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To the knowledge of the biology and distribution of *Monopis crocicapitella* (Clemens, 1860) (Lepidoptera: Tineidae), with remarks on cavernicolous Lepidoptera

К познанию биологии и распространения *Monopis crocicapitella* (Clemens, 1860) (Lepidoptera: Tineidae) с заметками о пещерных бабочках

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KEY WORDS: Abkhazia, cave, eutroglophile, subtroglophile, trogloxene, bat guano, new record.

КЛЮЧЕВЫЕ СЛОВА: Абхазия, пещера, эутроглофилы, субтроглофилы, троглоксены, гуано рукокрылых, новая находка.

ABSTRACT. The tineid moth, *Monopis crocicapitella* (Clemens, 1860) is recorded from Abkhazia, Caucasus for the first time, found there in the Adzaba Cave. Its diagnosis is given, and the main features of its biology and distribution are outlined. An identification key to troglophilic or potentially troglophilic species of the family Tineidae is presented. A complete checklist of the Lepidoptera species recorded from caves in the former USSR is compiled, based both on an analysis of the literature data and on the material kept in the available collections. Problems of an ecological classification of the Lepidoptera in caves of the former USSR are also discussed.

РЕЗЮМЕ. Приведены сведения о новой находке моли *Monopis crocicapitella* (Clemens, 1860) в пещере Адзаба в Абхазии. Приводится диагноз, особенности биологии и распространения этого вида. Представлен ключ для определения троглофильных видов семейства Tineidae. Представлен полный список чешуекрылых, отмеченных в пещерах бывшего СССР, основанный на анализе литературных данных и материале авторских сборов. Обсуждаются вопросы экологической классификации чешуекрылых пещер бывшего СССР.

Introduction

The invertebrate fauna that populates the caves and subterranean waters of Russia and other countries of the former USSR is currently known to contain no fewer than 735 species or subspecies from 278 families [Turbanov *et al*., 2016a–c]. Of them, only four species of Lepidoptera representing three families have been noted as troglophiles [Turbanov *et al*., 2016b], namely, *Triphosa dubitata* (Linnaeus, 1758) and *T. taochata* (Lederer, 1870), both Geometridae, *Scoliopteryx libatrix* (Linnaeus, 1758), Erebidae (referred to as Noctuidae), and *Tinea* sp., Tineidae. In addition, they reported "several" unnamed species as trogloxenes in the families Arctiidae, Depressaridae, Erebidae, Noctuidae, Nymphalidae, Pieridae and Tineidae (loc. cit., p. 1302–1303). Below we provide a full review of the lepidopterans recorded in caves of the former Soviet Union, including information about our new findings of some species in Crimean caves (see more in Taxonomic part). However, these species also need to be refined as regards their ecological status in cavernicoly (see more in Discussion and Conclusion).

In the spring of 2017, the first author collected some larvae of a microlepidopterous species on bat guano in the

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Adzaba Cave, Abkhazia, western Caucasus, with moths emerged a few weeks later in the laboratory. The species appears to be *Monopis crocicapitella* (Clemens, 1860).

The cave of Adzaba [in some sources it is referred to as Uaz-Abaa or Zamok Feodala (The Castle of a Feudal)] is located in the vicinity of Verkhnie Eshery (Upper Eshery) of the Sukhum District, in the lower reaches of Gumista River on the slopes of the right bank of the same gorge [Ivanitsky, 2016]. The entrance to the cave is surrounded by rock limestone outcrops. Near the entrance there is a small stream which originates in the depths of the cave. An archway entrance to the cave (Fig. 1) is oriented to the east, lying at an altitude of 350 m a.s.l.; its height is about 10 m, the width is 4–6 m. The cave is tree-like. The length of the course is 145 m. The cave is characterized as a karst cavity developed under the influence of low-yield flows resulting from small-sized karst cracks, being referred to cavities of modern generation [Tintilozov, 1976]. According to Gvozdetsky [1940], the entrance part of Adzaba is a deep gorge with sheer walls. It arose as the result of a collapsed cave roof with a window along the ceiling [Tintilozov, 1976]. Airflows are especially well expressed in the first knee: in the right half there is a warm entrance, the left half remains cold [Ivanitsky, 2016]. The Adzaba Cave supports 8 species of bats representing two families: *Rhinolophus hipposideros* (Bechstein, 1800), *R. ferrumequinum* (Schreber, 1774) and *R. euryale* Blasius, 1853, all Rhinolophidae; *Myotis mystacinus* (Kuhl, 1817), *M. blythii* (Tomes, 1857), *Plecotus auritus* (Linnaeus, 1758), *Barbastella barbastellus* Schreber, 1774 and *Miniopterus schreibersi* (Kuhl, 1817), all Vespertilionidae [Ivanitsky, 2016]. Near the location of the colony (close to the right wall at a distance of 30 meters from the cave entrance) there is a fairly large accumulation of bat guano (approximately 1 m × 0.3 m × 0.2 m), from which the larvae of *M. crocicapitella* were collected. Absolute air humidity outside is 16.2 mm, inside the cave it is 12.6 mm, the relative humidity is 91 and 96%, respectively [Ivanitsky, 2016]. The average temperature in the cave during the year is approximately 10–15° C.

So far the following troglophilic species of Tineidae have been identified from caves of the former USSR: *Monopis laevigella*, *Monopis* sp. [Mukhanov, Kapralov, 2010] and *Tinea* sp. [Vlasov, 1937]. In addition, we present a list of 12 troglophilic species of Tineidae (Lepidoptera) which are known to occur in the territory of the former USSR. All of them can live in caves. Their larvae feed on the guano of bats, drops of other mammals or birds, also on feathers, wool and other animal residues [Zagulajev, 1960]. Besides this, they have been mentioned as true troglophiles [Jakšić, 2017]. For each

