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The fauna and exploration of the Cyrilka crevice-type cave

Fauna a explorace rozsedlinové jeskyně Cyrilka

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Abstract. The Cyrilka cave is the second longest pseudokarst cave and the longest crevice-type cave in Czechia. This cave developed within the headscarp area of a deep-seated landslide. The cave became a focus of scientific research throughout the last decades, when several speleological maps have been compiled. We compared the maps in order to better understand the gradual exploration as well as the speleogenetic evolution of the cave. In recent years, we performed the preliminary faunistic survey in the cave and found 11 invertebrates and 5 vertebrates. The locality is threatened by many visitors and contamination by littering. We recommend the protection of the cave as a national monument.

INTRODUCTION

The Cyrilka cave is one of the most famous pseudokarst caves in Czechia. At 552 m in length, it is the longest crevice-type cave in Czechia according to the classification proposed by VÍTEK (1983) and the second-longest pseudokarst cave (after the Teplická cave: 1065 m) (cf. HROMAS et al. 2009). The depth of the cave is 16 m. The cave has been known for centuries. During last decades, several cave maps were published. We bring their first detailed comparison with respect to the gradual exploration of the cave as well as its exposure to mass movements.

We report the results of broad faunistic survey within this cave. Crevice-type caves in the Moravskoslezské Beskydy Mountains are commonly known as an important winter habitat for bats. The knowledge regarding the occurrence of other species, especially invertebrates, is incomplete and mainly caused by the poor accessibility of the caves. This study presents a list of the animal species whose occurrence in the Cyrilka cave was observed during the winter seasons in 2013 and 2015. Additionally, we investigated the number of human visitors to the cave entrance.

LOCATION AND DESCRIPTION OF THE CAVE

The Cyrilka cave is situated in the northeastern part of Czechia in the Moravskoslezské Beskydy Mountains (Fig. 1A), which are formed by flysch Mesozoic (Late Jurassic) to Paleogene/Neogene (Early Miocene) sedimentary rocks. During the Lower and Middle Miocene alpine orogeny phases, these sediments were folded and thrusted onto the foredeep in the northern direction, forming several nappes (MENČÍK et al. 1983). The Cyrilka cave is situated in the summit part of the Silesian Unit flysch nappe on the Radhošť Ridge (Fig. 1A), which is formed by the Godula Formation (Upper Godula beds). The sedimentary strata consist of thick-bedded sandstones or conglomerates alternating with very thin-bedded claystones or siltstones (MENČÍK et al. 1983). The Radhošť Ridge is important for the appearance of the Pustevny Sandstone, an informal member of the Godula Formation, characterized by thick-bedded green-grey greywacke or arkosic sandstone (ELIÁŠ 2000). During the Miocene, the rocks were disrupted by joints and faults (MENČÍK et al. 1983).

Because of the slight strata southeast dip, the Radhošť Ridge forms an escarpment with the northern slopes, forming short, steep scarp slopes, whereas the southern slopes are long and gentle dip slopes. The Cyrilka cave is situated on the eastern slope, which is strongly affected by deep-seated translational (consequent) landslides (Fig. 1B).

The cave is developed chiefly below the shallow trench with several pseudokarst sinkholes and rocky depressions filled with debris. The entrance into the cave is situated at the bottom of the southern part of the trench (49°29´09.96´´N, 18°15´48.96´´E), 1008 m a.s.l.

According to morphogenetic classification (URBAN & MARGIELEWSKI 2013; MARGIELEWSKI & URBAN 2017), the cave belongs to the category of intermediate crevice-type caves.

The cave comprises three morphologically distinguishable levels developed at a shallow depth. The middle level includes more than 90 % of underground passages, which are regularly shaped in geometry—high but narrow, with ceilings formed by upper beds or wedged boulders, and a floor formed by a mixture of debris and clayey mud (Fig. 2). The passages are somewhere widened into larger chambers (Fig. 2). Some cave segments are interconnected by very narrow crevices. Individual passages are terminated by narrowing, rock collapses or rigid rock walls.

