A survey of spiders (Araneae) inhabiting the euuedaphic soil stratum and the superficial underground compartment in Bulgaria

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Abstract: In 2005 a team of Bulgarian zoologists started a project aiming to study the invertebrates inhabiting the deeper soil stratum (euuedaphon) and the Superficial Underground Compartment (SUC) in Bulgaria. In the course of a four-year sampling, a total of 52 species of spiders were caught from 19 collecting sites and 9 geographical regions. They belong to the following families: Scytodidae (1), Segestriidae (1), Dysderidae (8), Nesticidae (1), Anaphidae (1), Theridiidae (1), Linyphiidae (20), Agelenidae (3), Cybaeidae (1), Dictynidae (2), Amaurobiidae (2), Liocranidae (3), Corinnidae (1), Zodariidae (1), Gnaphosidae (5), and Salticidae (1). The family Anapidae, with the species *Zangherella relicta* (Kratochvíl, 1935) is recorded from three sites in the Pirin and Slavyanka mountains, and this represents the first record of the family, genus and species in Bulgaria. In spite of the active investigations of the epigean and cave spiders in these regions over the years *Z. relicta* was not found and it seems it occurs only in deeper subterranean habitats and nowhere else. Comparative study of almost topotypic specimens of *Z. relicta* from Montenegro with those collected from Bulgaria showed no variation in the shape of palp and female vulvae. Until the true identity of *Z. apuliae* (Caporiacco, 1949) from Italy is revealed, it remains unclear whether *Z. relicta* and *Z. apuliae* are conspecific, as it remains unclear whether the older records of *Z. apuliae* from the Balkan Peninsula refer to this species or to *Z. relicta*. *Pelecopsis mengei* (Simon, 1884) (Linyphiidae) and *Scotolathys simplex* Simon, 1884 (Dictynidae) are also reported from Bulgaria for the first time, the latter being also new to FYR of Macedonia. A faunistic overview of the spiders found in these underground environments is made, along with remarks on the distribution and ecology of some rare and interesting species. The presence of cave-dwelling and superficial spiders in the sampled sites indicates that SUC and euuedaphon are inhabited by different ecotypes, e.g. litter- (tanathostromic), soil- (edaphic) and cave- (troglobitic) which at some places co-occur.

Key words: Anapidae, subterranean environments, troglomorphism, *Zangherella relicta*

There are various subterranean spaces that invertebrates inhabit. Depending mostly on their origins, size and distance from the surface one can distinguish different types of subterranean habitats, e.g. caves, lava tubes, microspaces in stony debris and scree, deep underground micro- and macropaces in the deeper gravel layers, etc. Each habitat has specific characteristics comprising temperature fluctuations, humidity, aeration, organic carbon levels, soil texture, etc. For instance daily temperature fluctuations exist in the surface of scree slopes and stony debris, while they cease completely at one-meter depth and after several dozens of metres inside large caves (RŮŽIČKA 1999). Organic carbon levels are higher in the Superficial Underground Compartment (SUC) than in caves (CULVER & PIPAN 2009). Animals that are adapted to living in complete darkness and with limited energy supplies usually acquire a specific appearance that includes depigmentation, micro- or anophthalmy, loss of wings, elaboration of extra-optic sensory structures, elongation of appendages (in cases of troglobionts) or shortening of appendages (in case of geobionts), cuticle thinning, etc. These morphological alterations known as troglomorphy are widespread in subterranean animals (CHRISTIANSEN 1962). Some species that inhabit SUC and deeper soil strata and have adapted to dwelling in these aphotic environments may have given rise to species occurring in caves (CULVER & PIPAN 2009). The vertical distribution of arthropods in the soil depends on the porosity of soil, soil type, temperature and humidity, as well as the amount of organic matter (LASKÁ et al. in press).

JUBERTIE et al. (1980) defined and described (in French) as the “Milieu Souterrain Superficiel” (MSS) one of the subterranean habitats where they found several troglomorphic invertebrates. In publications in English this particular environment is referred to as the “Superficial Underground Compartment” (SUC) or “Mesocavernous Shallow Stratum” (MSS) (Figs. 1-2). In addition to its geomorphologic structure,
the SUC has specific microclimatic and hydrological characteristics. According to JUBERTHIE & DECU (1994) the SUC exists as interconnected microspaces in valley versant scree or similar fissures in the superficial zone of maternal rocks. It connects with other profound subterranean environments like caves by way of deep fissures (NEGREA & BOITAN 2001). It is also believed that the SUC represents an intermediate stratum where litter- (tanathostromic), soil- (edaphic) and cave- (troglobitic) species may occur together. Furthermore, several SUC specialists highly adapted to subterranean manner of life inhabit the SUC and never penetrate into epigeic habitats. An example of such species is the beetle *Speonomus hygrophylus* Jeannel, 1907 (cf. CULVER & PIPAN 2009).

The euedaphic [from the Greek words “eu-” (= good) and “edaphos” (= land, earth)] soil stratum, also known as endogeic stratum is composed of mineral soil, just beneath the humus layer (cf. NEGREA & BOITAN 2001).

