

New records of millipedes (Diplopoda) from caves in Crimea and the Caucasus

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ABSTRACT. The results of a taxonomic treatment of Diplopoda collected recently in caves of Crimea and the Caucasus are presented. They concern at least 21 species from nine families and five orders. New faunistic information is provided, allowing for the distribution of a number of millipede species to be considerably refined. Problems of their ecological classification in relation to cavernicolity are discussed.

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KEY WORDS: Myriapoda, cave fauna, troglaxene, eutroglophiles, subtroglophiles, troglobiont, Russia, Abkhazia.

Новые находки двупарноногих многоножек (Diplopoda) в пещерах Крыма и Кавказа

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РЕЗЮМЕ. Представлены результаты фаунистической обработки сборов Diplopoda из пещер Кавказа (Россия, Абхазия) и Крыма, относящихся как минимум 21 виду из девяти семейств и пяти отрядов. В работе содержатся новые сведения, существенно

дополняющие наши знания о распространении ряда видов диплопод, и обсуждаются вопросы их экологической классификации по отношению к пещерам.

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КЛЮЧЕВЫЕ СЛОВА: Мургарода, пещерная фауна, троглоксен, эвтроглофилы, субтроглофилы, троглобионт, Россия, Абхазия.

Introduction

Studies on millipedes (Diplopoda) found in caves in the Caucasus and Crimea enjoy a long history and, in addition to being devoted to numerous species descriptions and/or records, a few overviews, both general as components of cave fauna and particular, focusing on diplopods alone (e.g., Golovatch, 1984/85; Barjadze *et al.*, 2015, 2019; Turbanov *et al.*, 2016; Golovatch *et al.*, 2018; etc.). There are also fresh papers dealing with individual taxonomic revisions which partly covered cave-dwelling Diplopoda and their distributions (Antić *et al.*, 2018; Vagalinski, Lazányi, 2018; Antić, Reip, 2020; Evsyukov *et al.*, 2018, 2020; Kokhia, Golovatch, 2020; etc.).

The present contribution considers millipedes recorded from caves of the Caucasus (Russia and Abkhazia) and Crimea, based on recent collections. Each new record is accompanied by remarks on the biogeographic and ecological status of the species concerned.

Material and methods

The material underlying the paper was collected by authors during the last decade, between 2011 and 2020. The samples are stored in 95% ethanol, currently being shared between the collections of the Zoological Museum of Moscow University (ZMUM) and the private collection of I. Turbanov (IT), as indicated below. The material representing the order Chordeumatida and, partly, the genus *Leucogeorgia* Verhoeff, 1930 (Julidae) from Causasian caves is omitted here, to be treated later by Dragan Ž. Antić, University of Belgrade - Faculty of Biol-

ogy, Institute of Zoology, Belgrade, Serbia, who revised and published the samples of these two groups taken earlier (Antić, Makarov, 2016; Antić *et al.*, 2018). Two samples of *Omobranchyulus* Lohmander, 1936 are likewise omitted, to be studied later by Bojan Vagalinski, Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, Sofia, Bulgaria. The pictures of live millipedes were taken in the field using an Olympus TG-5 (Olympus Corporation, Japan) or a Ricoh WG-4 (Ricoh Company Ltd, Japan) camera.

Results

The new records presented below concern at least 21 species of Diplopoda from nine families and five orders. Only a few of the species could not be fully identified in the lack of male samples, but the genera and families they are attributed to, albeit some provisionally so, are likewise important.

Taxonomic part

Order Polyxenida Lucas, 1840
Family Polyxenidae Lucas, 1840

Propolyxenus argentifer (Verhoeff, 1921)

MATERIAL. 1 ♂ (IT), Russia, Krasnodar Prov., 2 km W of Tuapse, flysch cliff near Kadosh Cape, Pauk Cave, 19.X.2019, P.V. Somchenko leg.

REMARKS. An eastern Mediterranean species known from Iran, Azerbaijan, Armenia, Georgia and Russia, including the Crimean Peninsula (Short *et al.*, 2020). The above sample

seems to represent the first record of this species from a cave, apparently as a troglonexe.