The majority of the passages follow a NNE–SSW orientation, parallel with the strike of the slope. The only exceptions are two ragged passages following two ENE–WSW fracture zones, which divide the cave into three morphologically and genetically different segments (Fig. 3). Each of them has undergone different gravitational evolution with different morphological results (see LENART et al., 2014). Small soda-straw stalactites have been found in the three positions within the New Part of the cave.

The dynamic microclimate is established within the cave. The air temperature and relative humidity of the cave was measured between years 1977–1982, when the temperature ranged between +4,5°C and +9,9°C. The relative humidity was 85–100 % (WAGNER et al. 1990). LENART (2012) measured between +6°C and +12°C inside the cave during the summer season and 6–8°C during the winter. The illuminance drops to 0 lx after 5 m from the entrance (LENART 2010).

EXPLORATION HISTORY

The legendary history of cave exploitation is connected to the colonization of the Moravskoslezské Beskydy Mountains by the Slavonic indigenous people. The old legends tell about the pagan god Radgost (Radegast) and his worshipers hiding in the cave; others are connected with the Wallachian colonization in the 15th century.

SKUTIL (1957) noted that the oldest traceable mention of the cave was from 1639. In 1755, the first map of the cave localization was published by V. Monse (WAGNER et al. 1990); however, this map was later lost. It is even possible that it was a fake. Another fantastic drawing of the Radhošť underground was published supposedly by F. Přikryl in 1895 (WAGNER et al. 1990), but we found practically the same drawing completed by GEYER (1755), documenting the mining works near Frenštát. ČETYNA (1966) compared Monse's map with the location of old shepherd's huts and he found a match. The shepherds may have used the cave entrances as shelters for milk products. The handwriting from 1830 describes the treasure hunts and the signs carved into the rocks (ŠEBESTA 1830). Between 1867 and 1936, several explorers visited the cave (Klička and Čech between 1867 and 1881, Obšívač in 1886, Přikryl and Mládek in 1895, Batke in 1903, Kramoliš, who published the first veracious description of the cave in 1904, Heinrich in 1936, and Kytlica in 1946).

The first accurate map of the cave was published in 1953 (Fig. 3A; TUČNÍK 1953). Since then, the cave has been extensively studied, further explored and mapped. The New Part of the cave was discovered in 1976, increasing the length from 165 to 375 m (cf. FOLDYNA 1968 and WAGNER et al. 1990 on Fig. 3D). More recent surveys increased the length to 511 m (WAGNER & LENART 2012) and 535 m in 2013 (LENART et al. 2013; Fig. 3E). In the most up-to-date survey, the overall length of the cave is now 552 m and the depth is 16 m.

MATERIALS AND METHODS

The High-resolution LiDAR-derived Digital Terrain Model in the form of hillshade for fig. 1 was provided by the State Administration of Land Surveying and Cadastre (DMR5G) with a spatial resolution of 1 m and the maximum error in altitude reaching 0.3 m in forested areas. The historical maps of the cave were collected from the published sources and compared with the up-to-date state.

Invertebrates and vertebrates of the Cyrilka cave were preliminarily studied by using conventional flashlights in aphotic part of the cave on the 5th of April 2013 and on the 22nd of January 2015 at the time of snow cover. Recorded species were examined in particular on the walls and ceilings (spiders, butterflies and bats) or on the floor under various objects (stones, remains of wood) throughout the cave. *Crumomyia* *parentela alpicola* was recorded on the conglomerate wall of the Entrance Chamber (Fig. 3E). In several cases, it was necessary to collect specimens for further determination by using entomological tweezers or an exhauster. Due to a difficult accessibility of the locality, we did not use any of the standard collecting methods, such as grids or kick sampling. Specimens were fixed in 70 % alcohol or killed by vapours of ethyl acetate. Materials were collected by J. Kupka. Leiodidae (Coleoptera) were identified by J. Vávra and Carabidae (Coleoptera) by J. Stanovský. Sphaeroceridae (Diptera) was identified by J. Roháček. Other materials were identified by J. Kupka.

Numbers of individual human visitors were counted based on the number of signatures found in the hidden cache situated in the entrance and covered by stone.