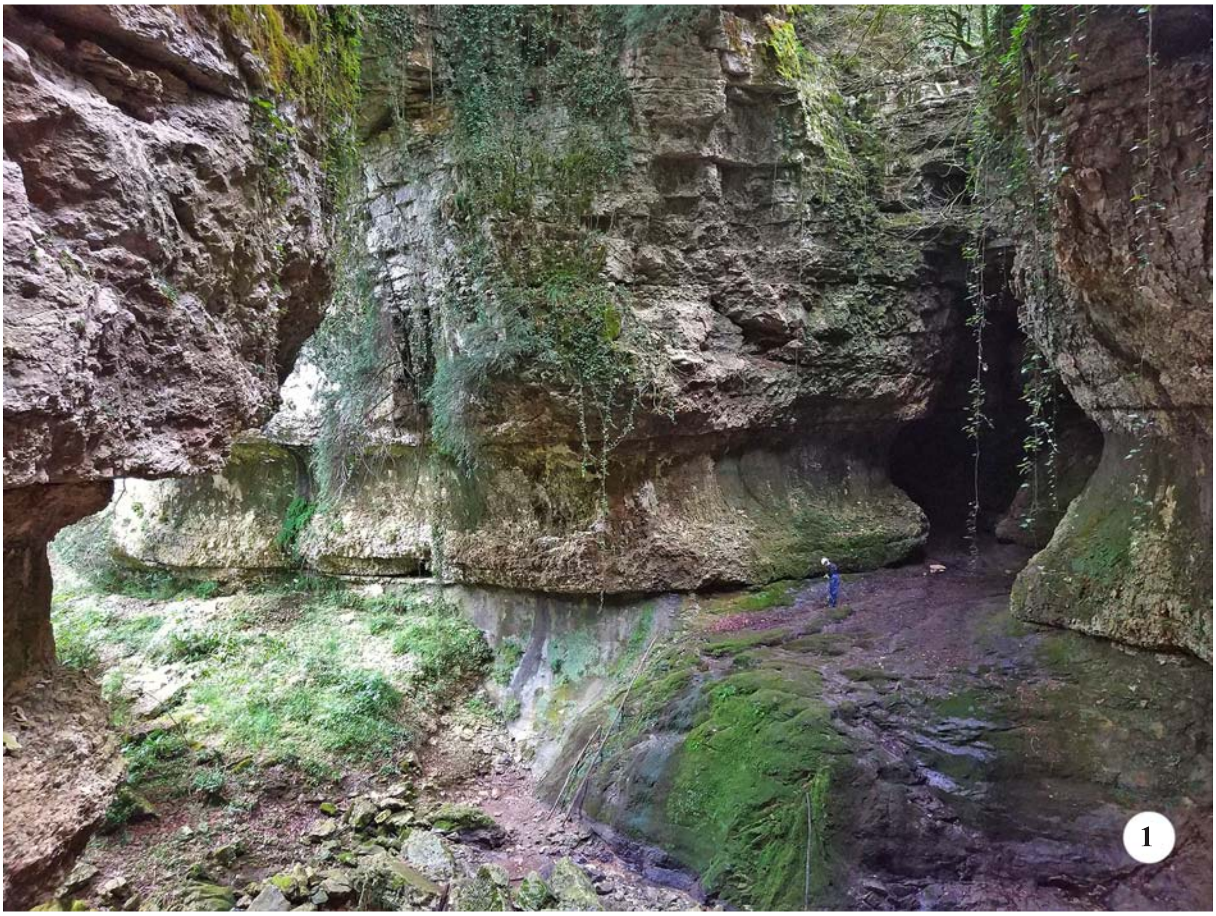


Fig. 1. The archway entrance to Adzaba Cave. Picture courtesy S.M. Turchinskaya.
Рис. 1. Вход в пещеру Адзаба. Фотография С.М. Турчинской.

species, we provide the distribution within the former USSR, where it can be met with in caves.

Nemapogon cloacellus (Haworth, 1828) — European part, Caucasus and Transcaucasus, Central Asia, Siberia, Far East.

Nemapogon granellus (Linnaeus, 1758) — European part, Caucasus and Transcaucasus, southern part of West Siberia.

Anomalotinea liguriella (Millière, 1879) — southern European part, Transcaucasus.

Trichophaga tapetzella (Linnaeus, 1758) — European part, southern part of West Siberia.

Monopis christophi (G. Petersen, 1957) — European part, southern part of West Siberia, Central Asia.

Monopis fenestratella (Heyden, 1863) — European part (Ukraine), Transcaucasus.

Monopis imella (Hübner, 1813) — European part, Caucasus and Transcaucasus, Central Asia, Siberia.

Monopis laevigella ([Denis et Schiffermüller], 1775) — European part, Caucasus and Transcaucasus, Central Asia, Siberia, Far East.

Monopis nonimella Zagulajev, 1955 — European part, southern part of West Siberia, Central Asia.

Monopis obviella ([Denis et Schiffermuller], 1775) — European part, Caucasus and Transcaucasus, southern part of West Siberia.

Monopis pallidella (Zagulajev, 1955) — European part, Caucasus, Central Asia, southern part of Siberia, Far East.

Monopis spilotella (Tengström, 1847) — European part, Siberia, southern part of the Far East.

The present paper provides a description, as well as the main details of the ecology and distribution of this interesting species which is being recorded from the country for the first time.

Material and methods

The description was made using a Leica EZ4 stereo microscope with LED illuminations. The images were taken with a Sony® α450 DSLR camera equipped with a Minolta® 50 f/2.8 Macro lens. The genitalia figures were taken with a Keyence® BZ-9000 Biorevo Fluorescence Microscope. The processing of all illustrations was finalized with Adobe® Photoshop® CS5 software. Pictures of live specimens in caves were made with a Ricoh WG-4 and Olympus TG-5 digital cameras.

All pictures of a dry specimen are labeled with a number, consisting of letters and digits: name of the family, two consecutive digits separated by hyphen and a year following n-dash (e.g. MICROLEPIDOPTERA pictures №№ 0209-0210–2018). These letter and digit codes correspond to the numbering system of the figured specimens in the third author's archive. The genitalia preparation is stored in a microtube with glycerol and pinned under the specimen. The dissected genitalia are fitted with the corresponding number placed in the microtube. This number as a label (e. g. Genitalia preparation № OG–034-2018) is pinned under the specimen and listed in the last author's archive.

The specimens of *M. crocicapitella* examined are deposited in the collection of Alexei N. Zamesov, Moscow, Russia (CAZM). All other lepidopterans described in this article are stored in the personal collection of the second author.