Order Glomerida Brandt, 1833
Family Glomeridellidae Cook, 1896

?*Typhloglomeris* spp.

MATERIAL. 2 ♀♀ (ZMUM), Abkhazia, Gudauta Distr., Duripsh, Lakerbaya Cave, 27.III.2017, I.S. Turbanov leg.; 1 juv. (IT), Russia, Krasnodar Prov., Apsheronsky Distr., NE spurs of Lago-Naki Mt. Range, Azish-Tau Ridge, Piketnaya Cave, 24.V.2020, P.V. Somchenko leg.

REMARKS. Even the generic assignment is bound to remain uncertain until ♂ material has been taken and studied. The samples above seem to be the first records of troglomorphic ?*Typhloglomeris* Verhoeff, 1898 from caves in Abkhazia, as well as Russia beyond the Sochi region, Krasnodar Province, whence the troglophilic *T. caucasica* Golovatch, 1975 has repeatedly been reported (Golovatch, 1975, 1981, 1989a; Golovatch, Chumachenko, 2013).

Family Glomeridae Leach, 1815

Hyleoglomeris specialis Golovatch, 1989

MATERIAL. 1 ♀ (ZMUM), Russia, Chechnya, Shatoy Distr., 7.7 km S of Ulus-Kert, right bank of Sharo-Argun River, Sayd-Emin (= Sayd-Emin Khyekh) Cave, 18.X.2019, S.A. Kapralov leg.

REMARKS. Endemic to the Caucasus, encountered in Russia, Georgia and Azerbaijan (Golovatch, 1989b). The above sample represents the first record of this species from a cave, apparently as a troglonexe.

Trachysphaera costata (Waga, 1857)

MATERIAL. 2 ♀♀ (ZMUM), Abkhazia, Gudauta Distr., Duripsh, Lakerbaya Cave, 27.III.2017, I.S. Turbanov leg.

REMARKS. A Central European to eastern Mediterranean species: Central, Eastern and

Southern Europe, Crimea, the Caucasus, Anatolia, the Near East and northwestern Iran. It has been recorded from the Mangupskaya II (Crimea) and Fanagoriyskaya caves (Krasnodar Prov.) (Golovatch, 1990, 2008, 2010). Above is the first record of this species from a cave in Abkhazia, apparently a troglophile.

Order Polyzoniida Cook, 1895
Family Hirudisomatidae Silvestri, 1896
Hirudisoma roseum (Victor, 1839)

MATERIAL. 1 ♀ (ZMUM), Russia, Republic of North Ossetia-Alania, Alagir Distr., 2 km S of Tamisk, 0.25 km from right bank of Ardon River, right bank of Kroygom Stream, Skubi-Nykhasakaya Cave, entrance part, 25.IX.2020, S.A. Kapralov leg.

REMARKS. Subendemic to the Caucasus: Russia, Abkhazia, Georgia, Azerbaijan and northern Turkey. Once recorded from near the entrance to the Sataplia I Cave, Kutaissi Distr., Georgia (Golovatch *et al.*, 2015). Above is the first record of this species from a cave in Abkhazia, apparently a troglonexe.

Order Julida Brandt, 1833
Family Blaniulidae C.L. Koch, 1847

Nopoiulus (Nopoiulus) kochii (Gervais, 1847)
Fig. 1.

MATERIAL. 1 ♂, 4 ♀♀ (ZMUM), Abkhazia, Sukhum Distr., near Guma, Mikhailovskaya (= Shromskaya, Sukhumskaya, Stalaktitovaya) Cave, 3.IX.2015; 1 ♂ (ZMUM), Crimea, region of Sevastopol, southern spurs of Mount Foros, Foroskaya Cave, 9.VI.2011; 1 ♀ (ZMUM), Crimea, Sevastopol, Mitropolichyi Sady natural border, near Vinogradnyi Cape, unnamed cave with a source, 7.VII.2017; all I.S. Turbanov leg.

