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Three new species of *Aphaobius* Abeille de Perrin, 1878 from Upper Carniola (Slovenia) (Coleoptera, Leiodidae, Cholevinae, Leptodirini)

Riassunto: *Tre nuove specie di* Aphaobius *Abeille de Perrin, 1878 dell'alta Carniola (Slovenia) (Coleoptera, Leiodidae, Cholevinae, Leptodirini).*
Vengono descritte tre nuove specie di *Aphaobius* dell'Alta Carniola (Slovenia): *Aphaobius mateji* n. sp. della grotta Jama na Pri hlodih a Zabrekve; *Aphaobius ninae* n. sp. della miniera Zaklonišče Tekstilindusa a Stražišče (Kranj) e *Aphaobius ajdae* n. sp. della grotta Kurnik a Mrtancova planina (Škofja Loka). Viene illustrata la distribuzione dei nuovi taxa in relazione alle altre specie del genere *Aphaobius*.

Abstract: Three new species of *Aphaobius* from the Upper Carniola (Slovenia) are described: *Aphaobius mateji* n. sp. from Jama na Pri hlodih cave in Zabrekve; *Aphaobius ninae* n. sp. from Zaklonišče Tekstilindusa mine in Stražišče (Kranj) and *Aphaobius ajdae* n. sp. from Kurnik cave in Mrtancova planina (Škofja Loka). A discussion on the distribution of the new taxa related to distribution of the other species of *Aphaobius* is presented here.

Key words: *Aphaobius*, *mateji* n. sp., *ninae* n. sp., *ajdae* n. sp., distribution, zoogeography.

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Introduction

The genus *Aphaobius* Abeille de Perrin, 1878, endemic to the (north-eastern Italy, Slovenia, southern Austria, and north-western Croatia), has been revised in 2010 by Bognolo and Vailati. Based on morphology, the authors brought the number of species of this genus to 19, elevating numerous subspecies to the species rank.

The peculiarity of the genus *Aphaobius* (as for example in the more showy and famous genus *Anthroherpon* Reitter, 1889), is the morphological homogeneity of the male genitalia, while the external morphology has distinct characters that are much more obvious and easier to use.

Despite the great study effort dedicated to this area in the past, new species are still discovered today, thanks to Bojan Kofler, tireless investigator who sent us the material. Here the author describes three new species of *Aphaobius* from Slovenia.

Materials and Methods

The material was collected by Bojan Kofler, using pitfall traps and hand collection, during a self-supported Subterranean fauna survey conducted through Slovenia.

All specimens are preserved dry; genitalia of the holotype (HT) and of some paratypes males and females are permanently mounted on slides with Canadian Balsam and pinned beneath the specimens.

Digital images of the habitus were taken with a Leica DFC295 camera mounted on a Leica M205 C Stereomicroscope, using Leica Application System V4.0 software.

Digital images of the aedeagus were taken with a Sony Cybershot DSC-W830 camera mounted on a Leitz Dialux Microscope, and processed with CombineZP software.

The following acronyms have been used for depositories of material:
CCa: Casale Collection, Turin, Italy
CGi: Giachino Collection, San Martino Canavese (TO), Italy.
CKo: Kofler Collection, Škofja Loka, Slovenia.
CVa: Vailati Collection, Brescia, Italy

The following acronyms have been used for the type of material:
HT: Holotype
PT(T): Paratype(s)

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TAXONOMY

Aphaobius mateji n. sp. (Figs. 3,12)
lsid:zoobank.org:act:
F672D3E2-3017-4CAB-B2B7-68C73BD860D7

Type locality: Slovenia, Zabrekve, Jama na Pri hlodih Cave, 830 m.
Type material: HT ♂, Slo. Zabrekve, J. na Pri hlodih, 2.3-1.8.2012, leg B. Kofler (CKo).
PTT: 4 ♂♂ 15 ♀♀, same data; 10 ♂♂ 13 ♀♀, same data, 1.8.2012-11.3.2013 (CKo, CGi, CCa, CVa).