The most serious contribution to the study of subterranean spiders and in particular those living in the stony debris and scree in Central Europe was made by Vlastimil RŮŽIČKA, who studied the underground spider assemblages in the Czech Republic, Romania, Montenegro and Austria (see e.g., RŮŽIČKA 1989, 1992; RŮŽIČKA & THALER 2002). However, this subject received very little attention in the other parts of Europe, and yet our knowledge of the underground spider assemblages in biodiversity-rich regions such as the Balkan Peninsula remains perfunctory. A profound review of spiders living in caves and hypogeic environments can be found in RIBERA & JUBERTHIE (1994).

The spiders living in superficial, hemiedaphic and cave environments in Bulgaria have been studied
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quite well for almost 120 years (see e.g., DELTSHEV & BLAGOEV 2003). At the same time though very little is known about the spiders inhabiting the strata below the upper soil layer, scree slopes, stony debris, and the network of micro-crevices in the maternal rock.

In 2005 a team of Bulgarian zoologists started a four-year project aiming to study the invertebrates inhabiting the subterranean environments in Bulgaria. Data resulting from this project have been published partially in taxonomic papers dealing with true bugs (SIMOV 2008), beetles (BEKCHIEV 2008; GUÉORGUIEV & BEKCHIEV 2009) and millipedes of the Acanthopetalum richii (Gray, 1832) group (STOEV 2008). Additionally, LAZAROV (2007) described the female of Harpactea srednagora Dimitrov & Lazarov, 1999 (Araneae: Dysderidae), a spider which was collected exclusively from subterranean habitats in Bulgaria. In other publications, LAZAROV & NAUMOVA (2010) and DELTSHEV et al. (in press), one further dysderid species was described from such environments in the Slavyanka and the Rhodopes mountains, and the thomisid spider Cosyptila thaleri Marusik & Kolvlyuk, 2005 was reported for the first time from the country. The aim of the present study is to put on record the results of the study of the spiders inhabiting the SUC and the euedaphic soil stratum in Bulgaria.

Material and Methods

The investigation was carried out in the period April 2006 – June 2009. Forty-three traps were set in the mountains of Vitosha, Pirin, Slavyanka, Belasitsa, Ruj, Western Rhodopes, Ichtimanska and Sashtinska Sredna Gora, and the Derventsky Heights (Fig. 3, Table 1). The trap was made of a PVC pipe with a diameter of 8 cm and two different lengths: 60 and 80 cm, respectively (Fig. 4). 108 holes with a diameter of 8 mm were made in the pipe, at a distance of 10 cm from its lower end (Fig. 4) and covering nearly 1/3 of its total length. A hole of 60 to 80 cm depth was dug in the ground where the pipe was placed vertically. After the proper positioning of the pipe, the space between the pipe and the hole was filled up, initially with gravel to the upper level of the holes and subsequently with soil and other particles up to the top of the pipe. A 10-centimetre plastic pot tied to a polythene rope was put at the bottom of the pipe. The pot was filled with etyenglycol with a few drops of formalin. The trap was covered tightly with a solid plastic cover and additionally with soil, tufts of grass and leaves to prevent penetration by the superficial fauna and infiltration of water during pouring rain. Description of each collecting site and the traps is given in Table 1. Usually, traps were checked and emptied once every three months, sometimes once or twice a year. All material was sorted down to a species level and put into 70% spirit. The entire collection is preserved in the Institute of Zoology, Bulgarian Academy of Sciences (IZ). Almost topotypic material of Zangherella relicta (Kratochvil, 1935) was obtained for study from the Senckenberg Museum Frankfurt (SMF). All drawings were made with a camera lucida mounted on a Wild stereoscope. Nomenclature follows PLATNICK (2010).

Results

A total of 52 species of spiders from 19 collecting sites and 9 geographical regions was collected. They belong to the following families: Scytodiidae (1), Segestriidae (1), Dysderidae (8), Nesticidae (1), Anapidae (1), Theridiidae (1), Linyphiidae (20), Agelenidae (3), Cybaeidae (1), Dictynidae (2), Amaurobidae (2), Liocranidae (3), Corinnidae (1), Zodariidae (1), Gnaphosidae (5), and Salticidae (1). The family Anapidae, with the species Zangherella relicta (Kratochvil,
1935), as well as the species *Pelecopsis mengei* (Simon, 1884) (Linyphiidae) and *Scotolathys simplex* Simon, 1884 (Dictynidae) are recorded for the first time from Bulgaria (Tab. 2).

**Interesting records of new or rare species**

**Dysderidae**

Dysderids are frequent in underground habitats and in leaf-litter, and prefer warm and humid environmental conditions. Whilst there are very few cave records in Bulgaria, dysderids are quite often found in caves elsewhere and some species are even cave specialists, which have become adapted to this particular environment (e.g. CHATZAKI & ARNEDO 2006). In Bulgaria only *Harpactea babori* (Nosek, 1905) has been recorded from caves (DELTCHEV et al. 2003). Nevertheless, the family is well represented in the SUC and euedaphic stratum (Table 2), whereby species like, e.g., *Harpactea srednogora*, *H. deltshevi* and *Dysdera longirostris*, were found at several sites and were among the most abundant species in the traps. Besides depigmentation, none of the dysderids found in the underground habitats possess obvious troglobiotic features to be categorized as representing strictly geo- or troglobiontic ecomorphotypes.

