růžička, 1999).

Pseudoscorpions were represented by two epigeic species. The identity of *Chtonius* cf. *ressli* must be confirmed by a detailed study. *C. ressli* Beier, 1956 was had not been recorded in Slovakia before.

The harvestman *Mitostoma chrysomelas* is the most frequent species inhabiting Slovak caves. It has trolophilous status (Stašiov et al., 2003). The second sampled opilionid species was the common epigeic *Leiobunum rupestre.*

The terrestrial isopods were represented by two epigeic species, of which *Armadillidium versicolor* is often found in the cave entrances (Gulička, 1985). The presence of the cavernicolous *Mesoniscus graniger* was not confirmed in the caves near Veľký Folkmar. This species occurs in several caves located in the central part of the Čierna hora Mts. (Mlejnek and Ducháč, 2001, 2002).

Trachysphaera costata is the only millepede species, which can be considered characteristic of the cave environment. In the Čierna hora Mts. *T. costata* colonises probably exclusively hypogean habitats. The other recorded millipede species are epigeic and common in the Western Carpathian forests (Mock, 2000b). The absence of millipedes from the family Attemsidae was unexpected. They are typical of cave arthropodocoenoses of the Central-West Carpathians, including the Ružínok karst valley in the Čierna hora Mts. (Košel, 2000; Mock, 2000a, 2000b).

The four recorded centipede species from the genus *Lithobius* are predators inhabiting various forest microsites. Because of the optimal microclimate and probably also favourable feeding conditions they sometimes penetrate into the entrance parts of the caves. The centipede *Lithobius erythrocephalus* reached the highest frequency and abundance. It is known also from other Slovak caves (Országh, 2000; Országh et al., 1994).

We can summarise that the caves of Veľký Folkmar in the Čierna hora Mts. are rich in arthropod communities. The short caves represent specific habitats with remarkable fauna. We can consider them as a key for our understanding of the natural history of the area (Vandel, 1965). They are sensitive to human disturbance and therefore in need of protection.

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References

Adis, J., 1979. Problems of interpreting arthropod sampling with pitfall traps. Zool. Anz., Jena, 202: 177-184

Bella, P., Holúbek, P. (eds.), 1999. Zoznam jaskýň na Slovensku [List of the caves in Slovakia]. MŽP, Bratislava, 268 pp. (in Slovak)

Erdös, M., 1979. Dokumentácia a registrácia povrchových a podzemných krasových javov v krasovom ostrove na severozápad od Košíc [Documentation and registration of surface and underground karst phenomena north-west of Košice]. Slovak Museum of the Speleology and Nature Protection, manuscript. Košice, 24 pp. (in Slovak)

Fenďa, P., Košel, V., 2000. Roztoče (Acari: Mesostigmata) jaskýň Slovenského raja [Mites (Acari: Mesostigmata) from caves of the Slovak Paradise], In: Mock, A., Kováč, Ľ., Fulín, M. (eds.), Fauna jaskýň (Cave Fauna). Košice, p. 21-30 (in Slovak)

Gnaspini, P., Hoenen, S., 1999. Considerations about the troglophilic habit: the cave cricket model. Mémoires de Biospéologie, 26: 151-158

Gulička, J., 1995. Pôdna a jaskynná makrofauna krasových pohorí Západných Karpát (I) [The soil and cave macrofauna of karstic mountains in the Western Carpathians (I)]. Slovenský kras, 23: 89-129 (in Slovak)

Košel, V., 1996. Podzemné biotopy [Subterranean biotopes]. In: Ružičková, H. et al. (eds.), Biotopy Slovenska. ÚKE SAV, Bratislava, p. 133-135 (in Slovak)

Košel, V., 2000. Regionalizácia jaskynnej a krasovej fauny Západných Karpát [Regionalisation of the cave and karst fauna of the Western Carpathians], In: Mock, A., Kováč, Ľ., Fulín, M. (eds.), Fauna jaskýň (Cave Fauna). Košice, p. 67-84 (in Slovak)

Košel, V., 2001. The Sciaridae (Diptera) from caves in Slovakia. Acta Universitatis Carolinae, Biologica, 45: 73-78

Kováč, Ľ., Mock, A., Ľuptáčik, P., Palacios-Vargas, J., 2002. Distribution of *Eukoenenia spelaea* (Peyerhimoff, 1902) (Arachnida, Palpigradida) in the Western Carpathians with remarks on its biology and behaviour. In: Tajovský, K., Balík, V., Pižl, V. (eds.), Studies on Soil Fauna in Central Europe. ISB AS CR, České Budějovice, p. 93-99