REMARKS. An ubiquitous species already reported, apparently as a troglophile, in a number of Crimean and Caucasian caves: referred to as *Blaniulus pulchellus* (Leach, 1814) in the Boryu-Teshik Cave, Crimea, Ai-Petri karst massif (Pliginsky, 1927); the Taglar Cave, Khojavend Distr., Azerbaijan; the Shirokopokos-



skaya, Bolshaya Kazatshebrodskaya and Malaya Kazatshebrodskaya caves, all near Sochi, Krasnodar Prov., Russia (Golovatch, 1981, 1984/85; Golovatch, Enghoff, 1990). The above samples represent the first reliable records of the species from both Abkhazia and Crimea.

Nopoiulus (Nopoiulus) ammonites
Enghoff, 1984

MATERIAL. 1 ♀ (IT), Russia, Krasnodar Prov., Mostovskoy Distr., Skalistyi Khrebet Mt. Range, 1.5 km NWW of Psebai, Ammonalnaya Cave, 21.III.2020; 1 ♀ (IT), same place, 2.3 km SWW of Besleneyevskaya, Besleneyevskaya I Cave, 25.I.2020; all P.V. Somchenko leg.

REMARKS. Narrowly endemic to caves in the same karst area, hitherto known only from the Ammonalnaya and Dedova Yama (= Dedova) caves, Mostovskoy Distr., Krasnodar Prov., Russia (Enghoff, 1984; Golovatch, Enghoff, 1990). This is a new, third record of this species, apparently a troglobite, this time from the Besleneyevskaya Cave, all three caves being located quite closely to one another.

Family Julidae Leach, 1814

Cylindroiulus horvathi (Verhoeff, 1897)

MATERIAL. 1 ♂ (ZMUM), Crimea, region of Sevastopol, western spurs of Ai-Petri Yayla Mt. Range, Mount Baltshik-Kaya, Uparennaya Cave, 17.III.2014; 1 ♀, 1 juv. (IT), Crimea, Bakhchisarai Distr., northwest spurs of Ai-Petri Yayla Mt. Range, Karadag Forest Area, Kristalnaya (= Imeni Maksimovicha) Cave, 6.X.2020; all I.S. Turbanov leg.

REMARKS. An Eastern European to eastern Mediterranean species reported from Romania, Hungary, Bulgaria, Poland, Serbia, and Crimea (Korsós, Read, 1994; Jovanović, Antić, 2015). It has already been recorded (as *C. ponticus* Golovatch, 1978, a junior synonym (Korsós, Read, 1994)) from three places in Crimea, including the entrance to the Krasnaya (= Kyzyl-Koba) Cave (Golovatch, 1978; Golovatch *et al.*, 2008, 2017). Apparently, this is a troglone.

Leucogeorgia rediviva Golovatch, 1983

MATERIAL. 2 ♂♂, 3 ♀♀ (ZMUM), Abkhazia, Gudauta Distr., Bzyb Mt. Range, Banka Cave (Snezhnaya cave system), Khrustalniy Meandr gallery, -570 m depth, in or near creek, 22.VIII.2017; 1 ♀ (ZMUM), same cave, -100 m depth, 25.VIII.2017; 2 ♂♂, 3 ♀♀ (ZMUM), same place, Snezhnaya Cave, Revushchiye Kaskady, -1530 m depth, near water, 23.VIII.2017; all I.S. Turbanov leg.

REMARKS. Narrowly endemic to several caves in central Abkhazia, apparently a troglobite (Golovatch, 1983; Antić, Reip, 2020). This species has already been recorded from the Snezhnaya cave system (Antić, Reip, 2020).