Diagnosis. An *Aphaobius* species that seems to be strictly related to *A. kofleri* Bognolo & Vailati (2010), owing to the apex of the median lobe of the aedeagus being large and rounded. The new species differs from *A. kofleri* by the apex of the median lobe, that is less rounded in dorsal view and is also clearly emarginated in the median area (Figs. 12-13), by the basal phanera of endophallus simple, the shorter elytra, the narrower pronotum, and by the 7th, 9th and 10th antennomeres obviously shorter. *A. mateji* differs from *A. miricae* Bognolo & Vailati (2010), by the apex of the median lobe, which is less rounded in dorsal view, by the basal phanera of endophallus simple, and by the wider elytra anteriorly. *A. mateji* differs from *A. kaplai* Bognolo & Vailati (2010) by the apex of the median lobe wider and more rounded in dorsal view, by the basal phanera of endophallus simple, and by the shorter body.

Description. Total length: ♂♂ 2.68-2.74 mm, ♀♀ 2.70-2.83 mm. Body brownish-testaceous, with legs, antennae and palpi of the same colour. Integument (pronotum and elytra) uniformly covered with yellow, moderately long and recumbent pubescence.
Head retractile, with an evident occipital carina; long pubescence and semi-erect on frons and clypeus. Eyes absent. Antennae relatively long, thin, reaching the middle of elytra in both males and females. Antennomere 1st as long as 2nd; antennomeres 1st to 6th filiform and longer than wider; antennomeres 7th, and 9th to 11th enlarged at apex; 7th longer than wide; 8th slightly elongate and narrower than 7th; 9th and 10th longer than wide; 11th longer than 10th.
Pronotum transverse (ratio maximum width/maximum length: 1.55 ♂♀), widest at the base, disk not flattened near basal angles; lateral margins regularly curved anteriorly, not sinuate, sub-rectilinear posteriorly near basal angles; basal angles square acute, not rounded. The base of pronotum slightly narrow than the base of elytra, laterally sinuate. Pronotum disc slightly granulose with evident microsculpture.
Legs relatively robust with simple tarsal claws. Protarsi four-segmented and not dilated in males. Protibiae gently arcuate outwards, without external comb of bristles; meso- and metatibiae straight, with two external apical spurs.
Mesosternal carina high, with anterior edge bisinuate and ventral one concave. Without tooth.
Elytra elliptical, elongate (ratio maximum width/maximum length: 0.75 ♂♀), each elytron rounded and apically narrowed in both sexes. Elytral disc convex, slightly depressed along suture towards the basal area; parasutural stria absent; disc with a transverse striation.
Aedeagus (Fig. 12) large, with stout median lobe in dorsal view, and sub-parallel lateral edges. Apical part widely rounded, not enlarged, with sub-truncate apex. Endophallus, in dorsal view, with a Y-shaped basal piece and one large, V-shaped distal piece. Parameres (Fig. 12) thin, as long as the median lobe, not curved inwards. Chaetotaxy represented by three setae: first one in apical position, second one in external, subapical position, and third one in inner position.

Etymology. This interesting species is dedicated to Matej Kofler, son of Bojan Kofler and his collaborator in the investigations of the subterranean fauna of Slovenia.

Distribution and ecology. *Aphaobius mateji* n. sp. is known only from the type locality, Jama na Pri hlodih Cave. This cave is located near the village of Zabrekve in the north-western part of Slovenia (Fig. 26). This is a small cave in dolomite rocks on the Sveti Mohor mountain (entrance altitude: 830 m). The cave is 45 m long and 15 m deep. Collection site number 14 (Fig. 23).
Associated Coleoptera fauna (not specialized) were: Carabidae: *Laemostenus schreibersi* Küster, 1846; Leiodidae: *Catops subfuscus* Kellner, 1846; *Colenis immunda* Sturm, 1807; Rhizophagidae: *Rhizophagus cribratus* Gyllenhal, 1827.

Aphaobius ninae n. sp. (Figs 1,10)
lsid:zoobank.org:act:
D7294CAE-A314-4961-808E-31C65F97B3B0

Type locality: Slovenia, Kranj, Stražišče, Zaklonišče Tekstilindusa.

Type material: HT ♂**,** Zaklonišče Tekstilindusa, Stražišče, Kranj, 10.9-15.12.2009, leg. Kofler (CKo). PTT: 17 ♂♂ 22 ♀♀, same data, 14.6-30.7.2010; 5 ♂♂ 9 ♀♀, same data, 19.3-14.6.2010; 1 ♂, same data, 15.6-22.7.2009; (CKo, CGi, CCa, CVa)

Diagnosis. An *Aphaobius* species of *Aphaobius muellerianus* Pretner, 1963 species group, which appears to be strictly related to *A. muellerianus* for the shape of aedeagus (rounded and enlarged in the preapical zone) and elytral shape (posteriorly enlarged). The new species differs from *A. muellerianus* by smaller size, more truncated apex of the median lobe in dorsal view, which is also shorter (Figs. 1, 16), basal phanera of endophallus simple, shorter and less globose elytra, and pronotum lateral sides not sinuated before the basal angles.

