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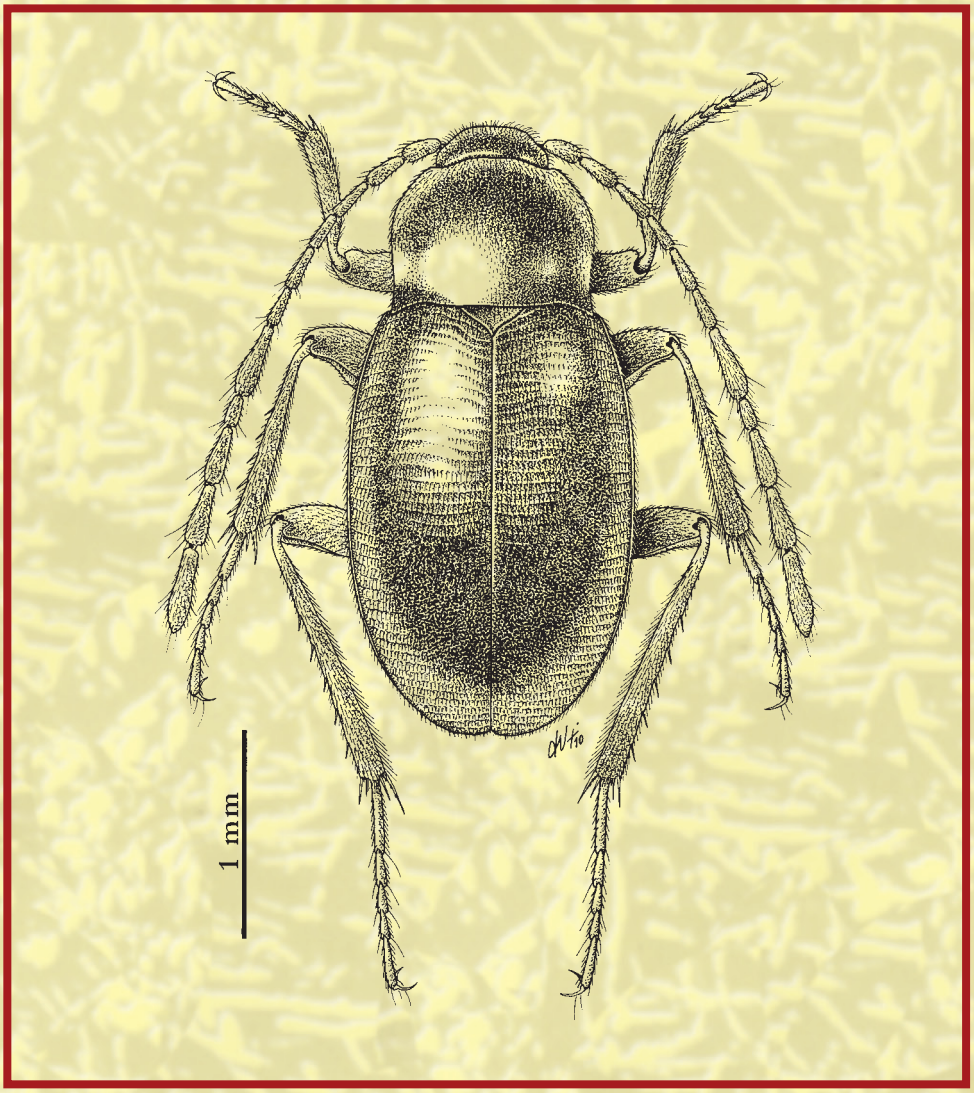

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Revision of the genus *Aphaobius* Abeille de Perrin, 1878 (Coleoptera, Cholevidae, Leptodirinae)

Marco BOGNOLO*, Dante VAILATI**

Abstract

The genus *Aphaobius* Abeille de Perrin, 1878, is endemic to caves and subterranean superficial environment of the north-western Balkan region (Slovenia, north-eastern Italy, southern Austria and north-western Croatia). Four species and several subspecies of *A. milleri* have been described so far. This revision gives a description of additional 7 species, modifies the status of 6 subspecies of *A. milleri* and 1 subspecies of *A. heydeni*, and establishes 7 new synonyms. All species are placed in 4 species groups, i.e. two monospecific groups, *muellerianus* and *heydeni*, including the species *A. muellerianus* Pretner, 1963, and *A. heydeni* Reitter, 1885, the *kraussi* group, which includes *A. mixanigi* n. sp., *A. angusticollis* n. sp., *A. knirschi* Müller, 1913 n. stat., *A. brevicornis* Mandl, 1940 n. stat. and *A. kraussi* Müller, 1910, and the *milleri* group, which includes *A. forojulensis* Müller, 1931 n. stat., *A. grottoloi* Vailati, 2004, *A. lebenbaueri* n. sp., *A. miricae* n. sp., *A. kaplai* n. sp., *A. fortesculptus* Müller, 1910 n. stat., *A. robustus* Müller, 1914 n. stat., *A. kahleni* n. sp., *A. milleri* (Schmidt, 1855), *A. ljubnicensis* Müller, 1914 n. stat., *A. kofleri* n. sp. and *A. alphonsi* Müller, 1914 n. stat..

Key words: Cholevidae, Leptodirinae, *Aphaobius*, revision, new species

Izvleček

Revizija rodu *Aphaobius* Abeille de Perrin, 1878 (Coleoptera, Cholevidae, Leptodirinae) – Rod *Aphaobius* Abeille de Perrin, 1878 je endemičen v jamah in podzemeljskih okoljih severozahodnega Balkana (Slovenija, severovzhodna Italija, južna Avstrija in severozahodna Hrvaška). Doslej so bile opisane štiri vrste in več podvrst *A. milleri*. V pričujočem prispevku avtorja opisujeta nadaljnjih sedem vrst, modificirata status šestih podvrst *A. milleri* in ene podvrste *A. heydeni* ter uveljavljata sedem novih sinonimov. Vse vrste razvrščata v štiri skupine, in sicer v dve monospecifični skupini *muellerianus* in *heydeni*, ki vključujeta vrsti *A. muellerianus* Pretner, 1963 in *A. heydeni* Reitter, 1885, skupino *kraussi*, ki vključuje *A. mixanigi* n. sp., *A. angusticollis* n. sp., *A. knirschi* Müller, 1913 n. stat., *A. brevicornis* Mandl, 1940 n. stat. in *A. kraussi* Müller, 1910, in skupino *milleri*, ki vključuje *A. forojulensis* Müller, 1931 n. stat., *A. grottoloi* Vailati, 2004, *A. lebenbaueri* n. sp., *A. miricae* n. sp., *A. kaplai* n. sp., *A. fortesculptus* Müller, 1910 n. stat., *A. robustus* Müller, 1914 n. stat., *A. kahleni* n. sp., *A. milleri* (Schmidt, 1855), *A. ljubnicensis* Müller, 1914 n. stat., *A. kofleri* n. sp. in *A. alphonsi* Müller, 1914 n. stat..

Ključne besede: Cholevidae, Leptodirinae, *Aphaobius*, revizija, nove vrste

* Vicolo degli Scaglioni 28, I-34141 Trieste, Italy. E-mail: marcobognolo@virgilio.it
** Via Interna 8, I-25127 Brescia, Italy. E-mail: vailatidante@alice.it

Introduction

The genus *Aphaobius* was established in 1878 by Abeille de Perrin to taxonomically segregate the species *Adelops milleri* (Schmidt, 1855), known only from the cave Velika Pasica, about 15 km southwards from Ljubljana (Slovenia). A few years later, the species *A. heydeni* Reitter, 1885 was described from the surroundings of Škofja Loka (Slovenia).

It was only after the first decade of the 20th century that the intense research into the subterranean fauna of Slovenia led by J. Müller gave rise to a remarkable increase on the knowledge of this genus. In several publications (Müller, 1910, 1913, 1914, 1917, 1925, 1931), this author described eleven taxa from various caves and old mines of Slovenia and Italy, attributing to almost all of them (with the exception of *A. heydeni robustus*) the rank of subspecies of *A. milleri*.

Further three subspecies of *A. milleri* were described in the ensuing decades by Mandl (Mandl, 1940, 1944, 1957) and then a new, remarkably distinct species from the cave Bidovčeva luknja near Kranj (Slovenia) was found and described by Pretner as *A. muellerianus* Pretner, 1963.

Only recently, new investigations led to the discovery of *A. milleri alpinus* Drovenik, Mlejnek & Moravec, 1995, as well as of a new species in Italy, *A. grottoloi*, from the cave Grotta di Taipana, about 20 km north-eastwards from Udine (Vailati, 2004). The latter author, underlining the syntopy of the new species with *A. milleri forojulensis*, put forward some doubts on the correct ranking of several subspecies of *A. milleri* and expressed the need for a thorough revision of the genus *Aphaobius*.

Meanwhile, in the last years, the notable efforts on field research carried out by one of the authors (M. Bognolo) and other friends and colleagues from Slovenia and Austria (B. Kofler, S. Polak, A. Kapla, T. Lebenbauer, H. Mixanig, M. Kahlen) led to the recording of many populations, thus providing useful material for the long waited revision.

As it was to be expected, some subspecies of *A. milleri* were acknowledged as valid species, others as synonyms, whilst the discovery of new species added further information to the complex systematics and distribution of this genus.

Materials and methods

More than 3,000 specimens from about 200 different sites were examined, coming from the authors' collections, the collections deposited at the Natural History Museums of Ljubljana, Innsbruck, Zagreb and Trieste, as well as many private collections of researchers who, during the last century, have been carrying out their investigations in the northern Balkan region.

The following acronyms have been used to identify the collections in which the specimens are deposited:

CAKH	Collection Andrej Kapla, Hrastnik, Slovenia
CAMR	Collection Arrigo Martinelli, Rovereto (TN), Italy
CBKS	Collection Bojan Kofler, Škofja Loka, Slovenia
CDVB	Collection Dante Vailati, Brescia, Italy
CHMK	Collection Harald Mixanig, Klagenfurt, Austria
CHPMZ	Hrvatski Prirodoslovni Muzej, Zagreb, Croatia
CMBT	Collection Marco Bognolo, Trieste, Italy
CMCSNB	Museo Civico di Storia Naturale, Brescia, Italy
CMCSNT	Museo Civico di Storia Naturale, Trieste, Italy
CMGB	Collection Mario Grottolo, Brescia, Italy
CMKI	Tiroler Landesmuseum Ferdinandeum, Innsbruck, Austria

CNMP	Notranjski Muzej Postojna, Postojna, Slovenia
CPDL	Collection Pretner-Drovenik, Ljubljana, Slovenia
CPMGT	Collection Pier Mauro Giachino, Torino, Italy
CPMP	Přírodovědecké Muzeum, Praha, Czech Republic
CTLS	Collection Thomas Lebenbauer, Seebenstein, Austria
CWSO	Collection Werner Schwienbacher, Ora (BZ), Italy

In addition to the examination of aedeagus variability among all populations, the abundant material was used to perform a detailed statistical analysis based on the following parameters, as further explained in Fig. 1.

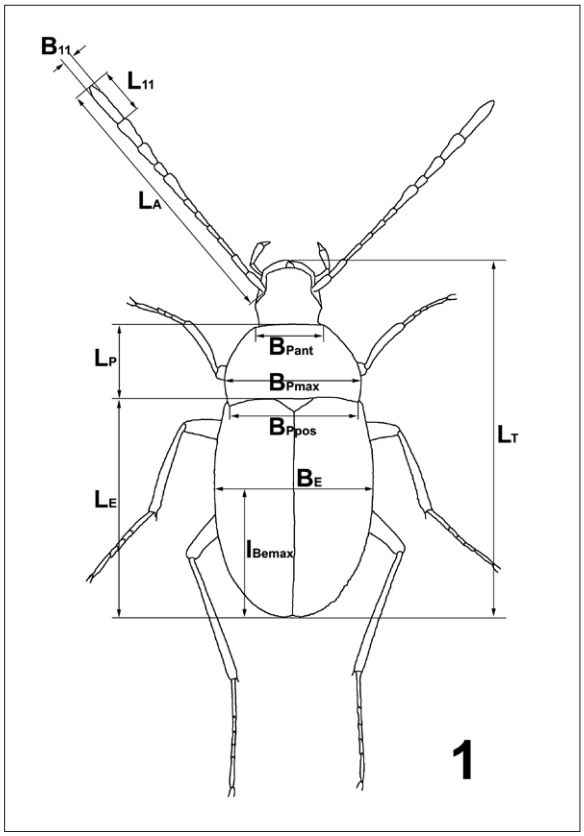

Fig. 1 *Aphaobius*: measured parameters

L_T:	total length (in mm) from the apex of the head to the apex of the elytra
k (L_A):	antennal elongation index = $L_A/(L_E+L_P)$ = length of antennae / (length of elytra + length of pronotum)
B_{Pmax}/L_P:	width / length ratio of pronotum
B_{Pant}/B_{Pmax}:	width of pronotum at the anterior margin / maximum width of pronotum
B_{Ppos}/B_{Pmax}:	width of pronotum at base / maximum width of pronotum
L_E/B_E:	length / width ratio of elytra
l_{Bemax}/L_E:	distance of widest point of elytra from apex / length of elytra
L_{11}/L_A:	length of 11th antennomere / length of antenna
L_{11}/B_{11}:	length / width ratio of 11th antennomere

Aphaobius Abeille de Perrin, 1878

Aphaobius Abeille de Perrin, 1878: 144
Aphaobius Abeille de Perrin, 1878: Ganglbauer, 1899: 95
Aphaobius Abeille de Perrin, 1878: Jeannel, 1911: 428
Aphaobius Abeille de Perrin, 1878: Jeannel, 1924: 227
Aphaobius Abeille de Perrin, 1878: Perreau, 2003: 221

Type species: *Aphaobius milleri* (Schmidt, 1855)

Redescription

A genus of medium-sized Leptodirinae (2.50-3.80 mm) belonging, on the basis of its overall features, to the "phyletic series of *Aphaobius*" (sensu Jeannel, 1924), with protarsi 4-segmented in both males and females, and tibiae without the comb of bristles on the external side. All species are apterous, anophthalmous and depigmented, while the general morphology is bathyscioid, but elongated and with the base of pronotum slightly narrowed.

Antennae thin, elongated, but always shorter than the body length, with the 11th antennomere from three to over four times longer than the 8th.

Pronotum with base narrower than the elytra, but always transverse, with sides from regularly rounded to slightly sinuate just before the base. Disc of the pronotum regularly convex, punctuation of small size. Pubescence moderately long and recumbent.

Elytra ovoid, largely rounded at apex, with maximum width varying from their middle to the anterior third, sutural stria absent, pubescence long and recumbent, aligned in transversal striae.

Mesosternal carina high, lamellar.

Male protarsi not dilated, 4-segmented, hardly differentiated from those of females. Protibiae not dilated apically, mesotibiae and metatibiae straight.

Median lobe of the aedeagus elongated, with subparallel sides and rounded apex in dorsal view, moderately curved in lateral view. Parameres thin and elongated, as long as the median lobe or longer, each bearing three setae at apex. Internal sac of the aedeagus with evident Y-shaped piece in the basal part.

Distribution and habitat

The genus *Aphaobius* is distributed mainly in Slovenia, with some populations reaching the southern Austria (Kärnten), north-eastern Italy (Friuli) and the north-western regions of Croatia (Istra, Gorski Kotar and Žumberačka gora).

The *Aphaobius* species are normally found in caves, both at entrances and in the deepest parts; in the northern part of the distribution area, however, many specimens have been found in old abandoned mines or even outside caves, in the subterranean superficial environment.

All collecting localities, either caves or superficial subterranean habitat sites, lie within limestones or conglomerate rocks, at altitudes ranging from 300 m up to the alpine zones over 2,000 m above sea level.

Phylogeny and biogeography

The genus is composed of four species groups: *muellerianus*, *heydeni*, *kraussi* and *milleri*.

The northern *kraussi* group is a cluster of species distributed on the left-hand side, downriver, of the river Sava. All species of this group are characterised by the aedeagus with sides thickened at apex and sinuate in the apical fifth, ligules strongly chitinized, and parameres clearly longer than the median lobe.

The *kraussi* group includes the species *A. mixanigi* n. sp., *A. angusticollis* n. sp., *A. knirschi* Müller, 1913 n. stat., *A. brevicornis* Mandl, 1940 n. stat. and *A. kraussi* Müller, 1910.

The southern *milleri* group clusters species distributed on the right-hand side of the river Sava. The species of this group are all characterised by the aedeagus with proximal edge of the apical orifice concave or straight, ligules not much chitinized and slightly diverging in dorsal view, and parameres not longer than the median lobe.

This group includes the species *A. forojulensis* Müller, 1931 n. stat., *A. grottoloi* Vailati, 2004, *A. lebenbaueri* n. sp., *A. miricae* n. sp., *A. kaplai* n. sp., *A. fortesculptus* Müller, 1910 n. stat., *A. robustus* Müller, 1914 n. stat., *A. kahleni* n. sp., *A. milleri* (Schmidt, 1855), *A. ljubnicensis* Müller, 1914 n. stat., *A. kofleri* n. sp. and *A. alphonsi* Müller, 1914 n. stat..

The *muellerianus* group and the *heydeni* group include, respectively, the sole species *A. muellerianus* Pretner, 1963 and *A. heydeni* Reitter, 1885. Due to their unique features, these two species are clearly distinguishable from all species of the genus *Aphaobius* already from their external morphology, as thoroughly described in the section "key to the species and species groups" as well as in the statistical tables shown in Figures 21 to 29.

The abundant material and the morphometric data collected led to the clarification of the relationships between all populations known so far. Thus, the following new synonyms were identified for subspecies which, according to the statistical analyses carried out, did not show any significant deviation from the taxonomical point of view.

Aphaobius kraussi Müller, 1910 = *Aphaobius milleri winkleri* Mandl, 1944 n. syn.; *Aphaobius kraussi* Müller, 1910 = *Aphaobius milleri hoelzeli* Mandl, 1957 n. syn.; *Aphaobius kraussi* Müller, 1910 = *Aphaobius milleri pretneri* Müller, 1913 n. syn.; *Aphaobius kraussi* Müller, 1910 = *Aphaobius milleri alpinus* Drovenik, Mlejnek & Moravec, 1995 n. syn.; *Aphaobius milleri* (Schmidt, 1855) = *Aphaobius milleri springeri* Müller, 1910 n. syn.; *Aphaobius milleri* (Schmidt, 1855) = *Aphaobius milleri grabowskii* Müller, 1917 n. syn.; *Aphaobius milleri* (Schmidt, 1855) = *Aphaobius milleri longipennis* Müller, 1931 n. syn..

The overall distribution of the genus *Aphaobius* shows a combination of species with large distribution areas and other species known from a single site or a very restricted geographic area. Besides, the relative convergence in the external morphology of populations belonging to different species aggravated a comparative approach based only on the qualitative analysis of newly discovered taxa. This is most likely the main driver for the description of many subspecies of *A. milleri* in the past century. As a matter of fact, the analyses carried out within this study proved that identifying a rational taxonomical segregation is not always feasible unless detailed morphometric comparisons are executed on all known geographic populations.

Another remarkable observation, already pointed out by Pretner (1963) and supported by the recent findings (e.g. *A. miricae* n. sp., Škofja Loka), is the outstanding concentration of different species in the restricted area around Škofja Loka.

The analysis of paleogeographic data seems to suggest that the higher density of species in the regions between Ljubljana and Železniki is associated with allopatric speciation due to the segregation of specific distribution areas originating in the early Quaternary period.

On the other hand, the southern part of the distribution area of the genus is populated only by the species *A. milleri*, with several local populations which, however, do not show any taxonomically significant differences in either their morphological features or the shape of the aedeagus. Such situation resembles the distribution of the genus *Bathyscimorphus* Jeannel, 1910; by comparison, the slight differences among populations of southern Slovenia and Croatia, spread in a wide and geologically diverse area, are likely due to a very recent or not yet completed segregation.

The correlation of paleogeographic features and allopatric speciation is even more evident when considering the *kraussi* and *milleri* species groups, rather than concentrating on single species. In

particular, the northern *kraussi* group is geographically located within the Southern Alps, whilst the southern *milleri* group is mainly located on the Outer Dinarides (Fig. 36). It is therefore clear that, in particular in central Slovenia (the area between Ljubljana and Kranj), such groups have long been isolated due to the movement of respective plates which, according to plate tectonics, slid along the contact boundary represented by the Sava fault (Schmid S. M., et al., 2008).

To sum up, the speciation patterns of the genus *Aphaobius* show past isolation in the region between Ljubljana and Železniki, characterised by the complex paleogeographic evolution, as opposed to a high dispersal activity of the southern area, along the typical north-west to south-east orientation of Mesozoic limestones in the northern Balkan area.

Key to the species and species groups

1. Species of extremely large size, with antennae exceptionally elongated, about as long as the combined length of elytra and pronotum in males, slightly shorter in females.
2 (*muellerianus* group)
-. **3**

<<*muellerianus* group>>

2. The 11th antennomere extremely slender, about 5 times longer than wide. Pronotum much elongated, with the base wide and lateral margins sinuate or straight.
Slovenia, caves near Zgornja Besnica (Kranj). ***A. muellerianus***

3. Aedeagus with a bulbous apex, widely rounded and larger than the cylindrical part of the median lobe. **4 (*heydeni* group)**
-. **5**

<<*heydeni* group>>

4. Elytra relatively short (length/width ratio is on average 1.35 in males and 1.31 in females), showing a distinctive sub-trapezoidal shape with maximum width in way of the anterior fourth.
Slovenia, surroundings of Škofja Loka. ***A. heydeni***

5. Aedeagus with sides thickened at apex, sinuate in the apical fifth. Ventrally, the proximal edge of the apical orifice is slightly convex or straight. Ligules strongly chitinized, straight in dorsal view, pointed and inclined downwards in lateral view. Parameres clearly longer than the median lobe.
Species distributed on the orographical left side of the river Sava. **6 (*kraussi* group)**

-. Aedeagus with proximal edge of the apical orifice concave or straight. Ligules not much chitinized, slightly diverging in dorsal view, pointed and inclined forward in lateral view. Parameres not longer than the median lobe.
Species distributed on the orographical right side of the river Sava, in a wide region spreading from the surroundings of Ljubljana southwards to the Snežnik mountain area (Slovenia) and Žumberačka gora (Croatia) and westwards to the eastern part of Friuli (Italy).
10 (*milleri* group)

<<*kraussi* group>>

6. Antennae exceptionally short. The length of antenna is on average 0.71 times the length of pronotum and elytra in males, and 0.57 times the length of pronotum and elytra in females.