Krumpál, M., 2000. Šťúriky (Pseudoscorpiones) jaskýň Čiernej hory (Slovensko) [Pseudoscorpions (Pseudoscorpiones) from the Čierna hora Mts. caves], In: Mock, A., Kováč, Ľ., Fulín, M. (eds.), Fauna jaskýň (Cave Fauna). Košice, p. 95-98 (in Slovak)

Ľuptáčik, P., Miko, L., 2003. Oribatid mites (Acarina, Oribatida) of the Slovak caves. Subterranean Biology, 1: 25-29

Mlejnek, R., Ducháč, V., 2001. Rozšíření *Mesoniscus graniger* (Crustacea: Isopoda: Oniscoidea) v Západních Karpatech [Distribution of *Mesoniscus graniger* (Crustacea: Isopoda: Oniscoidea) in the West Carpathians]. Natura carpatica, 42: 75-88 (in Czech)

Mlejnek, R., Ducháč, V., 2003. Troglobiontní a endogenní výskyt druhu *Mesoniscus graniger* (Crustacea: Isopoda: Oniscoidea) na území Západních Karpat [Troglobiotic and endogenous occurrence of *Mesoniscus graniger* (Crustacea: Isopoda: Oniscoidea) in the West Carpathians]. Acta Musei Reginaehradecensis, S. A., 29: 71-79 (in Czech)

Mock, A., 2000a. Millipedes (Diplopoda) of the Western Carpathian caves – a preliminary review. In: Wytwer, J., Golovatch, S. (eds), Progress in Studies on Myriapoda and Onychophora. Warszawa, Fragm. faun., 43 (Suppl.), p. 313-319

Mock, A., 2000b. Mnohonôžky (Diplopoda) jaskýň Čiernej hory (Slovensko, Západné Karpaty). [Millipedes of the caves of the Čierna hora Mts. (Slovakia, Western Carpathians)]. In: Mock, A., Kováč, Ľ., Fulín, M. (eds.), Fauna jaskýň (Cave Fauna). Košice, p. 115-128 (in Slovak)

Országh, I., 2000. Stonôžky (Antennata: Chilopoda) niektorých jaskýň Slovenska [Centipedes (Antennata: Chilopoda) from some caves in Slovakia]. In: Mock, A., Kováč, Ľ., Fulín, M. (eds.), Fauna jaskýň (Cave Fauna). Košice, p. 129-140 (in Slovak)

Országh, I., Košel, V., Országhová, Z., 1994. Príspevok k poznaniu stonožiek (Tracheata, Chilopoda) jaskýň Slovenska [A contribution to the knowledge of centipedes (Tracheata, Chilopoda) of the caves of Slovakia]. Slovenský kras, 32: 79-90 (in Slovak)

Roubal, J., 1929. Tré nových Coleopter z východu Československé republiky [Three new species of Coleoptera from the east part of the Czechoslovak Republic]. Čas. čs. spol. ent., 25 (1928): 99-102 (in Czech)

Růžička, V., 1999. The first steps in subterranean evolution of spiders (Araneae) in Central Europe. Journal of Natural History, 33: 255-265

Stašiov, S., Mock, A., Mlejnek, R., 2003. Nové nálezy koscov (Opiliones) v jaskyniach Slovenska [New records of harvestmen (Opiliones) in Slovak caves]. Slovenský kras (Acta Carsologica Slovaca), 41: 199-207 (in Slovak)

Svatoň, J., 2000. Fauna pavúkov (Araneae) slovenských jakýň [Spider fauna (Araneae) of Slovak caves]. In: Mock, A., Kováč, Ľ., Fulín, M. (eds.), Fauna jaskýň (Cave Fauna). Košice, p. 157-170 (in Slovak)

Vandel, A., 1965. Biospéologie. Le Biologie des Animaux Cavernicoles. Gauthier-Villars Editeur, Paris, xviii+619 pp.

Table 1. List of the arthropod taxa (Hexapoda excluded) inhabiting the caves near Veľký Folkmar. Their ecological classification (tp – eutroglophiles, s – forest soil/epigeic dwellers, n – nidicoles, p – ectoparasites, e – epigeic forms), numbers of individuals and effectiveness of methods used: numbers of individuals obtained by AT – alcohole traps, EBT – ethylen-beer traps, FT – formaline traps, by extraction of baits and organic materials – OM+BE, and by hand collections (IS_1 – 22.3., IS_2 -13.6., IS_3 - 14.10.2002).