Description. Total length: ♂♂ 2.74-2.85 mm, ♀♀ 2.85-2.90 mm. Body brownish-testaceous, with legs, antennae and palpi of the same colour. Integument (pronotum and elytra) uniformly covered with yellow, sparse, long and semierect pubescence.
Head retractile, with an evident occipital carina; pubescence long and semi-erect on frons and clypeus. Eyes absent. Antennae relatively long, thin, reaching the apical fourth of elytra both in males and females. Antennomere 1st as long as 2nd; antennomeres 1st to 6th filiform and longer than wider; antennomeres 7th, and 9th to 11th enlarged at apex; 7th longer than wide; 8th slightly elongate and narrower than 7th; 9th and 10th longer than wide; 11th longer than 10th.
Pronotum transverse (ratio maximum width/maximum length: 2.0 ♂♀), widest just before the base, disk not flattened near basal angles; lateral margins regularly curved anteriorly, not sinuate, posteriorly curved near basal angles; basal angles sub-acute, not rounded. The base of pronotum slightly narrow than the base of elytra, laterally sinuate. Pronotum disc slightly granulose with evident microsculpture.
Legs relatively robust with simple tarsal claws. Protarsi four-segmented and not dilated in males. Protibiae gently arcuate outwards, without external comb of bristles; meso- and metatibiae straight, with two external apical spurs.
Mesosternal carina high, with anterior edge bisinuate and ventral one concave. Without tooth.
Elytra elliptical, elongate (ratio maximum width/maximum length: 0.71 ♂♀), each elytron rounded and narrowed apically in both sexes. Elytral disc convex, slightly depressed along suture in basal area; parasutural stria absent; disc with a transverse striation.
Aedeagus (Fig. 1) large, with stout median lobe in dorsal view, and sub-parallel lateral edges. Apical part widely but poorly rounded, not enlarged, with apex not truncate. Endophallus, in dorsal view, with a Y-shaped basal piece and one large, X-shaped distal piece. Parameres (Fig. 1), thin, as long as or slightly longer than the median lobe, gently curved inwards. Chaetotaxy represented by three setae: first one in apical position, second one in external, subapical position, and third one in inner position.

Etymology. This interesting species is dedicated to Nina Kofler Kobal, daughter of Bojan Kofler and his collaborator in the investigations of the subterranean fauna of Slovenia.

Distribution and ecology. *Aphaobius ninae* n. sp. is known only from the type locality, Zaklonišče Tekstilindusa cave. It is an artificial mine excavated from a small natural cave. It is located near Kranj train station in the north-western part of Slovenia (Fig. 26). This cave, with entrance altitude at 365 m, is about 250 m long and 3 m deep. The section I – H represents the natural cave (Fig. 24) where the new species was found.
Associated Coleoptera fauna (specialized or not) were: Carabidae: *Laemostenus schreibersi* Küster 1846; *Anophthalmus egonis* Müller, 1923; Cryptophagidae: *Cryptophagus scutellatus* Newman, 1834.

Aphaobius ajdae n. sp. (Figs. 2,11)
lsid:zoobank.org:act:
8159AAE2-F250-4801-9D8A-78AACB6B579B

Type locality: Slovenia, Škofja Loka, Mrtancova planina, cave Kurnik

Type material: HT ♂, Šk. Loka, Mrtancova planina, Kurnik, 1.4-7.10.2014, leg. B. Kofler (CKo).
PTT: 6 ♂♂ 3 ♀♀, same data; 1 ♂, same data, 24.9.2013-1.4.2014; 2 ♀♀, same data, 8.5-4.11.2015; 4 ♂♂ 2 ♀♀, same data, 7.10.2014-8.5.2015; 2 ♂♂ 4 ♀♀, same data, 14.2-2.10.2017; 1 ♀, same data, 21.4-28.9.2021; 4 ♂♂ 2 ♀♀, same data, 14.3-27.9.2016; 2 ♀♀, same data, 2.4-28.10.2019; 2 ♀♀, same data, 28.10.2019-16.3.2020; 1 ♀, same data, 4.11.2015-14.3.2016; 5 ♂♂ 6 ♀♀, same data, 8.5.-4.11.2015: 2 ♂♂ 3 ♀♀, same data, 7.10.2014-8.5.2015; 1 ♀, same data, 27.9.2016-14.2.2017; 1 ♂, same data (CKo, CGi, CCa, CVa).