RESULTS AND DISCUSSION

Comparison of historical cave maps

If we compare three historical maps of the Cyrilka cave with the current one (Fig. 3), we can follow progressive discoveries and the evolution of the cave to some extent. Looking at Tučník's map from 1953, we see the Old Part of the cave with several passages leading to the spacious chambers (Fig. 3A). Compared with the map published by Foldyna in 1968 (Fig. 3B), the later has several differences. First, the cave is much larger, newly including the Back Part of the cave, which was connected with the Old Part. We do not know whether these new sections were discovered between 1953 and 1968, or whether Tučník's map is only partial. A second difference is visible in the entrance area. The entrance passage on Tučník's map is wide and long, connected with the ground surface by a circular manhole. In contrast, on the Foldyna's map, the same passage is collapsed and the entrance is opened within the narrow side crevice. At the time of mapping, the entrance was collapsed and it was necessary to dig it out (FOLDYNA 1968). Foldyna published the length of the cave as up to 40 m and the depth as 25 m, but these data are probably inaccurate. WAGNER et al. (1990) later reported the length of the Old Part of the cave as 165 m.

The third map was published after the new discoveries in 1976 by WAGNER et al. (1990). They discovered the New Part of the cave by exploring the crevice denoted in Fig. 3 as "c" (Fig. 3D). Note that this crevice is fully omitted on Tučník's map, and it is at least recorded on Foldyna's map. This narrow crevice leads to almost one-half of the entire cave system. WAGNER et al. (1990) reported the length as 375 m and the depth as 6 m. The recent discoveries are represented by elongations of the terminal passages of the cave, denoted as "d" in Fig. 3E. Surprisingly, the passages denoted as "e" seem to have been forgotten. Although Tučník mapped them, they are not depicted on Foldyna's and Wagner's maps. It is rather unlikely that these passages closed or collapsed and then later were re-established. However, such swift gravitational changes are observed in some caves in the Polish Outer Carpathians, e.g., Jaskinia Niedźwiedzia cave or Jaskinia Roztoczanska cave (J. Urban, pers. comm. 2018).

Biodiversity of the cave and human impact

We recorded 18 species from 10 families, listed in Tab. 1. Some of the species are shown in Fig. 4. There were two species of spiders found in the cave. The very numerous *Meta menardi* (Latreille, 1804) occurs exclusively within the specific shady habitats, cellars or caves (RŮŽIČKA 2007). *Tegenaria silvestris* (L. Koch, 1872) usually inhabits forests, living hidden under stones, in moss, leaves or tree cavities (BUCHAR & KŮRKA 1998; BUCHAR & RŮŽIČKA 2002). The species of beetles *Catops longulus* (Kellner, 1846) and *Catops picipes* (Fabricius, 1792) are frequently found in cave entrances or in burrows of mammals but are also found on the carrion (MAJER 1980). *Trechus pulchellus* (Putzeys, 1846) is one of the most common species, living mostly in wet leaves in the highlands and mountain forests (STANOVSKÝ & PULPÁN 2006). Two recorded species of Lepidoptera were of very low abundance. The inchworm *Triphosa dubitata* (Linnaeus, 1758) inhabits deciduous and mixed forests of cultural landscapes. The adults often hibernate in underground cavities (DVOŘÁK 2000; MACEK et al. 2012). Very common *Scoliopteryx libatrix* (Linnaeus, 1758) uses the shelters in caves, tunnels and cellars for hibernation (DVOŘÁK 2000; MACEK et al. 2009).

From the Diptera order, the subspecies *Crumomyia parentela alpicola* (Roháček in Troger & Roháček, 1980) was recorded for the first time in Czechia (collected in the Entrance Chamber of the cave; Fig. 3E), as published earlier by ROHÁČEK (2014). This cavernicolous population in the Cyrilka cave was clearly isolated for a long time from the Carpathian alpine populations of *C. p. alpicola* and may have survived as a glacial relict up to the present. The long impact of cavernicolous conditions (complete darkness, high humidity) resulted in the reduction of eyes as well as shortening of wings (ROHÁČEK 2014). This subspecies is known only from caves and is considered to be troglobiont (ROHÁČEK & PAPP 2000). In the Alps, it was recorded in Austria (Tiroler Zentralalpen: Obergurgl Mt. and Karnischen Alpen Mts: Obstans cave), Switzerland (Uri: Oberalppass and Fribourg: Moléson) and Italy (Cuneo: Valcasotto, Grotta delle Turbiglie). In the Carpathians, there are records from Slovakia (Malá Fatra Mts: Stoh Mt.; Slovenský raj Mts: Stratenská cave, Vlčia cave, Koniarova cave; Vysoké Tatry Mts: Velická dolina valley and Belianské Tatry Mts: Alabastrová cave). All records are from relatively high altitudes ~ 1000–2000 m (ROHÁČEK 2014).