Classification	List of taxons	Name of caves						Together	Effectiveness of methods						
		Márnica	Predná veľká	Klenbová	Nová galéria	Zelená puklinová	Hoľa I.		AT	EBT	FT	OM + BE	IS_1	IS_2	IS_3
	Oribatida							68							
tp	*Achipteria coleoptrata* (Linnaeus, 1758)	-	-	-	-	-	1		-	1	-	-	-	-	-
tp	*Belba clavigera* Willmann, 1954	-	3	8	-	-	-		-	-	4	-	4	-	-
s	*Carabodes ornatus* Štorkán, 1925	-	-	-	-	-	1		-	-	-	1	-	-	-
tp	*Damaeus* cf. *tecticola* (Michael, 1888)	-	10	1	-	-	-		-	-	11	-	-	-	-
tp	*Damaeus gracilipes* (Kulczynski, 1902)	-	-	1	-	-	-		-	-	1	-	-	-	-
?	*Dorycranosus* sp.	-	-	-	-	-	1		-	1	-	-	-	-	-
tp	*Liacarus subterraneus* (C. L. Koch, 1841)	-	-	1	-	-	-		-	1	-	-	-	-	-
tp	*Gemmazetes cavatica* (Kunst, 1962)	2	-	-	-	-	18		-	20	-	-	-	-	-
tp	*Gemmazetes* cf. *forsslundi* (Moritz, 1965)	-	-	2	-	-	-		-	-	-	2	-	-	-
s	*Xenillus clypeator* Robineau-Desvoidy, 1839	-	1	-	-	-	-		-	-	1	-	-	-	-
?	Damaeidae sp. 1	-	-	12	-	-	-		-	-	-	-	-	12	-
?	Damaeidae sp. 2	-	-	2	-	-	-		-	-	-	-	-	2	-
?	Damaeidae indet. juv.	-	4	-	-	-	-		-	-	4	-	-	-	-
	Gamasida							1062							
n	*Androlaelaps casalis* (Berlese, 1887)	-	9	-	-	-			-	-	9	-	-	-	-
s, n	*Cyrtolaelaps mucronatus* (G.et R. Canestrini, 1881)	-	-	5	-	-	861		-	21	135	705	3	-	-
n	*Euryparasitus emarginatus* (C.L.Koch, 1839)	-	-	-	-	-	2		-	1	-	-	-	1	-
n, p	*Haemogamasus nidi* Michael, 1892	-	-	-	-	-	1		-	1	-	-	-	-	-
s	*Hypoaspis aculeifer* G.Canestrini, 1884	-	-	1	-	-	-		1	-	-	-	-	-	-
s	*Hypoaspis heyi* Karg, 1962	2	-	-	-	-	-		-	1	1	-	-	-	-
p	*Ichoronyssus sp.*	-	-	1	-	-	-		-	-	1	-	-	-	-
tp	*Parasitus loricatus* (Wankel, 1861)	2	-	8	-	-	51		1	8	27	23	1	2	-
n, p	*Poecilochirus carabi* G.et R.Canestrini, 1882	-	-	-	-	-	2		-	-	2	-	-	-	-
s,n	*Proctolaelaps pygmaeus* (Muller, 1860)	1	1	-	-	-	-		-	1	1	-	-	-	-
tp	*Uroobovella advena* (Tragardh, 1912)	-	-	-	-	-	59		-	-	2	67	1	-	-
n, p	*Uroseius traegardhi* Hirschmann et Zirngiebl-Nicol, 1969	1	-	8	-	-	-		-	8	1	-	-	-	-
n	*Vulgarogamasus remberti* (Oudemans, 1912)	-	-	-	-	-	47		-	-	-	47	-	-	-
	Actinedida							373							
?	Eupodidae gen. sp. indet.	-	373	-	-	-	-		2	10	361	-	-	-	-
	Pseudoscorpionida							3							
s	*Chthonius* cf. *ressli* Beier, 1956	-	-	1	-	-	-		-	-	-	-	-	-	1
s	*Chthonius tenuis* L. Koch, 1873	-	-	1	-	-	-		-	-	-	-	1	-	-
s	*Chthonius* sp. juv.	-	1	-	-	-	-		-	-	1	-	-	-	-
	Araneae							**62**							
s	*Amaurobius febestralis* (Ström, 1768)	-	1	-	-	-	-		-	-	1	-	-	-	-
s	*Callobius claustrarius* (Hahn, 1833)	-	3	2	-	-	-		-	-	5	-	-	-	-
s	*Cicurina cicur* (Fabricius, 1793)	-	1	3	-	-	1		-	-	3	-	-	-	2
s	*Coelotes atropos* (Walckenaer,1830)	-	3	-	-	-	-		-	-	3	-	-	-	-
s	*Coelotes* sp. juv.	-	-	4	-	-	-		-	-	-	-	-	3	1
s	*Harpactea hombergi* (Scopoli, 1763)	-	1	-	-	-	-		-	-	-	-	-	1	-
s	*Histopona torpida* (C. L. Koch, 1837)	-	2	-	-	-	-		-	-	2	-	-	-	-
s	*Liocranum rupicola* (Walckenaer, 1830)	1	1	-	-	-	-		-	-	2	-	-	-	-
tp	*Meta menardi* (Latreille, 1804)	5	-	1	-	1	-		-	-	-	-	6	1	-
tp	*Metellina merianae* (Scopoli, 1763)	-	3	-	-	-	1		-	-	-	-	-	4	-
s	*Neriene peltata* (Wider, 1854)	-	1	-	-	-	-		-	-	1	-	-	-	-
s	*Nesticus cellulanus* (Clerck, 1757)	-	-	1	-	-	-		-	-	1	-	-	-	-
tp	*Porrhomma convexum* (Westring, 1851)	-	-	-	1	-	-		-	-	-	-	-	-	1
tp	*Porrhomma egeria* Simon, 1884	-	-	1	-	-	-		-	-	-	-	-	2	-
tp	*Porrhomma* sp.	-	-	5	-	-	-		-	-	1	-	1	1	2
s	*Tegenaria silvestris* L. Koch, 1872	-	3	5	-	-	-		-	-	4	-	4	-	-
s	*Tenuiphantes alacris*(Blackwall, 1853)	-	-	-	-	-	1		-	-	1	-	-	-	-
s	*Tenuiphantes flavipes*(Backwall, 1854)	-	-	-	-	1	-		-	-	-	-	-	1	-
s	*Thyreostenius parasiticus* (Westring, 1851)	-	-	6	-	1	2		-	-	-	-	-	3	6