**Nesticidae**

*Nesticus cellulanus*

Members of the family Nesticidae are prone to colonize shallow or deep subterranean spaces. KRA-TOCHVIL (1933) described several morphological alterations in nesticids resulting from their subterranean manner of living. Out of the three species of *Nesticus* hitherto known from Bulgaria, in the SUC and euedaphic stratum we have only found *N. cellulanus*. This species is widespread throughout the country, and is among the most common spiders in Bulgarian caves (DELTCHEV et al. 2003, DELTSHEV & PETROV 2008). In the Czech Republic it occurs in shallow subterranean spaces in scree, cave entrances, and buildings (BUCHAR & RŮŽÍČKA 2002).

**Anapidae**

**Zangherella relicta** (Figs. 5-13)

*Pseudanapis relicta* Kratochvil, 1935: 18, pl. 1, f. 7-12. Type locality: Montenegro: 1 ♂, 1 ♀. *=?Pseudanapis apuliae* sensu BRIGNOLI 1974, 1977, 1978, 1984, THALER & KNÖFEL 1998, nec CAPORIACCO 1949a: 4, f. 3-6.

**Material examined.** MONTENEGRO: 1 ♂, 1 ♀, Herceg Novi, Monastir Savina (Kotor Distr.), N42°27′12.5″, E18°33′12.5″, 50 m a.s.l., 11.VI.2006, A. Schönhofer leg. (SMF). BULGARIA: 3 ♂♂, 2 ♀♀, Pirin Mts., village of Gospodints, collecting site PE, 5.V.2007, P. Stoev leg.; 2 ♂♂, Slatyanka Mts., village of Kalimantsi, collecting site S-2, 19.VI-13.VII.2007, M. Langourov and N. Simov leg. (IZ). 2 ♀♀, Slatyanka Mts., Livade, collecting site S-1, 1.VII-1.VIII.2007, N. Simov leg.

**Diagnosis.** Anterior median eyes absent; the palpal organ complex: cymbium and tibia fused, tegulum
| No. | No of traps | Station | Trapping period | Geographical area | Description |
|-----|-------------|---------|----------------|-------------------|-------------|
| 1.  | 1           | VN-1    | 29.IV.2006     | Vitosha Mts.      | Northern slope, above Boyana, Boyanski kamak place, at the bottom of a 4-5 m deep microwave; dry, alt. ca 850 m; N 42°38’26.8” E23°16’32.1”; UTM FN82; samples taken at 50-60 cm depth. |
| 2.  | 2           | VN-2    | 30.IV.2006     | Vitosha Mts.      | Northern slope, two traps set ca. 30-35 m above Boyanski kamak, scree in mixed forest of Fagus sylvatica and Carpinus betulus; alt. ca 850 m; N42°38’26.8” E23°16’32.1”; UTM FN82; samples taken at 40-50 cm depth. |
| 3.  | 3           | VW      | 10-24.VI.2006  | Vitosha Mts.      | Western slope, three traps set near the cave Duhlata, village of Bosnek, limestone, stony substrate mixed with clay, alt. ca 950 m; N42°29’582”, E23°11’727”; UTM FN80; samples taken at 40-70 cm depth. |
| 4.  | 1           | VE      | 27.V.2006      | Vitosha Mts.      | Eastern slope, ca 28 km south of Sofia, on the road Sofia-Samokov, Yarema place; forest of Fagus sylvatica, in a stony, sandy substrate, humid, alt. ca 1400 m; UTM FN90; N42°30’289” E23°19’262”; samples taken at 60-70 cm depth. |
| 5.  | 2           | PW      | 7.V.2006       | Pirin Mts.        | Western slope, two traps set in the Zandana place, above village of Ilindentsi, limestone, scree, dry soil/ sandy substrate, alt. ca 500 m; N41°39’022” E23°15’156”; UTM FM81; samples taken at 40-60 cm depth. |
| 6.  | 1           | PN-1    | 24.V.2006      | Pirin Mts.        | Northern slope, ca 6 km before Predela, humid ravine, Fagus sylvatica forest, at the base of a Fagus tree, thick layer of leaf litter, humid soil mixed with stones, alt. ca 680 m; N41°55’134” E23°15’696”; UTM FM84; samples taken at 40-50 cm depth. |
| 7.  | 1           | PN-2    | 24.V.2006      | Pirin Mts.        | Northern slope, ca 150-200 m of the Baikushevata mura place on the way to hut Vihren, at the base of a scree, subalpine vegetation with scattered Pinus mugo trees, alt. 1900 m; N41°45’980” E23°25’233”; UTM GM03; samples taken at 40-50 cm depth. |
| 8.  | 1           | PE      | 25.V.2006      | Pirin Mts.        | Eastern slope, 3 km before village of Gospodints, Gotse Deltshev District, approx. 30 m sideward of the main road Bansko-Gotse Deltshev and ca 5-6 m off a small river; in a scree at the base of limestone rocks, close to a tree; alt. ca 600 m; N41°40’725” E23°43’502”; UTM GM21; samples taken at 40-50 cm depth. |
| 9.  | 3           | PS      | 25.V-18.VI.2006| Pirin Mts.        | Southern slope, Popovi livadi Place, three traps set in a marble stone debris sideward the road and in a small valley with Fagus forest; alt. ca 1370-1560 m; N41°33 E23°37; UTM GM10; samples taken at 30-50 cm depth. |
| 10. | 3           | WR-1    | 23.IV.2006     | West Rodoopes Mts.| Central parts, three traps set ca 1100 m after the crossroad to village of Borovo towards the village of Belitsa; on the left side of the road, in a small rocky valley overgrown with bushes and Pinus nigra, ca 50 m sideward the road, alt. ca 650 m; N41°50’332” E24°51’533”; UTM LG23; samples taken at 30-70 cm depth. |
| 11. | 1           | WR-2    | 14.VII.2007    | West Rodoopes Mts.| Southern parts, near village of Koshnitsa, below the cave Uhlovitsa; right side slope, above the path, at the foot of hornbeam bushes, not far from an old Fagus sp. tree, humid and shady place, gravels in the soil, alt. ca 900 m; N41°30’802” E24°39’590”; UTM LF09; samples taken at 60-70 cm depth. |
| 12. | 3           | EG      | 11.VI.2006     | Ruj Mts.          | Erma Gorge, ca 3 km of Tran Town, three traps set in close proximity to the tunnel; limestone, slope overgrown with hazel bush, ash-trees; rocky substrate, at the foot of rocks; alt. ca 700 m; N42°51’665”, E22°38’949”; UTM FN34; samples taken at 40-50 cm depth. |
voluminous, spermophore with many coils, embolic division consisting of filiform embolus and conductor (Figs. 5–8).