Diagnosis. An *Aphaobius* species of the *Aphaobius milleri* group (Schmidt, 1855), which seems closely related to *A. alphonsi* Müller, 1914, due to the rounded apex of the median lobe of aedeagus (not enlarged in preapical zone) and oval elytrae. The new species differs from *A. alphonsi* by its larger size, the more truncated apex of the median lobe in dorsal view, which is also longer (Fig. 11), the simple basal phanera of endophallus, the wider elytra, and the lateral side of the pronotum not sinuated before the basal angles.

Description. Total length: ♂♂ 2.77-2.87 mm, ♀♀ 2.87-2.92 mm. Body brownish-testaceous, with legs, antennae and palpi of the same colour. Integument (pronotum and elytra) uniformly covered with yellow, sparse, moderately long and semierect pubescence.
Head retractile, with evident occipital carina; long and semi-erect pubescence on frons and clypeus. Eyes absent. Antennae relatively long, thin, not reaching the apical fourth of elytra in both males and females. Antennomere 1st as long as 2nd; antennomeres 1st to 6th filiform and longer than wider; antennomeres 7th, and 9th to 11th enlarged at apex; 7th longer than wider; 8th slightly elongate and narrower than 7th; 9th and 10th longer than wider; 11th longer than 10th.
Pronotum transverse (ratio maximum width/maximum length: 1.9 ♂♀), widest just before the base, disk not flattened near basal angles; lateral margins regularly curved anteriorly, not sinuate, sub-rectilinear posteriorly near basal angles; basal angles sub-acute, not rounded. The base of pronotum slightly narrower than the base of elytra, laterally sinuate. Pronotum disc slightly granulose with evident microsculpture.
Legs relatively robust, with tarsal claws simple. Protarsi four-segmented and not dilated in males. Protibiae gently arcuate outwards, without external comb of bristles; meso- and metatibiae straight, with two external apical spurs.
Mesosternal carina high, with anterior edge bisinuate and the ventral one concave. Without tooth.
Elytra elliptical, elongate (ratio maximum width/maximum length: 0.73 ♂♀), each elytron rounded and narrowed apically in both sexes. Elytral disc convex, slightly depressed along suture in basal area; parasutural stria absent; disc with a transverse striation.
Aedeagus (Fig. 11) large, with stout median lobe in dorsal view, and sub-parallel lateral edges. Apical part poorly rounded, not enlarged, with apex not truncate. Endophallus, in dorsal view, with a Y-shaped basal piece and one small, poorly evident, X-shaped, distal piece. Parameres (Fig. 11), thin, as long as the median lobe, not curved inwards. Chaetotaxy represented by three setae: first one in apical position, second one in external, subapical position, and third one in inner position.

