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Authors: Šestáková, Anna, Mock, Andrej, Christophoryová, Jana, and Gajdoš, Peter

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## Two subterranean-dwelling spiders new to Slovakia (Araneae: Linyphiidae)

Anna Šestáková, Andrej Mock, Jana Christophoryová & Peter Gajdoš



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**Abstract.** Studies of subterranean habitats in Slovakia revealed two rare linyphiid spider species new to the country, *Pseudomaro aenigmaticus* Denis, 1966 and *Pseudocarorita thaleri* (Saaristo, 1971). *Pseudomaro aenigmaticus* was recorded in the Malé Karpaty Mountains in western Slovakia. A male was captured in the limestone Plavecká Cave and a female was found in a granitoid mesovoid shallow substratum (MSS) in the Jajcajov jarok Valley. One pair of *Pseudocarorita thaleri* was found in the MSS in the Belinské skaly Nature Monument in the Cerová vrchovina Highland in southern Slovakia. This study also presents the characteristic habitus and habitats of the recorded spiders.

**Keywords:** Central Europe, first records, hypogean habitats, *Pseudocarorita thaleri*, *Pseudomaro aenigmaticus*, Western Carpathians

**Zusammenfassung. Zwei unterirdisch lebende Spinnenarten neu in der Slowakei (Araneae: Linyphiidae).** Untersuchungen unterirdischer Lebensräume in der Slowakei erbrachten die Neunachweise von zwei Arten für das Land, *Pseudomaro aenigmaticus* Denis, 1966 und *Pseudocarorita thaleri* (Saaristo, 1971). *Pseudomaro aenigmaticus* wurde in den Kleinen Karpaten in der Westslowakei erfasst. Ein Männchen wurde in der Kalkhöhle Plavecká und ein Weibchen in einem oberflächennahen Lückensystem (mesovoid shallow substratum = MSS) im Tal Jajcajov jarok gefangen. Ein Paar von *Pseudocarorita thaleri* wurde ebenfalls im MSS im Belinské skaly Naturdenkmal im Cerová vrchovina Hochland in der Südslowakei nachgewiesen. Es wird der markante Habitus der Arten und Charakteristika ihrer Habitate präsentiert.

Spiders inhabiting subterranean habitats attract researchers because of their rarity and specific appearance associated with living in extreme conditions. These include permanent darkness, constant temperature and limited food supply. Efficient sampling techniques have been developed to improve the study of subterranean faunas (Mammola et al. 2016). Recently, Mammola et al. (in press) published a comprehensive summary of all hypogean spiders known in Europe, revealing the predominance of the family Linyphiidae in the subterranean ecosystem throughout the continent. Increasingly updated inventories of the Slovak subterranean fauna brought noticeable new discoveries in various invertebrate groups (Kováč et al. 2014). The present research on previously unexplored subterranean habitats revealed two rare, minute spiders new to Slovakia (Western Carpathian Mts.), *Pseudomaro aenigmaticus* Denis, 1966 and *Pseudocarorita thaleri* (Saaristo, 1971).

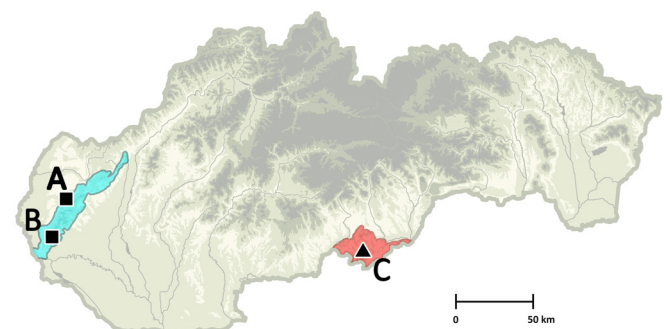
### Material and methods

The authors found evidence for the two spider species in Slovakia during three independent studies of the subterranean fauna in different subsurface habitats applying different research methods.

**A.** The Plavecká Cave in the Malé Karpaty Protected Landscape Area, Western Slovakia (48.4969°N, 17.2667°E; 222 m a.s.l.). This 936 m long Mesozoic limestone cave is situated at the foot of the western slope of a moist deciduous forest (Figs 1–2). Spiders were collected inside the cave in the “Dome of the bats”, with a constant temperature of 11 °C. It contains one of the largest summer bat nurseries for *Myotis myotis* (Borkhausen, 1797) in Slovakia, producing considerable amounts of guano, which

attracts many ground-dwelling invertebrates. Specimens were sampled in April and September 2005 using pitfall traps, heating extraction of the organic material using Tullgren funnels and by hand collection.