**Description.** See e.g., **KRATOCHVÍL** (1935), **THALER & KNOFLACH** (1998).

**Remarks.** Anapidae comprises araneoid spiders occurring in leaf-litter and moss on the ground of moist forests. The family has its highest diversity in the tropics, with only a few patchy distributed genera and species in the Holarctic region (PLATNICK & FORSTER 1989). Only two genera out of 38, namely *Comaroma* Bertkau, 1889 (1 species) and *Zangherella* Caporiacco, 1949 (3 species), occur in Europe (PLATNICK 2010).

**KRATOCHVÍL** (1935) described *Pseudanapis relicta* from a cave in the surroundings of Kotor, Montenegro. Later **CAPORIACCO** (1949a) described *Pseudanapis apuliae* from a cave in the surroundings of Orando, Italy. The genus *Zangherella* Caporiacco, 1949 was erected by **CAPORIACCO** (1949b) to accommodate the species *Z. minima* from Libya. **BRIGNOLI** (1968) re-described *Z. apuliae* and suggested that it might be a junior synonym of *P. relicta*. In another publica-

| No | No of traps | Station | Trapping period | Geographical area | Description |
|----|-------------|---------|----------------|------------------|-------------|
| 13. | 1 | S-1 | 4.VII.2006 | Sveti Iliya Mts. | Livade place near the village of Goleshevo; limestone slope in a *Pinus* forest; ca 1700 m, N41°23′53″, E23°36′30″; UTM GL18; samples taken at 40–50 cm depth. |
| 14. | 1 | S-2 | 8.VI.2006 | Sveti Iliya Mts. | Sveti Iliya place near the village of Kalimantsi; close to the chapel, below *Quercus coccifera* trees, alt. ca 500 m; N41°27′61″, E23°29′44″; UTM GL09; samples taken at 40–50 cm depth. |
| 15. | 2 | S-3 | 27.VI.2006 | Sveti Iliya Mts. | Peshternik place, two traps set near the village of Kalimantsi; travertine, below *Salix* sp. and *Corylus* sp., alt. 380 m; N41°27′56″, E23°29′68″; UTM GL09; samples taken at 40–60 cm depth. |
| 16. | 1 | BE | 13.VI.2008 | Belasitsa Mts. | Near the village of Kamena, on the right side coast of the river Kamenitsa, *Platanus orientalis* forest, scree, ca 40 m above the river, alt. ca 530 m; N41°21′46″ E23°04′47″; UTM FL78; samples taken at 60–70 cm depth. |
| 17. | 4 | SG-1 | 29.IV.2006 | Sashtinska Sredna Gora Mts. | Sveti Ivan place near Panagyurishte Town, four traps set in abandoned vineyard overgrown with scattered *Prunus* sp. trees and blackberries and in forest of *Pinus nigra*; deep soil layer, alt. ca 600 m; N42°31′00″, E24°11′03″; UTM KH60; samples taken at 40–90 cm depth. |
| 18. | 2 | SG-2 | 23.VI.2008 | Ichtimanska Sredna Gora Mts. | Small church ca 2 km of village Smolsko, two traps set in front of the entrance of a small cave and in a scree close to the road, mixed broad leaved forest, alt. ca 600 m; N42°39′17″, E23°55′11″; UTM GN42; samples taken at 40–70 cm depth. |
| 19. | 1 | DH | 10.V.2007 | Derventsky Heights | Village of Dennitsa, close to the main motorway to the village of Stefan Karadzhovo, Yambol District, sink-hole in *Quercus* forest, at the base of a large stone; alt. ca 360 m; N42°15′47″, E26°49′50″; UTM MG87; samples taken at 40–50 cm depth. |
Spiders inhabiting soil and underground in Bulgaria made it possible to compare vis-a-vis the available specimens. We were not able to find any reliable differences between the Montenegrin and Bulgarian specimens when studying the structure of the vulva and the male palp (compare Figs. 5-6, 9-10 with 7-8, 11-12). They also correspond well with the illustrations of specimens of Z. apuliae reported by THALER & KNOFLACH (1998) from Greece. We were not able to obtain comparative material of Z. apuliae from Italy nor to examine the type material and could not decide whether the two species, relicta and apuliae are conspecific, as presumed by BRIGNOLI (1968). Combined molecular and morphological analysis is required to determine whether Z. apuliae is a valid species of a possibly restricted distribution in the Apennines or whether there is only one valid species, Z. relicta, distributed from the Apennines to Asia Minor.
Table 2: List of the spiders found in the euedaphic soil stratum and the SUC in Bulgaria.