The 11th antennomere is extremely stocky, about 3.3 times longer than wide in males, and about 2.5 times longer than wide in females. Elytra moderately elongated. Alpine species of medium-small size.
Austria, Kärnten, Obir massif. ***A. brevicornis***
-. **7**

7. Antennae short, but longer than in *A. brevicornis*. The length of antenna is on average 0.79 times the length of pronotum and elytra in males, and 0.63 times the length of pronotum and elytra in females. The 11th antennomere is stocky, about 3.9 times longer than wide in males, and about 2.9 times longer than wide in females. Elytra relatively short, less elongated than in *A. brevicornis*.
Slovenia and Austria, the Karavanke Mts and Kamniško-Savinjske Alps. ***A. kraussi***
(synonyms: *A. milleri winkleri, A. milleri hoelzeli, A. milleri pretneri, A. milleri alpinus*)
-. **8**

8. Elytra clearly elongated, on average 1.47 times longer than their width in males, and 1.41 times longer than their width in females. Body of medium-large size, antennae medium-short, with the 11th antennomere normally elongated. Pronotum with sides regularly rounded, the maximum width never coinciding with the base.
Austria, Eisenkappel. ***A. mixanigi***
-. **9**

9. Pronotum much slender, on average 1.46 times wider that its length in males, and 1.52 times wider than its length in females. Sides of pronotum not much narrowed in the anterior part. Antennae very long, the 11th antennomere normally elongated.
Slovenia, Udin boršt (Kranj). ***A. angusticollis***
- Pronotum normally transverse, with sides regularly narrowed in the anterior part. Antennae long, the 11th antennomere particularly long compared to the total length of the antenna.
Slovenia, Dobrovlje (Celje). ***A. knirschi***

<<*milleri* group>>

10. Species of very large size, pronotum markedly transverse with sides strongly narrowed towards the anterior margin. Antennae relatively short, the 11th antennomere very short compared to the length of the antenna. Elytra short.
Italy, Friuli and western Slovenia. ***A. forojulensis***
-. **11**

11. Antennae short and stocky. Length of the antenna not exceeding four fifths of the combined length of pronotum and elytra in males, and not exceeding two thirds of the combined length of pronotum and elytra in females. The length/width ratio of the 11th antennomere generally not exceeding 4.4 in males and 3.2 in females. **12**
-. Antennae more elongated and slender. Length of the antenna exceeding four fifths of the combined length of pronotum and elytra in males, and exceeding two thirds of the combined length of pronotum and elytra in females. The length/width ratio of the 11th antennomere exceeds 4.4 in males and 3.2 in females. **16**

12. Small-sized species, pronotum exceptionally transverse (width/length ratio exceeding 1.67 in males and exceeding 1.75 in females) with sides strongly narrowed toward the anterior margin. Elytra extremely short, ovoid (length/width ratio is on average 1.31 in males and 1.25 in females). Antennae short and stocky, with the 11th antennomere long compared to the length of the antenna.
Italy, Grotta di Taipana. ***A. grottoloi***
-. **13**

13. Small-sized species, with elytra much elongated (length/width ratio is on average 1.46 in males and 1.41 in females). Antennae short and stocky, with the 11th antennomere long compared to the length of the antenna. Pronotum with sides regularly rounded, the maximum width never coinciding with the base.
Slovenia, Trnovski gozd. ***A. lebenbaueri***
-. **14**

14. Body exceptionally short (total length generally not exceeding 2.70 mm in males and 2.80 mm in females). Pronotum sub-trapezoidal with maximum width at base and sides slightly restricted at the anterior margin. Elytra relatively short.
Slovenia, Škofja Loka. ***A. miricae***
-. **15**

15. Pronotum transverse, with sides clearly restricted at the anterior margin. Elytra medium-short.
Slovenia, Bohinj Alps and Jelovica plateau. ***A. kaplai***
-. Pronotum less transverse than in *A. kaplai*, with sides relatively more enlarged at the anterior margin and maximum width generally coinciding with the aft base. Elytra more elongated.
Slovenia, Šmarna gora (Ljubljana). ***A. fortesculptus***

16. Species of very large size. Elytra relatively short with maximum width in way of the anterior third. Pronotum clearly transverse, sub-trapezoidal, with maximum width at base and sides markedly narrowed toward the anterior margin. Antennae long with the 11th antennomere very slender (length/width ratio is on average 5.3 in males and 4.1 in females).
Slovenia, Kamna Gorica (Radovljica). ***A. robustus***
-. **17**

17. Body of small size. Antennae very long with the 11th antennomere extremely slender (length/width ratio is on average 5.7 in males and 4.1 in females). Pronotum clearly transverse with sides narrowed in the anterior half, converging at the aft base. Elytra elongated.
Slovenia, caves on Šentviška gora. ***A. kahleni***
-. **18**

18. Pronotum sub-trapezoidal, with maximum width at base. **19**
-. Pronotum with sides regularly rounded from the base to the anterior margin, maximum width in way of the basal fourth, sides converging towards the aft base. Elytra medium-long. Antennae of medium length, 11th antennomere relatively long with respect to the total length of the antenna.

Southern Slovenia and Croatia. ***A. milleri***
(synonyms: *A. milleri grabowskii,*
A. milleri longipennis, A. milleri springeri)

19. Antennae long with the 11th antennomere relatively short with respect to the total length of the antenna. Elytra much elongated (length/width ratio is on average 1.46 in males and 1.39 in females). Pronotum less transverse.
Slovenia, Škofja Loka, caves on Mt Lubnik. ***A. ljubnicensis***
-. **20**

20. Species of medium size. Pronotum transverse, with sides regularly curved, restricted at the anterior margin, slightly converging at the aft base. Elytra of medium length.
Slovenia, Železniki, old mines. ***A. kofleri***
- Species of medium-small size. Pronotum less transverse than in *A. kofleri*, sub-trapezoidal in both males and females, with maximum width at base and sides not much narrowed toward the anterior margin. Elytra less elongated than in *A. kofleri*.
Slovenia, surroundings of Ljubljana, Goričane. ***A. alphonsi***

<<*muellerianus* group>>

Diagnosis

Species of the genus *Aphaobius* characterised by their extremely large size, with antennae exceptionally elongated, about as long as the combined length of elytra and pronotum in males, slightly shorter in females.

Aphaobius muellerianus Pretner, 1963
(Figs. 2, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30a, 37, 39)

Aphaobius muellerianus Pretner, 1963: 59
Aphaobius muellerianus Pretner, 1963: Pretner, 1968: 11

Type locality
Slovenia, Zgornja Besnica, Bidovčeva luknja (Slovene Cave Cadastre No. 70)

Analysed material
Slovenia, Zgornja Besnica, Bidovčeva luknja (Slovene Cave Cadastre No. 70): 1 ♂ Holotype, 31.XII.1933, Pretner (CPDL); 1 ♀ Paratype, 31.XII.1933, Pretner (CMCSNT); 4 ♂♂ 1 ♀ Paratypes, 12.I.1941, Pretner (CPDL); 2 ♂♂ 1 ♀ Paratypes, 2.VI.1946, Pretner (CPDL); 1 ♀ Paratype, 30.IV.1933, Pretner (CPDL); 2 ♂♂ 1 ♀ Paratypes, 6.I.1935, Pretner (CPDL, CMCSNT); 1 ♀, 26.II.1962, Pretner (CPDL); 31 ♂♂ 60 ♀♀, 11.IV-5.IX.1998, Kahlen (CMKI); 13 ♂♂ 16 ♀♀, 15.XII.1995, Bognolo (CMBT, CDVB).
Slovenia, Zgornja Besnica, Jeralovo brezno (Slovene Cave Cadastre No. 3854): 7 ♂♂ 6 ♀♀, 7.I.1973, Pretner (CPDL, CMCSNT); 1 ♂ 1 ♀, 19.XII.1999, Kahlen (CMKI).
Additional material examined (not measured)
Slovenia, Zgornja Besnica, Bidovčeva luknja (Slovene Cave Cadastre No. 70): 2 exx. Paratypes, 31.XII.1933, Pretner (CMGB); 2 exx., X.1986, Kofler (CBKS); 2 exx., V.1987, Kofler (CBKS); 2 exx., VI.1987, Kofler (CBKS); 2 exx., VII.1992, Kofler (CBKS); 2 exx., V.1987, Kofler (CMGB); 12 exx., 11.IV-5.IX.1998, Kahlen (CPMGT); 5 exx., 15.XII.1995, Bognolo (CDVB).

Slovenia, Zgornja Besnica, Jeralovo brezno (Slovene Cave Cadastre No. 3854): 4 exx., 7.I.1973, Pretner (CPMGT); 4 exx., 7.I.1973, Drovenik (CPMGT).

Diagnosis

The largest species of the genus *Aphaobius*, belonging to the *muellerianus* group, clearly distinguishable by the length of its antennae, which are more elongated than in any other species. 11th antennomere very long and slender. Pronotum elongated with sides sinuate or straight in the basal half.

Description

Total length with the head deflexed: ♂♂ 3.20-3.45 mm; ♀♀ 3.35-3.58 mm. Body, legs and antennae dark brown.

Antennae very long ($k(L_A)$: ♂♂ 0.99-1.03; ♀♀ 0.79-0.82), in the male almost reaching the apex of the elytra when stretched backwards. 11th antennomere very long and slender, 8th antennomere subcylindrical, almost 2.5 times shorter than the 7th.

Pronotum moderately transverse (B_{Pmax}/L_P: ♂♂ 1.29-1.42; ♀♀ 1.39-1.56), with maximum width at the base (B_{Ppos}/B_{Pmax}: ♂♂ 0.98-1.00; ♀♀ $B_{Ppos}=B_{Pmax}$). Sides regularly arcuate anteriorly (B_{Pant}/B_{Pmax}: ♂♂ 0.55-0.59; ♀♀ 0.52-0.56), sinuate in the basal half. Hind angles acute, marked.

Elytra ovoid (L_E/B_E: ♂♂ 1.44-1.53; ♀♀ 1.39-1.45), with maximum width at about the middle (L_{Bemax}/L_E: ♂♂ 0.50-0.55; ♀♀ 0.51-0.58), disc markedly convex.

Legs very long and slender.

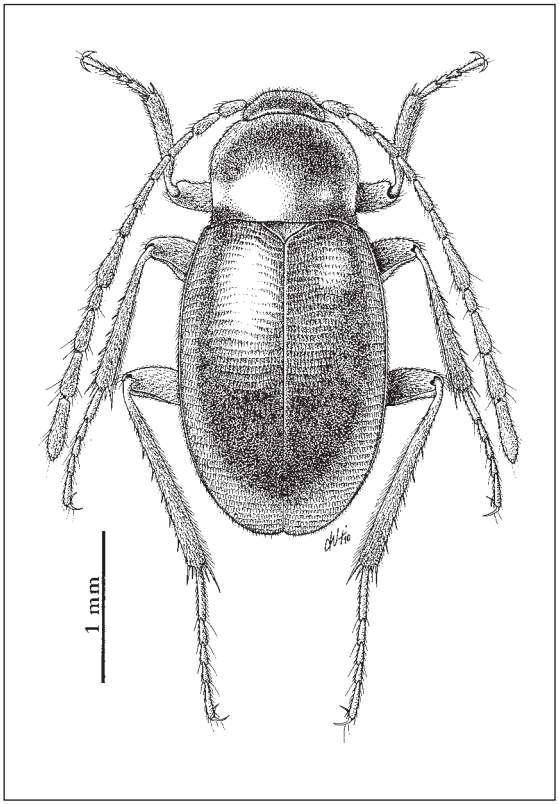

Fig. 2 *Aphaobius muellerianus* ♂, habitus.

Aedeagus with the median lobe elongated. Distal part of the median lobe, in dorsal view, with subparallel sides up to the apex, then curved and converging to a largely rounded end. Parameres as long as the median lobe.

Distribution and ecology

A. muellerianus is known only from the type locality and the Jeralovo brezno, a shaft located less than 2 km from the type locality. Near the village of Zgornja Besnica (Kranj, Slovenia), both caves are situated in the karst area of Mt Rovnik (Figs. 37, 39).

In Bidovčeva luknja, most of the specimens were caught using pitfall traps at the bottom of the last shaft, characterised by a high percolation of water along the walls.

In the type locality, the species is associated with the trechinae *Anophthalmus besnicensis* Pretner, 1949, and *Anophthalmus micklitzi rovnicensis* Daffner, 1996.

<<*heydeni* group>>

Diagnosis

Species of the genus *Aphaobius* characterised by the aedeagus with a bulbous apex, widely rounded and larger than the cylindrical part of the median lobe.

Aphaobius heydeni Reitter, 1885

(Figs. 3, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30b, 37, 40)

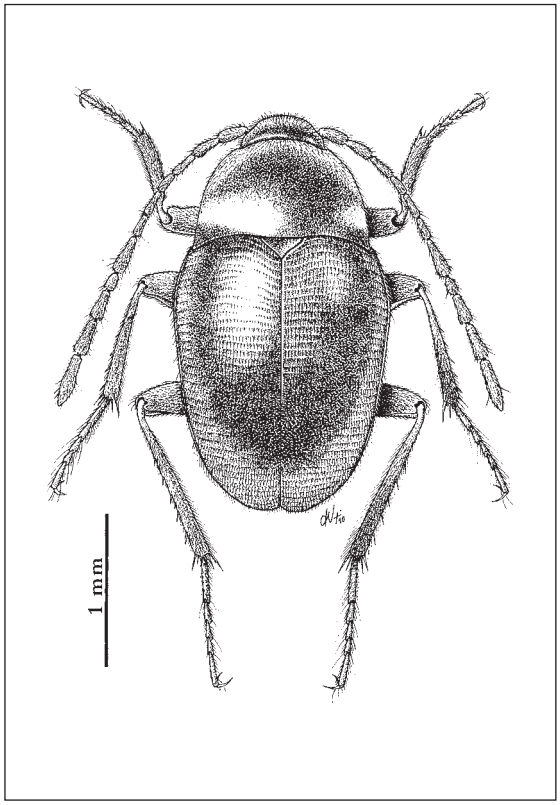

Fig. 3 *Aphaobius heydeni* ♂, habitus.

Aphaobius heydeni Reitter, 1885: 17
Aphaobius heydeni Reitter, 1885: Ganglbauer, 1899: 96
Aphaobius heydeni Reitter, 1885: Jeannel, 1911: 434
Aphaobius heydeni Reitter, 1885: Müller, 1913: 7
Aphaobius heydeni Reitter, 1885: Jeannel, 1924: 232
Aphaobius heydeni Reitter, 1885: Pretner, 1963: 63
Aphaobius heydeni Reitter, 1885: Pretner, 1968: 10

Type locality
Slovenia, caves in the surroundings of Škofja Loka

Analysed material
Slovenia, Škofja Loka, Bohkovo brezno (Slovene Cave Cadastre No. 629): 1 ♀, Hummler (CMCSNT); 1 ♂ 1 ♀, Kaufmann (CMCSNT); 1 ♂, 20.III.1977, Pretner (CPDL); 2 ♂♂, 10.IX.1913, Pretner (CPDL); 2 ♀♀, 27.II.1912, Staudacher (CPDL); 1 ♂, 20.II.1912, Gspan (CMCSNT).

Slovenia, Škofja Loka, Gipsova jama (Slovene Cave Cadastre No. 386): 1 ♂, 1.IX.1922, Pretner (CPDL); 4 ♂♂ 3♀♀, 20.III.1977, Pretner (CPDL).

Slovenia, Škofja Loka, Marijino brezno (Slovene Cave Cadastre No. 6): 10 ♂♂ 7 ♀♀, 15.III.1992, Etonti (CMBT, CDVB); 2 ♂♂ 2 ♀♀, IX.1922, Pretner (CPDL); 6 ♂♂ 6 ♀♀, 6.IX.1998, Kahlen (CMBT).

Slovenia, Škofja Loka, Migutovo brezno (Slovene Cave Cadastre No. 5): 12 ♂♂ 11 ♀♀, 15.III.1992, Cej & Vrezec (CMBT).

Slovenia, Škofja Loka, Štinetova jama (Slovene Cave Cadastre No. 240): 1 ♂ 3 ♀♀, 10.IV-4. IX.1998, Kahlen (CMKI); 1 ♂ 2 ♀♀, 10.IV.1999, Bognolo (CMBT); 2 ♀♀, 2.VII.1933, Pretner (CPDL).

Additional material examined (not measured)
Slovenia, Škofja Loka, Bohkovo brezno (Slovene Cave Cadastre No. 629): 12 exx., 1.IX.1922, Pretner (CMCSNT); 4 exx., IV.1989, Kofler (CBKS); 4 exx., 22.V.1989, Kofler (CBKS).

Slovenia, Škofja Loka, Gipsova jama (Slovene Cave Cadastre No. 386): 6 exx., 7.V.1986, Kofler (CBKS); 1 ex., 19.III.1972, Deeleman (CPMGT); 1 ex., Meschnigg (CPMGT); 2 exx., 28.VIII.1990, Comotti (CDVB); 2 exx., 26.VI.1925 Hicker (CPMGT); 1 ex., 21.VIII.1922, Pretner (CMCSNT); 5 exx., 1.IX.1922, Pretner (CMCSNT); 1 ex., 20.V.1914, Gspan (CMCSNT).

Slovenia, Škofja Loka, Marijino brezno (Slovene Cave Cadastre No. 6): 2 exx., IV.1983, Kofler (CBKS); 1 ex., VI.1985, Kofler (CBKS); 3 exx., IV.1987, Kofler (CBKS); 2 exx., II.1990, Kofler (CBKS); 32 exx., 10.IV-6.IX.1998, Kahlen (CPMGT); 4 exx., 15.III.1992, Vrezec (CMGB); 9 exx., 15.III.1992, Etonti (CDVB, CMGB); 2 exx., V.1990, Kofler (CMGB); 1 ex., (CMGB); 7 exx., 1.IX.1922, Pretner (CMCSNT).

Slovenia, Škofja Loka, Migutovo brezno (Slovene Cave Cadastre No. 5): 2 exx., IV.1985, Kofler (CBKS); 6 exx., 14.VIII.1988, Kofler (CBKS); 2 exx., (CPMGT); 1 ex., 2.VI.1911, Gspan (CPMGT); 1 ex., 12.V.1912, Gspan (CPMGT); 2 exx., 15.III.1992, Vrezec (CMGB); 3 exx., 15.III.1992, Etonti (CMGB); 4 exx., 19.IV.1935, Pretner (CPMGT).

Slovenia, Škofja Loka, Štinetova jama (Slovene Cave Cadastre No. 240): 7 exx., 19.VII.1990, Kofler (CBKS); 1 ex., IX.1984, Kofler (CBKS).

Diagnosis
A medium sized *Aphaobius* of the *heydeni* group, distinguishable by the shape of the elytra, which are relatively short, sub-trapezoidal, with the maximum width in way of the anterior fourth.

Description

Total length with the head deflexed: ♂♂ 2.85-3.10 mm; ♀♀ 2.90-3.25 mm. Body, legs and antennae brown-reddish.

Antennae long ($k(L_A)$: ♂♂ 0.86-0.89; ♀♀ 0.69-0.72), in males reaching the apical third of the elytra when stretched backwards. 11th antennomere long and slender, 8th antennomere about 2.5 times shorter than the 7th.

Pronotum transverse (B_{Pmax}/L_P: ♂♂ 1.60-1.70; ♀♀ 1.63-1.75), with maximum width at the base (♂♂ $B_{Ppos}=B_{Pmax}$; ♀♀ $B_{Ppos}=B_{Pmax}$). Sides regularly arcuate in the anterior third (B_{Pant}/B_{Pmax}: ♂♂ 0.48-0.51; ♀♀ 0.46-0.49), then feebly sinuate or straight till the hind angles. Hind angles acute, marked. Disc of the pronotum slightly flattened near the hind angles.

Elytra sub-trapezoidal (L_E/B_E: ♂♂ 1.32-1.38; ♀♀ 1.28-1.34) with maximum width in way of the anterior fourth (L_{Bemax}/L_E: ♂♂ 0.67-0.75; ♀♀ 0.66-0.74).

Legs long and slender.

Aedeagus with the median lobe elongated. Distal part of the median lobe, in dorsal view, with subparallel sides in the basal two thirds, then slightly diverging to form a largely rounded end, bulbous-shaped. Parameres as long as the median lobe.

Distribution and ecology

The species is spread in caves located in the karst area around Škofja Loka, mainly characterised by conglomerate rocks (Figs. 37, 40).

The associated fauna includes the trechinae *Anophthalmus alphonsi* (Müller, 1914) and *Orotrechus globulipennis* Schaum, 1860.

<<*kraussi* group>>

Diagnosis

A group of species of the genus *Aphaobius* characterised by the aedeagus with sides thickened at apex, ligules strongly chitinized and parameres clearly longer than the median lobe.

Aphaobius mixanigi n. sp.

(Figs. 4, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30c, 37)

Type locality

Austria, Eisenkappel, Lobnigschacht (Austrian Cave Cadastre No. 3933/7)

Type series

Holotype ♂:

Austria, Eisenkappel, Lobnigschacht (Austrian Cave Cadastre No. 3933/7): 25.IX.2005, Mixanig, Bognolo & Lebenbauer (CMKI).

Paratypes:

Austria, Eisenkappel, Lobnigschacht (Austrian Cave Cadastre No. 3933/7): 37 ♂♂ 37 ♀♀, 25.IX.2005, Mixanig, Bognolo & Lebenbauer (CMBT, CHMK, CTLS, CDVB); 19 ♂♂ 19 ♀♀, 25.X.1994-10.VI.1995, Kahlen & Egger (CMKI, CWSO).

Diagnosis

An *Aphaobius* of the *kraussi* group, distinguishable from the other species of this group by its larger size, the elytra much more elongated, the antennae clearly longer than in *A. brevicornis* and *A. kraussi*, shorter than in *A. angusticollis* and *A. knirschi*.

Description

Total length with the head deflexed: ♂♂ 2.94-3,12 mm; ♀♀ 3.07-3.30 mm. Body, legs and antennae brown-reddish.

Antennae medium-sized ($k(L_A)$: ♂♂ 0.81-0.83; ♀♀ 0.65-0.68), in males exceeding the middle of the elytra when stretched backwards. 11th antennomere long and slender, 8th antennomere about twice shorter than the 7th.

Pronotum transverse (B_{Pmax}/L_P: ♂♂ 1.45-1.56; ♀♀ 1.53-1.66), with maximum width at the basal third, base narrower (B_{Ppos}/B_{Pmax}: ♂♂ 0.95-0.98; ♀♀ 0.96-0.99). Sides regularly arcuate anteriorly (B_{Pant}/B_{Pmax}: ♂♂ 0.50-0.53; ♀♀ 0.49-0.51), converging posteriorly. Hind angles acute, not pointed.

Elytra ovoid, much elongated (L_E/B_E: ♂♂ 1.44-1.51; ♀♀ 1.36-1.43) with maximum width at about the middle (L_{Bemax}/L_E: ♂♂ 0.54-0.59; ♀♀ 0.55-0.59).

Legs relatively long and robust.

Aedeagus with the median lobe elongated. Distal part of the median lobe, in dorsal view, with subparallel sides in the basal four fifths, then slightly sinuate, with thickened sides converging to a rounded or feebly pointed end. Proximal edge of the apical orifice slightly convex or straight. Parameres longer than the median lobe.

Etymology

The new species was named after the Austrian entomologist Harald Mixanig from Klagenfurt.