- B.** The Jajcajov jarok Valley in the Malé Karpaty Protected Landscape Area, Western Slovakia (48.2667°N, 17.1167°E; 410 m a.s.l.). The subterranean sampling devices were placed in the granitoid scree slope covered by a beech forest (Figs 1, 3). The profile consisted of four horizons: litter and humus (0–5 cm deep), an organo-mineral layer (5–20 cm), a mixture of mineralized soil and rocks (20–75 cm) and gravel partially clogged with soil (75–110 cm). Each trapping set consisted of the plastic tube with openings at a depth of 5–95 cm and ten plastic jars, using 4% formalin and 50 % ethylene glycol as fixation fluids. The traps were exposed from June 2014 to October 2016.
- C.** The Belinské skaly Nature Monument in the Cerová vrchovina Protected Landscape Area, Southern Slovakia (48.2167°N, 19.8667°E; 460 m a.s.l.). The research was performed on the slope of the south-west oriented scree foothill, overgrown with an oak-hornbeam forest, below a basalt rock cliff with scarce xerophilous vegetation (Figs 1, 4). The substratum was composed of a mixture



**Fig. 1:** Distribution map of two new spiders to Slovakia: *Pseudocarorita thaleri* (triangle) and *Pseudomaro aenigmaticus* (squares). A. Plavecká Cave, B. Jajcajov jarok Valley, C. Belinské skaly, Blue – Malé Karpaty Mts., Red – Cerová vrchovina Mts.

Anna ŠESTÁKOVÁ: The Western Slovakian Museum, Múzejné nám. 3, 918 09 Trnava, Slovakia; E-mail: aseptakova@gmail.com  
 Andrej MOCK: Department of Zoology, Institute of Biology and Ecology, Faculty of Science, Pavol Jozef Šafárik University in Košice, Šrobárova 2, 041 67 Košice, Slovakia; E-mail: andrej.mock@upjs.sk  
 Jana CHRISTOPHORYOVÁ: Department of Zoology, Faculty of Natural Sciences, Comenius University, Mlynská dolina, Ilkovičova 6, SK 842 15 Bratislava, Slovakia; E-mail: christophoryova@gmail.com  
 Peter GAJDOŠ: Institute of Landscape Ecology, Nitra Branch, Slovak Academy of Sciences, Akademická 2, SK-94901 Nitra, Slovakia; E-mail: p.gajdos@savba.sk

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**Fig. 2:** Locality A. Entrance of Plavecká Cave (left) and the “Dome of the bats” (right) (Malé Karpaty Mts.) (photo: P. Luptáčík)



**Fig. 3:** Locality B. Jajcajov jarok Valley (Malé Karpaty Mts.) (photo: J. Christophoryová)



**Fig. 4:** Locality C. Belinské skaly (Cerová vrchovina Mts.) (photo: A. Mock)

of soil and rock fragments of about 2 cm in diameter. Here, we used the same type of subterranean sampling devices as in locality A (Mock et al. 2015). The traps were exposed from May 2012 to October 2013.

Microphotographs of specimens were taken using Canon EOS 100D and 1000D digital cameras mounted on a stereomicroscope (Intraco Micro STM 823 5410 and Zeiss Stemi 2000-C) and processed using the EOS Utility software. Digital images were combined with Zerene Stacker v. 1.04 and measurements were taken using AxioVision v. 4.6. The voucher specimens are deposited in 70% ethanol in the collection of the first author. Spiders were identified by V. Růžička, and the male of *Pseudomaro aenigmaticus* was confirmed by T. Blick. Nomenclature follows the World Spider Catalog (2017).