| Species                  | VN-1 | VN-2 | VW | VE | PW | PN-1 | PN-2 | PE | PS | WR-1 | WR-2 | EG | S-1 | S-2 | S-3 | BE | SG-1 | SG-2 | DH |
|--------------------------|------|------|----|----|----|------|------|----|----|------|------|----|----|----|----|----|------|------|----|
| Scytodidae               |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Scytodes thoracica (Latreille, 1802) | X    |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Segestridae              |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Segestria senoculata (Linnaeus, 1758) | X    |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Dysderidae               |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Dysderia hungarica Kulczyński, 1897 | X    |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Dysderia longirostris Doblka, 1853 | X    | X    |    |    |    |      |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Harpactea deltshevi Dimitrov & Lazarov, 1999 | X    | X    | X  |    |    |      |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Harpactea pr. deltshevi |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Harpactea mentor Lazarov & Naumova, 2010 | X    |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Harpactea saeva (Herman, 1879) | X    |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Harpactea samuili Lazarov, 2006 | X    |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Harpactea sredgnagora Dimitrov & Lazarov, 1999 | X    | X    | X  | X  | X  | X    |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Nesticidae               |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Nesticus cellulanus (Clerck, 1757) | X    |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Anapidae                 |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Zangherella relicta (Kratochvil, 1935) | X    |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Theridiidae              |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Robertus mediterraneus Eskov, 1987 |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Linyphiidae              |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Antrobyphantes rhodopenis (Drensky, 1931) | X    |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Centrometerus acutidentatus Deltshev, 2005 | X    | X    |    |    |    |      |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Centrometerus capucinus (Simon, 1884) |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Centrometerus cavernarum (L. Koch, 1872) | X    |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Centrometerus lakatnikensis (Drensky, 1931) | X    | X    | X  | X  | X  | X    |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Centrometerus milleri Deltshev, 1974 |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Diplostyla concolor (Wider, 1834) | X    | X    | X  | X  | X  | X    |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Lepthyphantes centromeroides Kulczyński, 1914 |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Lepthyphantes leptosus (Ohlert, 1865) | X    | X    | X  |    |    |      |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Mansuphantes mansuetus (Thorell, 1875) |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Miocosa blanda (Simon, 1884) |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Palliduphantes alutacius (Simon, 1884) | X    | X    |    |    |    |      |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Palliduphantes istrianus (Kulczyński, 1914) | X    | X    |    |    |    |      |      |    |    |      |      |    |    |    |    |    |      |      |    |
| Species | VN-1 | VN-2 | VW | VE | PW | PN-1 | PN-2 | PE | PS | WR-1 | WR-2 | EG | S-1 | S-2 | S-3 | BE | SG-1 | SG-2 | DH |
|---------|------|------|----|----|----|------|------|----|----|------|------|----|----|----|----|----|-----|-----|----|
| *Palliduphantes spelaeorum* (Kulczyński, 1914) |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| *Palliduphantes trnovensis* (Drensky, 1931) |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| *Pelecopsis mengei* (Simon, 1884) |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| *Sintula retroversa* (O. P.-Cambridge, 1875) |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| *Tenuiphantes tenuis* (Blackwall, 1852) |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| *Walckenaeria antica* (Wider, 1834) |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| *Walckenaeria mirata* (Menge, 1868) |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| **Agelenidae** |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| *Histopona tranterei* Deltchev, 1978 |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| *Tegenaria domestica* (Clerck, 1757) |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| *Malthonica silvestris* (L. Koch, 1872) |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| **Cybaeidae** |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| *Cybaeus balkanus* Deltchev, 1997 |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| **Dictynidae** |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| *Cicurina cicur* (Fabricius, 1793) |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| *Scotolathys simplex* Simon, 1884 |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| **Amaurobiidae** |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| *Eurocoelotes brevispinus* (Deltchev & Dimitrov, 1996) |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| *Eurocoelotes jurinitschi* (Drensky, 1915) |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| **Liocranidae** |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| *Agroca cuprea* Menge, 1873 |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| *Apostenus fuscus* Westring, 1851 |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| *Sagana rutilans* Thorell, 1875 |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| **Corinnidae** |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| *Phrurolithus festivus* (C.L. Koch, 1835) |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| **Zodariidae** |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| *Zodarion pirini* Drensky, 1921 |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| **Gnaphosidae** |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| *Drassyllus villicus* (Thorell, 1875) |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| *Echemus angustifrons* (Westring, 1861) |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| *Gnaphosa modestior* Kulczyński, 1897 |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| *Trachyzelotes pedestris* (C.L. Koch, 1837) |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| *Zelotes erebeus* (Thorell, 1871) |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| **Salticidae** |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
| *Euophrys frontalis* (Walckenaer, 1802) |      |      |    |    |    |      |      |    |    |      |      |    |    |    |    |    |   |    |
Distribution: Z. relicta is known from the cave Golobrazhnitsa and Herceg Novi, Kotor District, Montenegro (KRATOCHVÍL 1935, present study) and the mountains Pirin and Slavyanka in Bulgaria (present study). Records, possibly referable to Z. relicta (all sub Z. apuliae): Greece: Epirus (BRIGNOLI 1977, 1984), Corfu, Lefkada, Cephalonia (BRIGNOLI 1974, THALER & KNOFLACH 1998); Turkey: v. Salihli, Manisa (BRIGNOLI 1978).