The recent populations of *C. p. aplicola* may be considered to be glacial relicts of a strictly psychrophilic species that was probably widespread in Europe during the Pleistocene Ice Ages. During the post-glacial warming, it became restricted to alpine subterranean habitats and resulted in the contemporary insular distribution in the Balkan karst area (*C. p. parentela*; Séguy, 1963) and in the high altitudes of the Alps and Carpathians (*C. p. alpicola*) (ROHÁČEK 2014). On the other hand, *Crumomyia parentela* occurs in open alpine habitats above the timber line, living there in burrows of mammals (ROHÁČEK & KOŠEK 2003).

Trichocera regelationis (Linnaeus, 1758) is a common species of Diptera, which usually hibernates in caves (KOŠEL & HORVÁTH 1996). Summary of recorded invertebrate species and their abundance is shown in the Tab. 2. From the Vertebrates, five species of bats were recorded between 2013 and 2015. The most abundant was *Rhinolophus hipposideros* (Bechstein, 1800). Underground caves with a constant air temperature of 6 °C and high relative humidity are necessary for their hibernation. *Myotis myotis* (Borkhausen, 1797) is one of the most abundant and the biggest bats inhabiting the territory of Czechia. The occurrence of *Myotis emarginatus* (É. Geoffroy, 1806), *Myotis mystacinus* (Kuhl, 1817) and *Myotis nattereri* (Kuhl, 1817) was very rare. The population of bats in the Cyrilka cave has been studied almost continuously since 1976 (WAGNER 2001). During that time, four other species of bats: *Myotis daubentonii* (Kuhl, 1817), *Myotis bechsteinii* (Kuhl, 1817), *M. mystacinus* and *Plecotus auritus* (Linnaeus, 1758) were recorded, but their occurrence was unique and irregular. Tab. 3 shows the results of bat counts from 1976 to 2015. Only two species, *Rhinolophus hipposideros* and *Myotis myotis*, are numerous and regular. The most abundant is *R. hipposideros*, whose colonies reach up to 121 individuals. Since 1980, the populations of bats in Czechia have stabilized or even increased, as in the case of *R. hipposideros* and *M. myotis* (ŘEHÁK 1997; ZUKAL et al. 2003; BUFKA & ČERVENÝ 2012). Different numbers of hibernating bats through the years have many causes. Their unambiguous interpretation is not possible due to the lack of knowledge about the life of the bats and their ecological demands. In addition, factors affecting the numbers of bats are rather complex. First, the methodology of bat counting is nonuniform. There is also the factor of the researcher's subjectivity and experience. The counts were provided within different months and different hours, which could influence the obtained numbers because of the seasonal and circadian rhythms of species. Regardless, an increase in the abundance of *Rhinolophus hipposideros* corresponds to trends in Czechia (ŘEHÁK 2006).

According to the legends and historical descriptions, the Cyrilka cave has been known for centuries, although the only preserved signs of human activities are inscriptions carved into the cave walls (FOLDYNA 1968). Because the cave is visited regularly by speleologists and adventurers, it is contaminated by littering, especially the chambers and passages near the entrance, as well as the bottom of a superficial trench above the cave. For the protection of the cave, the entrance is secured by a lockable gate, but from time to time, it is damaged. The access of part of the cave site to visitors during the year 2014 can be estimated from the number of signatures found in the hidden cache (Fig. 5). The attendance at the site is the most intense in the summer season, holidays and weekends. If we take into account that Fig. 5 only shows the people who found the hidden cache, the real number of visitors should be much higher. We assume that only minimum of them visited also the internal parts of the cave.