Table 1. Continuation.

Classification	List of taxons	Name of caves						Together	Effectiveness of methods						
		Mámica	Predná veľká	Klenbová	Nová galéria	Zelená puklinová	Hoľa I.		AT	EBT	FT	OM + BE	IS_1	IS_2	IS_3
	Opilionida							3							
s	*Leiobunum rupestre* (Herbst, 1799)	-	1	-	-	-	-		-	-	-	-	-	-	1
tp	*Mitostoma chrysomelas* (Hermann, 1804)	-	1	-	1	-	-		-	-	-	-	-	-	2
	Oniscidea							26							
s	*Armadillidium versicolor* Stein, 1859	3	21	-	-	-	-		-	-	12	-	12	-	-
s	*Trachelipus* cf. *pseudoratzeburgi* (Verhoeff, 1907)	-	-	1	1	-	-		-	-	-	-	-	-	2
	Diplopoda							10							
s	*Julus curvicornis* Verhoeff, 1899	-	-	1	-	-	-		-	-	1	-	-	-	-
s	*Leptoiulus bakonyensis* Verhoeff, 1899	-	2	-	-	-	-		-	-	1	-	1	-	-
s	*Leptoiulus* cf. *trilobatus* (Verhoeff, 1894)	-	-	1	-	-	-		-	-	-	-	-	-	1
s	*Polydesmus complanatus* (Linnaeus, 1761)	-	-	-	1	-	-		-	-	-	-	-	-	1
s	*Polyzonium germanicum* Brandt, 1831	-	-	1	-	-	-		-	-	-	-	-	-	1
s	*Strongylosoma stigmatosum* (Eichwald, 1830)	-	-	-	-	-	1		-	-	-	-	-	1	-
tp	*Trachysphaera costata* (Waga, 1857)	2	-	-	-	-	-		-	-	-	2	-	-	-
s	Julidae gen. sp. juv.	-	-	-	-	-	1		-	-	-	-	-	1	-
	Chilopoda							22							
s	*Lithobius erythrocephalus* C.L. Koch, 1847	-	1	7	2	-	-		-	1	-	-	2	2	5
s	*Lithobius forficatus* (Linnaeus, 1758)	-	-	1	4	1	-		-	-	-	-	1	1	1
s	*Lithobius mutabilis* L. Koch, 1862	-	-	-	-	-	2		-	-	1	-	-	1	-
s	*Lithobius pelidnus* Haase, 1880	-	-	1	-	-	-		-	-	-	-	-	-	-
s	*Lithobius* sp. juv.	-	-	3	-	-	-		-	-	-	-	-	-	3
	Nunmber of specimens	19	447	96	10	4	**1053**	1629	4	75	580	**847**	37	39	30
	Number of species	9	21	**30**	6	4	17	59	2	12	**29**	7	12	15	13
	Number of troglophilous species	4	4	**9**	2	1	5	15	1	4	**7**	4	**5**	3	2