Linyphiidae

Antrohyphantes rhodopensis
This species was hitherto known only from caves of the Western Rhodope Mts. and from the orophyte zone of the Rila and Pirin mountains (DELTSHEV 1996, DELTSHEV & PETROV 2008). Its presence in subterranean environments in southern Pirin adds very little to its geographical distribution but shows that the species is a subterranean specialist which is likely to be restricted to colder microhabitats and suitable humidity.

Centromerus milleri
This species was hitherto known only from Dupnitsa cave in the Strandzha Mts., the European part of Turkey (anophthalmic population, Deltshev, unpublished), Maronia cave in north-eastern Greece, several caves in the Eastern Rhodope Mts. and Stapalkata Cave in the Western Rhodope Mts., Bulgaria (DELTSHEV & PETROV 2008). The new record from the Ruj Mts. significantly extends its range in north-western direction and indicates a possibly wider distribution. The anophthalmic population in the cave Dupnitsa is of special interest, as it might represent a new, closely related troglobitic species. A molecular study of the different populations may reveal the routes of colonization, specialization and evolution of the species in the different parts of its distribution area. The Ruj population does not show any obvious morphological difference from the other Bulgarian population.

Centromerus acutidentatus
The species belongs to the sylvaticus-group of the genus Centromerus Dahl, 1886 and is currently known from caves in Bulgaria, FYR Macedonia and Serbia (DELTSHEV & ĆURČIĆ 2002). As well as in caves, the species has also been found in the detritus of forests, and now also in the Vitosha Mts. at a depth of 40-60 cm.

Centromerus cavernarum
This species is known in Bulgaria from 10 caves in the West Rhodope Mts. (Lepenitsa, Zmiin Burun, Chelovshkata peshtera), Stara Planina Mts. (Prelaz, Prikazna, Zlatnata peshtera), Pirin Mts. (Starshe-litsa), Strandzha Mts. (Hambarcheto) and the Predbalkan (Bacho Kiro, Gurlyova dupka) (BERON 1994, DELTSHEV et al. 2003), as well as from other subterranean soil habitats. It occurs among detritus and deep under stones in beech and spruce forests, in void systems, and in scree (LASKA et al. in press). It is also quite common in caves in the Czech Republic and Slovakia (cf. RŮŽIČKA 2007).

Lepthyphantes centromeroides
This species is comparatively widespread on the Balkan Peninsula and can be considered as an example showing the process of cave colonization and subterranean adaptation. It occurs in caves, but also in the humus and ground detritus (DEELEMAN-REINHOLD 1978: 196-200).

Genus Palliduphantes Saaristo & Tanasevitch, 2001
The genus is represented in Bulgaria by 6 species: Palliduphantes alutacius, P. istrianus, P. pallidus, P. pillichi, P. spelaeorum and P. trnovensis. They are characteristic and widespread in caves and occur also in humus and ground detritus (DELTSHEV 1980, DELTSHEV & PETROV 2008).

Pelecopsis mengei
The species is widespread in the Holarctic region (PLATNICK 2010), and this represents the first record from Bulgaria. So far it is known only from the region of Panagyurishte, where it was found in the soil at a depth of 40-90 cm.

Agelenidae

Histopona tranteevi
So far this species was known only from a few caves in the Western Rhodope Mts. (DELTSHEV & PETROV 2008). The new records from subterranean habitats in Ruj, the Western Rhodopes and Slavyanka mountains suggest that it is much more widespread than previously thought. The species is obviously inclined to dwell in semiaphotic and aphotic environments. The Ruj locality lies quite apart from the other two and suggests that the species also occur in similar habitats in Serbia.
Dictynidae

Cicurina cicur

The majority of the species of the genus Cicurina (Cicurella) Chamberlin & Ivie, 1940 show a clear preference for life in subterranean environments, as just in North America over 60 cave-dwelling species with a different degree of cave adaptation have been described (PAQUIN & DUPERRÉ 2009). C. cicur is the only representative of this genus in Europe. As well as in subterranean habitats, it was also recorded from caves in Eastern Bulgaria (Shumen Distr. and Strandzha Mts.). It also lives under stones, in leaf-litter and in decaying wood in micropores with high humidity (BUCHAR & RŮZIČKA 2002). In Germany it is active in winter (Blick pers. comm.).