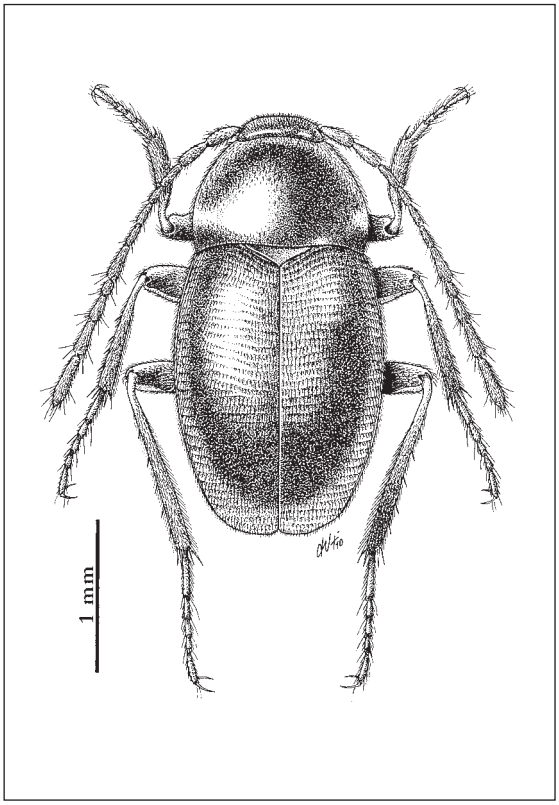

Fig. 4 *Aphaobius mixanigi* ♂, habitus.

Distribution and ecology

A. mixanigi n. sp. is known from its type locality only (Fig. 37), a 100 m deep vertical shaft on Mt Lobnig (Eisenkappel, Austria), where the new species can be found in the deepest parts of the cave. The associated cave fauna consists of the carabid beetle *Orotrechus haraldi* Daffner, 1990.

Aphaobius angusticollis n. sp.
(Figs. 5, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30d, 37, 39)

Type locality
Slovenia, Spodnje Duplje, Arneševa luknja (Slovene Cave Cadastre No. 763)

Type series
Holotype ♂:
Slovenia, Spodnje Duplje, Arneševa luknja (Slovene Cave Cadastre No. 763): 10.VI.1946, Pretner (CPDL).
Paratypes:
Slovenia, Spodnje Duplje, Arneševa luknja (Slovene Cave Cadastre No. 763): 8 ♂♂ 3 ♀♀, 10.VI.1946, Pretner (CPDL); 18 ♂♂ 16 ♀♀, 13.IV-4.IX.1998, Kahlen (CMBT, CDVB); 9 ♂♂ 12 ♀♀, 18.XI.1998, Bognolo (CMBT); 2 ♀♀, 14.IV.1998, Kahlen (CMKI); 1 ♀, 5.V.1946, Pretner (CPDL); 2 ♂♂ 6 ♀♀, 12.V-22.VII.1999, Kofler (CBKS).

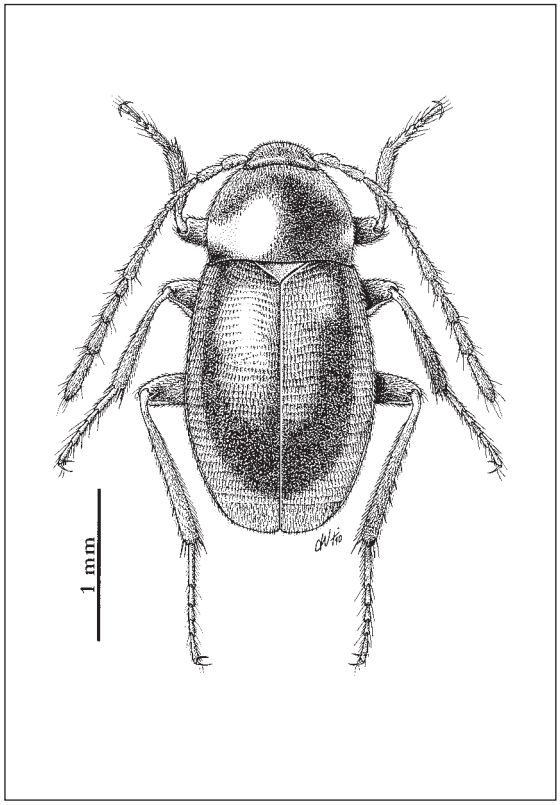

Fig. 5 *Aphaobius angusticollis* ♂, habitus.

Slovenia, Spodnje Duplje, Velika Lebinca (Slovene Cave Cadastre No. 765): 2 ♂♂ 7 ♀♀, 10.VI.1946, Pretner (CPDL).

Slovenia, Cerklje na Gorenjskem, Urhova jama (Slovene Cave Cadastre No. 505): 1 ♀, 20.VII.1979, Novak (CPDL).

Diagnosis

A medium sized *Aphaobius* of the *kraussi* group, distinguishable from the other species of this group by the shape of its pronotum, which is more slender and with sides less narrowed in the anterior part, as well as the antennae more elongated.

Description

Total length with the head deflexed: ♂♂ 2.80-2.98 mm; ♀♀ 2.90-3.10 mm. Body, legs and antennae brown.

Antennae long ($k(L_A)$: ♂♂ 0.87-0.90; ♀♀ 0.70-0.74), in males reaching the apical third of the elytra when stretched backwards. 11th antennomere long and slender, 8th antennomere about twice shorter than the 7th.

Pronotum moderately transverse (B_{Pmax}/L_P: ♂♂ 1.44-1.51; ♀♀ 1.48-1.,57), with maximum width at the basal third, base narrower (B_{Ppos}/B_{Pmax}: ♂♂ 0.95-0.98; ♀♀ 0.97-1.00). Sides regularly arcuate anteriorly (B_{Pant}/B_{Pmax}: ♂♂ 0.54-0.56; ♀♀ 0.52-0.54), converging or feebly sinuate posteriorly. Hind angles acute, not pointed.

Elytra ovoid (L_E/B_E: ♂♂ 1.36-1.44; ♀♀ 1.32-1.38), with maximum width at about the middle (L_{Bemax}/L_E: ♂♂ 0.52-0.59; ♀♀ 0.53-0.57).

Legs long and slender.

Aedeagus with the median lobe elongated. Distal part of the median lobe, in dorsal view, with subparallel sides in the basal four fifths, then slightly sinuate, with thickened sides converging to a rounded end. Proximal edge of the apical orifice slightly convex or straight. Parameres longer than the median lobe.

Etymology

The new species was named after the shape of its pronotum, which is more slender than in all other species of the genus *Aphaobius*, with the only exception of *A. muellerianus*.

Distribution and ecology

A. angusticollis n. sp. is known from its type locality and two other caves (Figs. 37, 39), all lying in a restricted area within conglomerates and limestones located about 2 km north of Naklo (Kranj).

Aphaobius knirschi Müller, 1913 n. stat.
(Figs. 6, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30e, 37)

Aphaobius milleri knirschi Müller, 1913: 6
Aphaobius milleri knirschi Müller, 1913: Jeannel, 1924: 232
Aphaobius milleri knirschi Müller, 1913: Pretner, 1968: 11

Type locality

Slovenia, Vransko, Škadovnica (Slovene Cave Cadastre No. 482)

Analysed material

Slovenia, Dobrovlje, Brezno presenečenj (Slovene Cave Cadastre No. 4500): 1 ♂, 7.VIII.2002, Kapla (CAKH).

Slovenia, Dobrovlje, Covška prepad (Slovene Cave Cadastre No. 486): 9 ♂♂ 9 ♀♀, 25.IX.1938, Pretner (CPDL); 1 ♀, 6.IX.1937, Pretner (CPDL); 7 ♂♂ 4 ♀♀, 26.IV.1998, Comotti (CMBT).

Slovenia, Golte, Kebrova luknja (Slovene Cave Cadastre No. 561): 5 ♂♂ 4 ♀♀, 7.V.2005, Kapla (CMBT).

Slovenia, Šmihelj pri Mozirju, Konečka Otlica (Slovene Cave Cadastre No. 795): 1 ♂ 4 ♀♀, 22.IV.1950, Pretner (CPDL).

Slovenia, Dobrovlje, Krapljetova jama (Slovene Cave Cadastre No. 484): 8 ♂♂ 5 ♀♀, 1.VIII.1937, Pretner (CPDL); 6 ♂♂ 6 ♀♀, 29.V.1999, Bognolo (CMBT); 2 ♂♂ 3 ♀♀, 4.VII.1937, Pretner (CPDL); 8 ♂♂ 5 ♀♀, 6.XI.1937, Pretner (CPDL).

Slovenia, Dobrovlje, Lesjakova Štabirnica (Slovene Cave Cadastre No. 479): 6 ♂♂ 5 ♀♀, 11.VII.1937, Pretner (CPDL).

Slovenia, Dobrovlje, Lomski brlog (Slovene Cave Cadastre No. 496): 1 ♂ 4 ♀♀, 7.XI.1937, Pretner (CPDL).

Slovenia, Zgornji Tuhinj, Selska luknja (not registered): 3 ♂♂ 4 ♀♀, 17.VI.1934, Pretner (CPDL); 3 ♀♀, 31.VII-27.X.1993, Udržal (CPDL); 3 ♂♂ 1 ♀, 8.VII.1934, Pretner (CPDL).

Slovenia, Vransko, Škadovnica (Slovene Cave Cadastre No. 482): 1 ♂ Holotype, (CMCSNT); 2 ♂♂ 1 ♀ Paratypes, (CMCSNT); 4 ♀♀, 31.VII.1937, Pretner (CPDL); 3 ♂♂ 5 ♀♀, 4.IX.1937, Pretner (CPDL); 1 ♂ 1 ♀, Pretner (CPDL).

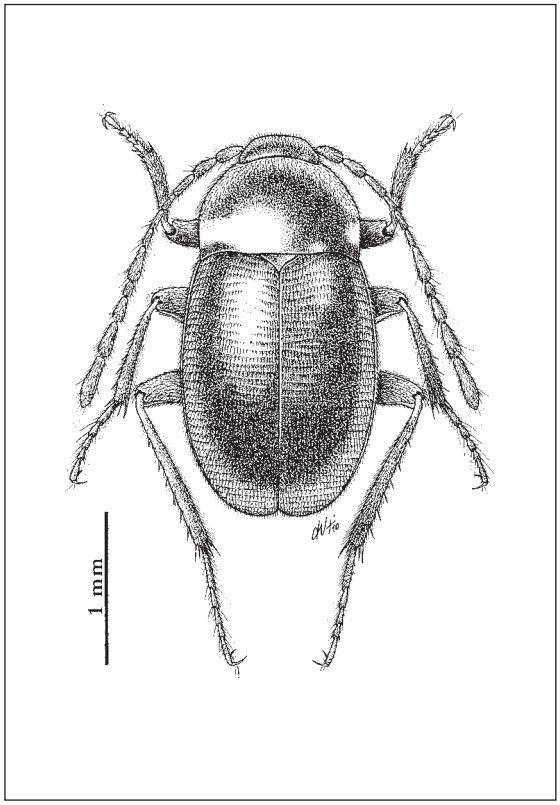

Fig. 6 *Aphaobius knirschi* ♂, habitus.

Slovenia, Golte, Snežna jama pod Gostečnikovim stanom (Slovene Cave Cadastre No. 638): 8 ♀, 10.IX.1939, Pretner (CPDL).

Slovenia, Vransko, Štabirnica (Slovene Cave Cadastre No. 502): 1 ♂ 1 ♀, 10.VII.1902, Penecke (CMKI); 10 ♂♂ 9 ♀♀, 7.XI.1937, Pretner (CPDL).

Slovenia, Vransko, Veternica (Slovene Cave Cadastre No. 539): 1 ♂ 1 ♀, 19.VI.1938, Pretner (CPDL).

Slovenia, Dobrovlje, Vračka zijalka (Slovene Cave Cadastre No. 468): 1 ♀ Paratype, Pož (CMCSNT); 1 ♂, 11.VII.1937, Pretner (CPDL); 1 ♂, 15.VIII.1937, Pretner (CPDL); 4 ♂♂ 4 ♀♀, 17.V.1937, Pretner (CPDL); 1 ♀, 6.IX.1937, Pretner (CPDL).

Additional material examined (not measured)

Slovenia, Dobrovlje, Covška prepad (Slovene Cave Cadastre No. 486): 2 exx., 4.VI.1964, Drovenik (CPMGT); 10 exx., 15.VIII.1937, Braslovec (CPMGT); 5 exx., 15.VIII.1937, Braslovec (CDVB).

Slovenia, Dobrovlje, Krapljetova jama (Slovene Cave Cadastre No. 484): 10 exx., 1.VIII.1937, Pretner (CPMGT); 2 exx., 1.VIII.1937, Pretner (CDVB); 6 exx., 1933, Kodrič (CPMP); 4 exx., 5.IX.1937, Pretner (CPMGT).

Slovenia, Dobrovlje, Lesjakova Štabirnica (Slovene Cave Cadastre No. 479): 6 exx., 15.X.1995-19.V.1996, Vavra (CPMGT).

Slovenia, Vransko, Škadovnica (Slovene Cave Cadastre No. 482): 5 exx. Paratypes, Knirsch (CPMGT), 1 ex., (CPMGT); 10 exx., 31.VII.1937, Pretner (CPMGT); 5 exx., 31.VII.1937, Pretner (CPMGT); 8 exx., 23.VI.2002 (CMGB); 1 ex., Pretner (CMGB); 1 ex., Pretner (CDVB); 5 exx., 17.IV-16.X.1994, Vavra (CMGB); 35 exx., 4.IX.1937, Pretner (CMCSNT, CDVB); 1 ex., 27.II.1923 (CPMGT).

Diagnosis

A medium sized *Aphaobius* of the *kraussi* group, generally affine to *A. angusticollis*, but distinguishable from the latter by the pronotum more transverse and sub-trapezoidal, the antennae less elongated, and the 11th antennomere slender and very long compared to the total length of the antenna.

Description

Total length with the head deflexed: ♂♂ 2.75-3.05 mm; ♀♀ 2.88-3.19 mm. Body, legs and antennae brown.

Antennae long (k(L_A): ♂♂ 0.83-0.88; ♀♀ 0.67-0.75), in males reaching the apical third of the elytra when stretched backwards. 11th antennomere long and slender, 8th antennomere about 2.5 times shorter than the 7th.

Pronotum transverse (B_{Pmax}/L_P: ♂♂ 1.48-1.60; ♀♀ 1.50-1.65), with maximum width just before the base (B_{Ppos}/B_{Pmax}: ♂♂ 0.95-1.00; ♀♀ 0.97-1.00). Sides regularly arcuate from the base to the anterior margin (B_{Pant}/B_{Pmax}: ♂♂ 0.50-0.54; ♀♀ 0.48-0.52). Hind angles acute, not pointed.

Elytra ovoid, elongated (L_E/B_E: ♂♂ 1.38-1.46; ♀♀ 1.32-1.41) with maximum width at about the middle (L_{Bemax}/L_E: ♂♂ 0.52-0.59; ♀♀ 0.54-0.59).

Legs relatively long and slender.

Aedeagus with the median lobe elongated. Distal part of the median lobe, in dorsal view, with subparallel sides in the basal four fifths, then slightly sinuate, with thickened sides converging to a rounded end. Proximal edge of the apical orifice slightly convex or straight. Parameres longer than the median lobe.

Distribution and ecology

A. knirschi is known from caves on Dobrovlje, Menina planina and Golte (Fig. 37), a large karst area between Kamnik and Velenje, characterised by limestones and dolomitic limestones.

Aphaobius brevicornis Mandl, 1940 n. stat.
(Figs. 7, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30f, 37)

Aphaobius milleri brevicornis Mandl, 1940: 31
Aphaobius milleri brevicornis Mandl, 1940: Pretner, 1968: 10

Type locality
Austria, Kärnten, old mines on Mt Obir

Analysed material
Austria, Kärnten, Obir, Stollen (not registered): 1 ♂ 2 ♀♀ Paratypes, Meschnigg (CMCSNT).
Austria, Kärnten, Obir, alten Stollen, westl. Repnik-hube, 1,100 m (not registered): 1 ♂, 26.V.1983, Kahlen (CMKI).
Austria, Kärnten, Obir, Stollen o.d. Altenbergschacht (not registered): 1 ♂, 15.I.1983, Mixanig (CMKI); 1 ♀, 8.I.1983, Mixanig (CMKI).
Austria, Kärnten, Obir, Stollen, 1,400 m (not registered): 5 ♂♂ 5 ♀♀, 6.VIII.2005, Mixanig, Bognolo & Lebenbauer (CMBT).
Austria, Kärnten, Obir, Stollen, 1,600 m (not registered): 7 ♂♂ 11 ♀♀, 6.VIII.2005, Mixanig, Bognolo & Lebenbauer (CMBT, CDVB).

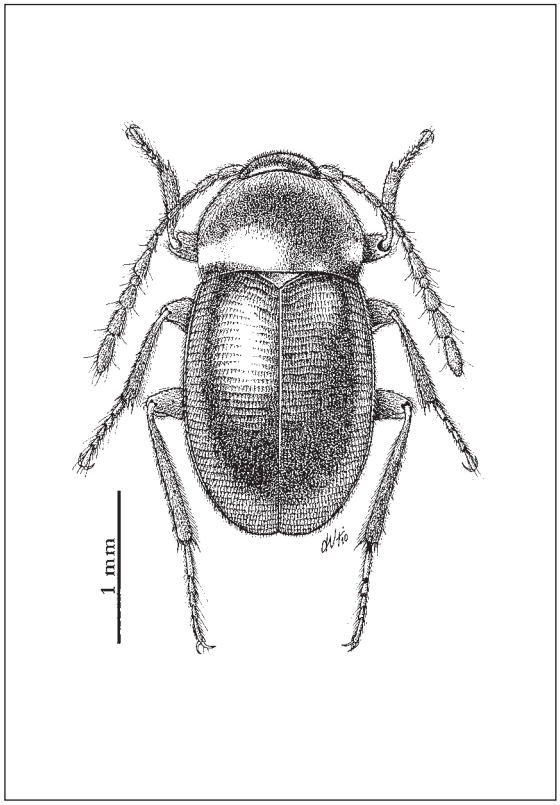

Fig. 7 *Aphaobius brevicornis* ♂, habitus.

Austria, Kärnten, Obir, Stollen, 1,940 m (not registered): 3 ♂♂ 3 ♀♀, 6.VIII.2005, Mixanig, Bognolo & Lebenbauer (CMBT).

Austria, Kärnten, Obir, Stollen, 1,980 m (not registered): 2 ♂♂ 2 ♀♀, 6.VIII.2005, Mixanig, Bognolo & Lebenbauer (CMBT).

Austria, Kärnten, Obir, Marienzubau, 2,000 m (not registered): 2 ♂♂ 2 ♀♀, 24.VI-2.X.1995, Gitzen (CMBT).

Austria, Kärnten, Jauernik-Matzen, Christinenschacht, 1,500 m (Austrian Cave Cadastre No. A/3924): 2 ♂♂, 12.XI.1983, Mixanig (CMKI); 2 ♀♀, 18.2.1984, Mixanig (CMKI); 1 ♂ 2 ♀♀, 26.11.1983, Mixanig (CMKI, CMBT).

Additional material examined (not measured)

Austria, Kärnten, Obir, Stollen, 1,600 m (not registered): 8 exx., 6.VIII.2005, Mixanig, Bognolo & Lebenbauer (CDVB).

Austria, Kärnten, Obir, Stollen, 1,940 m (not registered): 1 ex., 27.VII.1994, Monguzzi (CPMGT).

Austria, Kärnten, Jauernik-Matzen, Christinenschacht, 1,500 m (Austrian Cave Cadastre No. A/3924): 1 ex., 18.II.1984, Mixanig (CMGB); 2 exx., 26.XI.1983, Mixanig (CDVB).

Diagnosis

A medium-small sized *Aphaobius* of the *kraussi* group, clearly distinguishable by its antennae, which are evidently shorter and stockier than in any other species of the genus.

Description

Total length with the head deflexed: ♂♂ 2.72-2.95 mm; ♀♀ 2.91-3.10 mm. Body, legs and antennae brown-reddish.

Antennae exceptionally short ($k(L_A)$: ♂♂ 0.69-0.72; ♀♀ 0.54-0.58), in males barely reaching the middle of the elytra when stretched backwards. 11th antennomere short and stocky, 8th antennomere almost 3 times shorter than the 7th.

Pronotum transverse (B_{Pmax}/L_P: ♂♂ 1.57-1.65; ♀♀ 1.60-1.69), with maximum width at the basal third. Base slightly narrower (B_{Ppos}/B_{Pmax}: ♂♂ 0.94-0.98; ♀♀ 0.96-0.99), feebly sinuate. Sides regularly arcuate anteriorly (B_{Pant}/B_{Pmax}: ♂♂ 0.47-0.51; ♀♀ 0.46-0.51), weakly converging posteriorly. Hind angles obtuse.

Elytra ovoid (L_E/B_E: ♂♂ 1.39-1.46; ♀♀ 1.32-1.42) with maximum width at about the middle (L_{Bemax}/L_E: ♂♂ 0.58-0.61; ♀♀ 0.51-0.60).

Legs relatively short.

Aedeagus with the median lobe elongated. Distal part of the median lobe, in dorsal view, with subparallel sides in the basal four fifths, then slightly sinuate, with thickened sides converging to a rounded end. Proximal edge of the apical orifice slightly convex or straight. Parameres longer than the median lobe.

Distribution and ecology

A. brevicornis is endemic to the alpine massif of Mt Obir in southern Austria (Fig. 37). Natural caves are quite rare in this area, but since its discovery the species was found in many old mines, which are located all over Mt Obir, at altitudes ranging from about 1,000 m to 2,000 m.

The associated cave fauna consists of the carabid beetles *Orotrechus carinthiacus* Mandl, 1940, *Anophthalmus pretneri fodinae* Mandl, 1940, and the leptodirine *Lotharia angulicollis* Mandl, 1944.