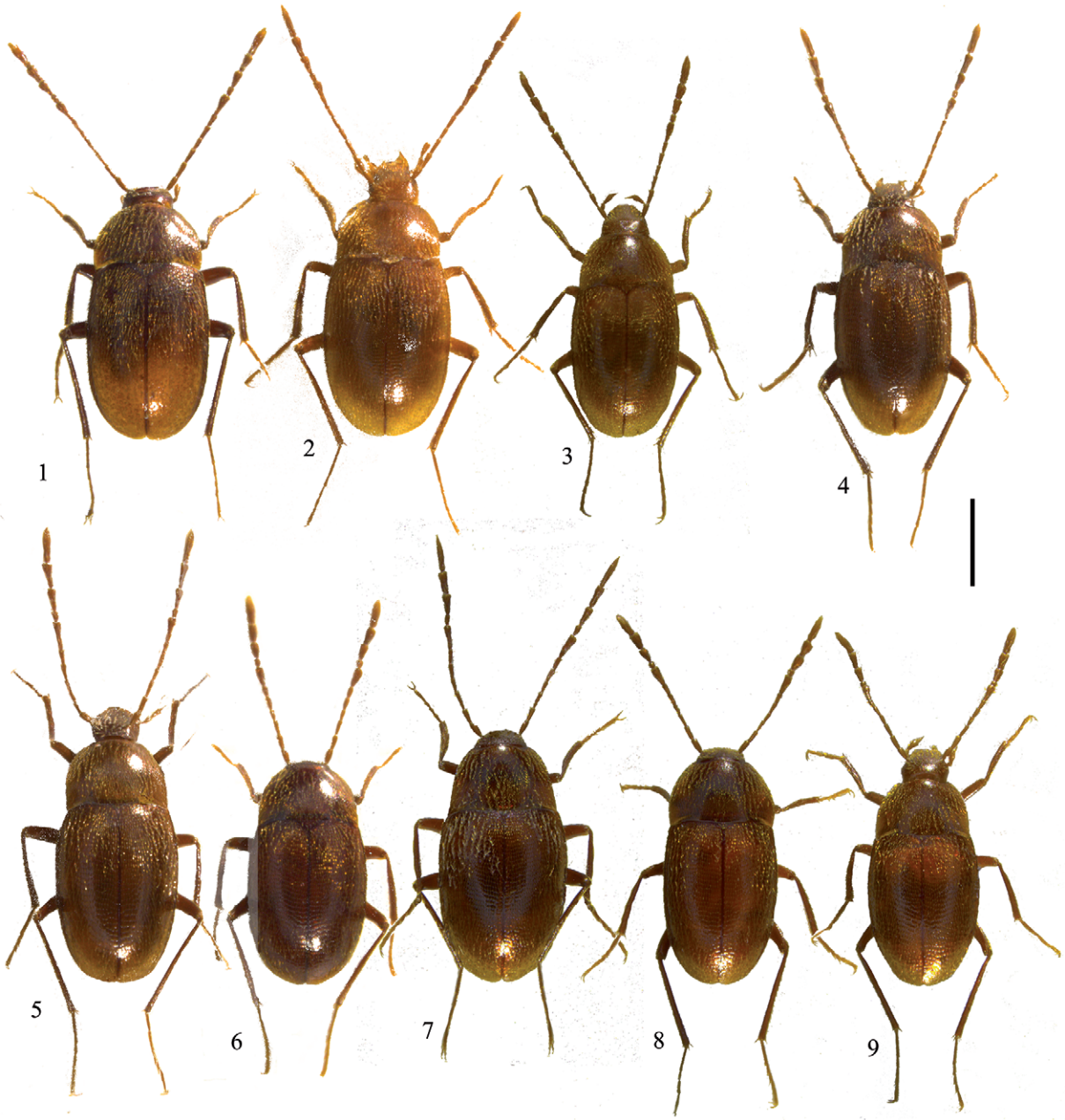
Etymology. This interesting species is dedicated to Ajda Kobal, granddaughter of Bojan Kofler and his collaborator in the investigations of the subterranean fauna of Slovenia.

Distribution and ecology. *Aphaobius ajdae* n. sp. is known only from the type locality, the Kurnik cave. It is a small cave in a small, isolated karst area in the vicinity of Škofja Loka (Fig. 26). The cave is located on the hill Mrtancova planina (entrance altitude: 455 m). It is 16 m long and 7 m deep. Epigean and hypogean beetle fauna of the cave is rich. The new *Aphaobius* species was found at the end of the cave (Fig. 25, point 1).
Associated Coleoptera fauna (specialized or not) were: Carabidae: *Laemostenus schreibersi* Küster, 1846; Cryptophagidae: *Cryptophagus croaticus* Reitter, 1879; *Cryptophagus punctipennis* Brisout, 1863; Curculionidae: *Otiorhynchus* (*Troglorhynchus*) *anophthalmus* Schmidt, 1854; Latridiidae: *Dienerella clathrata* Mannerheim, 1844; Leiodidae: *Agaricophagus cephalotes* Schmidt, 1841; *Bathyscia montana montana* Schiödte, 1848; *Catops subfuscus* Kellner, 1846; *Choleva sturmi* Brisout, 1863; *Bathyscimorphus* sp. n.; Staphylinidae Pselaphinae: *Bryaxis lokayi* Machulka, 1927; Scydmaenidae: *Scydmoraphes tuberculifer* Roubai, 1926; Staphylinidae: *Lathrobium cavicola* Müller, 1856.