Megaphyllum tauricum (Attems, 1907)

MATERIAL. 1 ♂, 3 ♀♀ (ZMUM), Crimea, region of Sevastopol, western spurs of Ai-Petri Yayla Mt. Range, north side of Mount Foroskiy Kant, Yegerskaya II Cave, 20.V.2011; 2 ♂♂, 1 ♀ (ZMUM), Crimea, Bakhchisarai Distr., northwest spurs Ai-Petri Yayla Mt. Range, Karadag

Figs 1–4. Some millipedes in caves of the Caucasus and Crimea. 1 — live *Nopoiulus (Nopoiulus) kochii* (Gervais, 1847), ♂ from Mikhailovskaya (= Shromskaya, Sukhumskaya, Stalaktitovaya) Cave, Abkhazia; 2 — live *Syrioiulus kovali* (Golovatch, 2008), ♀ from Tshernoretshenskaya Cave, Crimea; 3 — live *Polydesmus (Polydesmus) abchasius* Attems, 1898, ♂ from Anuchvinskaya (= Past' Tigra) Cave, Abkhazia; 4 — live *Caucasodesmus turbanovi* Golovatch et VandenSpiegel, 2015, ♂ from Tuakskaya (= Ful-Koba) Cave, Crimea. Photographs by I.S. Turbanov.

Рис. 1–4. Некоторые двупарноногие многоножки в пещерах Кавказа и Крыма. 1 — прижизненная фотография *Nopoiulus (Nopoiulus) kochii* (Gervais, 1847), ♂ из пещеры Михайловская (= Шромская, Сухумская, Сталактитовая), Абхазия; 2 — прижизненная фотография *Syrioiulus kovali* (Golovatch, 2008), ♀ из пещеры Чернореченская, Крым; 3 — прижизненная фотография *Polydesmus (Polydesmus) abchasius* Attems, 1898, ♂ из пещеры Анухвинская (= Пасть Тигра), Абхазия; 4 — прижизненная фотография *Caucasodesmus turbanovi* Golovatch et VandenSpiegel, 2015, ♂ из пещеры Туакская (= Фул-Коба), Крым. Фотографии И.С. Турбанова.

Forest Area, Kristalnaya (= Imeni Maksimovicha) Cave, 1.V.2013; 2 juv. (IT), same cave, 6.X.2020; all I.S. Turbanov leg.

REMARKS. Endemic to Crimea (Lazányi, Vagalinski, 2013), already recorded, albeit without exact location, from caves in Mountainous Crimea (Golovatch *et al.*, 2017) based on the above material.

Omobrachiulus caucasicus (Karsch, 1881)

MATERIAL. 1 ♀ (ZMUM), Russia, Chechnya, Shatoy Distr., 7.7 km S of Ulus-Kert, right bank of Sharo-Argun River, Camila (= Camila-Khyekh) Cave, 15.X.2019, S.A. Kapralov leg.

REMARKS. This widespread and common eastern Mediterranean species, often referred to as *Omobrachiulus brachyurus* (Attems, 1899), its junior synonym (Vagalinski, Golovatch, in preparation), is subendemic to the Caucasus, known from Russia, Georgia, Armenia, Azerbaijan, Iran, Turkey and Greece (Vagalinski, Lazányi, 2018). Recorded as *Megaphyllum* (*Omobrachiulus*) *brachyurum thassensis* Mauriès, 1985 from the Drakotrypa Cave, Thasos Island, Greece (Mauriès, 1985). The above sample represents the first record of the species from a cave in Russia, apparently a troglaxene.

Pachyiulus krivolutskyi Golovatch, 1977

MATERIAL. 1 ♀ (ZMUM), Abkhazia, Ochamchira Distr., near Otap, Samshitovaya Cave, 21.VIII.2015; 2 ♀♀ (ZMUM), same place, Uatapachy (= Kolodets nad Golovoy Otapa) Cave, 24.VIII.2015; 1 ♂ (ZMUM), same place, Marshania Cave, 12.XI.2014; all I.S. Turbanov leg.

REMARKS. This species is the largest in size in the entire Caucasus, endemic to its western part: Russia, Abkhazia and Georgia (Evsyukov, 2016). It has been recorded from the Cave Ushchelnaya (= Pionerskaya) near Sochi, and a nameless grotto near Novorossiysk, Krasnodar Prov., Russia (Golovatch, 1984/85). The above samples represent the first reports of the species from caves in Abkhazia.