Aphaobius kraussi Müller, 1910
(Figs. 8, 21, 22, 23, 24, 25, 26, 27, 28, 29, 31, 37)

Aphaobius kraussi Müller, 1910 = *Aphaobius milleri pretneri* Müller, 1913 n. syn.
Aphaobius kraussi Müller, 1910 = *Aphaobius milleri winkleri* Mandl, 1944 n. syn.
Aphaobius kraussi Müller, 1910 = *Aphaobius milleri hoelzeli* Mandl, 1957 n. syn.
Aphaobius kraussi Müller, 1910 = *Aphaobius milleri alpinus* Drovenik, Mlejnek & Moravec, 1995 n. syn.
Aphaobius kraussi Müller, 1910: 185
Aphaobius kraussi Müller, 1910: Jeannel, 1911: 433
Aphaobius milleri kraussi Müller, 1910: Müller, 1913: 6
Aphaobius milleri kraussi Müller, 1910: Jeannel, 1924: 231
Aphaobius milleri kraussi Müller, 1910: Pretner, 1968: 11
Aphaobius milleri pretneri Müller, 1913: 5
Aphaobius milleri pretneri Müller, 1913: Jeannel, 1924: 231
Aphaobius milleri pretneri Müller, 1913: Pretner, 1968: 11
Aphaobius milleri winkleri Mandl, 1944: 104
Aphaobius milleri winkleri Mandl, 1944: Pretner, 1968: 11
Aphaobius milleri hoelzeli Mandl, 1957: 5
Aphaobius milleri hoelzeli Mandl, 1957: Pretner, 1968: 11
Aphaobius milleri alpinus Drovenik, Mlejnek & Moravec, 1995: 3

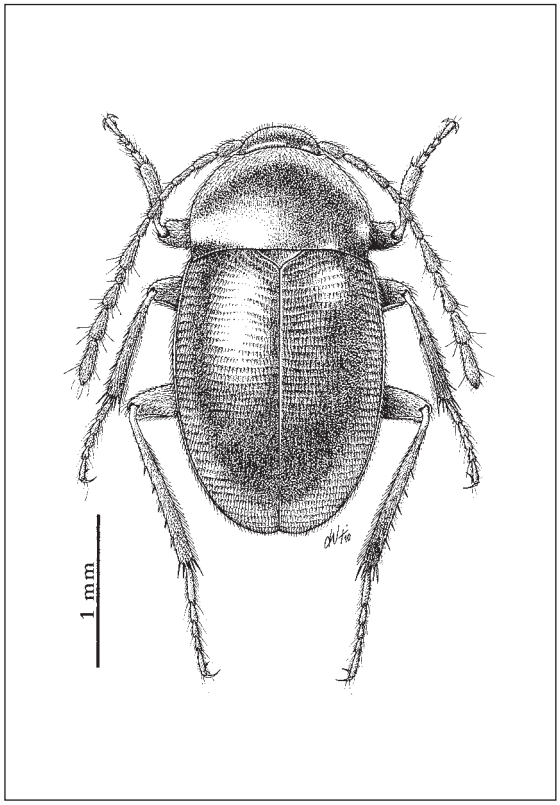

Fig. 8 *Aphaobius kraussi* ♂, habitus.

Type locality

Slovenia, Kamniške Alps, Trbiška zijalka (Slovene Cave Cadastre No. 467)

Analysed material

Slovenia, Zgornje Jezersko, Brezno na Murnovem (Slovene Cave Cadastre No. 2298): 4 ♀♀, 23.X.1970, Drovenik (CPDL); 1 ♂, 26.IX.1970, Drovenik (CPDL).

Slovenia, Podljubelj, Doljni rov pri Potočniku (not registered): 1 ♂, 1993, Kofler (CBKS); 1 ♂ 2 ♀♀, VIII-XI.1994, Kofler (CBKS); 2 ♂♂ 3 ♀♀, XI.1994-IV.1995, Kofler (CBKS).

Slovenia, Savinjska dolina, Erjavčeva jama (Slovene Cave Cadastre No. 466): 4 ♂♂ 10 ♀♀, 16.V.1937, Pretner (CPDL); 1 ♂ 1 ♀, 25.VI.1988, Nicoli (CMKI).

Slovenia, Zgornje Jezersko, Jama na Babi (Slovene Cave Cadastre No. 2299): 2 ♂♂, 23.X.1970, Drovenik (CPDL); 1 ♂, 26.IX.1970, Drovenik (CPDL).

Slovenia, Savinjska dolina, Jama na Raduhi (Slovene Cave Cadastre No. 2217): 1 ♀, 16.V.1937, Pretner (CPDL).

Slovenia, Velika planina, Jama v Kofcah (Slovene Cave Cadastre No. 120): 3 ♀♀, 21.VII.1935, Pretner (CPDL).

Slovenia, Savinjske Alps, Kamniška jama (Slovene Cave Cadastre No. 5058): 17 ♂♂ 17 ♀♀, 21.VIII.2004, Bognolo (CMBT); 2 ♂♂ 1 ♀, 29.V.1988 (CPDL); 2 ♂♂ 3 ♀♀, V.1986 (CPDL); 1 ♂ 1 ♀, VI.1983, Drovenik (CPDL); 1 ♂ 4 ♀♀, VII.1986 (CPDL); 1 ♀, X.1985 (CPDL).

Slovenia, Peca, Korančovka (Slovene Cave Cadastre No. 2503): 1 ♂ 2 ♀♀, 11.IX.1962, Pretner (CPDL); 1 ♀, 4.X.1978, Novak (CPDL).

Slovenia, Savinjske Alps, Macesnikova zijalka (Slovene Cave Cadastre No. 635): 3 ♂♂ 8 ♀♀, X.1939, Vršnik (CPDL).

Slovenia, Kamniške Alps, Pečovska parna (Slovene Cave Cadastre No. 2932): 13 ♂♂ 27 ♀♀, 21.X.1993-12.V.1994, Kahlen (CMKI).

Slovenia, Olševa, Potočka zijalka (Slovene Cave Cadastre No. 634): 3 ♂♂ 2 ♀♀, 13.VII.1996-15. VI.1997, Kofler (CBKS); 1 ♂, 1930, Brodar (CPDL); 1 ♀, X.1939, Vršnik (CPDL).

Slovenia, Begunjščica, Rov 2 Pri Knapih (not registered): 5 ♂♂ 4 ♀♀, 1.V.1998-10.VI.1999, Kofler (CBKS); 12 ♂♂ 16 ♀♀, 31.VIII.1997-1.V.1998, Kofler (CBKS, CMBT).

Slovenia, Begunjščica, Rov pod stezo pri knapih (not registered): 9 ♂♂ 10 ♀♀, 10.IX.1978, Pretner (CPDL).

Slovenia, Stol, Rov pod Valvazorjevo kočo (not registered): 1 ♂ (holotype of *A. milleri pretneri* Müller, 1913), 16.VIII.1912, Pretner (CMCSNT); 1 ♀ (paratype of *A. milleri pretneri* Müller, 1913), 16.VIII.1912, Pretner (CMCSNT); 1 ♂ (paratype of *A. milleri pretneri* Müller, 1913), VIII.1911, Pretner (CPDL); 1 ♀ (paratype of *A. milleri pretneri* Müller, 1913), VIII.1912, Pretner (CPDL); 1 ♂ (paratype of *A. milleri pretneri* Müller, 1913), (CMCSNT).

Slovenia, Peca, Rov pri koči na Peci, 1,560 m (not registered): 4 ♂♂ 1 ♀, 12.IX.1962, Pretner (CPDL).

Slovenia, Raduha, Snežna jama na planini Arto (Slovene Cave Cadastre No. 1254): 1 ♂ (holotype of *A. milleri alpinus* Drovenik, Mlejnek & Moravec, 1995), 15.IX.1989, Drovenik (CPDL); 5 ♀♀ (paratypes of *A. milleri alpinus* Drovenik, Mlejnek & Moravec, 1995), 15.IX.1989, Drovenik (CPDL); 2 ♂♂, 14.VI.2003, Bognolo (CMBT); 1 ♂, 22.X.1993-13.V.1994, Kahlen (CMKI); 5 ♂♂ 12 ♀♀, 28.XI.2002, Bognolo (CMBT); 7 ♂♂ 5 ♀♀, 31.X.2004, Bognolo (CMBT).

Slovenia, Grintavec, Spodmol Sp. Ravni (not registered): 1 ♀, 10.VIII.1997-7.VIII.1998, Kofler (CBKS); 5 ♂♂ 3 ♀♀, 31.VII.1999-20.VIII.2000, Kofler (CBKS); 1 ♂ 3 ♀♀, 7.VIII.1998-31.VII.1999, Kofler (CBKS).

Slovenia, Kamniške Alps, Trbiška zijalka (Slovene Cave Cadastre No. 467): 1 ♂ Holotype, VII.1906, (CMCSNT); 2 ♂♂ 3 ♀♀ Paratypes, VII.1906, (CMCSNT); 6 ♂♂ 12 ♀♀, 11.VII.2004,

Bognolo (CMBT); 2 ♂♂ 3 ♀♀, 16.V.1937, Pretner (CPDL); 33 ♂♂ 39 ♀♀, 21.X.1993-12.V.1994, Kahlen (CMKI).

Slovenia, Velika Planina, Velika Veternica (Slovene Cave Cadastre No. 121): 2 ♀♀, 11.VIII.1935, Pretner (CPDL).

Slovenia, Grintavec, Zg. Ravni (ground traps): 2 ♂♂, 23.XI.2000-5.X.2001, Kofler (CBKS).

Austria, Kärnten, Petzen, Auguststollen, 1,367 m (not registered): 2 ♂♂ 3 ♀♀, 16.X.1988, Mixanig (CMBT).

Austria, Kärnten, Singerberg, Hafnerhöhle (Austrian Cave Cadastre No. 3915/1): 2 ♂♂ 1 ♀ (paratypes of *A. milleri hoelzeli* Mandl, 1957), 29.XI.1955, Hölzel (CPDL); 7 ♂♂ 21 ♀♀, VIII.1979, Gitzen (CMBT).

Austria, Kärnten, Singerberg, Stollen I, 1,300 m (not registered): 2 ♀♀, 28.X.1984, Mixanig (CMKI).

Austria, Kärnten, Singerberg, Stollen II, 1,260 m (not registered): 8 ♂♂, 7.VIII.2005, Mixanig, Bognolo & Lebenbauer (CMBT).

Austria, Kärnten, Hochstuhl, Knappenhöhle, 1,820 m (Austrian Cave Cadastre No. A/3914/1): 1 ♂ 1 ♀, 10.IX.1988, Mixanig (CMKI).

Austria, Kärnten, Petzen, Kolscha-stollen, 1,350 m (not registered): 1 ♂ 2 ♀♀ (paratypes of *A. milleri winkleri* Mandl, 1944), Winkler (CPDL); 3 ♂♂ 10 ♀♀, 14.X.1988, Mixanig & Kahlen (CMKI); 1 ♀, 1955, Mandl (CPDL).

Additional material examined (not measured)

Slovenia, Kamniške Alps, Pečovska parna (Slovene Cave Cadastre No. 2932): 49 exx., 1.V.1995, Grottolo (CMGB); 9 exx., 10.VI.1995, Grottolo (CMGB).

Slovenia, Kamniške Alps, Trbiška zijalka (Slovene Cave Cadastre No. 467): 25 exx., 1.VIII.1937, Pretner (CMCSNT); 2 exx., 12.XII.1987, Etonti (CPMGT); 9 exx., 15.IV-14.X.1994, Vavra (CPMGT); 22 exx., 29.VII.1994, Monguzzi (CPMGT); 4 exx., 11.V-30.IX.1999, Mlejnek (CPMGT); 1 ex., 11.V-30.IX.1999, Mlejnek (CDVB); 2 exx., 1.VIII.1937, Rose (CPMGT); 15 exx., 8.X.1994, Grottolo (CMGB); 87 exx., 10.VI.1995, Grottolo (CMGB); 4 exx., 29.I.1992, Martinu (CMGB); 37 exx., 1.V.1995, Grottolo (CDVB).

Slovenia, Olševa, Potočka zijalka (Slovene Cave Cadastre No. 634): 8 exx., 22.X.1998-14.V.1999, Malinka (CMGB); 2 exx., 13.VII.1996-15.VI.1997, Kofler (CMGB).

Slovenia, Peca, Rov pri koči na Peci, 1,560 m (not registered): 1 ex., 12.IX.1962, Pretner (CPMGT).

Slovenia, Raduha, Snežna jama na planini Arto (Slovene Cave Cadastre No. 1254): 2 exx. (paratypes of *A. milleri alpinus* Drovenik, Mlejnek & Moravec, 1995), 1.IX-7.XI.1992, Mlejnek (CPMGT); 1 ex., 2.V-30.VIII.1992, Mlejnek (CPMGT); 36 exx., 23.VII.1996, Schwienbacher (CMGB); 3 exx., 10.VI.1995, Grottolo (CMGB); 1 ex., 10.VI.1995, Grottolo (CDVB).

Slovenia, Savinjska dolina, Erjavčeva jama (Slovene Cave Cadastre No. 466): 2 exx., 16.V.1937, Pretner (CPMGT).

Slovenia, Savinjska dolina, Jama na Raduhi (Slovene Cave Cadastre No. 2217): 6 exx., 23.VII.1996, Schwienbacher (CMGB).

Slovenia, Savinjske Alps, Kamniška jama (Slovene Cave Cadastre No. 5058): 6 exx., 9.V-29.VIII.1992, Mlejnek (CPMGT).

Slovenia, Stol, Rov pod Valvazorjevo kočo (not registered): 1 ex. (paratype of *A. milleri pretneri* Müller, 1913), IX.1911, (CPMGT).

Austria, Kärnten, Petzen, Kolscha-stollen, 1,350 m (not registered): 1 ♀ (paratype of *A. milleri winkleri* Mandl, 1944), (CMGB); 3 exx., Winkler (CPMGT); 1 ex., Winkler (CDVB); 1 ex., Mandl (CMGB); 1 ex., (CPMGT).

Austria, Kärnten, Singerberg, Hafnerhöhle (Austrian Cave Cadastre No. 3915/1): 1 ex. (paratype of *A. milleri hoelzeli* Mandl, 1957), (CPMGT); 6 exx. (paratypes of *A. milleri hoelzeli* Mandl, 1957), 29.XI.1955, Hölzel (CPMGT, CMGB); 6 exx., VIII.1979, Gitzen (CMGB).

Diagnosis

A medium-small sized *Aphaobius* of the *kraussi* group, generally affine to *A. brevicornis*, but distinguishable from the latter by its less short and stocky antennae, as well as the clearly shorter elytra.

Description

Total length with the head deflexed: ♂♂ 2.75-3.05 mm; ♀♀ 2.91-3.18 mm. Body, legs and antennae brown-reddish.

Antennae short ($k(L_A)$: ♂♂ 0.76-0.81; ♀♀ 0.61-0.65), in males reaching the middle of the elytra when stretched backwards. 11th antennomere relatively stocky, 8th antennomere about 2.5 times shorter than the 7th.

Pronotum transverse (B_{Pmax}/L_P: ♂♂ 1.55-1.68; ♀♀ 1.58-1.76), with maximum width at the basal third, base narrower (B_{Ppos}/B_{Pmax}: ♂♂ 0.95-0.99; ♀♀ 0.97-1.00). Sides regularly arcuate anteriorly (B_{Pant}/B_{Pmax}: ♂♂ 0.48-0.52; ♀♀ 0.47-0.51), converging posteriorly. Hind angles acute, not pointed.

Elytra ovoid (L_E/B_E: ♂♂ 1.33-1.41; ♀♀ 1.28-1.37) with maximum width at about the middle (L_{Bemax}/L_E: ♂♂ 0.55-0.62; ♀♀ 0.54-0.61).

Legs relatively short and robust.

Aedeagus with the median lobe elongated. Distal part of the median lobe, in dorsal view, with subparallel sides in the basal four fifths, then slightly sinuate, with thickened sides converging to a rounded end. Proximal edge of the apical orifice slightly convex or straight. Parameres longer than the median lobe.

Distribution and ecology

A. kraussi is distributed over a wide alpine and sub-alpine area on the hydrographic left side of the river Sava (Fig. 37), mainly characterised by limestones and dolomitic limestones, and extending from Kamnik northwards to the Karavanke range, from Mt Stol to Raduha and Peca at the easternmost end of the distribution area.

<<*milleri* group>>

Diagnosis

A group of species of the genus *Aphaobius* characterised by the aedeagus with sides not thickened at apex, feebly chitinized ligules and parameres not longer than the median lobe.

Aphaobius forojulensis Müller, 1931 n. stat.
(Figs. 9, 21, 22, 23, 24, 25, 26, 27, 28, 29, 32a, 37)

Aphaobius milleri forojulensis Müller, 1931: 198
Aphaobius milleri forojulensis Müller, 1931: Pretner, 1968: 10

Type locality
Italy, Friuli, Grotta di Villanova (Italian Cave Cadastre No. 323/Fr)

Analysed material

Italy, Friuli, Grotta di Villanova (Italian Cave Cadastre No. 323/Fr): 3 ♂♂ 5 ♀♀ Paratypes, 26.VIII.1928, Pretner (CPDL); 1 ♀, 31.III.1968, Pretner (CPDL); 5 ♂♂ 7 ♀♀, 31.VIII.1997-1.V.1998, Egger & Kahlen (CMKI); 27 ♂♂ 23 ♀♀, 6.III.1994, Bognolo (CMBT, CDVB); 3 ♀♀, 9.XI.1969; Pretner (CPDL).

Italy, Friuli, Grotta di Montefosca (Italian Cave Cadastre No. 1649/Fr): 11 ♂♂ 10 ♀♀, 17.III.1996, Bognolo (CMBT).

Italy, Friuli, Grotta di Taipana (Italian Cave Cadastre No. 61/Fr): 2 ♀♀, 19.XII.1992, Daffner (CMKI); 8 ♂♂ 17 ♀♀, 31.VIII.1997-1.V.1998, Egger & Kahlen (CMKI); 13 ♂♂ 11 ♀♀, 31.VIII.1997-1.V.1998, Lebenbauer (CMBT).

Italy, Friuli, Grotta sopra Berda (not registered): 1 ♀, 17.III.1996, Bognolo (CMBT).

Italy, Friuli, Voragine a SO del Matajur (Italian Cave Cadastre No. 7/Fr): 1 ♂ 1 ♀, 14.VIII.1995, Kahlen (CMKI); 2 ♀♀, VII.1983, Colla (CMCSNT).

Slovenia, Trenta, Jama nad rudnikom Pri Štolnu (Slovene Cave Cadastre No. 835): 1 ♂, 11.IX.1954, Pretner (CPDL); 2 ♂♂ 2 ♀♀, 3.XI.1995, Bognolo (CMBT).

Slovenia, Livek, Jama v Malenščah (Slovene Cave Cadastre No. 4451): 1 ♀, 11.V-15.VIII.1996, Kahlen (CMKI); 1 ♂ 1 ♀, 17.IX.1994-30.IV.1995, Kahlen & Egger (CMKI); 1 ♂, 9.V.2004, Bognolo (CMBT).

Slovenia, Trenta, Jama v rudniku Pri Štolnu (Slovene Cave Cadastre No. 836): 3 ♂♂ 3 ♀♀, 10.IX.1996, Bognolo (CMBT); 3 ♂♂ 2 ♀♀, 18.IX.1994-12.VIII.1995, Kahlen & Egger (CMKI).

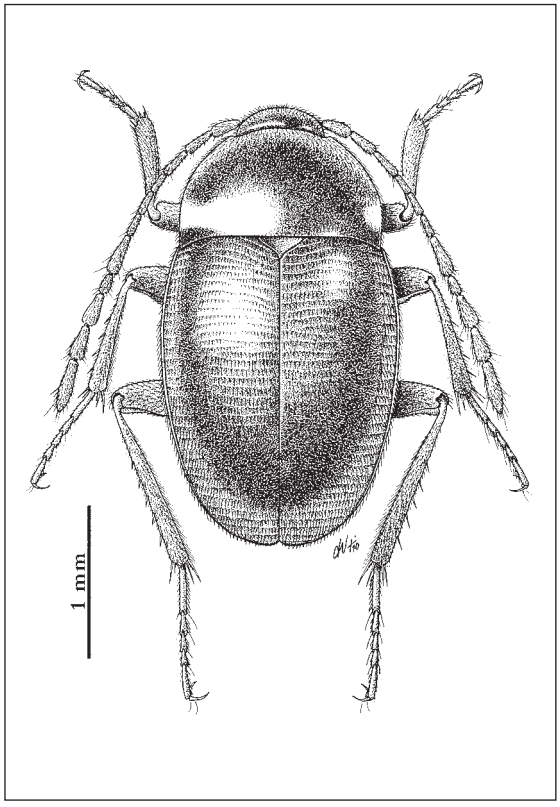

Fig. 9 *Aphaobius forojulensis* ♂, habitus.

Slovenia, Matajur, Klet (Slovene Cave Cadastre No. 1032): 1 ♂ 2 ♀♀, 20.IX.1954, Pretner (CPDL).

Slovenia, Tolmin, Pološka jama (Slovene Cave Cadastre No. 3000): 1 ♂ 3 ♀♀, 9.X.1966, Pretner (CPDL); 3 ♀♀, 9.V.1966, Pretner (CPDL).

Slovenia, Zadnja Trenta, Vršac, Rudnik na Srednici, 1,800 m (not registered): 2 ♂♂ 6 ♀♀, 15.IX.1954, Pretner (CPDL).

Slovenia, Matajur, Snežna jama nad Svinjsko planino (Slovene Cave Cadastre No. 822): 2 ♀♀, 20.IX.1954, Pretner (CPDL); 1 ♀, 4.VIII.1950, Pretner (CPDL).

Slovenia, Kanin, Snežnica ob poti pod Kaninsko kočo, 1,560 m (not registered): 1 ♂ 3 ♀♀, 23.VIII.1954, Pretner (CPDL).

Slovenia, Kobarid, Turjeva jama (Slovene Cave Cadastre No. 821): 1 ♂ 2 ♀♀, 11.V.1996, Kahlen (CMKI); 3 ♂♂ 3 ♀♀, 11.V-15.VIII.1996, Kahlen (CMKI).

Additional material examined (not measured)

Italy, Friuli, Caverna 2° a SW del Monte Matajur (Italian Cave Cadastre No.383/Fr): 1 ex., VII.1993, Monguzzi (CPMGT); 1 ex., 2.IV.1993, Monguzzi (CDVB).

Italy, Friuli, Grotta di Montefosca (Italian Cave Cadastre No. 1649/Fr): 8 exx., 28.II.1994, Monguzzi (CDVB); 2 exx., 29.IV.1980, Rosa (CPMGT); 1 ex., 23.XI.1993, Trezzi (CPMGT).

Italy, Friuli, Grotta di Taipana (Italian Cave Cadastre No. 61/Fr): 3 exx., 31.V.1986, Giachino (CPMGT); 28 exx., 4.I.2003, Grottolo (CMGB); 18 exx., 1.VIII.2001, Grottolo (CMGB); 10 exx., 20.V.2001, Grottolo (CMGB); 5 exx., 31.VIII.2002, Grottolo (CMGB); 95 exx., 24.VII.1999, Grottolo (CMGB).

Italy, Friuli, Grotta di Villanova (Italian Cave Cadastre No. 323/Fr): 8 exx., 6.III.1994, Bognolo (CDVB); 1 ex., 24.VII.1999, Grottolo (CMGB).

Italy, Friuli, Voragine a SO del Matajur (Italian Cave Cadastre No. 7/Fr): 12 exx., 1.X.1995, Monguzzi (CPMGT); 1 ex., VII.1983, Colla (CMGB).

Diagnosis

The largest *Aphaobius* of the *milleri* group, distinguishable from the other species of this group also by its pronotum, transverse with sides strongly narrowed towards the anterior margin, as well as by the 11th antennomere, which is very short in comparison with the antenna length.

Description

Total length with the head deflexed: ♂♂ 3.12-3.39 mm; ♀♀ 3.10-3.52 mm. Body, legs and antennae dark brown.

Antennae of medium length ($k(L_A)$: ♂♂ 0.75-0.,83; ♀♀ 0.63-0.69), in males reaching the middle of the elytra when stretched backwards. 11th antennomere short, 8th antennomere about 2.5 times shorter than the 7th.