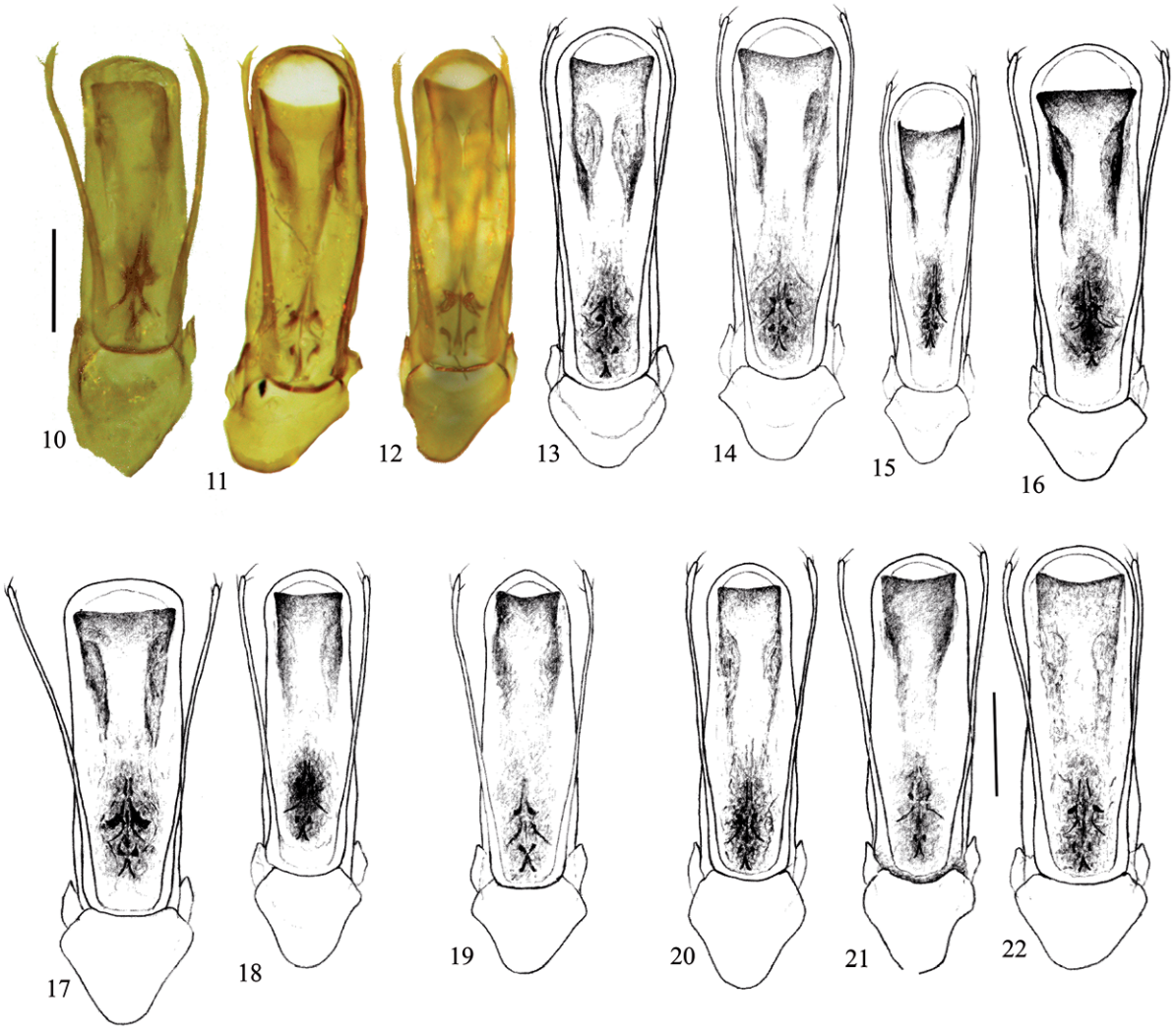
REMARKS

The discovery of these three new species is unexpected in a very well-studied area from the subterranean point of view, such as Slovenia (Perreau, 2000; 2004). The three new species seem to have restricted distribution (Fig. 26), like some of the species belonging to the genus *Aphaobius*.

In *Aphaobius* species groups, we find species with large distribution and species with short distribution range, so therefore other short-range endemic undescribed taxa should be expected, especially at the outer margins of the distribution range.