## Results and discussion

### Araneae (Linyphiidae)

#### *Pseudocarorita thaleri* (Saaristo, 1971)

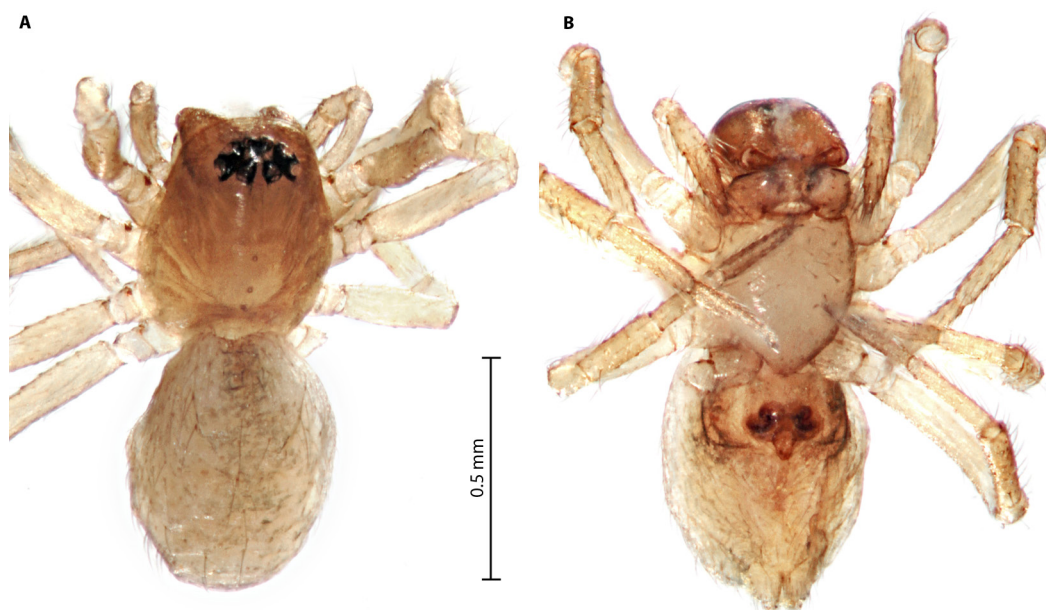
**Material examined.** SLOVAKIA: Cerová vrchovina Highlands, 1♂, 1♀ – Belinské skaly, subterranean sampling devices, jar at 15 cm below the surface, 12.X.2012–2.V.2013 (leg. T. Šášková and A. Mock).

Female (Fig. 5): Body length 1.07 mm. Prosoma 0.52 mm long and 0.44 mm wide.

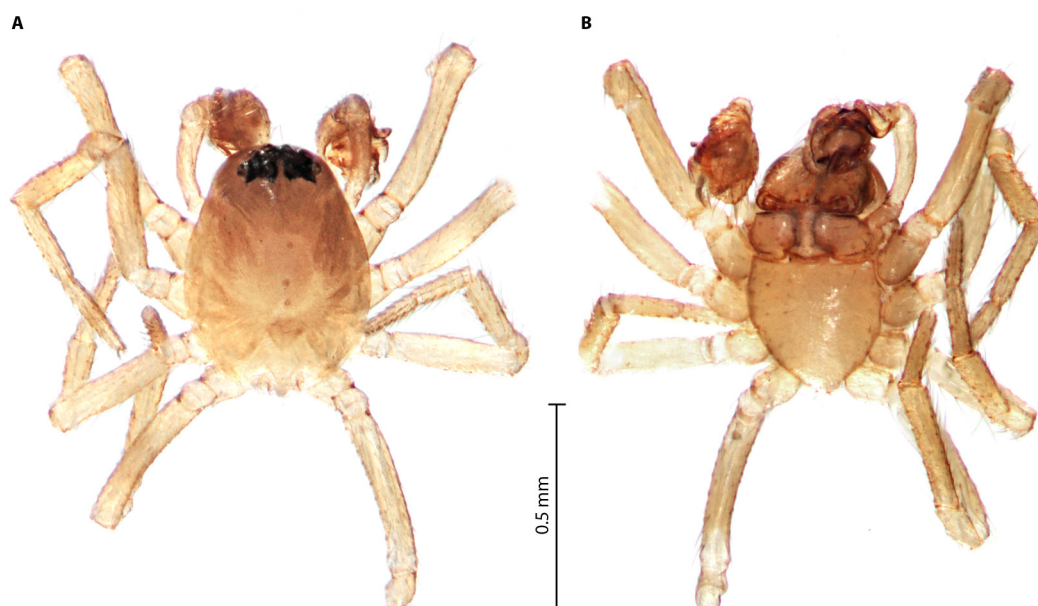
Male (Fig. 6): Opisthosoma missing. Prosoma 0.61 mm long and 0.46 mm wide.