Pronotum clearly transverse (B_{Pmax}/L_P: ♂♂ 1.61-1.77; ♀♀ 1.66-1.83), with maximum width at the basal fourth. Base slightly narrower (B_{Ppos}/B_{Pmax}: ♂♂ 0.98-1.00; ♀♀ 0.98-1.00), sides arcuate and much narrowed anteriorly (B_{Pant}/B_{Pmax}: ♂♂ 0.43-0.46; ♀♀ 0.42-0.45), weakly converging posteriorly. Hind angles acute, not pointed.

Elytra ovoid, relatively short (L_E/B_E: ♂♂ 1.31-1.40; ♀♀ 1.25-1.35), with maximum width at about the middle (L_{Bemax}/L_E: ♂♂ 0.57-0.67; ♀♀ 0.57-0.66).

Legs long and robust.

Aedeagus with the median lobe elongated. Distal part of the median lobe, in dorsal view, with subparallel sides up to the apex, then curved and converging to a largely rounded end. Ligules slightly diverging in dorsal view, pointed and inclined forward in lateral view. Proximal edge of the apical orifice concave or straight. Parameres as long as the median lobe.

Distribution and ecology

A. forojulensis, the westernmost species of the genus *Aphaobius*, is widely spread in the karst area between the north-eastern part of Friuli (Italy) and western Slovenia (Fig. 37). The species is often found in active caves with stable water flow or high percolation and is generally associated with different species of the genus *Anophthalmus* (e.g. *A. fabbrii* Müller, 1931, *A. manhartensis* Meschnigg, 1943, *A. leander* Sciaky, Monguzzi & Trezzi, 1999, etc.) as well as the leptodirinae *Oryotus indentatus* Pretner, 1955.

Aphaobius grottoloi Vailati, 2004
(Figs. 10, 21, 22, 23, 24, 25, 26, 27, 28, 29, 32b, 37)

Aphaobius grottoloi Vailati, 2004: 91

Type locality
Italy, Friuli, Taipana (UD), Grotta di Taipana (Italian Cave Cadastre No. 61/Fr).

Analysed material
Italy, Friuli, Taipana (UD), Grotta di Taipana (Italian Cave Cadastre No. 61/Fr): 2 ♂♂ 1♀, 31.VIII.1997-1.V.1998, Egger & Kahlen (CMKI); 2 ♂♂ 3 ♀♀, 31.VIII.1997-1.V.1998, Lebenbauer (CMBT); 10 ♀♀, 14.IV-7.X.2004, Lebenbauer (CTLS).

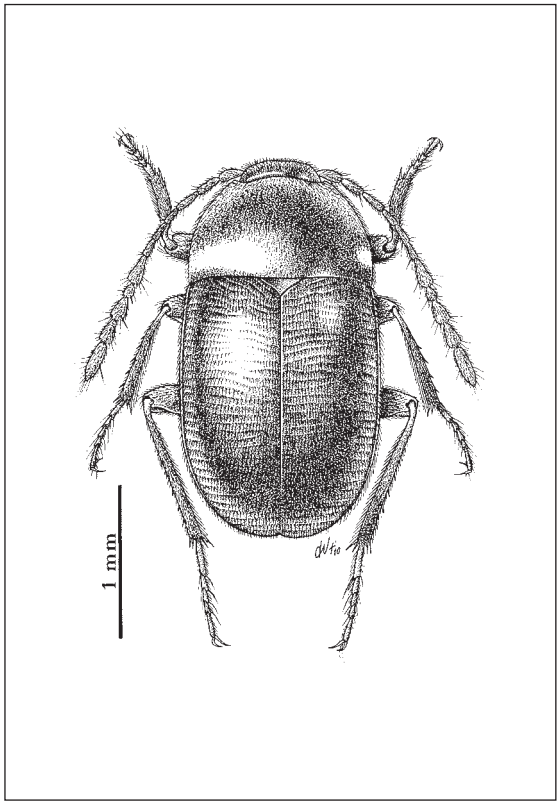

Fig. 10 *Aphaobius grottoloi* ♂, habitus.

Additional material examined (not measured)

Italy, Friuli, Taipana (UD), Grotta di Taipana (Italian Cave Cadastre No. 61/Fr): 1 ♂ Holotype, 24.VII.1999, Grottolo (CMCSNB); 5 exx. Paratypes, 24.VII.1999, Grottolo (CMGB, CDVB); 5 exx. Paratypes, 4.I.2003, Grottolo (CMGB); 5 exx. Paratypes, 1.VIII.2001, Grottolo (CMGB, CDVB); 3 exx. Paratypes, 8.III.2003, Grottolo (CMGB); 1 ex. Paratype, 18.V.2003, Grottolo (CMGB); 2 exx. Paratypes, 20.V.2001, Grottolo (CMGB).

Diagnosis

An *Aphaobius* of the *milleri* group, distinguishable by its very small size, as well as by the antennae, which are shorter and stockier than in other species of the group, and the elytra, which are ovoid and shorter than in any other species of the genus *Aphaobius*.

Description

Total length with the head deflexed: ♂♂ 2.73-2.85 mm; ♀♀ 2.65-2.85 mm. Body, legs and antennae dark brown.

Antennae very short ($k(L_A)$: ♂♂ 0.73-0.76; ♀♀ 0.60-0.63), in males barely reaching the middle of the elytra when stretched backwards. 11th antennomere relatively long compared to length of the antenna, 8th antennomere about 2.5 times shorter than the 7th.

Pronotum clearly transverse (B_{Pmax}/L_P: ♂♂ 1.67-1.72; ♀♀ 1.75-1.84), with maximum width at the base (B_{Ppos}/B_{Pmax}: ♂♂ 0.99-1.00; ♀♀ 1.00). Sides regularly arcuate, with the anterior margin particularly narrowed (B_{Pant}/B_{Pmax}: ♂♂ 0.45-0.47; ♀♀ 0.43-0.46). Hind angles acute, not pointed.

Elytra ovoid, stocky (L_E/B_E: ♂♂ 1.29-1.32; ♀♀ 1.23-1.27) with maximum width at about the middle (L_{Bemax}/L_E: ♂♂ 0.59-0.63; ♀♀ 0.55-0.60).

Legs relatively short.

Aedeagus with the median lobe elongated. Distal part of the median lobe, in dorsal view, with subparallel sides up to the apex, then curved and converging to a largely rounded end. Ligules slightly diverging in dorsal view, pointed and inclined forward in lateral view. Proximal edge of the apical orifice straight. Parameres as long as the median lobe.

Distribution and ecology

The species is known only from the type locality (Fig. 37), a small sub-horizontal cave near the village of Taipana. The site is mainly characterised by active caves that originated within a mixed combination of karst veins and flysch layers.

A remarkable record is that "Grotta di Taipana" is the only known cave so far where two different species of the genus *Aphaobius* (namely *A. grottoloi* and *A. forojulensis*) can be found in the same habitat. The associated cave fauna also includes the carabid beetle *Anophthalmus fabbrii linicola* Sciaky, 1987.

Aphaobius lebenbaueri n. sp.

(Figs. 11, 21, 22, 23, 24, 25, 26, 27, 28, 29, 32c, 37)

Type locality

Slovenia, Trnovski gozd, Ledenica pri Dolu (Slovene Cave Cadastre No. 751)

Type series

Holotype ♂:

Slovenia, Trnovski gozd, Ledenica pri Dolu (Slovene Cave Cadastre No. 751): 30.VI.2001, Bognolo (CPDL).

Paratypes:

Slovenia, Trnovski gozd, Ledenica pri Dolu (Slovene Cave Cadastre No. 751): 2 ♀♀, 15.IX.1952, Pretner (CPDL); 2 ♂♂ 1 ♀, 21.XI.1949, Pretner (CPDL); 4 ♀♀, 21.VI.1992, Bognolo (CMBT); 28 ♂♂ 23 ♀♀, 30.VI.2001, Bognolo (CMBT, CTLS, CDVB); 4 ♀♀, 7.VI.1992, Bognolo (CMBT).

Slovenia, Trnovski gozd, Bošnarjev brezen (Slovene Cave Cadastre No. 782): 1 ♂ 1 ♀, 16.IX.1952, Pretner (CPDL).

Slovenia, Trnovski gozd, Jama 3 pri jamah za lesom (Slovene Cave Cadastre No. 556): 6 ♂♂ 10 ♀♀, 2.IX.1953, Pretner (CPDL).

Diagnosis

A small *Aphaobius* of the *milleri* group, distinguishable from the other species of this group by its short and stocky antennae, combined with very elongated elytra.

Description

Total length with the head deflexed: ♂♂ 2.60-2.79 mm; ♀♀ 2.72-3.05 mm. Body, legs and antennae brown-reddish.

Antennae short (k(L_A): ♂♂ 0.78-0.83; ♀♀ 0.64-0.66), in males reaching the middle of the elytra when stretched backwards. 11th antennomere relatively long with respect to the antenna length, 8th antennomere about 2.5 times shorter than the 7th.

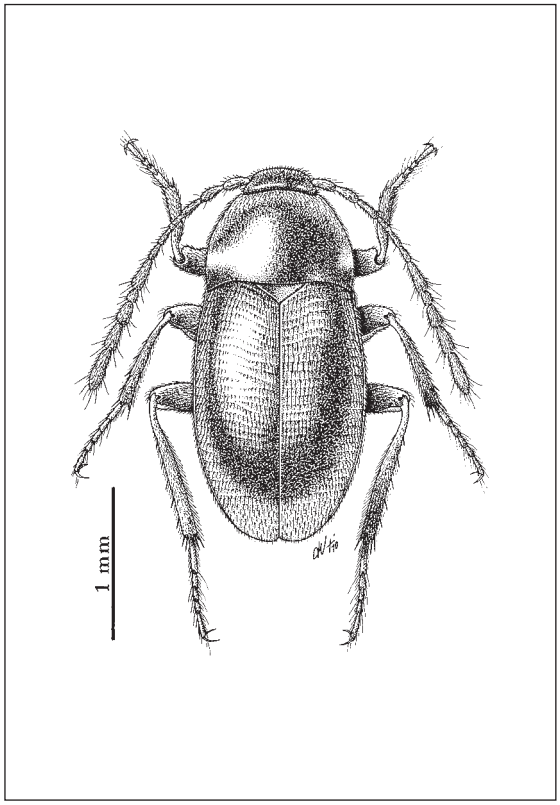

Fig. 11 *Aphaobius lebenbaueri* ♂, habitus.

Pronotum transverse (B_{Pmax}/L_P: ♂♂ 1.52-1.60; ♀♀ 1.57-1.64), with maximum width at the basal third, base narrower (B_{Ppos}/B_{Pmax}: ♂♂ 0.95-0.99; ♀♀ 0.96-0.99). Sides regularly arcuate anteriorly (B_{Pant}/B_{Pmax}: ♂♂ 0.51-0.53; ♀♀ 0.48-0.51), converging posteriorly. Hind angles acute, not pointed.

Elytra ovoid, clearly elongated (L_E/B_E: ♂♂ 1.43-1.47; ♀♀ 1.37-1.44) with maximum width at about the middle (L_{Bemax}/L_E: ♂♂ 0.54-060; ♀♀ 0.53-0.61).

Legs moderately long and slender.

Aedeagus with the median lobe elongated. Distal part of the median lobe, in dorsal view, with subparallel sides up to the apex, then curved and converging to a largely rounded end. Ligules slightly diverging in dorsal view, pointed and inclined forward in lateral view. Proximal edge of the apical orifice concave. Parameres as long as the median lobe.

Etymology

The new species was named after the Austrian entomologist Thomas Lebenbauer from Seebenstein.

Distribution and ecology

A. lebenbaueri inhabits both caves and subterranean superficial environment of the Trnovski gozd karst plateau (Fig. 37). The associated cave fauna consists of the carabid beetles *Anophthalmus ravasinii* Müller, 1922, and *Anophthalmus sanctaeluciae fabioi* Daffner, 1996, as well as the leptodirinae of the genera *Bathyscimorphus* Jeannel, 1910, *Oryotus* Miller, 1856 and *Astagobius* Reitter, 1886.

Aphaobius miricae n. sp.

(Figs. 12, 21, 22, 23, 24, 25, 26, 27, 28, 29, 32d, 37, 40)

Type locality

Slovenia, Škofja Loka, Slugov brezen (Slovene Cave Cadastre No. 2062)

Type series

Holotype ♂:

Slovenia, Škofja Loka, Slugov brezen (Slovene Cave Cadastre No. 2062): V.1987, Kofler (CPDL).

Paratypes:

Slovenia, Škofja Loka, Slugov brezen (Slovene Cave Cadastre No. 2062): 28 ♂♂ 32 ♀♀, V.1987, Kofler (CBKS, CMBT); 1 ♂ 1 ♀, V.1976, Broder (CPDL).

Slovenia, Škofja Loka, Močilnik (Slovene Cave Cadastre No. 6640): 1 ♂, 13.III-29.VIII.1999, Kofler (CBKS).

Diagnosis

The smallest species of the genus *Aphaobius*, belonging to the *milleri* group, characterised also by its short and stocky antennae, as well as by its sub-trapezoidal pronotum, with maximum width at base and sides slightly restricted at the anterior margin.

Description

Total length with the head deflexed: ♂♂ 2.57-2.70 mm; ♀♀ 2.70-2.80 mm. Body, legs and antennae brown-reddish.

Antennae short ($k(L_A)$: ♂♂ 0.75-0.79; ♀♀ 0.65-0.67), in males reaching the middle of the elytra when stretched backwards. 11th antennomere relatively stocky, 8th antennomere about 2.5 times shorter than the 7th.

Pronotum transverse (B_{Pmax}/L_P: ♂♂ 1.51-1.59; ♀♀ 1.57-1.64), with maximum width at the base (B_{Ppos}/B_{Pmax}: ♂♂ 1.00; ♀♀ 1.00). Sides regularly arcuate from the base to the anterior margin (B_{Pant}/B_{Pmax}: ♂♂ 0.51-0.53; ♀♀ 0.49-0.51). Hind angles acute, not pointed.

Elytra ovoid (L_E/B_E: ♂♂ 1.33-1.38; ♀♀ 1.29-1.35) with maximum width at about the middle (L_{Bemax}/L_E: ♂♂ 0.56-0.63; ♀♀ 0.56-0.63).

Legs moderately long and slender.

Aedeagus with the median lobe elongated. Distal part of the median lobe, in dorsal view, with subparallel sides up to the apex, then curved and converging to a largely rounded end. Ligules slightly diverging in dorsal view, pointed and inclined forward in lateral view. Proximal edge of the apical orifice concave. Parameres as long as the median lobe

Etymology

The new species was named after its discoverer Ms Mira Kofler from Škofja Loka.

Distribution and ecology

Aphaobius miricae n. sp. has been found only in two small caves situated within an isolated karst spot near Škofja Loka (Figs. 37, 40).

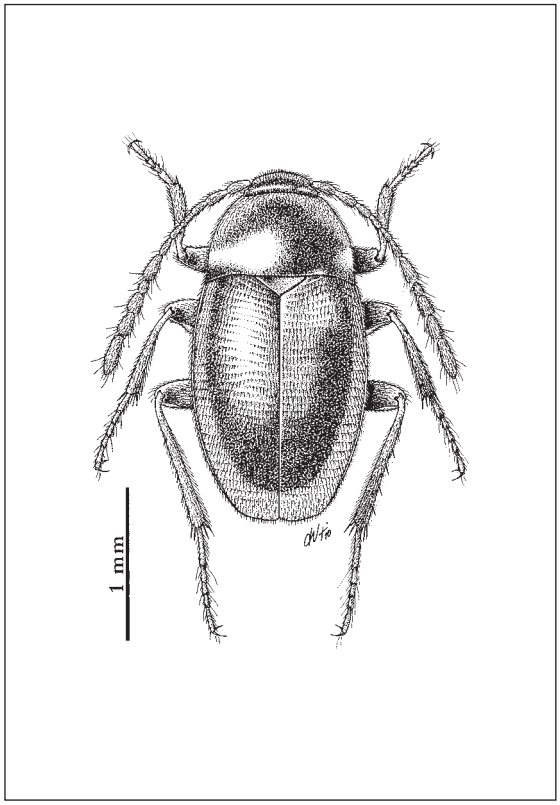

Fig. 12 *Aphaobius miricae* ♂, habitus.

Aphaobius kaplai n. sp.
(Figs. 13, 21, 22, 23, 24, 25, 26, 27, 28, 29, 33a, 33b, 33c, 37)

Type locality
Slovenia, Kolnica, Častitljiva luknja (Slovene Cave Cadastre No. 395)

Type series
Holotype ♂:
Slovenia, Kolnica, Častitljiva luknja (Slovene Cave Cadastre No. 395): 5.XI.1997, Bognolo (CPDL).
Paratypes:
Slovenia, Kolnica, Častitljiva luknja (Slovene Cave Cadastre No. 395): 1 ♀, 11.VI.1936, Pretner (CPDL); 2 ♂♂ 3 ♀♀, 17.VIII.1920, Pretner (CPDL, CMCSNT); 2 ♂♂ 2 ♀♀, 2.VI.1946, Pretner (CPDL); 23 ♂♂ 20 ♀♀, 5.XI.1997, Bognolo (CMBT, CAKH, CDVB); 2 ♂♂ 2 ♀♀, 7.IX.1914, Pretner (CPDL, CMCSNT); 1 ♂, 9.XII.1945, Pretner (CPDL).
Slovenia, Bohinj, Jama na Grivi (Slovene Cave Cadastre No. 374): 1 ♀, VIII.1939, Pretner (CPDL).
Slovenia, Jama na Jelovici (not registered): 1 ♀, 22.VIII.2003, Kapla (CAKH).
Slovenia, Planina Viševnik, Jama na sedlu (not registered): 2 ♀♀, 1.IX.1935, Pretner (CPDL).
Slovenia, Bohinj, Jama za križem (Slovene Cave Cadastre No. 642): 1 ♀, VIII.1939, Pretner (CPDL); 1 ♀, 27.VIII.1939, Pretner (CPDL); 1 ♀, XII.1940, Pretner (CPDL).
Slovenia, Bohinj, Jama za Vahtam (Slovene Cave Cadastre No. 644): 2 ♀♀, 1938, Žvan (CPDL); 1 ♀, 1938, Žvan (CPDL).
Slovenia, Dražgoše, Konasnica (Slovene Cave Cadastre No. 1241): 3 ♂♂ 3 ♀♀, 11.IV-5.IX.1998, Kahlen (CMKI); 2 ♀♀, 16.X.1999-5.II.2000, Kofler (CBKS); 2 ♂♂ 3 ♀♀, 16.III-8.IX.2001, Kofler (CBKS); 2 ♂♂ 3 ♀♀, 20.V-1.VIII.2000, Kofler (CBKS).
Slovenia, Krnica, Pesjakov buden (Slovene Cave Cadastre No. 261): 1 ♀, 5.XI.1997, Bognolo (CMBT).
Slovenia, Planina Viševnik, Rov ob poti na sedlu (not registered): 1 ♂, VIII.1939, Pretner (CPDL); 1 ♀, 1.9.1935, Pretner (CPDL).
Slovenia, Planina Viševnik, Rov pri mostu (not registered): 1 ♀, 28.VIII.1938, Pretner (CPDL).
Slovenia, Mežakla, Snežna jama na Obranci (Slovene Cave Cadastre No. 976): 1 ♂ 1 ♀, 6.VIII.1922, Pretner (CPDL).
Slovenia, Ratitovec, Štoln na Altemavru (not registered): 1 ♀, VII.1993, Kofler (CBKS); 1 ♂, X.1996-V.1997, Kofler (CBKS); 1 ♂, 18.V-11.VII.1997, Kofler (CBKS); 3 ♀♀, VII-IX.1997, Kofler (CBKS); 3 ♀♀, 16.V-18.IX.1998, Kofler (CBKS); 3 ♂♂ 2 ♀♀, 10.IX.1998-12.VI.1999, Kofler (CBKS); 1 ♂ 3 ♀♀, 12.VI-22.VIII.1999, Kofler (CBKS); 2 ♂♂ 5 ♀♀, 27.V-11.VIII.2000, Kofler (CBKS); 1 ♀, 26.V-15.IX.2001, Kofler (CBKS).
Slovenia, Planina Viševnik, Strmi rov na levo od steze na sedlu (not registered): 1 ♂, 28.VIII.1938, Pretner (CPDL).
Slovenia, Podnart, Turkovo brezno (Slovene Cave Cadastre No. 234): 1 ♂ 2 ♀♀, 5.IV.1970, Drovenik (CPDL).
Slovenia, Planina Viševnik, Veliki rov pri mostu (not registered): 1 ♂, VIII.1939, Pretner (CPDL).
Slovenia, Bohinj, Zlatica (Slovene Cave Cadastre No. 1): 1 ♂, VIII.1939, Pretner (CPDL).

Diagnosis

A medium-small sized *Aphaobius* of the *milleri* group, generally affine to *A. lebenbaueri*, but distinguishable from the latter by the less elongated elytra, as well as by the pronotum, which is more transverse with sides clearly restricted at the anterior margin.

Description

Total length with the head deflexed: ♂♂ 2.71-2.97 mm; ♀♀ 2.78-3.05 mm. Body, legs and antennae brown-reddish.

Antennae short ($k(L_A)$: ♂♂ 0.76-0.80; ♀♀ 0.61-0.66), in males reaching the middle of the elytra when stretched backwards. 11th antennomere relatively stocky, 8th antennomere about 2.5 times shorter than the 7th.

Pronotum transverse (B_{Pmax}/L_P: ♂♂ 1.57-1.65; ♀♀ 1.63-1.70), with maximum width at the basal third, base narrower (B_{Ppos}/B_{Pmax}: ♂♂ 0.97-1.00; ♀♀ 0.98-1.00). Sides regularly arcuate and clearly restricted anteriorly (B_{Pant}/B_{Pmax}: ♂♂ 0.47-0.49; ♀♀ 0.45-0.47), converging posteriorly. Hind angles acute, not pointed.

Elytra ovoid, medium-short (L_E/B_E: ♂♂ 1.33-1.41; ♀♀ 1.27-1.36) with maximum width at about the middle (L_{Bemax}/L_E: ♂♂ 0.55-0.61; ♀♀ 0.56-0.60).

Legs relatively short and robust.

Aedeagus with the median lobe elongated. Distal part of the median lobe, in dorsal view, with subparallel sides up to the apex, then curved and converging to a largely rounded end. Ligules slightly diverging in dorsal view, pointed and inclined forward in lateral view. Proximal edge of the apical orifice concave. Parameres as long as the median lobe.