Figs. 1-9. Habitus of male *Aphaobius* species. 1) *A. ninae* n. sp.; 2) *A. ajdae* n. sp.; 3) *A. mateji* n. sp.; 4) *A. kofleri*; 5) *A. ljubnicensis*; 6) *A. alphonsi*; 7) *A. heydeni*; 8) *A. kaplai*; 9) *A. miricae*. Scale bar: 1 mm.



Figs. 10-22. Median lobe of aedeagus in dorsal view of *Aphaobius* spp. 10) *A. ninae* n. sp. HT ♂; 11) *A. ajdae* n. sp. HT ♂; 12) *A. mateji* n. sp. HT ♂; 13) *A. kofleri*; 14) *A. ljubnicensis*; 15) *A. alphonsi*; 16) *A. muellerianus*; 17) *A. heydeni*; 18, 19, 20) *A. kaplai*; 21) *A. robustus*; 22) *A. miricae*. Scale bar: 0.1 mm. From Bognolo & Vailati (2010), modified.

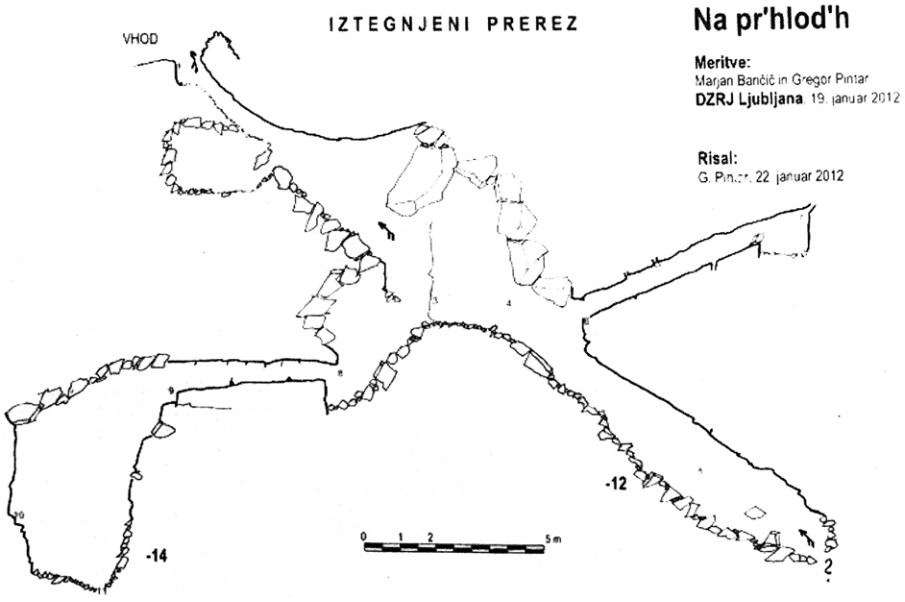


Fig. 23. Topographic map of Jama na Pri hlodih cave.