CONCLUSIONS

Although the Cyrilka cave has been known for many years, it became an important focus of research during the last decades. From the comparison of four historical and actual speleological maps, we indicated the gradual exploration as well as possible gravitational movements within the cave.

The authors performed the first broad faunistic survey within the cave. We found 11 invertebrates and 5 vertebrates. The cave plays an important role as a winter habitat for bats. Colonies of *Rhinolophus hipposideros* vary from 2 to 121 individuals each year.

Presently, the investigated cave is threatened by contamination by rubbish associated with the high attendance of human visitors.

For its natural, scientific and historical importance, the authors recommend the protection of the cave and its surroundings as a national monument.

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Tab. 1. Overview of animal species recorded in the Cyrilka cave

Group	Family	Species
spiders (Araneida)	Agelenidae	*Tegenaria silvestris* (L. Koch, 1872)
	Tetragnathidae	*Meta menardi* (Latreille, 1804)
beetles (Coleoptera)	Carabidae	*Trechus pulchellus* (Putzeys, 1846)
	Leiodidae	*Catops longulus* (Kellner, 1846)
		Catops picipes (Fabricius, 1792)
moths (Lepidoptera)	Geometridae	*Triphosa dubitata* (Linnaeus, 1758)
	Noctuidae	*Scoliopteryx libatrix* (Linnaeus, 1758)
true flies and mosquitoes (Diptera)	Sphaeroceridae	*Crumomyia parentela alpicola* (Roháček in Troger & Roháček, 1980)
	Trichoceridae	*Trichocera regelationis* (Linnaeus, 1758)
vertebrates (Vertebrata)	Rhinolophidae	*Rhinolophus hipposideros* (Bechstein, 1800)
	Vespertilinidae	*Myotis myotis* (Borkhausen, 1797)
		Myotis emarginatus (É. Geoffroy, 1806)
		Myotis mystacinus (Kuhl, 1817)
		Myotis nattereri (Kuhl, 1817)
		Myotis daubentonii (Kuhl, 1817)
		Myotis bechsteinii (Kuhl, 1817)
		Plecotus auritus (Linnaeus, 1758)

Tab. 2. Summary of recorded invertebrates and their abundance in years 2013 and 2015

Group	Species	2013	2015
spiders (Araneida)	*Tegenaria silvestris* (L. Koch, 1872)	2	1
	Meta menardi (Latreille, 1804)	4	3
beetles (Coleoptera)	*Trechus pulchellus* (Putzeys, 1846)	2	3
	Catops longulus (Kellner, 1846)	1	-
	Catops picipes (Fabricius, 1792)	2	-
moths (Lepidoptera)	*Triphosa dubitata* (Linnaeus, 1758)	1	-
	Scoliopteryx libatrix (Linnaeus, 1758)	3	5
true flies and mosquitoes (Diptera)	*Crumomyia parentela alpicola* (Roháček in Troger & Roháček, 1980)	3	-
	Trichocera regelationis (Linnaeus, 1758)	3	4

Tab. 3. Summary of recorded hibernating bat species and their maximum abundance in each year (sources: WAGNER, 2001; J. Lenart (unpubl.); J. Kupka (unpubl.); J. Szalai (unpubl.) and J. Wagner (unpubl.))