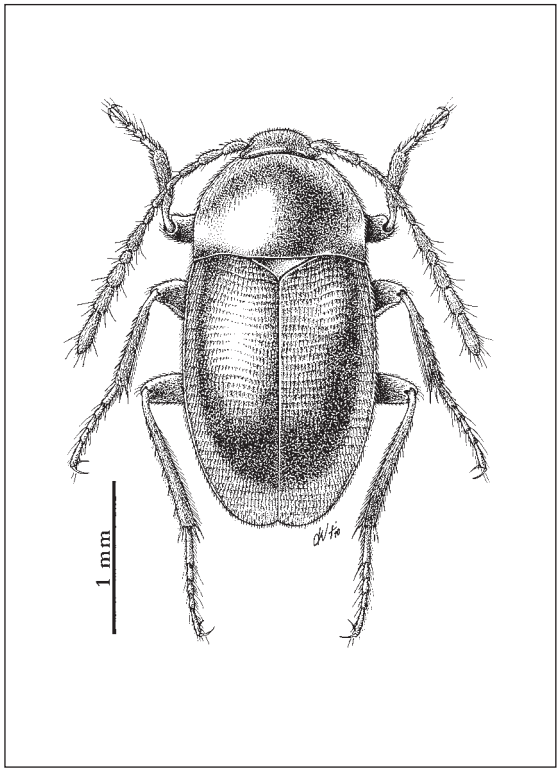

Fig. 13 *Aphaobius kaplai* ♂, habitus.

Etymology
The new species was named after the Slovene entomologist Andrej Kapla from Hrastnik.

Distribution and ecology
A. kaplai n. sp. is distributed in the Alpine area ranging from Mt Ratitovec northward to the Mežakla plateau and northwestward to the Bohinj area (Fig. 37). This area is mainly characterised by caves and potholes within limestones and dolomitic limestones.

Aphaobius fortesculptus Müller, 1925 n. stat.
(Figs. 14, 21, 22, 23, 24, 25, 26, 27, 28, 29, 32e, 37, 41)

Aphaobius milleri fortesculptus Müller, 1925: 46
Aphaobius milleri fortesculptus Müller, 1925: Pretner, 1968: 10

Type locality
Slovenia, Šmarna gora, Matjaževa jama (Slovene Cave Cadastre No. 69)

Analysed material
Slovenia, Šmarna gora, Matjaževa jama (Slovene Cave Cadastre No. 69): 1 ♂ Holotype, 1.VII.1916, Springer (CMCSNT); 1 ♀ Paratype, 21.VI.1916, Springer (CMCSNT); 2 ♀♀, 12.VI-25.

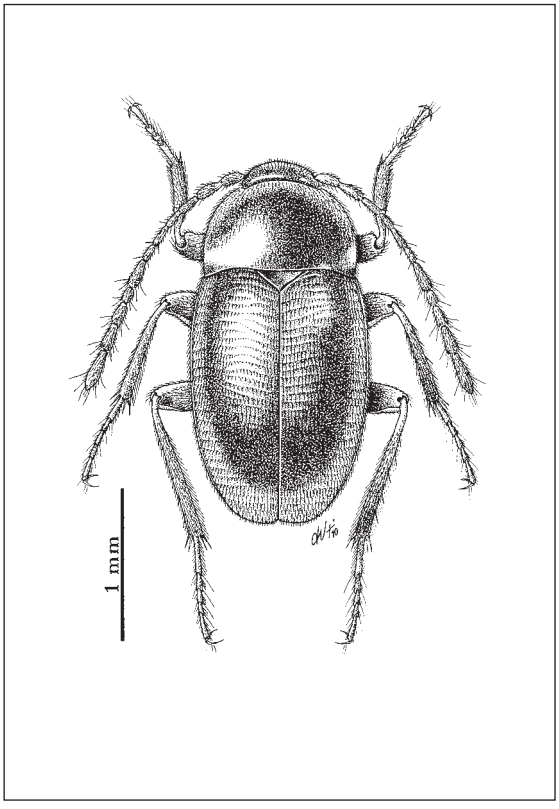

Fig. 14 *Aphaobius fortesculptus* ♂, habitus.

XI.2004, Kofler (CBKS); 3 ♂♂ 1 ♀, 15.VIII.1946, Pretner (CPDL); 1 ♂ 2 ♀♀, IV-VIII.1995, Kofler (CBKS, CMBT).

Diagnosis

A relatively small *Aphaobius* of the *milleri* group, generally affine to *A. kaplai*, but distinguishable from the latter by its more elongated elytra, as well as by the shape of its pronotum, which is sub-trapezoidal, less transverse and with sides less restricted at the anterior margin.

Description

Total length with the head deflexed: ♂♂ 2.72-2.92 mm; ♀♀ 2.90-3.04 mm. Body, legs and antennae brown.

Antennae short ($k(L_A)$: ♂♂ 0.76-0.80; ♀♀ 0.64-0.67), in males reaching the middle of the elytra when stretched backwards. 11th antennomere relatively stocky, 8th antennomere about 2.5 times shorter than the 7th.

Pronotum transverse (B_{Pmax}/L_P: ♂♂ 1.50-1.64; ♀♀ 1.58-1.67), with maximum width at the base (B_{Ppos}/B_{Pmax}: ♂♂ 0.99-1.00; ♀♀ 1.00). Sides regularly arcuate from the base to the anterior margin (B_{Pant}/B_{Pmax}: ♂♂ 0.50-0.52; ♀♀ 0.48-0.49). Hind angles acute, not pointed.

Elytra ovoid (L_E/B_E: ♂♂ 1.40-1.44; ♀♀ 1.33-1.37) with maximum width at about the middle (L_{Bemax}/L_E: ♂♂ 0.55-0.58; ♀♀ 051-058).

Legs relatively short and robust.

Aedeagus with the median lobe elongated. Distal part of the median lobe, in dorsal view, with subparallel sides up to the apex, then curved and converging to a largely rounded end. Ligules slightly diverging in dorsal view, pointed and inclined forward in lateral view. Proximal edge of the apical orifice concave. Parameres slightly shorter than the median lobe.

Distribution and ecology

A. fortesculptus is known only from Matjaževa jama (Figs. 37, 41), a sub-horizontal cave situated at the base of Šmarna gora near Ljubljana. From the geological point of view, this small mountain is a segregated karst spot of limestones, completely surrounded by alluvial deposits and sediments.

Aphaobius robustus Müller, 1914 n. stat.
(Figs. 15, 21, 22, 23, 24, 25, 26, 27, 28, 29, 33d, 37, 39)

Aphaobius heydeni robustus Müller, 1914: 1025
Aphaobius heydeni robustus Müller, 1914: Jeannel, 1924: 232
Aphaobius heydeni robustus Müller, 1914: Pretner, 1963: 63
Aphaobius heydeni robustus Müller, 1914: Pretner, 1968: 10

Type locality

Slovenia, Kamna Gorica, Jama pri Lipniški skali (Slovene Cave Cadastre No. 397)

Analysed material

Slovenia, Kamna Gorica, Jama pri Lipniški skali (Slovene Cave Cadastre No. 397): 1 ♂ Holotype, 16.IX.1914, Pretner (CMCSNT); 1 ♀, 18.VIII.1922, Pretner (CPDL); 1 ♀, 12.IV-4.IX.2002, Kahlen (CMKI); 1 ♀, 2.VI-15.VIII.2001, Kofler (CBKS); 1 ♀, 21.XII.2002-4.V.2003,

Kofler (CBKS); 1 ♀, 27.III-4.X.2004, Kofler (CBKS); 1 ♀, 4.V-28.VI.2003, Kofler (CBKS); 3 ♂♂ 16 ♀♀, 5.IV-7.IX.2002, Kofler (CBKS, CMBT); 1 ♂ 3 ♀♀, 7.IX-21.XII.2002, Kofler (CBKS).

Slovenia, Lipnica, Štoln nad Dobravskim mostom (not registered): 1 ♂, 11.VI.1936, Pretner (CPDL).

Diagnosis

A large *Aphaobius* of the *milleri* group, distinguishable from the other species of this group by its elongated and slender antennae, combined with the short elytra, with maximum width in way of the anterior third, as well as by the sub-trapezoidal pronotum, with maximum width at base and sides markedly narrowed toward the anterior margin.

Description

Total length with the head deflexed: ♂♂ 3.02-3.18 mm; ♀♀ 3.15-3.40 mm. Body, legs and antennae brown.

Antennae long ($k(L_A)$: ♂♂ 0.85-0.88; ♀♀ 0.69-0.74), in males reaching the apical third of the elytra when stretched backwards. 11th antennomere slender, 8th antennomere about twice shorter than the 7th.

Pronotum transverse (B_{Pmax}/L_P: ♂♂ 1.58-1.67; ♀♀ 1.65-1.75), with maximum width at the base (B_{Ppos}/B_{Pmax}: ♂♂ 1.00; ♀♀ 1.00). Sides regularly arcuate from the base to the anterior margin, which is clearly narrowed (B_{Pant}/B_{Pmax}: ♂♂ 0.47-0.49; ♀♀ 0.45-0.48). Hind angles acute, marked.

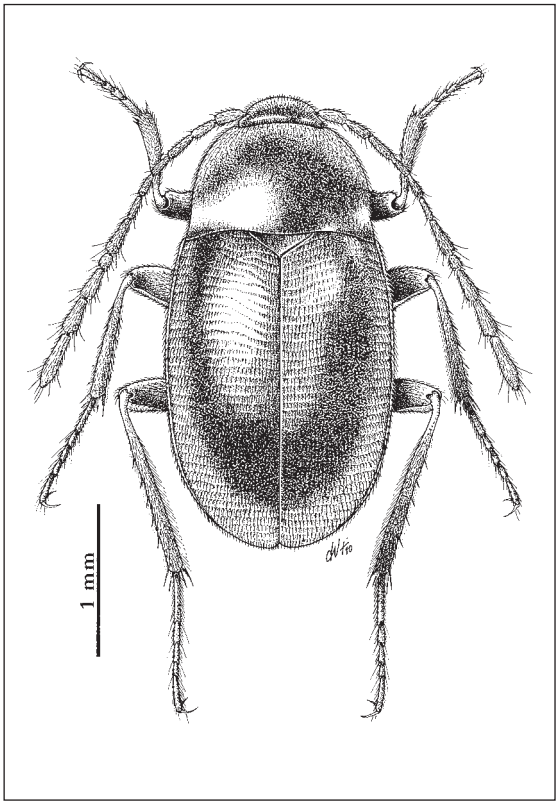

Fig. 15 *Aphaobius robustus* ♂, habitus.

Elytra ovoid, relatively short (L_E/B_E: ♂♂ 1.30-1.41; ♀♀ 1.27-1.31), with maximum width in way of the basal third (L_{Bemax}/L_E: ♂♂ 0.62-0.67; ♀♀ 0.57-0.63).

Legs long and slender.

Aedeagus with the median lobe elongated. Distal part of the median lobe, in dorsal view, with subparallel sides up to the apex, then curved and converging to a largely rounded end. Ligules slightly diverging in dorsal view, pointed and inclined forward in lateral view. Proximal edge of the apical orifice concave. Parameres as long as the median lobe.

Distribution and ecology

A. robustus is distributed in a restricted and geographically segregated region near the village of Lipnica (Kamna Gorica), where it has so far been recorded only in two small caves located within limestone rocks (Figs. 37, 39).

Aphaobius kahleni n. sp.
(Figs. 16, 21, 22, 23, 24, 25, 26, 27, 28, 29, 33e, 37, 38)

Type locality
Slovenia, Slap ob Idrijci, Krasnica (Slovene Cave Cadastre No. 806)

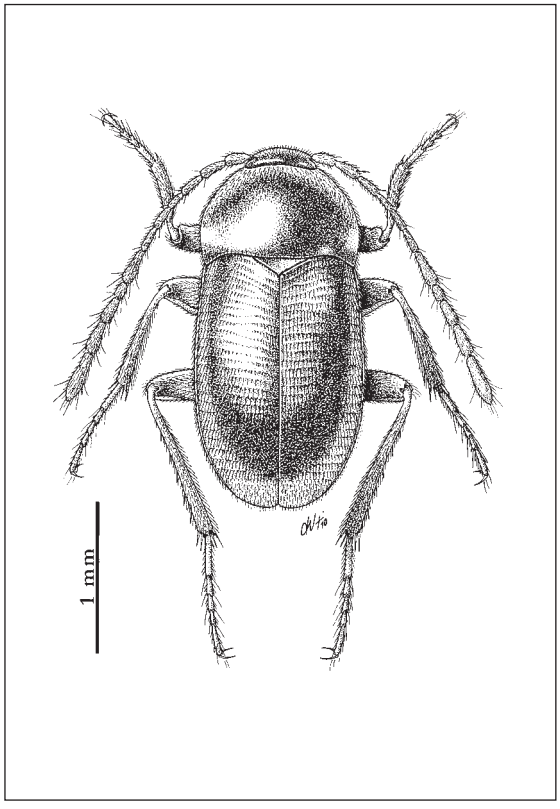

Fig. 16 *Aphaobius kahleni* ♂, habitus.

Type series
Holotype ♂:
Slovenia, Slap ob Idrijci, Krasnica (Slovene Cave Cadastre No. 806): 14.V-16.IX.1994, Egger & Kahlen (CPDL).
Paratypes:
Slovenia, Slap ob Idrijci, Krasnica (Slovene Cave Cadastre No. 806): 4 ♂♂ 7 ♀♀, 14.V-16.IX.1994, Egger & Kahlen (CMKI); 9 ♂♂ 14 ♀♀, 16.IX.1994-30.IV.1995, Egger & Kahlen (CMKI, CPDL, CMBT); 5 ♂♂ 8 ♀♀, V-VI.1995, Lebenbauer (CMKI); 6 ♂♂ 4 ♀♀, 7.V.1996, Martinelli (CAMR).
Slovenia, Slap ob Idrijci, Zidanica v Žlebeh (Slovene Cave Cadastre No. 805): 3 ♀♀, 31.X.1996, Bognolo (CMBT); 2 ♂♂, 7.V.1995, Bognolo (CMBT).

Diagnosis
A small *Aphaobius* of the *milleri* group, distinguishable by its more elongated antennae and by its 11th antennomere, which is slenderer than in other species of this group.

Description
Total length with the head deflexed: ♂♂ 2.65-2.88 mm; ♀♀ 2.75-2.95 mm. Body, legs and antennae brown-reddish.
Antennae very long ($k(L_A)$: ♂♂ 0.89-0.95; ♀♀ 0.73-0.76), in males reaching the apical third of the elytra when stretched backwards. 11th antennomere very long and slender, 8th antennomere about 2.5 times shorter than the 7th.
Pronotum clearly transverse (B_{Pmax}/L_P: ♂♂ 1.56-1.73; ♀♀ 1.63-1.80), with maximum width at the basal third, base narrower (B_{Ppos}/B_{Pmax}: ♂♂ 0.97-0.99; ♀♀ 0.98-1.00). Sides regularly arcuate anteriorly (B_{Pant}/B_{Pmax}: ♂♂ 0.47-0.49; ♀♀ 0.46-0.49), converging posteriorly. Hind angles acute, not pointed.
Elytra ovoid, clearly elongated (L_E/B_E: ♂♂ 1.43-1.50; ♀♀ 1.36-1.43) with maximum width at about the middle (L_{Bemax}/L_E: ♂♂ 0.53-0.60; ♀♀ 0.52-0.59).
Legs long and slender.
Aedeagus with the median lobe elongated. Distal part of the median lobe, in dorsal view, with subparallel sides up to the apex, then curved and converging to a largely rounded end. Ligules slightly diverging in dorsal view, pointed and inclined forward in lateral view. Proximal edge of the apical orifice slightly concave or straight. Parameres slightly shorter than the median lobe.

Etymology
The new species was named after the Austrian entomologist Manfred Kahlen from Innsbruck.

Distribution and ecology
A. kahleni n. sp. has so far been known only from two caves situated within a segregated karst area in the eastern part of Šentviška gora (Figs. 37, 38).

Aphaobius milleri (Schmidt, 1855)
(Figs. 17, 21, 22, 23, 24, 25, 26, 27, 28, 29, 34, 37)

Aphaobius milleri (Schmidt, 1855) = *Aphaobius milleri springeri* Müller, 1910 n. syn.
Aphaobius milleri (Schmidt, 1855) = *Aphaobius milleri grabowskii* Müller, 1917 n. syn.
Aphaobius milleri (Schmidt, 1855) = *Aphaobius milleri longipennis* Müller, 1931 n. syn.

Adelops milleri Schmidt, 1855: 3
Aphaobius milleri (Schmidt, 1855): Abeille de Perrin, 1878: 148
Aphaobius milleri (Schmidt, 1855): Reitter, 1885: 16
Aphaobius milleri (Schmidt, 1855): Ganglbauer, 1899: 95
Aphaobius milleri (Schmidt, 1855): Jeannel, 1911: 430
Aphaobius milleri (Schmidt, 1855): Müller, 1913: 4
Aphaobius milleri (Schmidt, 1855): Müller, 1914: 1021
Aphaobius milleri (Schmidt, 1855): Jeannel, 1924: 230
Aphaobius milleri (Schmidt, 1855): Pretner, 1968: 11
Aphaobius milleri (Schmidt, 1855): Pretner, 1973: 178
Aphaobius milleri springeri Müller, 1910: 185
Aphaobius milleri springeri Müller, 1910: Jeannel, 1911: 430
Aphaobius milleri springeri Müller, 1910: Müller, 1913: 5
Aphaobius milleri springeri Müller, 1910: Jeannel, 1924: 231
Aphaobius milleri springeri Müller, 1910: Pretner, 1968: 11
Aphaobius milleri grabowskii Müller, 1917: 624
Aphaobius milleri grabowskii Müller, 1917: Jeannel, 1924: 231
Aphaobius milleri grabowskii Müller, 1917: Pretner, 1968: 11
Aphaobius milleri longipennis Müller, 1931: 198
Aphaobius milleri longipennis Müller, 1931: Pretner, 1968: 11

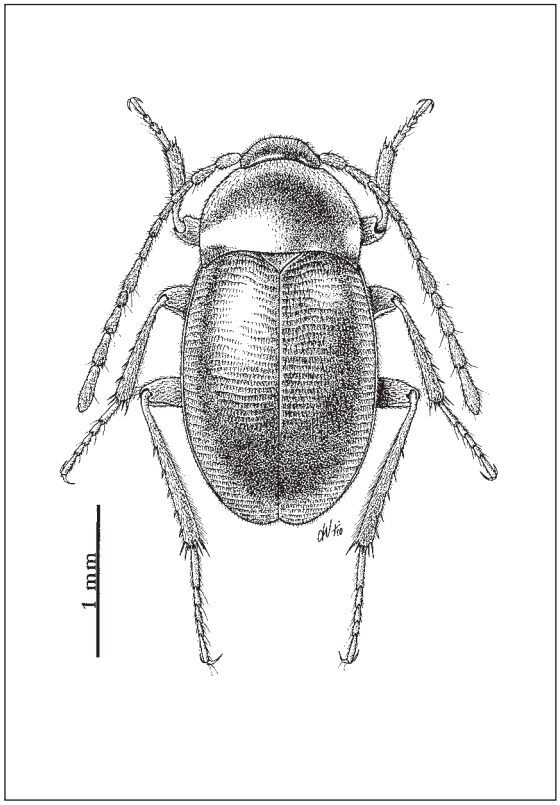

Fig. 17 *Aphaobius milleri* ♂, habitus.

Type locality

Slovenia, Gornji Ig, Velika Pasica (Slovene Cave Cadastre No. 75)

Analysed material

Slovenia, Gornji Ig, Velika Pasica (Slovene Cave Cadastre No. 75): 3 ♂♂ 1 ♀, 13.VII.1914, Gspan (CPDL); 2 ♂♂ 1 ♀, 27.VII.1914, Gspan (CPDL); 1 ♂, 2.IX.1918, Kuščer (CPDL); 1 ♀, 26.VII.1935, Pretner (CPDL); 9 ♂♂ 9 ♀♀, 9.IV.1968, Pretner (CPDL); 7 ♂♂ 10 ♀♀, 19.V.1992, Etonti (CMBT, CDVB); 4 ♂♂ 10 ♀♀, 8.II.1997, Bognolo (CMBT, CDVB); 7 ♂♂ 6 ♀♀, 27.III.1999, Bognolo (CMBT).

Slovenia, Iška vas, Benkotova jama (Slovene Cave Cadastre No. 325): 3 ♂♂ 7 ♀♀, 11.III.1934, Pretner (CPDL); 1 ♀, 25.II.1934, Pretner (CPDL).

Slovenia, Snežnik, Blatna jama na Zgornji Lenčajski cesti (Slovene Cave Cadastre No. 993): 1 ♀, 24.VI.1977, Pretner (CPDL); 1 ♂ 8 ♀♀, 24.VIII.1977, Pretner (CPDL).

Slovenia, Mokrec, Brezno na Skedenci (Slovene Cave Cadastre No. 353): 5 ♂♂ 4 ♀♀, 24.VI.1934, Pretner (CPDL); 2 ♂♂ 7 ♀♀, 9.X.1994, Etonti (CMBT).

Slovenia, Snežnik, Brezno pri Barki (Slovene Cave Cadastre No. 4272): 1 ♂ 1 ♀, 6.VI.2002, Polak (CNMP); 1 ♂ 2 ♀♀, 6.VII.2002, Polak (CNMP).

Slovenia, Prestranek, Brezno pri Pretrti jami (Slovene Cave Cadastre No. 894): 5 ♂♂ 5 ♀♀, 11.VIII.1952, Pretner (CPDL).

Slovenia, Blegoš, Brezen v Jelenjah (Slovene Cave Cadastre No. 2100): 5 ♂♂ 5 ♀♀, 5.VIII.2007-20.IX.2008, Zakrajšek & Kofler (CBKS).

Slovenia, Prestranek, Brezno v Lozi (Slovene Cave Cadastre No. 265): 1 ♂, 22.IV.1955, Pretner (CPDL).

Slovenia, Laze pri Planini, Brezno v Suhem vrhu (Slovene Cave Cadastre No. 3143): 1 ♂ 6 ♀♀, 10.XII.1967, Pretner (CPDL).

Slovenia, Orehek, Brlovka (Slovene Cave Cadastre No. 977): 6 ♂♂ 6 ♀♀, VII.1925, Pretner (CPDL); 5 ♀♀, 6.XII.1967, Pretner (CPDL).

Slovenia, Predgriže, Ciganska jama (Slovene Cave Cadastre No. 493): 1 ♂ 1 ♀, 31.VIII.1998, Bognolo (CMBT).

Slovenia, Postojna, Črna jama (Slovene Cave Cadastre No. 471): 3 ♂♂ 2 ♀♀, VII.1914, Pretner (CPDL); 4 ♂♂ 5 ♀♀, 17.IX.1949, Pretner (CPDL); 12 ♂♂ 12 ♀♀, 25.II.1998, Bognolo (CMBT).

Slovenia, Horjul, Divja jama v Zamelšah (Slovene Cave Cadastre No. 262): 1 ♂ (holotype of *A. milleri grabowskii* Müller, 1917), VII.1916 (MCSNT); 1 ♀ (paratype of *A. milleri grabowskii* Müller, 1917), VII.1916 (MCSNT); 1 ♂ 3 ♀♀, 19.VIII.1933, Pretner (CPDL); 1 ♀, 1.IX.1946, Pretner (CPDL); 15 ♂♂ 14 ♀♀, 7.XI.2004, Bognolo (CMBT).