Results

Family **Tineidae** Latreille, 1810

Monopis crocicapitella (Clemens, 1860)
Figs 1–8.

"*T.*[*inea*] *crocicapitella*." — Clemens, 1860*: 257 (key), 258, fig. 1a. Type locality: not stated [= North America: USA, Philadelphia (?)].

= "*Tinea amandatella*." — Walker, 1863: 480. Type locality: "Ceylon." [= Sri Lanka].

= "[*Tinea*] *Hyalinella* n. sp." — Staudinger, 1870: 229. Type locality: "… aus Griechenland, … Malaga …" [Greece; Spain: Málaga].

= "*Blabophanes Lombardica* n. spec."— Hering, 1889: 295. Type locality: "Der Fundort des Thiers ist in der Brianza (nördliche Lombardei) ..." [= Italy: Lombardy].

= "*Blabophanes heringi*" — Richardson, 1893: 14. Type locality: "… at Portland …" [= England: Isle of Portland].

= "*Amydria prometapias*, n. sp." — Klunder van Gyen, 1913: 339. Type locality: "Santiago" [= Chile: Santiago].

= "*Monopis cecconii* n. sp." — Turati, 1919: 339, pl. 4, fig. 52. Type locality: "Tangeri (Marocco) …" [= Morocco: Tangeri].

= "*Monopis dobrogica* n. sp." — Georgescu, 1964: 589, pl. 1. Type locality: "… r. Medgidia, reg. Dobrogea." [= Romania: Dobrogea].

MATERIAL. 3 ♂♂, 1 ♀, Western Caucasus, Abkhazia, Sukhum Distr., near Verkhnie Eshery, Adzaba Cave, 350 m a.s.l., 4.III.2017, ex l., A.A. Turbanova leg. (pictures №№ 0209-0216–2018); 1 ♂, 1 ♀, same locality, 2.II.2018, ex l., A.A. Semikolennykh leg. (pictures №№ 0217-0218–2018). 26 different instar larvae, same locality, 4.III.2017, A.A. Turbanova leg.; 4 mid instar larvae, VII.2018, A.A. Turbanova leg.

DESCRIPTION. Males (Figs 2–3) and females show no differences in the conformation of the antennae and the colouration of various parts of the wings and body. Females are only slightly larger than males. Alar expanse 9–16 mm.

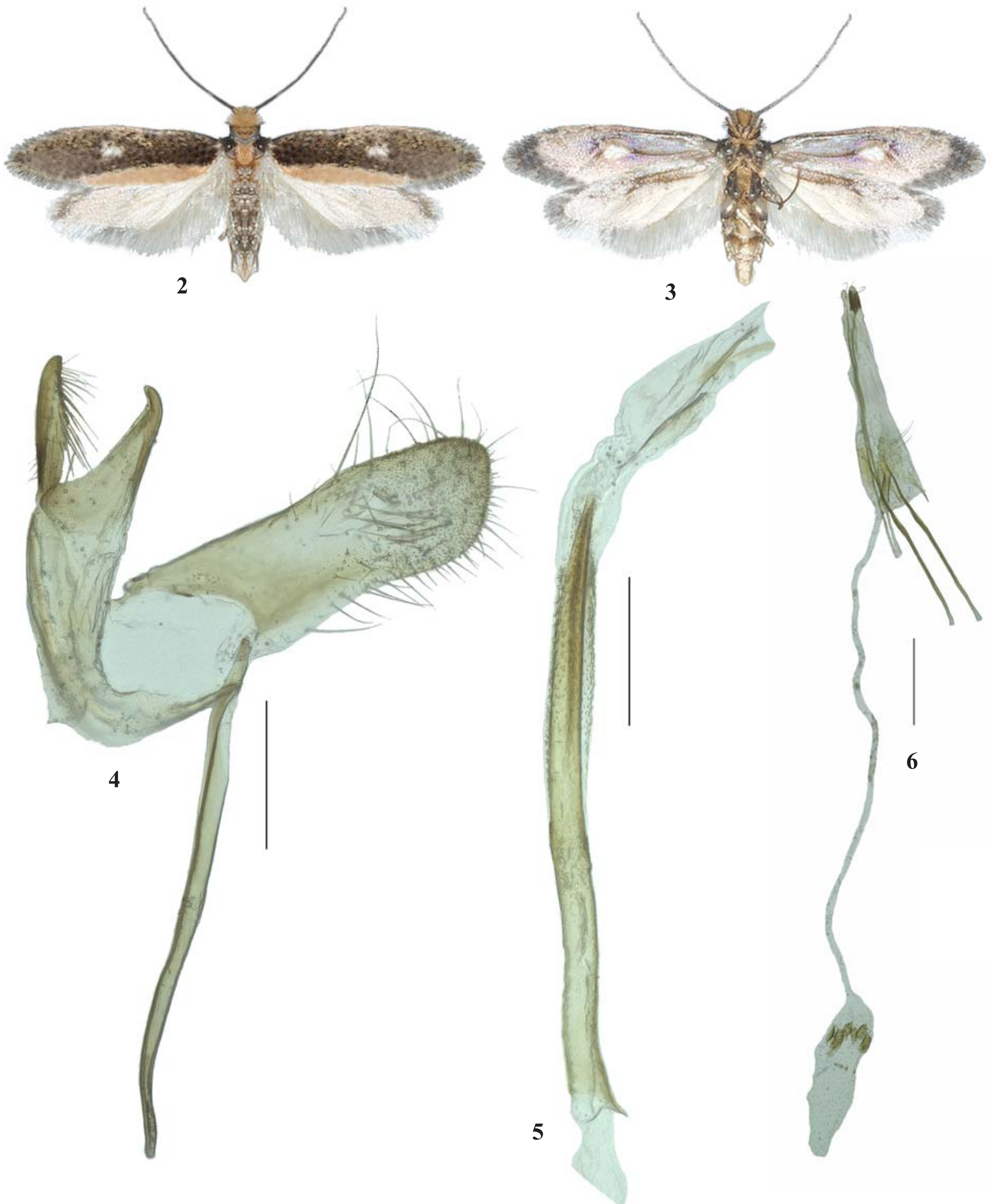
Head with antennae filiform, dark brown to dark grey; frons and vertex covered with long yellowish-ocher hair-like scales; labial palpus yellowish-ocher with golden sheen dorsally and dark grey with golden sheen ventrally.