Pachyiulus flavipes (C.L. Koch, 1847)

MATERIAL. 1 ♂, 3 ♀♀, 2 juv. (ZMUM), Crimea, region of Sevastopol, western spurs of Ai-Petri Yayla Mt. Range, north side of Mount Foroskiy Kant, Yegerskaya II Cave, 20.V.2011; 1 ♂ (ZMUM), Crimea, region of Sevastopol, western spurs of Ai-Petri Yayla Mt. Range, Mount Biyuk-Sinor, Sakhtykh Cave, 26.VIII.2012; 1 ♀ (ZMUM), Crimea, Bakhchisarai Distr., northwest spurs Ai-Petri Yayla Mt. Range, Karadag Forest Area, Kristalnaya (= Imeni Maksimovicha) Cave, 1.V.2013; all I.S. Turbanov leg.

REMARKS. A widespread eastern Mediterranean species, often synanthrope (Mauriès *et al.*, 1997; Frederiksen *et al.*, 2012). It has been recorded from caves, albeit without exact location, in Crimea (Golovatch *et al.*, 2017) based on the above samples, apparently a troglaxene.

Syrioiulus kovali (Golovatch, 2008)

Fig. 2.

MATERIAL. 2 ♂♂, 1 ♀ (ZMUM), Crimea, region of Sevastopol, Baydarskaya Valley, near Rodnikovskoye, Skelskaya Cave, 4.III.2018; 2 ♂♂, 3 ♀♀ (IT), same cave, 29.IX.2019, all I.S. Turbanov, A.A. Turbanova leg.; 1 ♀ (IT), Crimea, region of Sevastopol, canyon of Tshernaya River, Tshernoretshenskaya Cave, 14.I.2020; 1 juv. (IT), Crimea, region of Sevastopol, western spurs of Ai-Petri Yayla Mt. Range, Mount Mortsheka, Druzhba Cave, 3.X.2020, I.S. Turbanov leg.

REMARKS. Endemic to southwestern Crimea, a troglaxene known only from a number of caves in the Ai-Petri, Baydarsko-Balaklavsky and Bakhchysarai karst massifs (Golovatch, 2008; Golovatch *et al.*, 2017; Turbanov *et al.*, 2018). The Tshernoretshenskaya Cave is a new locality for the species.

Syrioiulus sp.

MATERIAL. 1 ♀ (ZMUM), Crimea, Belogorsk Distr., SE spurs of Karabi Yayla Mt.

Range, near Tshigenitra Pass, Tuakskaya (= Ful-Koba) Cave, 16.VII.2016, I.S. Turbanov leg.

REMARKS. To identify this species, ♂ material must be collected and studied. This is the first record of the genus *Syrioilulus* Verhoeff, 1914 in caves in the eastern part of Mountainous Crimea.

Order Polydesmida Leach, 1815

Family Paradoxosomatidae Daday, 1889

Strongylosoma kordylamythrum Attems, 1898

MATERIAL. 4 ♂♂, 7 ♀♀, 2 juv. (ZMUM), Abkhazia, Ochamchira Distr., near Otap, Golova Otapa Cave, in bat guano, 8.IX.2014; 2 ♂♂, 2 ♀♀, 4 juv. (ZMUM), Abkhazia, Ochamchira Distr., near Thina, Thinskaya Cave, in bat guano, 10.IX.2015; 2 ♂♂, 1 ♀, 2 juv. (ZMUM), Abkhazia, Sukhum Distr., near Verkhnie Eshery, Adzaba Cave, in bat guano, 14.IX.2014; 3 ♂♂, 1 ♀ (ZMUM), Abkhazia, Gudauta Distr., near Anuchva, Anuchvinskaya (= Past' Tigra) Cave, 11.IX.2015; 1 ♂ (ZMUM), Abkhazia, Gudauta Distr., Duripsh, Duripshskaya Vodyanaya Cave, 29.VIII.2017; 1 ♀ (ZMUM), same place, Lakerbaya Cave, 27.III.2017; all I.S. Turbanov leg.