This tiny linyphiid species was described as *Maro thaleri* by Saaristo (1971) based on a single female collected in the Austrian Alps. Thaler (1980) added a description of the male, revising an older collection of spiders from the Austrian and Swiss Alps. The species was placed in the genus *Maro* with some hesitation. After the male was found, Wunderlich (1980) created a monotypic genus *Pseudocarorita* for this species based on its similarity to the genus *Carorita*.

**Habitat.** *Pseudocarorita thaleri* occurs mainly in litter (Nentwig et al. 2017), but is also regularly found in trunk collectors in the low mountain ranges of Germany (Blick 2011) and occasionally in caves; it is considered a troglaxene (Blick pers. comm.). The type specimen was captured in Austria by sieving pine needles in an Alpine montane forest at 900 to 1000 m a.s.l. (Saaristo 1971). Additional Alpine records were documented from different localities at 435 to 2190 m a.s.l. (Thaler 1980). In the Czech Republic the species occurs in ragged terrain at lower altitudes in the litter of various forests, such as oak, alder and spruce (Buchar & Růžička 2002).



**Fig. 5:** *Pseudocarorita thaleri* female from the Belinské skaly Nature Monument, Slovakia. **A.** dorsal view; **B.** ventral view



**Fig. 6:** *Pseudocarorita thaleri* male from the Belinské skaly Nature Monument, Slovakia. **A.** dorsal view; **B.** ventral view

Belgian specimens were also found in lower altitude forests, at about 100 m a.s.l. (Segers & Bosmans 1988). Slovak specimens were captured in an oak-hornbeam forest at 460 m a.s.l. within the talus deposits.

**Status.** The species is red-listed as vulnerable in the Czech Republic (VU) (Řezáč et al. 2015) and in Germany is classified as least concern (LC) (Blick et al. 2016).

**Distribution.** A Central European species found in Austria, Belgium, the Czech Republic, Germany and Switzerland (Helsdingen 2017) and now also in Slovakia.

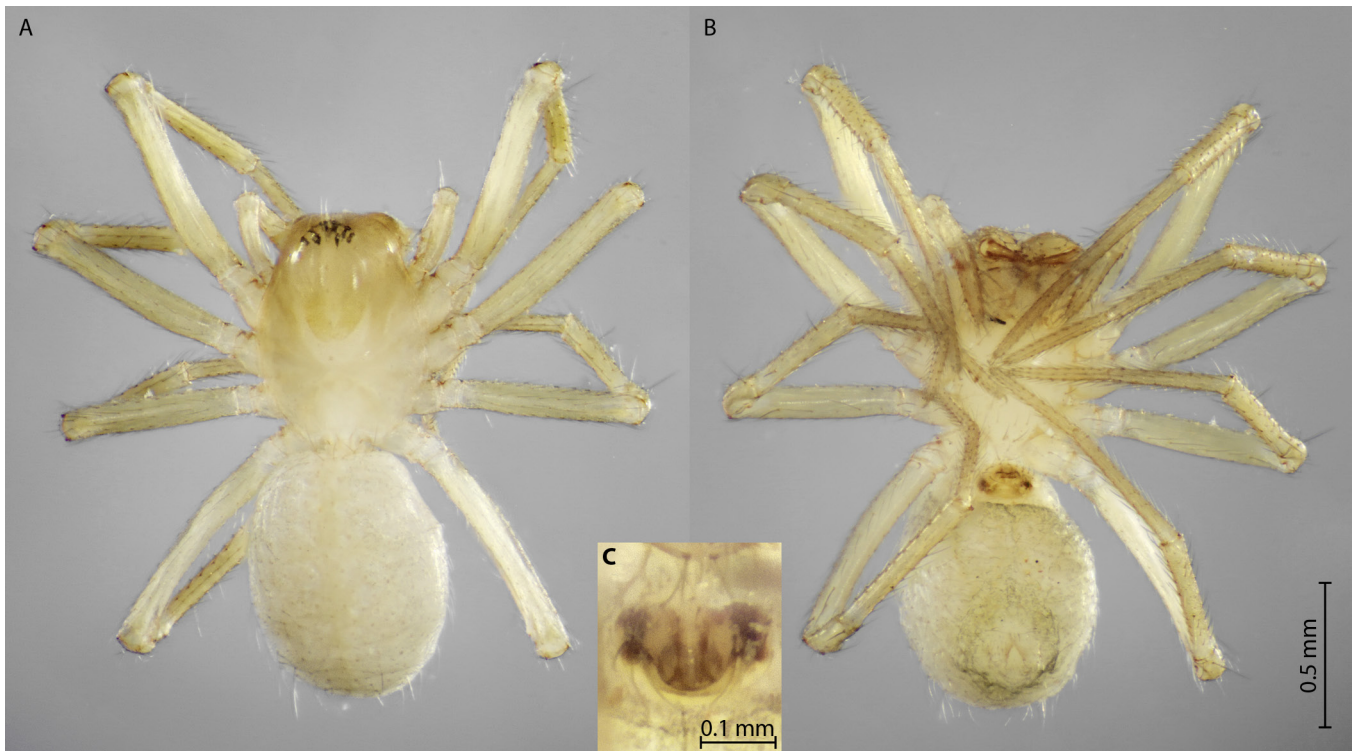
#### *Pseudomaro aenigmaticus* (Denis, 1966)