Slovenia, Golobinka pri Borovnici (Slovene Cave Cadastre No. 753): 1 ♀, 1.IV.1918, Staudacher (CPDL).

Slovenia, Logatec, Gradišnica (Slovene Cave Cadastre No. 86): 1 ♂, 30.VII.1927, (CPDL); 1 ♂, 15.VIII.1934, Pretner (CPDL); 11 ♂♂ 7 ♀♀, 8.IV.1974, Kranjc (CPDL).

Slovenia, Košana, Jama 2 ob Košanski poti (Slovene Cave Cadastre No. 1568): 9 ♂♂ 9 ♀♀, 8.V.1963, Pretner (CPDL).

Slovenia, Veliki Otok, Jama Koliševka (Slovene Cave Cadastre No. 147): 2 ♂♂, 19.VI.1954, Pretner (CPDL); 8 ♂♂ 10 ♀♀, 9.VII.1954, Pretner (CPDL).

Slovenia, Podklanec, Jama na Pucovem Kuclu (Slovene Cave Cadastre No. 6908): 1 ♂ 1 ♀, VI.1992, Kofler (CBKS); 5 ♂♂ 6 ♀♀, 6.XI.1992, Kofler (CBKS); 1 ♂, III.1993, Kofler (CBKS).

Slovenia, Mokrec, Jama pri Riži (Slovene Cave Cadastre No. 358): 3 ♂♂ 5 ♀♀, 2.XII.1934, Pretner (CPDL).

Slovenia, Žiri, Jama pri Svetih Treh Kraljih (Slovene Cave Cadastre No. 541): 2 ♂♂ 1 ♀, V-IX.1992, Kofler (CBKS); 2 ♂♂ 2 ♀♀, IX-XI.1992, Kofler (CBKS); 1 ♂ 2 ♀♀, VI-IX.1993, Kofler (CBKS).

Slovenia, Prestranek, Jama Svetega Janeza pri Prestranku (Slovene Cave Cadastre No. 897): 4 ♂♂ 5 ♀♀, 11.VIII.1952, Pretner (CPDL); 6 ♂♂ 6 ♀♀, 23.VIII.1952, Pretner (CPDL).

Slovenia, Kočevje, Jama Treh Bratov pri Kočevju (Slovene Cave Cadastre No. 141): 1 ♂ (holotype of *A. milleri longipennis* Müller, 1931), Gspan (MCSNT); 1 ♀ (paratype of *A. milleri longipennis* Müller, 1931), Gspan (MCSNT); 1 ♂, Tax (MCSNT); 1 ♂ 2 ♀♀, Kodrič (CPDL); 1 ♂, 15.VI.1933, Pretner (CPDL); 1 ♀, 1937, Kodrič (CPDL); 3 ♂♂ 2 ♀♀, 16.V.1974, Schmid (CPDL); 7 ♂♂ 8 ♀♀, 24.VI.1994, Kahlen & Egger (CMKI); 9 ♂♂ 22 ♀♀, 1.VII.1994, Kahlen & Egger (CMKI).

Slovenia, Lesno brdo, Jama v Bukovju (Slovene Cave Cadastre No. 44): 1 ♀, 22.XII.1935, Pretner (CPDL); 2 ♀♀, 5.I.1936, Pretner (CPDL).

Slovenia, Ledine, Jama v globinah (Slovene Cave Cadastre No. 817): 2 ♀♀, 15.V.1976, Pretner (CPDL); 14 ♂♂ 28 ♀♀, 15.V.1977, Pretner (CPDL); 9 ♂♂ 9 ♀♀, 11.VII.1997, Bognolo (CMBT).

Slovenia, Orehek, Jama v lozi pri Orehku (Slovene Cave Cadastre No. 1659): 2 ♂♂ 1 ♀, 30.V.1962, Pretner (CPDL).

Slovenia, Prestranek, Jama v podorni vrtači pri Prestranku (Slovene Cave Cadastre No. 1039): 1 ♀, 2.V.1954, Žele (CPDL); 1 ♀, 17.VI.1954, Pretner (CPDL).

Slovenia, Todraž, Jama za Hudim lazom I (Slovene Cave Cadastre No. 2041): 1 ♀, 27.XII.1975, Pretner (CPDL); 6 ♂♂ 20 ♀♀, 8.I.1977, Pretner (CPDL).

Slovenia, Prestranek, Jernejeva jama (Slovene Cave Cadastre No. 929): 2 ♀♀, 18.XI.1951, Pretner (CPDL).

Slovenia, Ig, Kevderc pri Planinci (Slovene Cave Cadastre No. 525): 1 ♀, 9.IV.1968, Pretner (CPDL).

Slovenia, Hotedrščica, Kmetova jama (Slovene Cave Cadastre No. 1769): 1 ♀, 28.VII.1958, Pretner (CPDL).

Slovenia, Prestranek, Konjska jama (Slovene Cave Cadastre No. 925): 1 ♂ 3 ♀♀, 18.XI.1951, Pretner (CPDL).

Slovenia, Postojna, Kotova jama (Slovene Cave Cadastre No. 1608): 3 ♀♀, 27.V.1961, Pretner (CPDL); 7 ♂♂ 5 ♀♀, 16.VI.1961, Pretner (CPDL).

Slovenia, Lož, Križna jama (Slovene Cave Cadastre No. 65): 1 ♂ 1 ♀, 1935, Dolar (CPDL).

Slovenia, Kočevski rog, Ledena jama (Slovene Cave Cadastre No. 1301): 3 ♂♂ 31 ♀♀, 31.X.1967, Pretner (CPDL); 5 ♂♂ 9 ♀♀, 3.VI-10.VI.1995, Kahlen (CMKI).

Slovenia, Postojna, Ledena jama pod Magdaleno goro (Slovene Cave Cadastre No. 781): 10 ♂♂ 10 ♀♀, 20.IX.1949, Pretner (CPDL).

Slovenia, Kočevski rog, Ledena jama pri Kunču (Slovene Cave Cadastre No. 669): 1 ♀, XII.1939, Pretner (CPDL); 6 ♂♂ 5 ♀♀, 20.IX.1969, Pretner (CPDL); 4 ♂♂, 8.VI.1995, Kahlen & Egger (CMKI).

Slovenia, Snežnik, Ledenica pri Grdi jami (not registered): 2 ♀♀, 28.X.2002, Polak (CNMP).

Slovenia, Krim, Ledenica pri Planinci (Slovene Cave Cadastre No. 77): 2 ♂♂ 2 ♀♀, V.1916, Springer (CPDL); 3 ♀♀, 4.V.1968, Pretner (CPDL).

Slovenia, Logaška planota, Lenarčičeva jama 1 (Slovene Cave Cadastre No. 657): 2 ♂♂ 5 ♀♀, 9.VI.1998, Bognolo (CMBT).

Slovenia, Laze pri Planini, Mačkovica (Slovene Cave Cadastre No. 52): 1 ♀, 1.IX.1928, Pretner (CPDL); 1 ♀, 26.IV.1939, Eržen (CPDL); 13 ♂♂ 5 ♀♀, 11.VIII.1957, Pretner (CPDL); 1 ♂ 6 ♀♀, 11.X.1978, Pretner (CPDL); 1 ♂, 28.V.1992, Bognolo (CMBT).

Slovenia, Kočevje, Mala Knežja jama (Slovene Cave Cadastre No. 667): 3 ♂♂ 4 ♀♀, XII.1939, Pretner (CPDL).

Slovenia, Gornji Ig, Mala Pasica (Slovene Cave Cadastre No. 76): 1 ♀, 11.III.1934, Pretner (CPDL).

Slovenia, Prestranek, Markandelov spodmol (Slovene Cave Cadastre No. 1074): 7 ♂♂ 7 ♀♀, 21.V.1955, Pretner (CPDL).

Slovenia, Žiri, Matjaževe kamre (Slovene Cave Cadastre No. 672): 2 ♂♂, VI-X.1990, Kofler (CBKS); 3 ♂♂ 5 ♀♀, VI-X.1991, Kofler (CBKS).

Slovenia, Hleviše, Mravljetovo brezno v Gošarjevih rupah (Slovene Cave Cadastre No. 7400): 1 ♂, IV-IX.1994, Kofler (CBKS); 1 ♂, 30.III-31.X.1996, Kofler (CBKS); 1 ♂ 4 ♀♀, 31.X.1996-12. IV.1997, Kofler (CBKS); 1 ♂, 12.IV-17.X.1997, Kofler (CBKS).

Slovenia, Košana, Neverški spodmol (Slovene Cave Cadastre No. 956): 5 ♂♂ 7 ♀♀, 18.IV.1963, Pretner (CPDL).

Slovenia, Prestranek, Ovčja jama (Slovene Cave Cadastre No. 889): 5 ♂♂ 5 ♀♀, 11.VIII.1952, Pretner (CPDL); 1 ♀, 9.XI.1952, Žele (CPDL).

Slovenia, Horjul, Pavletova jama (Slovene Cave Cadastre No. 3171): 2 ♀♀, 27.III.1977, Pretner (CPDL); 1 ♂ 2 ♀♀, 27.IV.1977, Pretner (CPDL).

Slovenia, Postojna, Pekel 1 pri Ponikvah (Slovene Cave Cadastre No. 1037): 1 ♂, 12.V.1954, Pretner (CPDL); 9 ♂♂ 10 ♀♀, 17.VI.1954, Pretner (CPDL).

Slovenia, Brestovica pri Povirju, Petnjak (Slovene Cave Cadastre No. 952): 1 ♂ (holotype of *A. milleri springeri* Müller, 1910), X.1909, Müller (CMCSNT); 3 ♂♂ 2 ♀♀ (paratypes of *A. milleri springeri* Müller, 1910), X.1909, Müller (CMCSNT); 3 ♂♂ 1 ♀, X.1925, Pretner (CPDL); 3 ♂♂ 3 ♀♀, 11.VI.1992, Bognolo (CMBT); 14 ♂♂ 9 ♀♀, 23.IX.1995, Bognolo (CMBT); 3 ♂♂ 5 ♀♀, 9.IV.1996, Kahlen (CMKI).

Slovenia, Orehek, Pivka jama pri Orehku (Slovene Cave Cadastre No. 961): 2 ♂♂ 2 ♀♀, 24.III.1929, Pretner (CPDL); 9 ♂♂ 9 ♀♀, 29.IV.1962, Pretner (CPDL).

Slovenia, Polhov gradec, Riharjev kogel (Slovene Cave Cadastre No. 336): 1 ♀, 29.IV.1934, Pretner (CPDL).

Slovenia, Prestranek, Strmi spodmol (Slovene Cave Cadastre No. 899): 5 ♂♂ 6 ♀♀, 23.VIII.1952, Pretner (CPDL).

Slovenia, Petkovec, Turkova jama (Slovene Cave Cadastre No. 41): 1 ♂, 27.X.1935, Pretner (CPDL); 6 ♂♂ 6 ♀♀, 27.XII.1936, Pretner (CPDL); 1 ♀, I.1937, Eržen (CPDL); 1 ♂, 18.V.1994, Bognolo (CMBT).

Slovenia, Dobec, Ulenca (Slovene Cave Cadastre No. 602): 2 ♀♀, 20.IV.1961, Pretner (CPDL); 2 ♂♂ 6 ♀♀, 22.X.1967, Pretner (CPDL); 12 ♂♂ 12 ♀♀, 3.XI.1996, Bognolo (CMBT).

Slovenia, Kočevski rog, Ušiva jama (doline, not registered): 1 ♂ 2 ♀♀, 5.VI.1995, Kahlen (CMKI).

Slovenia, Verd, Velika jama za Široko Mlako (Slovene Cave Cadastre No. 82): 2 ♀♀, 19.VI.1927, (CPDL).

Slovenia, Košana, Vodna jama v Lozi (Slovene Cave Cadastre No. 911): 1 ♀, 23.XI.1952, Pretner (CPDL).

Slovenia, Nanos, Volčja jama (Slovene Cave Cadastre No. 743): 1 ♂ 3 ♀♀, 10.VIII.1949, Pretner (CPDL); 1 ♂ 7 ♀♀, 24.V.1965, Pretner (CPDL); 2 ♂♂ 3 ♀♀, 17.V.1992, Bognolo (CMBT); 2 ♂♂ 2 ♀♀, 28.V.1992, Bognolo (CMBT); 8 ♀♀, 18.X.2003, Bognolo (CMBT).

Slovenia, Orehek, Žegnana jama (Slovene Cave Cadastre No. 960): 1 ♂, VIII.1924, Pretner (CPDL); 2 ♂♂, 10.III.1929, Pretner (CPDL); 3 ♂♂ 4 ♀♀, 24.III.1929, Pretner (CPDL); 5 ♂♂ 5 ♀♀, 29.IV.1962, Pretner (CPDL); 1 ♂ 1 ♀, 4.VIII.1978, Pretner (CPDL).

Croatia, Istra, Dane, Novačka pečina: 1 ♂ 3 ♀♀, 30.VI.1968, Pretner (CPDL); 1 ♀, 30.X.1989, Etonti (CMBT); 4 ♀♀, 23.V-14.VI.1970 (CHPMZ).

Croatia, Gorski Kotar, Gerovo, Lazac, Jama Štemajzlinka: 1 ♂, 3.VIII.2003, Ozimec (CHPMZ).

Croatia, Žumberačka gora, Sošice, Jezernice, Jama Pušina: 5 ♂♂ 3 ♀♀, 19.VII.1998-28.XI.1999, Rubinić (CHPMZ); 1 ♂, 30.XI.2002, Ozimec & Rubinić (CHPMZ).

Additional material examined (not measured)

Slovenia, Postojna, Črna jama (Slovene Cave Cadastre No. 471): 3 exx., 5.VI.1987, (CPMGT); 112 exx., 5.VII.1987, Nicoli (CMGB); 3 exx., 6.VII.1986, Nicoli (CMGB); 2 exx., Haucke (CPMGT); 5 exx., 17.IX.1949, Pretner (CPMGT).

Slovenia, Košana, Jama 2 ob Košanski poti (Slovene Cave Cadastre No. 1568): 8 exx., 8.V.1963, Pretner (CPMGT).

Slovenia, Veliki Otok, Jama Koliševka (Slovene Cave Cadastre No. 147): 6 exx., 9.VII.1954, Pretner (CPMGT).

Slovenia, Podklanec, Jama na Pucovem Kuclu (Slovene Cave Cadastre No. 6908): 2 exx., VI.1992, Kofler (CBKS); 4 exx., VI-XI.1992, Kofler (CBKS); 2 exx., III.1993, Kofler (CBKS).

Slovenia, Mokrec, Jama pri Riži (Slovene Cave Cadastre No. 358): 1 ex., 9.XII.1934, (CMGB).

Slovenia, Žiri, Jama pri Svetih Treh Kraljih (Slovene Cave Cadastre No. 541): 7 exx., III.1993, Kofler (CBKS).

Slovenia, Kočevje, Jama Treh Bratov pri Kočevju (Slovene Cave Cadastre No. 141): 2 exx., 2.V-15.VII.2000, Malinka (CMGB, CDVB); 2 exx., 7.VII-1.XI.2002, Malinka (CMGB); 3 exx., 24.VI-1.XI.2001, Malinka (CMGB).

Slovenia, Ig, Kevderc pri Planinci (Slovene Cave Cadastre No. 525): 2 exx., 4.V.1968, (CPMGT).

Slovenia, Postojna, Ledena jama pod Magdaleno goro (Slovene Cave Cadastre No. 781): 7 exx., Pretner (CPMGT).

Slovenia, Kočevski rog, Ledena jama pri Kunču (Slovene Cave Cadastre No. 669): 9 exx., 17.VIII.1996, Comotti (CPMGT); 2 exx., 20.IX.1969, Drovenik (CPMGT).

Slovenia, Krim, Ledenica pri Planinci (Slovene Cave Cadastre No. 77): 2 exx., 12.V.1916, (CMCSNT); 1 ex., 10.IV.1912, Gspan (CMCSNT); 1 ex., 10.IX.1911, Gspan (CMCSNT).

Slovenia, Postojna, Magdalena jama (Slovene Cave Cadastre No. 820): 1 ex., (CPMGT).

Slovenia, Žiri, Matjaževe kamre (Slovene Cave Cadastre No. 672): 2 exx., VI.1990, Kofler (CBKS); 5 exx., VI-X.1990, Kofler (CBKS); 3 exx., VI-X.1991, Kofler (CBKS).

Slovenia, Hleviše, Mravljetovo brezno v Gošarjevih rupah (Slovene Cave Cadastre No. 7400): 4 exx., IV-IX.1994, Kofler (CBKS); 1 ex., X.1995-III.1996, Kofler (CBKS); 1 ex., 30.III-31.X.1996, Zakrajšek (CBKS); 4 exx., 31.X.1996-12.IV.1997, Kofler (CBKS).

Slovenia, Brestovica pri Povirju, Petnjak (Slovene Cave Cadastre No. 952): 2 exx., VI.1920, (CMCSNT); 3 exx., X.1921, (CMCSNT); 7 exx., 11.VI.1992, Bognolo (CPMGT); 1 ex., 22.V.1966, Drioli (CPMGT); 18 exx., 22.V.1966, Drioli (CMGB); 3 exx., 22.V.1966, Drioli (CDVB).

Slovenia, Orehek, Pivka jama pri Orehku (Slovene Cave Cadastre No. 961): 4 exx., 21.VI.1986, Nicoli (CMGB).

Slovenia, Gornji Ig, Velika Pasica (Slovene Cave Cadastre No. 75): 1 ex., 1.VII.1914, Gspan (MCSNT); 1 ex., 17.VII.1914, Gspan (MCSNT); 1 ex., 25.X.1970, Schmid (CPMGT); 1 ex., 21.X.1973, Schmid (CPMGT); 4 exx., 19.V.1992, Etonti (CMGB); 2 exx., 7.VIII.1990, Kofler (CMGB); 3 exx., 8.II.1997, Bognolo (CDVB).

Slovenia, Nanos, Volčja jama (Slovene Cave Cadastre No. 743): 2 exx., V.1898, Penecke (CMCSNT); 2 exx., 8.VIII.1993, Gasparo (CPMGT).

Slovenia, Orehek, Žegnana jama (Slovene Cave Cadastre No. 960): 18 exx., 31.V.1992, Gasparo (CPMGT).

Croatia, Istra, Dane, Novačka pečina: 2 exx., 30.X.1989, Etonti (CPMGT).

Diagnosis

A medium sized *Aphaobius* of the *milleri* group, generally affine to *A. kahleni*, but distinguishable from the latter by the slightly larger size and shorter antennae, with the 11th antennomere less slender, and the pronotum less transverse.

Description

Total length with the head deflexed: ♂♂ 2.71-3.05 mm; ♀♀ 2.82-3.22 mm. Body, legs and antennae brown.

Antennae long ($k(L_A)$: ♂♂ 0.82-0.89; ♀♀ 0.66-0.73), in males reaching the middle of the elytra when stretched backwards. 11th antennomere long and slender, 8th antennomere about 2.5 times shorter than the 7th.

Pronotum transverse (B_{Pmax}/L_P: ♂♂ 1.49-1.62; ♀♀ 1.54-1.68), with maximum width at the basal third, base narrower (B_{Ppos}/B_{Pmax}: ♂♂ 0.95-0.98; ♀♀ 0.96-0.99). Sides regularly arcuate and narrowed anteriorly (B_{Pant}/B_{Pmax}: ♂♂ 0.49-0.53; ♀♀ 0.47-0.51), converging posteriorly. Hind angles acute, not pointed.

Elytra ovoid, elongated (L_E/B_E: ♂♂ 1.40-1.50; ♀♀ 1.34-1.43) with maximum width at about the middle (L_{Bemax}/L_E: ♂♂ 0.55-0.63; ♀♀ 0.55-0.62).

Legs relatively long and slender.

Aedeagus with the median lobe elongated. Distal part of the median lobe, in dorsal view, with subparallel sides up to the apex, then curved and converging to a largely rounded end. Ligules slightly diverging in dorsal view, pointed and inclined forward in lateral view. Proximal edge of the apical orifice slightly concave or straight. Parameres as long as the median lobe.

Distribution and ecology

A. milleri is spread over a very large area (Fig. 37), extending from the surroundings of Ljubljana southwards to the northern regions of Croatia (Istra, Gorski Kotar, Žumberačka gora). The species is normally found in caves, potholes and, occasionally, in the subterranean superficial environment. The associated cave fauna includes various species of the genus *Anophthalmus* Sturm, 1844, as well as *Typhlotrechus bilimeki* s.l. and the leptodirinae of the genera *Bathyscimorphus* Jeannel, 1910, *Oryotus* Miller, 1856, *Leptodirus* Schmidt, 1832, and *Astagobius* Reitter, 1886.

Aphaobius ljubnicensis Müller, 1914 n. stat.
(Figs. 18, 21, 22, 23, 24, 25, 26, 27, 28, 29, 35a, 37, 40)

Aphaobius milleri ljubnicensis Müller, 1914: 1024
Aphaobius milleri ljubnicensis Müller, 1914: Jeannel, 1924: 231
Aphaobius milleri lubnicensis Müller, 1914: Pretner, 1968: 11

Type locality
Slovenia, Škofja Loka, Kevderca na Lubniku (Slovene Cave Cadastre No. 3)

Analysed material
Slovenia, Škofja Loka, Kevderca na Lubniku (Slovene Cave Cadastre No. 3): 1 ♀ Holotype, 12.V.1912, Gspan (CMCSNT); 1 ♀ Paratype, 12.V.1912, Gspan (CMCSNT); 1 ♀ Paratype, 16.V.1912, Gspan (CMCSNT); 2 ♂♂, 23.V.1914, Gspan (CMCSNT); 1 ♀, 29.VIII.1922, Pretner (CPDL); 2 ♂♂ 2 ♀♀, 1.IX.1922, Pretner (CPDL); 3 ♂♂ 3 ♀♀, 23.II.1936, Pretner (CPDL); 22 ♂♂ 11 ♀♀, 8. II.1976, Pretner (CPDL); 1 ♂ 1 ♀, 31.VIII.1984, Mixanig (CMKI); 2 ♂♂ 2 ♀♀, 4.IV.1993,

Etonti (CMBT); 15 ♂♂ 19 ♀♀, 4.VI.1993, Cej & Vrezec (CMBT); 12 ♂♂ 7 ♀♀, 23.V.1999, Bognolo (CMBT).

Additional material examined (not measured)

Slovenia, Škofja Loka, Kevderca na Lubniku (Slovene Cave Cadastre No. 3): 7 exx., 2.X.1916, (CMCSNT); 1 ex., 12.VI.1983, Kofler (CBKS); 3 exx., II.1989, Kofler (CBKS); 5 exx., VII.1989, Kofler (CBKS, CMGB); 1 ex., VII-X.1991, Kofler (CBKS); 1 ex., Hicker (CPMGT); 2 exx., VII.1959, Pretner (CPMGT); 1 ex., 23.IV.1927, Gspan (CPMGT); 1 ex., (CPMGT); 3 exx., I.1976, Broder (CPMGT); 36 exx., 10.IV-6.IX.1998, Kahlen (CPMGT); 7 exx., 4.IV.93, Etonti (CMGB); 1 ex., 21.VIII.1922, Pretner (CMGB); 3 exx., 27.VIII.1922, Pretner (CMCSNT); 2 exx., 1.IX.1922, Pretner (CMCSNT); 1 ex., 14.IV.1993, Vrezec (CMGB); 8 exx., 23.V.1999, Bognolo (CDVB).