Thorax with tegula dark brown to black with bronze-violet sheen, mesothorax and thorax laterally pale ocher with bronze sheen.

Legs with fore coxa grey with golden-bronze sheen and pale ocher margins; other parts of fore legs grey with bronze-violet sheen; mid femur pale ocher with golden-bronze sheen and grey scales distally; mid tibia grey with bronze sheen and a small pale ocher spot exteromedially; spurs pale ocher with golden sheen; mid tarsus ventrally and distal tarsomere fully pale ocher with golden sheen, dorsally grey with bronze sheen and a small pale ocher spot distally on four basal tarsomeres; hind leg entirely pale ochre with golden sheen.

* The paper entitled "Contributions to American Lepidopterology, by Brackenridge Clemens, M.D." was presented for publication in the Proceedings on September 20, 1859, but it was published in 1860, this information to be found in Fox's work: "Vol. XI (1859). Signatures 15–19 in one (pages 193–270) was receipt acknowledged by the Smithsonian Institution, January 10, 1860" [Fox, 1913: xii].

Forewing dorsally (Fig. 2) grey-brown with bronze sheen and an admixture of individual pale ocher scales with golden sheen; anal margin light creamy; a large black longitudinal spot anteriorly at base; R–Cu-cell rather large, translucent, white with golden sheen; ventrally (Fig. 3) grey with bronze sheen gradually lightened anally; cilia grey with bronze sheen.



Figs 2–6. *Monopis crocicapitella* (Clemens, 1860): 2 — dorsal view. Microlepidoptera picture No. 0209-2018; 3 — ventral view. Microlepidoptera picture No. 0210-2018 (alar expanse 10.4 mm); 4–5 — male genitalia (4 — lateral view; 5 — aedeagus). Genital preparation No. OG–034-2018; 6 — female genitalia. Genital preparation No. OG–035-2018. Scale bar 0.25 mm.

Рис. 2–6. *Monopis crocicapitella* (Clemens, 1860): 2 — сверху. Microlepidoptera снимок № 0209-2018; 3 — снизу. Microlepidoptera снимок № 0210-2018 (размах крыльев 10.4 мм); 4–5 — гениталии самца (4 — сбоку; 5 — эдеагус). Препарат гениталий № OG–034-2018; 6 — гениталии самки. Препарат гениталий № OG–034-2018. Масштаб 0.25 мм.

Hindwing (Fig. 2) dorsally pale ocher with golden sheen, slightly darkened costally; ventrally grey with bronze sheen gradually lightened baso-anally; cilia grey with bronze sheen, pale ocher anally.

Abdomen entirely pale ocher with golden sheen.

Male genitalia (Figs 4–5). Genitalia preparation No. OG–034-2018.

Female genitalia (Fig. 6). Genitalia preparation No. OG–035-2018.

DIFFERENTIAL DIAGNOSIS. All above potential or true troglophilic tineid species of the former USSR can be identified using the following key based on external characters:

1. Forewing with neither any translucent nor hyaline spot ... 2
— Forewing with a translucent spot in distal part of R–Cu-cell .... 6 (*Monopis* Hübner, 1826 [“1816”])
2. Basal third or even half of forewing monochrome dark and distal part distinctly lighter .... *Trichophaga tapetzella* (Linnaeus, 1758)
— Forewing with a different colour pattern 3
3. Forewing ocher with three or four small dark brown to black spots 4
— Colour pattern of forewing consisting of white, ocher, light brown, brown or dark brown spots 5
4. Hindwing grey-brown with cilia yellowish ocher, visibly lighter than background colouration .... *Anomalotinea liguriella* (Millière, 1879)
— Hindwing yellowish with cilia grey-brown, visibly darker than background colouration .... *Tinea unipunctella* Zagulajev, 1960
5. Forewing with a small, rounded, white spot in distal part of R–Cu-cell; hindwing completely dark grey-brown ... . *Nemapogon cloacellus* (Haworth, 1828)
— Forewing without a small, rounded, white spot in distal part of R–Cu-cell; hindwing dark brown to brown, gradually lightened basally .... *Nemapogon granellus* (Linnaeus, 1758)
6. Forewing monochrome, with neither contrasting stripes nor spots 7
— Forewing with a contrasting stripe or spot 10
7. Forewing light straw-yellow .... *Monopis christophi* (G. Petersen, 1957)
— Forewing pale grey, brown or dark brown 8
8. Forewing with a translucent spot in distal part of R–Cu-cell relatively large and well visible .... *Monopis fenestratella* (Heyden, 1863)
— Forewing with a translucent spot in distal part of R–Cu-cell relatively small and visible on lumen only 9
9. Vertex brown to yellow-brown; fore and hindwing pale grey with golden sheen .... *Monopis pallidella* (Zagulajev, 1955)
— Vertex bright yellow-orange to orange; fore and hindwing brown or dark brown 12
10. Fore- and hindwing monochrome brown to dark brown .... *Monopis imella* (Hübner, 1813)
— Forewing brown to dark brown, hindwing visibly lighter 11
11. Forewing with a contrasting ocher spot medially .... *Monopis laevigella* ([Denis et Schiffermüller], 1775)
— Forewing without a contrasting ocher spot medially .... *Monopis nonimella* Zagulajev, 1955
12. Forewing with two large, triangular, light creamy to ocher-creamy spots at costal margin medially and anal margin subdistally .... *Monopis spilotella* (Tengström, 1847)
— Forewing with a light creamy to pale orange anal margin 13
13 Background colouration of forewing dark brown; cilia of hindwing monochrome dark brown .... *Monopis obviella* ([Denis et Schiffermuller], 1775)
— Background colouration of forewing grey-brown; cilia of hindwing grey, anally pale ocher .... *Monopis crocicapitella* (Clemens, 1860)

DISTRIBUTION. A nearly worldwide distributed, but extremely localized. Reported from North [Clemens, 1860] and South America [Klunder van Gyen, 1913], Europe [Hering, 1889; Richardson, 1893; Georgescu, 1964; Jakšić, 2017], Africa [Turati, 1919] and Asia [Walker, 1863; Byun *et al*., 2014]. Within the former USSR, it has been recorded only from Russia [Zagulajev, 1960; Catalogue, 2008] and Abkhazia (new record).