REMARKS. An eastern Mediterranean species subendemic to the Caucasus: Russia, Abkhazia, Georgia, Turkey, Azerbaijan and Iran. It has been recorded as a troglophile in a number of caves: Psebe Cave, Tuapse Distr.; Shirokopokosskaya and Labirintovaya (= Bozhyey Materi, Our Lady) caves near Sochi; Ammonalnaya Cave, Mostovskoy Distr., Krasnodar Province (Evsyukov *et al.*, 2016). The above samples represent the first records of this species from caves in Abkhazia.

Family Polydesmidae Leach 1815

Polydesmus (Polydesmus) abchasius
Attems, 1898

Fig. 3.

MATERIAL. 1 ♂ (ZMUM), Abkhazia, Gudauta Distr., near Anuchva, Anuchvinskaya

(= Past' Tigra) Cave, 11.IX.2015, I.S. Turbanov leg.

REMARKS. Endemic to the western and central Caucasus: Russia, Abkhazia and Georgia. It has been recorded from the Nikortsmina Cave, Ambrolauri Distr., Georgia (Golovatch *et al.*, 2016). Apparently a troglaxene, the above sample representing the first record of this species from caves in Abkhazia.

Polydesmus (Nomarchus) mediterraneus
Daday, 1889

MATERIAL. 1 ♂ (ZMUM), Crimea, Bakhchisarai Distr., northeastern spurs of the Ai-Petri Yayla Mt. Range, Bash-Dere Area, Avanytura Cave, 15.XI.2014, I.S. Turbanov leg.

REMARKS. An eastern Mediterranean species: the Balkans and Romania, obviously introduced to Crimea and the Caucasus (Abkhazia) (Golovatch, 1978; Golovatch *et al.*, 2016). It was recorded from the Skelskaya Cave, Crimea (Golovatch, 1978), while the above new sample represents a new locality in Crimea; apparently a troglaxene.

Brachydesmus furcatus Lohmander, 1936

MATERIAL. 1 ♂ (ZMUM), Russia, Krasnodar Province, Apsheronky Distr., NE spurs of Lago-Naki Mt. Range, Azish-Tau Mt. Ridge, Piketnaya Cave, 6.XI.2020, I.S. Turbanov leg.

REMARKS. Endemic to the western Caucasus: Russia and Abkhazia [Golovatch *et al.*, 2016], also encountered as a troglophile in a few caves: Akhunsкая, Fanagoriyskaya, Medvezhya and Baribana, all within the Krasnodar Prov., Russia (Strasser, 1970; Golovatch *et al.*, 2016, 2018).

Brachydesmus jubatus Attems, 1907

MATERIAL. 1 ♂, 11 juv. (ZMUM), Crimea, region of Sevastopol, Baydarskaya Valley, near Kizilivoye, Mamut-Tshokrak Cave, 14.V.2011; 1 ♂, 2 ♀♀, 2 juv. (ZMUM), Crimea, region of Sevastopol, Baydarskaya Yayla Mt. Range, Donguz-Orun Ridge, Zelenykh Kamneyedov Cave, 27.V.2011; all I.S. Turbanov.

REMARKS. A circum-Pontic species known from the Rostov-on-Don Region of Russia, Crimea, northern Turkey and eastern Romania (Evsyukov, Golovatch, 2013). It was recorded, albeit without exact locality, from caves in Crimea (Golovatch *et al.*, 2017), apparently as a troglophile and at least in part based on the above samples.

Family Trichopolydesmidae Verhoeff, 1910

Caucasodesmus turbanovi Golovatch
et VandenSpiegel, 2015
Fig. 4.

MATERIAL. 2 ♀♀ (ZMUM), 1 ♂, 2 ♀♀ (IT), Crimea, Belogorsk Distr., southeastern spurs of the Karabi Yayla Mt. Range, near Chigenitra Pass, Tuakskaya (= Ful-Koba) Cave, 16.VII.2016, I.S. Turbanov leg.