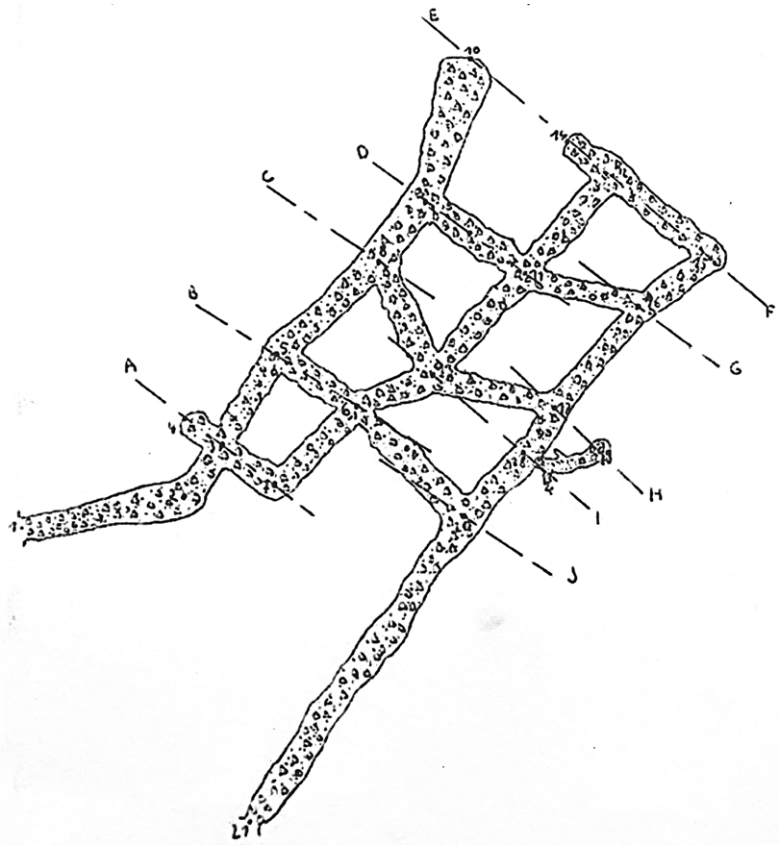


Fig. 24. Topographic map of Zaklonišče Tekstilindusa mine.

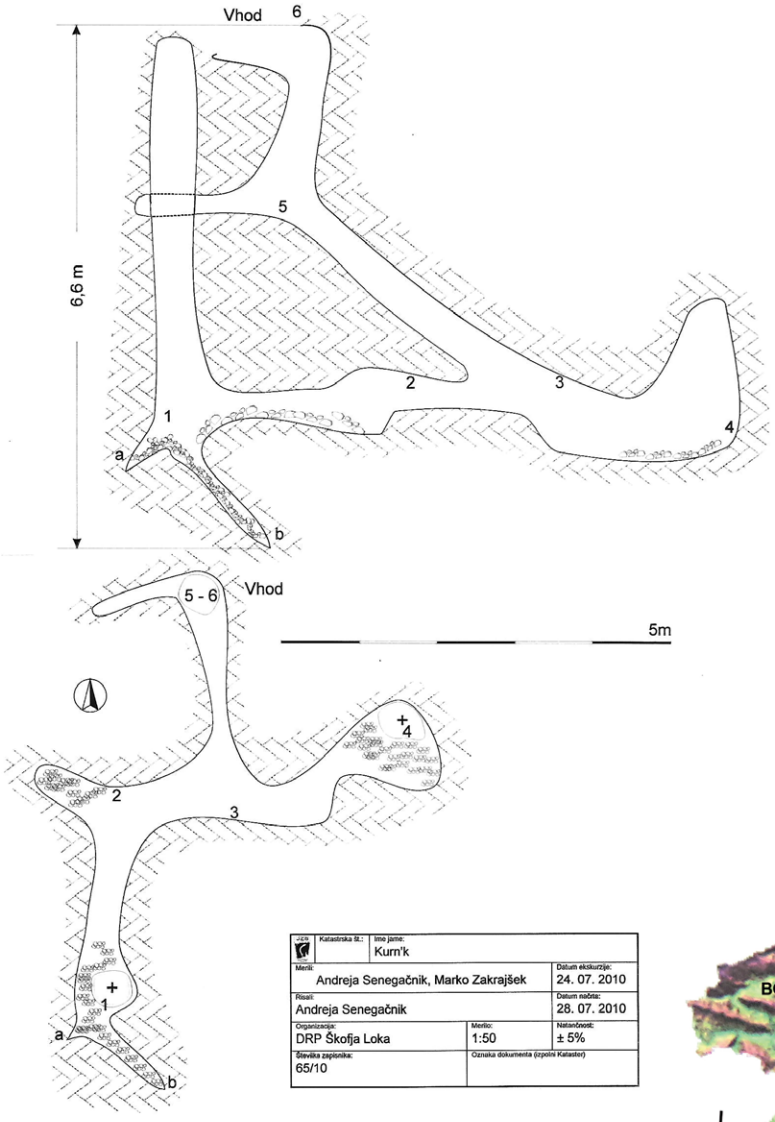


Fig. 25. Topographic map of Kurnik cave.

Fig. 26. Distribution map of the new species of *Aphaobius*. A) *A. mateji* n. sp.; B) *A. ninae* n. sp.; C) *A. ajdae* n. sp.

Acknowledgments

My warmest thanks to Bojan Kofler, that collected these new species, strongly supported by his children Matej and Nina and his granddaughter Ajda, to whom the new species will be dedicated. Bojan provided me with geographic data and friendly invited me to describe them. I am particularly grateful to my friends Achille Casale (Torino, Italy) and Giulia Perina (Perth, Australia) for useful suggestions and improvements to an early version of the manuscript, and Giovanni Bosio for the support with the photos taken at Settore Fitosanitario in Turin.

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