Scotolathys simplex

Besides the underground samples, the species was also recently found from epigeic habitats near the village of Kamenitsa, Maleshevska Planina Mts., SW Bulgaria N 41.6496°, E 23.1607°, alt. 200 m (1♂, 1♀, 12.VI.2005, S. Lazarov leg.) and from FYR of Macedonia (2♀♂, Veles Town, near Mladost Lake, N 41.7755°, E 21.755°, alt. 240 m, 19.IV.2002, S. Lazarov leg.), which are the first records of this genus and species from both countries. The species is widely distributed in the Mediterranean region, being hitherto known from Algeria, Greece, Bulgaria, FYR of Macedonia, Spain and Ukraine (MARUSIK et al. 2009, PLATNICK 2010). GERTSCH (1946) suggested the synonymy of the genus Scotolathys Simon, 1884 with the genus Latbys Simon, 1884, but the former was recently resurrected by MARUSIK et al. (2009).

Discussion

Twenty-five per cent of the spiders (13 species) found in the SUC and euedaphon stratum are also known from caves. All of them show one or more troglomorphic traits (Table 3) and thus they could be considered true hypogelicolous animals (subterranean specialists). The remaining species are either surface dwelling (e.g. Eurocoelotes jurinitschi, Gnaphosa modestior) species or they had accidentally fallen in the traps when they were laid (Euophrys frontalis).

In a survey of the spiders living in deeper soil layers in the Czech Republic, LASKA et al. (in press) found 48 species of spiders, of which five, Palliduphantes alutaceus, Centromerus casernarum, Diplostyla concolor, Nesticus cellulanus, and Cicurina cicur, the authors considered more or less bound to subterranean environments. P. alutaceus was found to occur at a maximum depth of 95 cm, C. casernarum at 75 cm, D. concolor at 15 cm, and both N. cellulanus and C. cicur at 85 cm. These species were also found during our study, as D. concolor was found at 8 collecting sites. Another frequently collected species was Harpactea srednagora, which was found at 11 sites.

Of all the species found in the SUC and euedaphon only Anthrobyphantes rhodopenis, Centromerus milleri and Zangherella relicta have a distinct troglo-morphic appearance. All three are also known from caves. If we adopt the recent classification of subterranean biota (SKET 2008), where troglobionts are defined as "strongly bound to hypogean habitats", then the species mentioned above should be considered troglobionts. However, there are some alternative classifications of the subterranean animals, e.g. that of DECU et al. (2006) who distinguish between hypogelicolous and cavernicolous fauna, and further subdivide the former category into colluviotroglobitic, eluviotroglobitic, cleitrotroglobitic and volcanotroglobitic, based on the origins and texture of the substrate (colluvic, eluvic, cleitric and volcanic MSS, respectively). According to the latter classification Zangherella relicta, which was found only at a depth of 40-50 cm, could be considered a true colluviotroglobite, if it is proved that in Bulgaria it occurs only in the SUC and is absent in caves or superficial soil layers. Histopona tranteevi and Centromerus milleri were hitherto known only from a limited number of caves (DELTSHEV & PETROV 2008) but turned out to also live below 30 cm depth in the SUC and euedaphon. It is evident that the boundary between true troglobionts and true geobionts is very vague and there is no unequivocal tool for identifying to which of these two categories an animal belongs. Table 3 summarizes the distribution of the species found in subterranean habitats in Bulgaria and provides information on their troglomorphic traits. There are several highly adapted cavernicolous species such as Centromerus bulgarianus and Troglobyphantes drenskii, which are so far unknown from soil strata and the SUC and might thus represent true cave-dwellers. Other troglomorphic species, which are usually considered either eutroglophiles or troglobites, such as Centromerus cavernarum, C. lakatnikensis, C. milleri, Leptyphantes centromeroides, Palliduphantes istrianus, P. spelaeorum and P. trnovenus have been recorded from both caves and deeper soil strata and their habitat preferences are in need of more profound studies.
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Table 3: List of the cave-dwelling and subterranean spiders in Bulgaria with their troglomorphic traits and habitats inhabited.