Year	Species							
	Myotis bechsteinii	***Myotis daubentonii***	***Myotis emarginatus***	***Myotis myotis***	***Myotis mystacinus***	***Myotis nattereri***	***Plecotus auritus***	***Rhinolophus hipposideros***
1976	~	~	~	1	~	~	~	1
1977	~	1	~	3	1	~	~	10
1978	~	~	~	1	~	~	~	6
1979	~	~	~	35	3	~	~	6
1980	~	~	~	1	1	~	~	6
1981	~	~	~	~	1	~	~	6
1984	~	~	~	2	~	~	~	~
1987	~	1	1	2	~	~	~	2
1988	~	~	1	6	~	~	~	9
1989	~	2	~	15	1	1	~	9
1991	~	~	1	3	1	~	~	5
1993	~	~	~	7	~	~	1	17
1994	~	1	~	4	1	~	~	10
1995	~	~	~	5	1	~	~	8
1996	~	1	~	12	~	~	~	13
1997	~	2	1	11	6	~	2	23
1998	~	~	~	5	~	~	1	9
1999	~	~	~	1	~	~	~	11
2000	~	~	~	1	~	~	~	14
2001	~	~	~	1	~	~	~	10
2002	~	~	~	3	1	~	~	2
2003	~	2	~	6	1	~	~	32
2004	~	~	1	~	~	~	~	13
2005	1	~	1	4	1	~	~	45
2006	~	~	~	3	~	~	~	27
2007	~	~	1	~	~	~	~	64
2008	~	1	~	3	2	~	2	46
2009	~	~	2	2	1	~	~	24
2010	~	~	~	3	~	~	~	34
2011	~	~	1	7	1	~	~	8
2012	~	~	1	2	~	~	~	59
2013	~	~	~	15	~	~	~	74
2014	~	~	1	5	~	1	~	111
2015	~	~	1	6	2	~	~	121

Fig. 1. Regional setting: A – SRTM model of the broader area; B – High-resolution LiDAR-derived Digital Terrain Model (hillshade); highlighted area of clear topographic response to gravitational movement

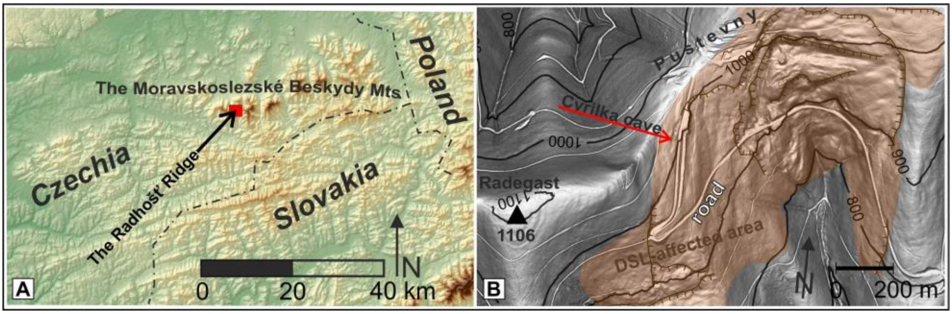

Fig. 2. Interior of the cave: A – Entrance Chamber with rotated rock blocks; B – Bedding Chamber; C – The Back Part; D – Colony of the little horseshoe bat (*Rhinolophus hipposideros*) in the Gilotina Chamber; E – Entrance (photos: J. Lenart (A–D), J. Wagner (E))

Fig. 3. Progress in the cave exploration – comparison of maps: A – TUČNÍK (1953); B – FOLDYNA (1968); C – PAVLICA (1966); D – WAGNER et al. (1990); E – recent cave plan by LENART (2012); a–e – changes/discoveries