BIONOMICS. As we have already mentioned above, the larvae of this species were collected on the guano of bats. Unfortunately, we do not know yet what exactly serves as food for the larvae: mycelium of fungi, excrements or keratinous remains of the vital activity of bats or something else.

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8

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Figs 7–8. Last instar larva of *Monopis crocicapitella* (Clemens, 1860): 7 — ventral view; 8 — lateral view.

Рис. 7–8. Взрослая гусеница *Monopis crocicapitella* (Clemens, 1860): 7 — вид снизу; 8 — вид сбоку.

Fig. 9. *Alucita cancellata* (Meyrick, 1908) in the Mangupskaya I (= MK-1) Cave. Photo by I.S. Turbanov.

Рис. 9. *Alucita cancellata* (Meyrick, 1908) в пещере Мангупская I. Фотография И.С. Турбанова.

According to literature sources, larvae of this species live in nests of birds and in places of bat accumulations. They feed on the remains of animal origin: feathers, hairs, bristles and dried feces [Zagulajev, 1960]. The species has two generations per year. Moths are on wings in the early spring and in the beginning of autumn. The larva lives inside a sheath made of grains of sand and dust (Fig. 7). The caudal end of the sheath is rounded and flattened dorsoventrally (Fig. 8).

Monopis laevigella ([Denis et Schiffermüller], 1775)

Noted from caves in the European part of Russia, albeit without definite localities [Mukhanov, Kapralov, 2010]. According to A.V. Mukhanov and S.A. Kapralov [2010], the development of this species is associated with bat guano.

Monopis sp.

Noted from caves in the European part of Russia, albeit with neither definite localities nor an accurate species identification [Mukhanov, Kapralov, 2010]. According to A.V. Mukhanov and S.A. Kapralov [2010], the development of this species is associated with bat guano.

Tinea unipunctella Zagulajev, 1960

Originally described from two specimens from Turkmenistan, Central Asia, including a female from an unnamed cave near Bacharden [Zagulajev, 1960]. Most likely, the earlier record of *Tinea* sp.n. from the Bakharden (= Durun) Cave [Vlasov, 1937] belonged to the same species. According to Ya.P. Vlasov [1939], this species is quite common in the Bakharden (= Durun) Cave and its larvae develop in bat guano.

Family **Acrolepiidae** Heinemann, 1870

Digitivalva christophi (Toll, 1958)

Summer pseudodiapause (estivation) of imago was noted in unnamed caves and grots Kazantip nature reserve in Crimea [Budashkin, 2006].

Family **Depressariidae** Meyrick, 1883

Agonopterix sp.

Noted from caves in the European part of Russia, albeit without definite localities [Mukhanov, Kapralov, 2010].

Family **Alucitidae** Leach, 1815

Alucita cancellata (Meyrick, 1908)
Fig. 9.

MATERIAL EXAMINED. 2 ♂♂, 3 ♀♀, Crimean Peninsula, Bakhchysaraisky Karst Massif, steep escarpment of Baba-Dagh Plateau (= Mangup-Kale Gorodishche), Mangupskaya I Cave, 28.IV.2017, leg. I.S. Turbanov; 10 ♂♂, 9 ♀♀, same cave, 6–8.V.2017, leg. O.L. Makarova, K.V. Makarov; 1 ♂, 1 ♀, same cave, 11.VI.2018, leg. I.S. Turbanov; 2 ♂♂, 1 ♀, Ai-Petri Karst Massif, Baydarskaya Valley, Skelskaya Cave, 9.V.2018, leg. I.S. Turbanov.

NOTES. This species is being recorded from Crimean caves for the first time.

Family **Geometridae** Leach, 1815

Triphosa dubitata (Linnaeus, 1758)
Fig. 10.

MATERIAL EXAMINED. 1 ♂, 2 ♀♀, Crimean Peninsula, Bakhchysaraisky Karst Area, steep escarpment of Baba-Dagh Plateau (= Mangup-Kale Gorodishche), Mangupskaya I Cave, 28.IV.2017; 3 ♂♂, 1 ♀, same cave, 11.VI.2018; 2 ♀♀, same massif, southeastern cliffs of the Kurushlyuk Mt., Tavrskaya Cave, 15.VI.2013; 1 ♀, Baydarsko-Balaklavsky Karst Massif, western spurs of Kala-Fatlar Mt., Kalafatlar-Kobasy Cave, 27.VI.2017; 1 ♂, 2 ♀♀, same massif and mountain, Gekkonovaya Cave, 27.VI.2017; 3 ♂♂, 1 ♀, same massif, southwest spurs of Asketi Mt., Asketi Cave, 31.VII.2017; 2 ♂♂, 1 ♀, same massif, canyon of the Tshernaya River, Tshernorechenskaya Cave, 5.VII.2017; 2 ♀♀, same massif, Baydarskaya Valley, Mamut-Tshokrak Cave, 6.V.2012, 1 ♂, same cave, 2.VII.2017; 1♀, Ai-Petri Karst Massif, Baydarskaya Valley, Baydar-Tshokrak Cave, 2.VII.2017; 3 ♂♂, 4 ♀♀, same massif and valley, Skelskaya Cave, 10.VII.2017, 1 ♂, same cave, 9.V.2018; 1 ♂, 3 ♀♀, same massif and valley, Entuziastov Cave, 5.V.2017; 1 ♀, same massif, canyon of the Uzundzha River, Uzundzha Cave, 19.VII.2017; 2 ♂♂, 1 ♀, same massif, plateau of Foroskiy Kant Mt., Egerskaya II Cave, 4.II.2011; 4 ♂♂, 2 ♀♀, same massif, Bash-Dere area, Avantyura Cave, 15.XI.2014; 1 ♂, 1 ♀, same massif, northern slopes of the Ayu-Teshik Mt., Ayu-Teshik Cave, 2.V.2015, 4 ♂♂, 5 ♀♀, same cave, 16.VII.2017; 2 ♂♂, same massif, Tshaynyi Domik area, Beryu-Teshik Cave, 17.VII.2017; 1 ♂, 3 ♀♀, same massif, Bolshoy Babulgan area, Kuban Cave, 16.VII.2017; 2 ♂♂, 5 ♀♀, same massif, Karadag Forest area, Kristalnaya Cave, 3.V.2015; 1 ♀, same massif and area, Koryta Cave, 8.III.2014; 1 ♂, Yaltinsky Karst massif, western slopes of the Kaply-Kayanskaya Mt., Kaply-Kayanskaya Cave, 29.VI.2017; 2 ♀♀, same