REMARKS. Endemic to a cave in Mountainous Crimea, hitherto known as a troglomite only from the Tuakskaya (= Ful-Koba) Cave (Golovatch, VandenSpiegel, 2015). Above is a strictly topotypic material.

Caucasodesmus svetlanae Golovatch
et VandenSpiegel, 2015

MATERIAL. 1 ♀ (ZMUM), Crimea, region of Sevastopol, Baydarskaya Valley, near Rodnikovskoye, Skelskaya Cave, 4.III.2018; 1 ♂, 1 ♀ (IT), same cave, 29.IX.2020; all I.S. Turbanov, A.A. Turbanova leg.

REMARKS. Endemic to caves in the southwestern part of Mountainous Crimea (Golovatch, VandenSpiegel, 2015; Turbanov *et al.*, 2018). This troglobiont species has already been recorded from the Skelskaya Cave (Turbanov *et al.*, 2018).

Discussion

Despite several recent review papers devoted to the cave millipede fauna of the regions concerned (Golovatch, 1984/85; Turbanov *et al.*, 2016; Golovatch *et al.*, 2018; etc.), the question of an ecological classification of the cave-dwelling Diplopoda remains open. Above,

under each species account, we applied the classical classification that divides the subterranean fauna into three categories only: troglonexes, trogliphiles, and troglobionts (Vandel, 1964). Below we attempt to classify the above records from an ecological viewpoint using an even more advanced ecological classification by Boris Sket (2008), based on which it appears possible to delimit the following four categories as applied to Diplopoda: (1) troglobiont is a species or population strictly bound to a hypogean habitat; (2) eutrogliphile is an essentially epigean species, but capable of maintaining a permanent subterranean population; (3) subtrogliphile is inclined perpetually or temporarily to inhabiting a subterranean habitat, but is bound to the surface for some biological functions (e.g. feeding); (4) troglonexe is a species only occurring sporadically (accidentally) underground.

We refer the following diplopod species to the group of troglobionts: *Nopoiulus (N.) ammonites*, *Leucogeorgia rediviva*, *Syrioiulus kovali*, *Caucasodesmus turbanovi* and *C. svetlanae*. These millipedes are known only from caves and show well-defined troglomorphies. Conditionally, *?Typhloglomeris* spp. may also join this group, but it seems noteworthy that one of the two troglomorphic species of *Typhloglomeris* in the Caucasus, *T. caucasica*, has been found epigeically and thus treated as an eutrogliphile (Golovatch, Chumachenko, 2013). In contrast, the likewise troglomorphic *T. palatovi* Golovatch et Turbanov, 2018, from the Chortskhu Cave in western Georgia, is considered to represent a troglobiont (Golovatch, Turbanov, 2018).

Both *Nopoiulus (N.) kochii* and *Strongylosoma kordylamythrum* can be attributed to the group of eutrogliphiles as well, because even though being epigean, they are capable of maintaining stable and self-reproducing underground populations. The repeated records of *S. kordylamythrum* on bat guano inside caves are noteworthy, the collections often covering various developmental stadia.

Both *Trachysphaera costata* and *Brachydesmus jubatus* seem to belong to the group of

subtroglophiles, epigeal species using caves for certain life purposes, e.g., hibernation and/or aestivation, and/or suitable food resources.

All remaining species of Diplopoda recorded above seem to represent the group of troglonexes: *Polyxenus argentifer*, *Hyleoglomeris specialis*, *Hirudisoma roseum*, *Cylindroiulus horvathi*, *Megaphyllum tauricum*, *Omobrachiulus caucasicus*, *Pachyiulus krivolutskyi*, *P. flavipes*, *Polydesmus abchasius*, and *P. mediterraneus*. These dipopods are typical epigeal species that enter the caves often accidentally (e.g., falling down vertical wells) and usually die to serve as part of the allochthonous organic matter thereafter.

Compliance with ethical standards

CONFLICTS OF INTEREST: The authors declare that they have no conflicts of interest.

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