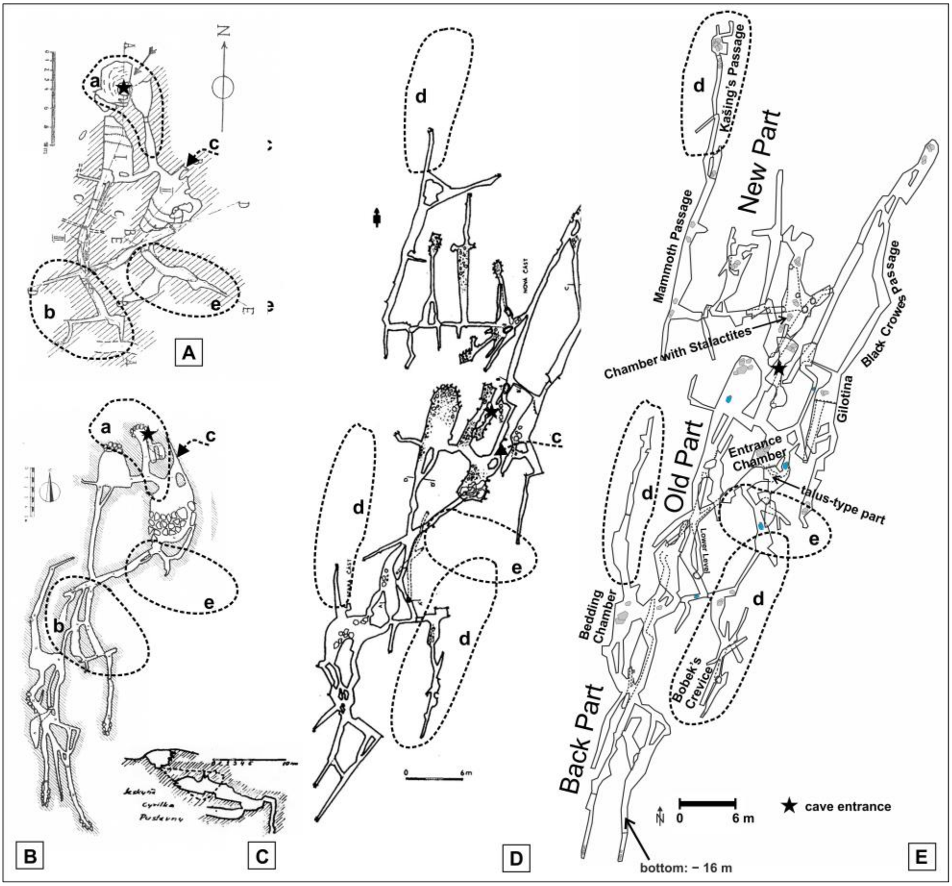

Fig. 4. Fauna of the Cyrilka cave: A – spider (*Tegenaria silvestris*); B – The European Cave Spider (*Meta menardi*); C – The Lesser Horseshoe Bat (*Rhinolophus hipposideros*); D – The Greater Mouse-eared Bat (*Myotis myotis*); E – The Tissue (*Triphosa dubitata*); F – The Herald (*Scoliopteryx libatrix*); Photos: A–E: J. Kupka, F: J. Lenart

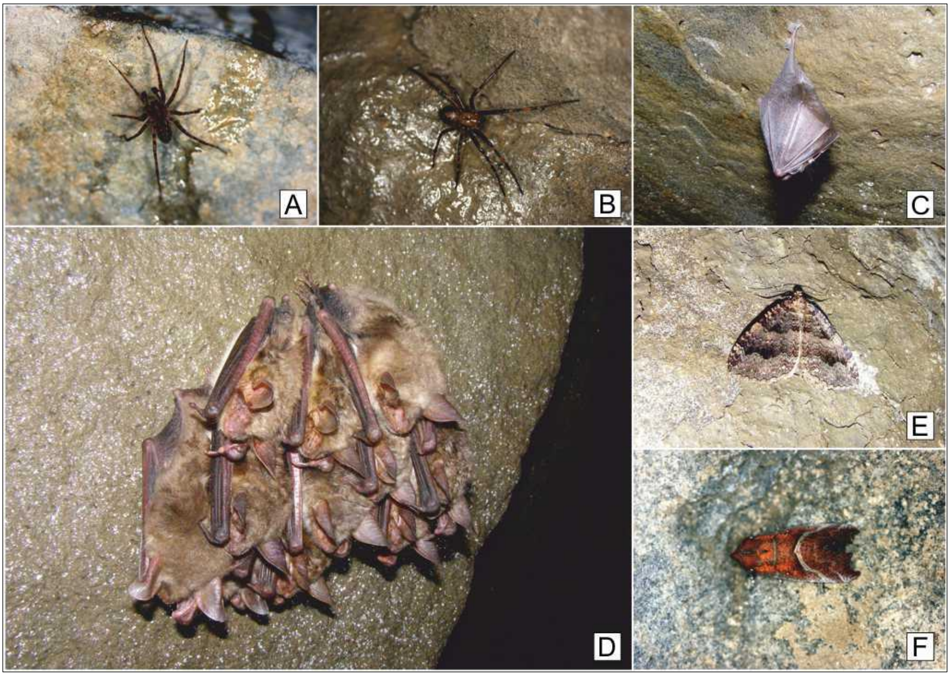

Fig. 5. Number of individual entrance visitors in 2014 – signings from the hidden cache