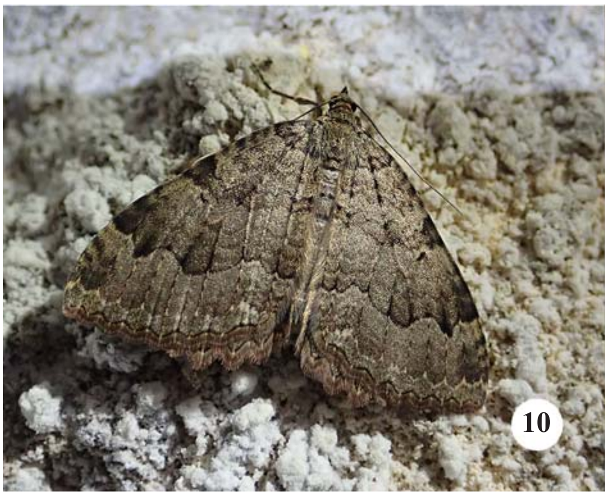

Fig. 10. *Triphosa dubitata* (Linnaeus, 1758) in the Mangupskaya I (= MK-1) Cave. Photo by I.S. Turbanov.
Рис. 10. *Triphosa dubitata* (Linnaeus, 1758) в пещере Мангупская I. Фотография И.С. Турбанова.
Fig. 11. *Operophtera brumata* Linnaeus, 1758 in the Mar-Khosar Cave. Photo courtesy G.A. Prokopov.
Рис. 11. *Operophtera brumata* Linnaeus, 1758 в пещере Мар-Хосар. Фотография Г.А. Прокопова.

massif, canyon of the Biyuk-Uzenbash River, Biyuk-Uzenbash Cave, 28.VI.2017; 1 ♀, Tshatyr-Dagh Karst Massif, the northern edge of the lower plateau, Suuk-Koba Cave, 13.II.2015; 2 ♀♀, same massif, Mramornaya Cave, 2.II.2016; 1 ♀, Dolgorukovsky Karst Massif, western spurs of Dolgorukovskaya Yaila, Eni-Sala III Cave, 31.I.2016; 2 ♂♂, 6 ♀♀, same massif, central part of Dolgorukovskaya Yaila, Sliyanie Cave, 23.VII.2017; 1 ♂, same massif, Proval II Cave, 13.V.2017; 2 ♂♂, 1 ♀, same massif, southeastern part of Dolgorukovskaya Yaila, Partizanskaya Cave, 14.V.2015; 4 ♀♀, same massif, Vostotshny Potok Cave, 5.IV.2014; 4 ♂♂, 1 ♀, Karabi Karst Massif, near Tshigenitra Pass, Tuakskaya Cave, 7.VI.2014; 9 ♂♂, 11 ♀♀, same massif, central part of Karabi Yaila, Monastyr-Tshokrak Cave, 25.VII.2010; 6 ♂♂, 14 ♀♀, Eghiz-Tinakh Karst Valley, Eghiz-Tinakh I Cave, 26.VII.2010; 3 ♀♀, same massif and valley, Yabushkan-Koba Cave, 12.VIII.2017, all leg. I.S. Turbanov.

NOTES. Noted from caves in Georgia, Caucasus: Dolabistavi, Sakishore and Usholta [Barjadze *et al*., 2015a, b]; and in Crimea: Kizil-Koba (Dolgorukovsky Karst Massif), Uzun-Koba, Binbash-Koba, Utshunzhu (Tshatyr-Dagh Karst Massif), Ayu-Teshik, Egerskaya, Tainstvennaya and Villyaburunskaya (Ai-Petri Karst Massif) [Pliginsky, 1927; Koval, 2001; Matyushkin, 2012].

Triphosa sabaudiata (Duponchel, 1830)

Noted from the Bakharden (= Durun) Cave in Turkmenistan [Vlasov, 1937].

?*Triphosa taochata* (Lederer, 1870)

Noted from the Crimean cave Kizil-Koba (Dolgorukovsky Karst Massif) [Pliginsky, 1927], but it still remains unknown if it does occur in the peninsula, as V.G. Pliginsky listed this species as only provisionally identified and differing in a number of characteristics from both *T. taochata* and *T. sabaudiata*. In our opinion, these data also concern *T. dubitata*.

Operophtera brumata Linnaeus, 1758
Fig. 11.

Noted from unnamed caves in Crimea [Prokopov, Turbanov, 2017]; according to a personal communication of G.A. Prokopov, this species was actually recorded from the Kizil-Koba and Mar-Khosar caves (Dolgorukovsky Karst Massif).

Camptogramma bilineata (Linnaeus, 1758)

Noted from unnamed caves in Crimea [Prokopov, Turbanov, 2017]; according to a personal communication of G.A. Prokopov, this species was actually recorded from the Kizil-Koba Cave (Dolgorukovsky Karst Massif).

Ectropis crepuscularia ([Denis, Schiffermüller], 1775)

Noted from caves in the European part of Russia, albeit without definite localities given [Mukhanov, Kapralov, 2010].

Family **Lasiocampidae** Harris, 1841

?*Gastropacha* sp.

Noted from the Crimean Daniltsha-Koba Cave (Ai-Petri Karst Region) [Lebedinsky, 1914]; in our opinion, this record actually concerns *G. quercifolia* (Linnaeus, 1758), the only species of this genus known to occur in the peninsula.

Family **Erebidae** Leach, 1815

Scoliopteryx libatrix (Linnaeus, 1758)
Fig. 12.