**Material examined:** SLOVAKIA: Malé Karpaty Mts, 1♂ – Plavecká Cave (the “Dome of the bats”), pitfall traps, 30.IV–14.IX.2005 (leg. P. Luptáčík, A. Mock); 1♀ – Jajcajov jarok Valley, scree slope overgrown with a beech forest below a limestone massif, subterranean sampling devices, jar at 75 cm below the surface, 14.XI.2014–16.XII.2014 (leg. P. Fenda, K. Hruzová, K. Krajčovičová, J. Christophoryová).

Female (Fig. 7): Body length 1.67 mm. Prosoma 0.80 mm long and 0.60 mm wide.

Male (Fig. 8): Body length 1.79 mm. Prosoma 0.82 mm long and 0.62 mm wide.

Despite having small, pigmented eyes, *Pseudomaro aenigmaticus* is listed among the troglomorphic spiders (Růžička et al. 2013). One of the first findings was a female collected in castle cellars near Barbencon in Belgium (Denis 1966). Since then, it has been found in several other European countries (Blick & Kreuels 2002). The occurrence of *P. aenigmaticus* in Slovak caves was already predicted by Franc (1999). During intensive research over the past 15 years its presence was now finally confirmed in Slovakia. A record from China by Fei & Gao (1996) is considered a misidentification because of a considerably larger body size compared to the European specimens (Rozwałka & Olbrycht 2017). The genus *Pseudomaro* was erected on the basis of a single female having a quite dissimilar epigyne structure compared to *Maro* species (Saaristo 1971). Roberts (1987) considered the genus closer to *Mioxena*



**Fig. 7:** *Pseudomaro aenigmaticus* female from the Jajcajov jarok Valley, Slovakia. **A.** dorsal view; **B.** ventral view; **C.** epigyne

or *Asthenargus*. Until now few males of the species have been identified, but still not formally described. However, Blick et al. (in prep.) are in process of publishing a comprehensive taxonomy of *P. aenigmaticus* and its relatives, thus we refrain from describing the male in the present paper.

**Habitat.** This species seems to prefer caves and similar habitats (Blick & Kreuels 2002), given that most of the recorded specimens have been discovered there (Blick & Kreuels 2002, Růžička & Buchar 2008, Růžička et al. 2013). Slovak speci-

mens were also found in a cave and 75 cm beneath the surface in the granitoid mesovoid shallow substratum. Further findings refer to post-mining dumps (Staręga 1996), railway underpasses (Kúrka et al. 2015), beech forests (Milasowszky et al. 2015), and oak and fir forests (Rozwałka & Olbrycht 2017). They have also been identified in different types of agricultural landscape, including fields, open grasslands, meadows, fallow lands, shrubland and urban and rural landscapes such as parks, orchards and abandoned mining and quarry sites (Blick & Kreuels 2002). Colonisation of new habitats presumably occurs via ballooning (Blandenier & Fürst 1998). **Status.** This species is red-listed in Central Europe due to very rare and scarce findings; endangered in Poland (EN) (Staręga et al. 2002), vulnerable in Germany (VU) (Blick et al. 2016) and listed under least concern in the Czech Republic (LC) (Řezáč et al. 2015).

**Distribution.** European species recorded in Austria, Belgium, the Czech Republic, Germany, Great Britain, Italy, Luxembourg, Poland and Switzerland (Blick & Kreuels 2002, Helsdingen 2013, World Spider Catalog 2017).

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**Fig. 8:** *Pseudomaro aenigmaticus* male from the Plavecká Cave, Slovakia. **A.** dorsal view; **B.** ventral view

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