| Taxa                        | Deep Cave | Shallow cave; Cave entrances | Euedaphon and SUC | Troglomorphic traits                      |
|-----------------------------|-----------|------------------------------|-------------------|-------------------------------------------|
| Leptonetidae                |           |                              |                   |                                           |
| *Protoleptoneta bulgarica*  | +         |                              |                   | Depigmentation, elongation of legs        |
| Delshev, 1972               |           |                              |                   |                                           |
| *Protoleptoneta beroni*     | +         |                              |                   | Depigmentation, elongation of legs        |
| Delshev, 1977               |           |                              |                   |                                           |
| Nesticidae                  |           |                              |                   |                                           |
| *Nesticus beroni*           | +         |                              |                   | Depigmentation, microphthalmy, elongation of legs |
| Delshev, 1977               |           |                              |                   |                                           |
| *Nesticus cellulanus*       | + +       |                              |                   | Partial depigmentation, elongation of legs |
| (Clerck, 1757)              |           |                              |                   |                                           |
| *Nesticus eremita*          | +         |                              |                   | Depigmentation, elongation of legs        |
| Simon, 1879                 |           |                              |                   |                                           |
| Anapidae                    |           |                              |                   |                                           |
| *Zangherella relicta*       | +         |                              |                   | Depigmentation, microphthalmy, dwarfism   |
| (Kratochvil, 1935)          |           |                              |                   |                                           |
| Theridiidae                 |           |                              |                   |                                           |
| *Robertus frivaldszkyi*     | +         |                              |                   | Depigmentation                            |
| (Chyzer, 1894)              |           |                              |                   |                                           |
| Linyphiidae                 |           |                              |                   |                                           |
| *Antrohyphantes balcanicus* | +         |                              |                   | Depigmentation, microphthalmy, elongation of legs |
| (Drensky, 1931)             |           |                              |                   |                                           |
| *Antrohyphantes rhodopensis*| + + +     |                              |                   | Depigmentation, microphthalmy, elongation of legs |
| (Drensky, 1931)             |           |                              |                   |                                           |
| *Antrohyphantes sophianus*  | +         |                              |                   | Depigmentation, microphthalmy, elongation of legs |
| (Drensky, 1931)             |           |                              |                   |                                           |
| *Centromerus acutidentatus* | + + +     |                              |                   | Depigmentation, anophthalmy               |
| Delshev, 2005               |           |                              |                   |                                           |
| *Centromerus bulgarianus*   | +         |                              |                   | Depigmentation                            |
| (Drensky, 1931)             |           |                              |                   |                                           |
| *Centromerus capucinus*     | + +       |                              |                   | Depigmentation                            |
| Simon, 1884                 |           |                              |                   |                                           |
| *Centromerus cavernarum*    | +         |                              |                   | Depigmentation                            |
| (L. Koch, 1872)             |           |                              |                   |                                           |
| *Centromerus lakatnikensis* | +         |                              |                   | Depigmentation                            |
| (Drensky, 1931)             |           |                              |                   |                                           |
| *Centromerus milleri*       | + + +     |                              |                   | Depigmentation, anophthalmy, microphthalmy |
| Delshev, 1974               |           |                              |                   |                                           |
| *Diplocephalus foraminifer* | + +       |                              |                   | Depigmentation                            |
| (O.P.- Cambridge, 1875)     |           |                              |                   |                                           |
| *Diplostyla concolor*       | +         |                              |                   | Depigmentation                            |
| (Wider, 1834)               |           |                              |                   |                                           |
| *Lepthyphantes centromeroides* | +         |                              |                   | Depigmentation, elongation of legs         |
| Kulczyński, 1914            |           |                              |                   |                                           |
| *Lepthyphantes leprosus*    | + +       |                              |                   | Partial depigmentation, elongation of legs |
| (Ohlert, 1865)              |           |                              |                   |                                           |
| *Microctenonyx subitaneus*  | + +       |                              |                   | Depigmentation                            |
| (O.P.- Cambridge, 1875)     |           |                              |                   |                                           |

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| Taxa                                      | Deep Cave | Shallow cave; Cave entrances | Euedaphon and SUC | Troglomorphic traits              |
|-------------------------------------------|-----------|------------------------------|-------------------|-----------------------------------|
| *Palliduphantes alutarius* Simon, 1884    | +         | +                            |                   | Depigmentation, elongation of legs |
| *Palliduphantes byzantinus* (Fage, 1931)  | +         |                              |                   | Depigmentation, elongation of legs |
| *Palliduphantes istrianus* Kulczyński, 1914 | +         |                              |                   | Depigmentation, elongation of legs |
| *Palliduphantes pallidus* (O.P.- Cambridge, 1871) | +         |                              |                   | Depigmentation, elongation of legs |
| *Palliduphantes pillichi* (Kulczyński, 1915) | +         |                              |                   | Depigmentation, elongation of legs |
| *Palliduphantes trnovenensis* (Drensky, 1931) | +         |                              |                   | Depigmentation, elongation of legs |
| *Palliduphantes spelaeorum* (Kulczyński, 1914) | +         |                              |                   | Depigmentation, elongation of legs |
| *Porrhomma convexum* (Westring, 1861)      | +         | +                            |                   | Depigmentation                     |
| *Porhroma microps* (Roewer, 1931)          | +         |                              |                   | Depigmentation, microphthalmal, anophthalmal |
| *Thyreosthenius parasiticus* (Westring, 1851) | +         |                              |                   | Depigmentation                     |
| *Troglohyphanthes drenski* (Dentshev, 1973) | +         |                              |                   | Depigmentation, microphthalmal, anophthalmal |
| *Troglohyphanthes bureschianus* Dentshev, 1975 | +         |                              |                   | Depigmentation, elongation of legs |
| **Ageleidae**                             |           |                              |                   |                                   |
| *Histopona tranteevi* Dentshev, 1978       | +         | +                            | +                 | Depigmentation, elongation of legs |
| **Dictynidae**                            |           |                              |                   |                                   |
| *Cicurina cicur* (Fabricius, 1793)         | +         |                              |                   | Depigmentation                     |

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