MATERIAL EXAMINED. 1 ♂, Crimea Peninsula, Bakhchysaraisky Karst Massif, steep escarpment of Baba-Dagh Plateau (= Mangup-Kale Gorodishche), Mangupskaya I Cave, 28.IV.2017; 1 ♀, same massif, southeastern cliffs of Kurushlyuk Mt., Tavrskaya Cave, 15.VI.2013; 2 ♀♀, Baydarsko-Balaklavsky Karst Massif, western spurs of Kala-Fatlar Mt., Gekkonovaya Cave, 27.VI.2017; 1 ♀, same massif, canyon of the Tshernaya River, Tshernorechenskaya Cave, 5.VII.2017; 1♂, 2 ♀♀, same massif, Baydarskaya Valley, Mamut-Tshokrak Cave, 6.V.2012; 2 ♀♀, Ai-Petri Karst Massif, Baydarskaya Valley, Baydar-Tshokrak Cave, 2.VII.2017; 1 ♂, 1 ♀, same massif and valley, Skelskaya Cave, 10.VII.2017; 2 ♂♂, 1 ♀, same massif and valley, Tshernaya Cave, 5.V.2017; 2 ♀♀, same massif and valley, Urkusta-Tshokrak-Koba Cave, 6.VIII.2017; 2 ♀♀, same massif, canyon of Uzundzha River, Uzundzha Cave, 19.VII.2017; 1 ♂, same massif, plateau of Foroskiy Kant Mt., Egerskaya II Cave, 4.II.2011; 1 ♂, same massif, Bash-Dere area, Avantyura Cave, 15.XI.2014; 2 ♂♂, 1 ♀, same massif, Karadag Forest area, Koryta Cave, 8.III.2014; 1 ♀, Yaltinsky Karst massif, western slopes of the Kaply-Kayanskaya Mt., Kaply-Kayanskaya Cave, 29.VI.2017; 2 ♂♂, 1 ♀, Tshatyr-Dagh Karst Massif, the northern edge of the lower plateau, Suuk-Koba Cave, 13.II.2015; 1 ♂,

Fig. 12. *Scoliopteryx libatrix* (Linnaeus, 1758) in the Kizil-Koba Cave. Photo courtesy G.A. Prokopov.
Рис. 12. *Scoliopteryx libatrix* (Linnaeus, 1758) в пещере Кизил-Коба. Фотография Г.А. Прокопова.
Fig. 13. *Apopestes spectrum* (Esper, 1787) in the Biyuk-Tekne-Bel Cave. Photo by I.S. Turbanov.
Рис. 13. *Apopestes spectrum* (Esper, 1787) в пещере Бинок-Текне-Бель. Фотография И.С. Турбанова.

same massif, Binbash-Koba, 13.II.2015; 2 ♀♀, Dolgorukovsky Karst Massif, western spurs of Dolgorukovskaya Yaila, Kizil-Koba Cave, 5.III.2018; 1 ♂, same massif, Eni-Sala III Cave, 31.I.2016; 2 ♀♀, same massif, southeastern part of Dolgorukovskaya Yaila, Partizanskaya Cave, 14.V.2015; 1 ♂, 2 ♀♀, Karabi Karst Massif, near Tshigenitra Pass, Tuakskaya Cave, 7.VI.2014; 1 ♂, Eghiz-Tinakh Karst Valley, Yabushkan-Koba Cave, 12.VIII.2017, all leg. I.S. Turbanov.

NOTE. Originally found in the Baskuntshakskaya Cave and in three neighbouring unnamed caves in the Astrakhan Region, southern Russia [Kapralov, Chernorudsky, 2007]; in caves of the Nizhniy Novgorod Region, albeit without definite localities given [Kapralov, 2007; Kapralov, Chernorudsky, 2009]; in a number of caves in the European part of Russia, also without definite localities [Mukhanov, Kapralov, 2010]; in the Shulgan-Tash Cave in Bashkortostan [Kapralov, 2010]; in the caves Eranka, Berezovskaya, Lypinskaya, Kizelovskaya, Mariinskaya, Ladeinaya, Letutshikh Myshey, Obvalynaya, Rossiyskaya, Rebristaya, Tshudesnitsa, Kungur Ice Cave, Babinogorskaya, Ordinskaya, Besymiannaya, Geologov I, II and III [Pankov *et al*., 2009]; in caves of Georgia: Dolabistavi and Sakishore [Barjadze *et al*., 2015a, b]; in the Crimean caves Kizil-Koba (Dolgorukovsky Karst Massif), Beryu-Teshik, Ayu-Teshik and Daniltsha-Koba (Ai-Petri Karst Massif) [Pliginsky, 1927].

Apopestes spectrum (Esper, 1787)
Fig. 13.

MATERIAL EXAMINED. 1 ♂, 3 ♀♀, Crimea Peninsula, Baydarsko-Balaklavsky Karst Massif, Baydarskaya Valley, Biyuk-Tekne-Bel Cave, 28.VI.2010; 1 ♂, 1 ♀, same massif, on the southern spurs of Foros Mt., Forosskaya Cave, 25.VI.2017, all leg. I.S. Turbanov.

NOTES. This species is being recorded from Crimean caves for the first time.

Autophila asiatica (Staudinger, 1888)

Noted from in unnamed cave near Partisanskoye village and Zmeinaya Cave in Crimea [Budashkin *et al*., 2004].

Autophila limbata (Staudinger, 1871)

Noted from in unnamed cave near Partisanskoye village in Crimea [Klyuchko, 1971].

Family **Noctuidae** Latreille, 1809

Hypena rostralis (Linnaeus, 1758)

Noted from the Shulgan-Tash Cave in Bashkortostan [Kapralov, 2010; Mukhanov, Kapralov, 2010] and in unnamed cave near Partisanskoye village in Crimea [Budashkin *et al*., 2004].

Apamea lateritia (Hufnagel, 1766)

Noted from the Kungur Ice Cave in the Perm Region [Pankov et al., 2009].

Family **Arctiidae** Leach, 1815

Axiopoena maura (Eichwald, 1830)

Noted from the Bakharden (= Durun) Cave in Turkmenistan [Vlasov, 1937].

Axiopoena karelini (Ménétriés, 1863)

Larvae and moths were collected in unnamed caves of the Razdan Gorge in Armenia by O. Gorbunov.

Spilosoma urticae (Esper, 1789)

Noted from the Babinogorskaya Cave in the Perm Region [Pankov *et al*., 2009].

Family **Pieridae** Duponchel, 1835

Colias hyale (Linnaeus, 1758)

Noted from the Tarkolskaya Cave in the Altai Region [Malkov, Marinin, 1989].

Family **Satyridae** Boisduval, 1833

Hipparchia parisatis laeta (Christoph, 1877)

Noted from the Bakharden (= Durun) Cave in Turkmenistan [Vlasov, 1937].

Chazara persephone (Hübner, 1805)

Noted from the Bakharden (= Durun) Cave in Turkmenistan, referred to as *Satyrus anthe* Ochsenheimer, 1807 [Vlasov, 1937].

Family **Nymphalidae** Rafinesque, 1815

Aglais urticae (Linnaeus, 1758)

Noted from the Tarkolskaya and Elendinskaya caves in the Altai Region [Malkov, Marinin, 1989]; from caves in the European part of Russia, albeit without definite localities provided [Mukhanov, Kapralov, 2010]; from the Kollektor Cave in the Perm Region [Pankov *et al*., 2009].

Inachis io (Linnaeus, 1758)

Noted from caves in the European part of Russia, albeit without definite localities given [Mukhanov, Kapralov, 2010].

Discussion and Conclusion

Despite the earlier reviews [Kniss, 2001; Mukhanov, Kapralov, 2010; Turbanov *et al*., 2016b; Golovatch *et al*., 2018], the question concerning the ecological classification of these species remains open. To solve this problem, we used the ecological classification of B. Sket [2008], based on which it appears possible to use the following three categories as applied to Lepidoptera: (1) eutroglophile is an essentially epigean species, but capable of maintaining a permanent subterranean population; (2) subtroglophile is inclined perpetually or temporarily to inhabiting a subterranean habitat, but is bound to the surface for some biological functions (e.g. feeding); (3) trogloxene is a species only occurring sporadically (accidentally) underground.

To the eutroglophile group we assign species of the family Tineidae – *Monopis crocicapitella*, *Monopis laevigella*, *Monopis* sp. and *Tinea unipunctella*, as all these epigean species are capable both of keeping stable populations on bat guano formations in caves and of completing the life cycle there without leaving this habitat [Zagulajev, 1960; Jakšić, 2017].

The subtroglophile group contains *Alucita cancellata*, *Digitivalva christophi*, *Triphosa dubitata*, *Scoliopteryx libatrix*, *Autophila asiatica*, *A. limbata* and *Apopestes spectrum*. At the larval stage all these epigean species are trophically associated with plants growing on the surface. However, they do use caves for hibernation or aestivation. A number of researchers share a similar point of view as regards the ecological status of *T. dubitata* and *S. libatrix* [Bourne, Cherix, 1978; Turquin, 1994; Beshkov, Petrov, 1996; Jakšić, 2017].

There are records available in the literature that the numbers of these species in some caves can reach 100–1000 specimens [Bourne, Cherix, 1978; Kučinić, 2002]; we had similar observations in 2010 for *T. dubitata* in the Monastyr-Tshokrak and Eghiz-Tinakh I caves (Karabi Karst Massif, Crimea). Almost all species of *Alucita* Linnaeus, 1758 are trogloxenes, except some of subtroglophile species, e.g., *A. cymmatodactyla* (Zeller, 1852) [Beshkov, Petrov, 1996; Jakšić, 2017]. As regards *A. cancellata*, we are also inclined to consider it as a subtroglophile, based on our own continuous observations of this species in 2010–2018 in various caves of Crimea. Unfortunately, until 2017 the observations were left without any material taken, because the species was considered trogloxenic. Species of *Digitivalva* Gaedike, 1970 are considered as a trogloxene by different researchers [Beshkov, Petrov, 1996] or as a subtroglophile [Capuse, Georgescu, 1962; Skalski, 1972; Rákosy, 2003–2004; Jakšić, 2017; etc.]. Following by data of Yu.I. Budashkin [2006] regarding using of caves and grots by *D. christophi* in Kazantip nature reserve in Crimea as a shelter for summer estivation we refer this species to subtroglophile. A number of researchers [Beron, 1994; Rákosy, 2003–2004; Jakšić, 2017] regarded species of *Autophila* Hübner, 1823 and *A. spectrum* as a trogloxenes species, but according to S. Beshkov and B. Petrov [1996], it is a subtroglophiles. We share the same point of view, based on our own observations of *A. spectrum*, as this species shows a well-marked negative phototaxis, during the daytime trying to take shelter in various dark places where the light fails to penetrate. In karst landscapes, caves are certainly the best habitat to look for and find such places.

The trogloxene group includes all other lepidopterans considered – *Agonopterix* sp., *Triphosa sabaudiata*, ?*T. taochata*, *Operophtera brumata*, *Camptogramma bilineata*, *Ectropis crepuscularia*, ?*Gastropacha* sp., *Hypena rostralis*, *Apamea lateritia*, *Axiopoena maura*, *A. karelini*, *Spilosoma urticae*, *Colias hyale*, *Hipparchia parisatis laeta*, *Chazara persephone*, *Aglais urticae* and *Inachis io*. All these epigean species, like the subtroglophile one in the larval stage, are trophically associated with plants growing on the surface. However, adults do not use caves regularly, instead only rarely penetrating them in search of a shelter, a place for a daily rest and, much less often, for hibernation (except for *A. urticae* and *I. io*) or aestivation. Many researchers have a similar opinion as regards most of these species [Beron, 1994; Beshkov, Petrov, 1996; Kučinić, 2002; Turquin, 1994; etc.].

Thus, in accordance with the above review, 28 species of Lepidoptera from 12 families are noted to occur in caves of the former USSR, of which 4 are eutroglophiles, 7 subtroglophiles, while 17 are trogloxenes. There is little doubt that the faunal composition of Lepidoptera in caves of the study areas is far richer and it requires further long-term and special studies.

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