Slovenia, Škofja Loka, Lubniška jama (Slovene Cave Cadastre No. 4): 3 exx., VI.1985, Kofler (CBKS); 2 exx., VIII.1987, Kofler (CBKS); 3 exx., VII.1989, Kofler (CBKS).

Slovenia, Škofja Loka, Brezno na Malem Lubniku (Slovene Cave Cadastre No. 7274): 12 exx., 16.VI.1996-2.II.1997, Kofler (CBKS).

Slovenia, Škofja Loka, Maužarjeva jama (Slovene Cave Cadastre No. 8052): 4 exx., 12.V-15. VIII.2001, Kofler (CBKS).

Diagnosis

A medium-large sized *Aphaobius* of the *milleri* group, generally affine to *A. milleri*, but distinguishable from the latter by its more elongated antennae, with the 11th antennomere relatively

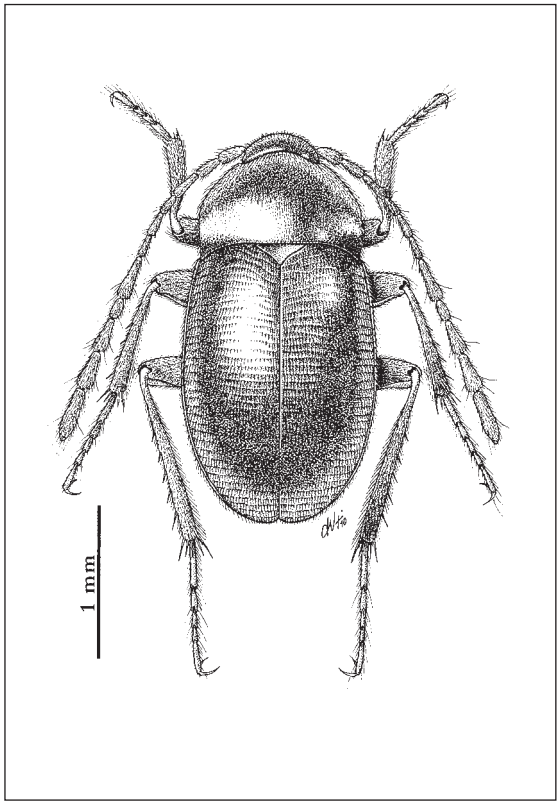

Fig. 18 *Aphaobius ljubnicensis* ♂, habitus.

shorter with respect to the total length of the antenna, as well as the pronotum sub-trapezoidal and less transverse.

Description

Total length with the head deflexed: ♂♂ 2.92-3.10 mm; ♀♀ 3.07-3.18 mm. Body, legs and antennae brown.

Antennae long ($k(L_A)$: ♂♂ 0.86-0.92; ♀♀ 0.69-0.73), in males reaching the apical third of the elytra when stretched backwards. 11th antennomere long and slender, 8th antennomere about 2.5 times shorter than the 7th.

Pronotum transverse, sub-trapezoidal (B_{Pmax}/L_P: ♂♂ 1.44-1.53; ♀♀ 1.52-1.63), with maximum width at base (B_{Ppos}/B_{Pmax}: ♂♂ 0.98-1.00; ♀♀ 0.98-1.00). Sides regularly arcuate anteriorly (B_{Pant}/B_{Pmax}: ♂♂ 0.51-0.53; ♀♀ 0.48-0.51). Hind angles acute, sometimes slightly pointed.

Elytra ovoid, clearly elongated (L_E/B_E: ♂♂ 1.40-1.51; ♀♀ 1.37-1.42) with maximum width at about the middle (L_{Bemax}/L_E: ♂♂ 0.54-0.61; ♀♀ 0.55-0.61).

Legs long and slender.

Aedeagus with the median lobe elongated. Distal part of the median lobe, in dorsal view, with subparallel sides to the apex, then curved and converging to a largely rounded end. Ligules slightly diverging in dorsal view, pointed and inclined forward in lateral view. Proximal edge of the apical orifice concave. Parameres as long as the median lobe.

Distribution and ecology

A. ljubnicensis has been found only in the caves of Mt Lubnik near Škofja Loka, in a restricted area lying within limestones and dolomitic limestones (Figs. 37, 40). The associated cave fauna includes the carabidae *Anophthalmus alphonsi ljubnicensis* (Müller, 1914), *Anophthalmus bohiniensis nonveilleri* Scheibel, 1933, and *Orotrechus globulipennis* Schaum, 1860

Aphaobius kofleri n. sp.
(Figs. 19, 21, 22, 23, 24, 25, 26, 27, 28, 29, 35b, 37, 40)

Type locality
Slovenia, Železniki, Rudnik pri Graparju (not registered)

Type series
Holotype ♂:
Slovenia, Železniki, Rudnik pri Graparju (not registered): 20.VIII.1985, Kofler (CPDL).
Paratypes:
Slovenia, Železniki, Rudnik pri Graparju (not registered): 2 ♀♀, V.1984, Kofler (CBKS); 2 ♂♂ 3 ♀♀, 20.VIII.1985, Kofler (CBKS); 3 ♀♀, 27.V.1988, Kofler (CBKS); 2 ♂♂ 4 ♀♀, VI.1988, Kofler (CBKS); 2 ♂♂ 1 ♀, 21.VII.1988, Kofler (CBKS); 30 ♂♂ 37 ♀♀, 11.IV-5.IX.1998, Kahlen (CMKI, CMBT).

Slovenia, Železniki, Rudnik Bela Njiva (not registered): 2 ♂♂ 4 ♀♀, 20.VI.1983, Kofler (CBKS); 1 ♂ 5 ♀♀, 20.VIII.1985, Kofler (CBKS); 1 ♂, V.1986, Kofler (CBKS); 12 ♀♀, 10.VI.1988, Kofler (CBKS); 1 ♀, 19.VI-10.VIII.1996, Kofler (CBKS); 2 ♂♂ 2 ♀♀, 10.VIII.1996-16.III.1997, Kofler (CBKS, CMBT); 1 ♂ 1 ♀, 16.III-11.VII.1997, Kofler (CBKS, CMBT).

Slovenia, Železniki, Rudnik na Vancovcu (not registered): 4 ♂♂ 2 ♀♀, IV-XII.1995, Kofler (CBKS, CMBT); 4 ♂♂ 3 ♀♀, 19.IV-10.VIII.1996, Kofler (CBKS); 2 ♀♀, 14.III-11.VII.1997, Kofler (CBKS); 2 ♂♂ 3 ♀♀, 13.III-21.IX.1998, Kofler (CBKS, CMBT).

Slovenia, Železniki, Rudnik nad Smolevo (not registered): 1 ♂ 2 ♀♀, 19.IV-10.VIII.1996, Kofler (CBKS); 4 ♂♂ 3 ♀♀, 13.III-21.IX.1998, Kofler (CBKS).

Slovenia, Železniki, Štoln na grebenu Špika (not registered): 1 ♂ 3 ♀♀, 19.IV-10.VIII.1996, Kofler (CBKS); 1 ♂, 10.VIII.1996-14.III.1997, Kofler (CBKS).

Slovenia, Kranj, Stražišče, Zaklonišče Tekstilindusa (not registered): 1 ♂, 22.XII.2008-15.VI.2009, Kofler (CMBT); 2 ♂♂ 2 ♀♀, 15.VI-22.VII.2009, Kofler (CMBT); 3 ♂♂, 22.VII-10.IX.2009, Kofler (CMBT).

Diagnosis

A medium sized *Aphaobius* of the *milleri* group, generally affine to *A. milleri*, but distinguishable from the latter by its less elongated elytra, the sub-trapezoidal pronotum and the 11th antennomere, which is relatively shorter with respect to the total length of the antenna.

Description

Total length with the head deflexed: ♂♂ 2.78-3.10 mm; ♀♀ 2.87-3.24 mm. Body, legs and antennae brown.

Antennae long (k(L_A): ♂♂ 0.83-0.87; ♀♀ 0.66-0.69), in males reaching the middle of the elytra when stretched backwards. 11th antennomere long and slender, 8th antennomere about 2.5 times shorter than the 7th.

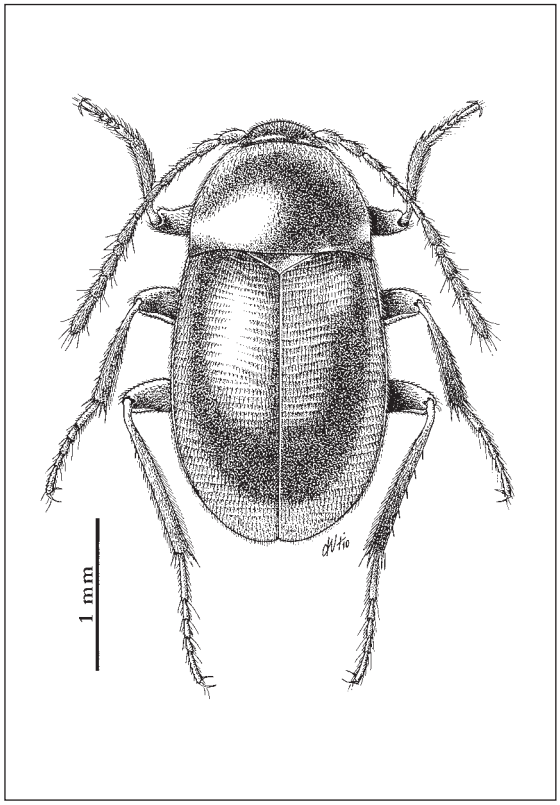

Fig. 19 *Aphaobius kofleri* ♂, habitus.

Pronotum transverse (B_{Pmax}/L_p: ♂♂ 1.50-1.63; ♀♀ 1.55-1.67), with maximum width at the basal fourth, base slightly narrower (B_{Ppos}/B_{Pmax}: ♂♂ 0.97-1.00; ♀♀ 0.99-1.00). Sides regularly arcuate anteriorly (B_{Pant}/B_{Pmax}: ♂♂ 0.49-0.52; ♀♀ 0.48-0.50). Hind angles acute, not pointed.

Elytra ovoid (L_E/B_E: ♂♂ 1.40-1.44; ♀♀ 1.30-1.37), with maximum width at about the middle (L_{Bemax}/L_E: ♂♂ 0.52-0.57; ♀♀ 0.51-0.59).

Legs relatively long and slender.

Aedeagus with the median lobe elongated. Distal part of the median lobe, in dorsal view, with subparallel sides up to the apex, then curved and converging to a largely rounded end. Ligules slightly diverging in dorsal view, pointed and inclined forward in lateral view. Proximal edge of the apical orifice concave. Parameres as long as the median lobe.

Etymology

The new species was named after the Slovene entomologist Bojan Kofler from Škofja Loka.

Distribution and ecology

A. kofleri n. sp. has so far been known only from old abandoned manganese mines within conglomerate and limestone rocks in the small mountains south of Železniki (Figs. 37, 40). The associated cave fauna includes the carabid beetle *Anophthalmus alphonsi skofjeloscensis* Daffner, 1996.

Aphaobius alphonsi Müller, 1914 n. stat.
(Figs. 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 35c, 37, 41)

Aphaobius milleri alphonsi Müller, 1914: 1023
Aphaobius milleri alphonsi Müller, 1914: Jeannel, 1924: 231
Aphaobius milleri alphonsi Müller, 1914: Pretner, 1968: 10

Type locality
Slovenia, Goričane, Babja luknja (Slovene Cave Cadastre No. 35)

Analysed material
Slovenia, Goričane, Babja luknja (Slovene Cave Cadastre No. 35): 1 ♂ Holotype, 6.IV.1902, Gspan (CMCSNT); 1 ♀ Paratype, 7.III.1912, Gspan (CMCSNT); 1 ♀, 8.IV.1916, Springer (CMCSNT); 1 ♀, 1.VI.1916, Springer (CMCSNT); 2 ♀♀, 10.VII.1917, (CMCSNT); 2 ♀♀, 5.VI.1933, Pretner (CPDL); 1 ♂, 4.II.1934, Pretner (CPDL); 6 ♂♂, 18.II.1934, Pretner (CPDL); 1 ♂ 3 ♀♀, 7.IV.1992, Etonti (CMBT); 12 ♂♂ 12 ♀♀, 24.X.1998, Kofler (CMBT); 11 ♂♂ 6 ♀♀, 17.III.1999, Kofler (CMBT, CDVB).

Slovenia, Babni Dol, Jama 1 v Jurčetovih Percah (Slovene Cave Cadastre No. 366): 1 ♂ 1 ♀, 31.V.1934, Pretner (CPDL); 1 ♀, 19.VII.1980, Novak (CPDL).

Slovenia, Medvode, Jama na Kravjeku (Slovene Cave Cadastre No. 586): 4 ♂♂ 4 ♀♀, 16.IX.2000-6.IV.2001, Kofler (CBKS).

Additional material examined (not measured)

Slovenia, Goričane, Babja luknja (Slovene Cave Cadastre No. 35): 9 exx., 31.I-19.II.1998, Kofler (CBKS); 3 exx., 22.V-18.VIII.1998, Kofler (CBKS); 6 exx., 17.III.1999, Kofler (CDVB); 1 ex., 8.IV-8.VIII.2000, Kofler (CPMGT).

Slovenia, Medvode, Jama na Kravjeku (Slovene Cave Cadastre No. 586): 8 exx., 16.IX.2000-6. IV.2001, Kofler (CBKS).

Diagnosis

A medium-small sized *Aphaobius* of the *milleri* group, generally affine to *A. milleri* and *A. kofleri*, but distinguishable from these species by the shape of pronotum, which is clearly sub-trapezoidal, less transverse and less restricted at the anterior margin, as well as by its less elongated elytra.

Description

Total length with the head deflexed: ♂♂ 2.65-2.95 mm; ♀♀ 2.78-3.20 mm. Body, legs and antennae brown.

Antennae long ($k(L_A)$: ♂♂ 0.84-0.88; ♀♀ 0.67-0.72), in males reaching the middle of the elytra when stretched backwards. 11th antennomere long and slender, 8th antennomere almost 3 times shorter than the 7th.

Pronotum transverse (B_{Pmax}/L_P: ♂♂ 1.42-1.50; ♀♀ 1.54-1.62), with maximum width at the base (B_{Ppos}/B_{Pmax}: ♂♂ 0.99-1.00; ♀♀ 1.00). Sides regularly arcuate from the base to the anterior margin (B_{Pant}/B_{Pmax}: ♂♂ 0.52-0.56; ♀♀ 0.49-0.52). Hind angles acute, not pointed.

Elytra ovoid (L_E/B_E: ♂♂ 1.37-1.41; ♀♀ 1.29-1.35), with maximum width at about the middle (L_{Bemax}/L_E: ♂♂ 0.54-0.58; ♀♀ 0.53-0.58).

Legs relatively long and slender.

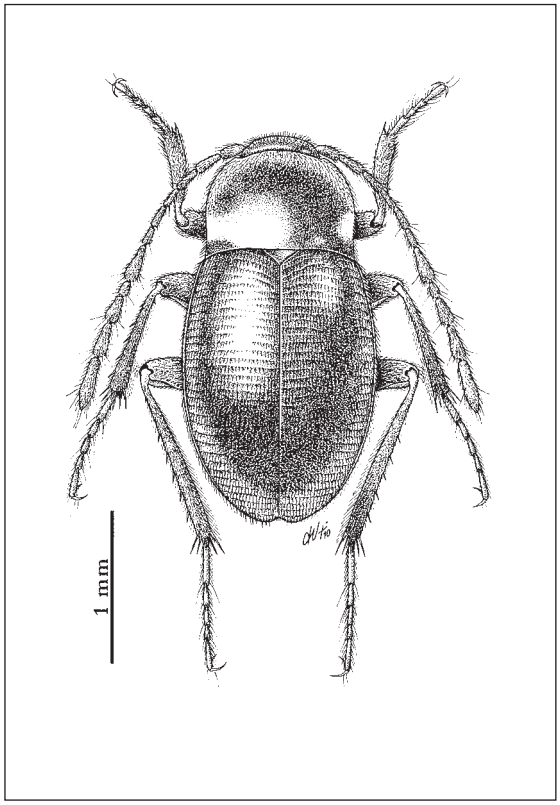

Fig. 20 *Aphaobius alphonsi* ♂, habitus.

Aedeagus with the median lobe elongated. Distal part of the median lobe, in dorsal view, with subparallel sides up to the apex, then curved and converging to a largely rounded end. Ligules slightly diverging in dorsal view, pointed and inclined forward in lateral view. Proximal edge of the apical orifice concave. Parameres as long as the median lobe.

Distribution and ecology

A. alphonsi has been known from small sub-horizontal caves located in a restricted area of limestone rocks near Medvode (Ljubljana), on the orographical right side of the river Sava (Figs. 37, 41).

Overview list of the genus *Aphaobius*

The following list provides a quick reference summary of all designated species of the genus *Aphaobius*, reporting the recognised synonyms and the modifications of taxonomic status.

1) *A. alphonsi* Müller, 1914 n. stat.
= *A. milleri alphonsi* Müller, 1914
2) *A. angusticollis* n. sp.
3) *A. brevicornis* Mandl, 1940 n. stat.
= *A. milleri brevicornis* Mandl, 1940
4) *A. forojulensis* Müller, 1931 n. stat.
= *A. milleri forojulensis* Müller, 1931
5) *A. fortesculptus* Müller, 1925 n. stat.
= *A. milleri fortesculptus* Müller, 1925
6) *A. grottoloi* Vailati, 2004
7) *A. heydeni* Reitter, 1885
8) *A. ljubnicensis* Müller, 1914 n. stat.
= *A. milleri ljubnicensis* Müller, 1914
9) *A. kahleni* n. sp.
10) *A. kaplai* n. sp.
11) *A. knirschi* Müller, 1913 n. stat.
= *A. milleri knirschi* Müller, 1913
12) *A. kofleri* n. sp.
13) *A. kraussi* Müller, 1910
= *A. milleri pretneri* Müller, 1913 n. syn.
= *A. milleri winkleri* Mandl, 1944 n. syn.
= *A. milleri hoelzeli* Mandl, 1957 n. syn.
= *A. milleri alpinus* Drovenik, Mlejnek & Moravec, 1995 n. syn.
14) *A. lebenbaueri* n. sp.
15) *A. milleri* (Schmidt, 1855)
= *A. milleri springeri* Müller, 1910 n. syn.
= *A. milleri grabowskii* Müller, 1917 n. syn.
= *A. milleri longipennis* Müller, 1931 n. syn.
16) *A. miricae* n. sp.
17) *A. mixanigi* n. sp.
18) *A. muellerianus* Pretner, 1963
19) *A. robustus* Müller, 1914 n. stat.
= *A. heydeni robustus* Müller, 1914

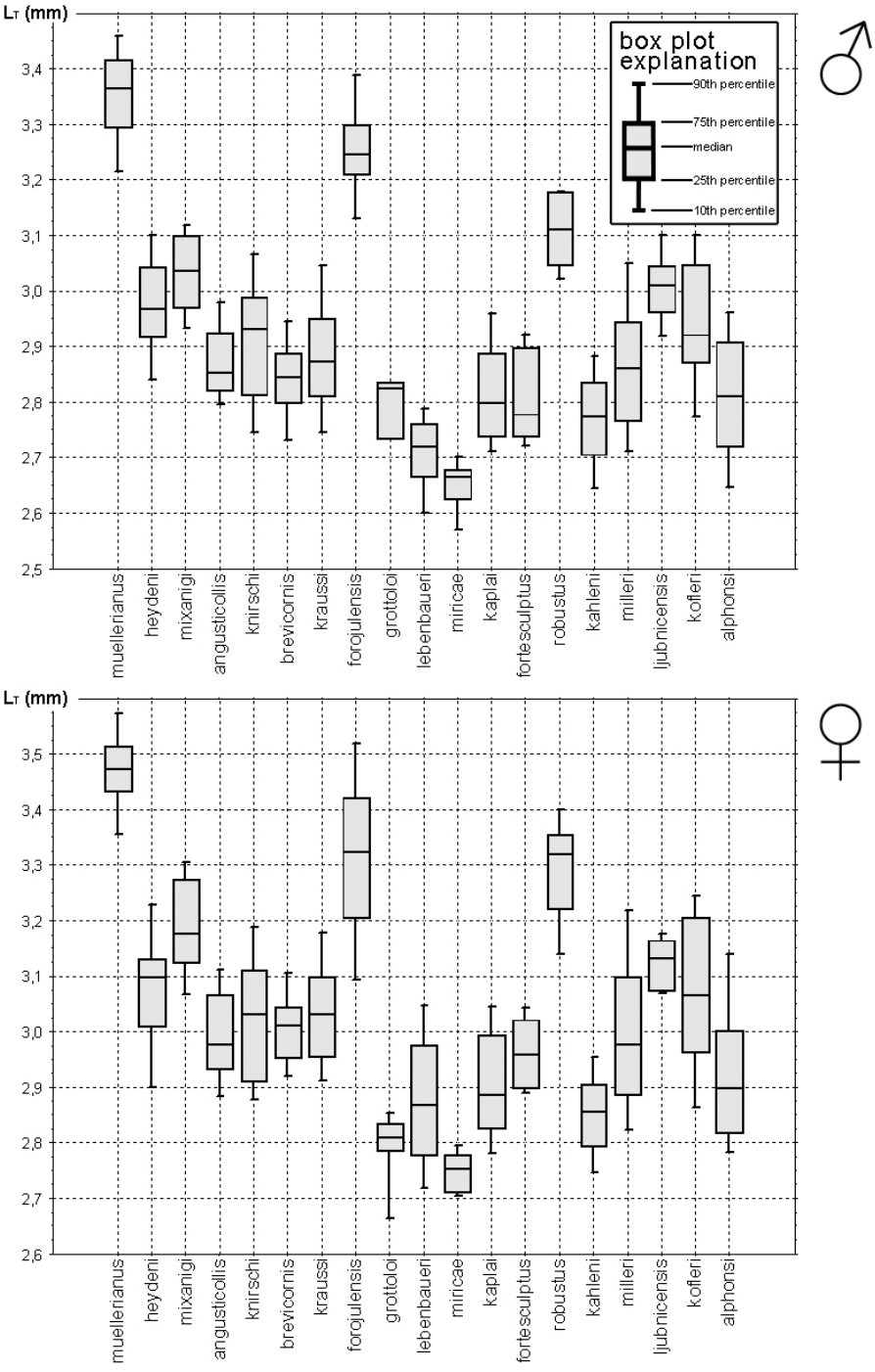

Fig. 21 *Aphaobius* spp.: box plots of L_T, total length (in mm) from the apex of the head to the apex of the elytra.

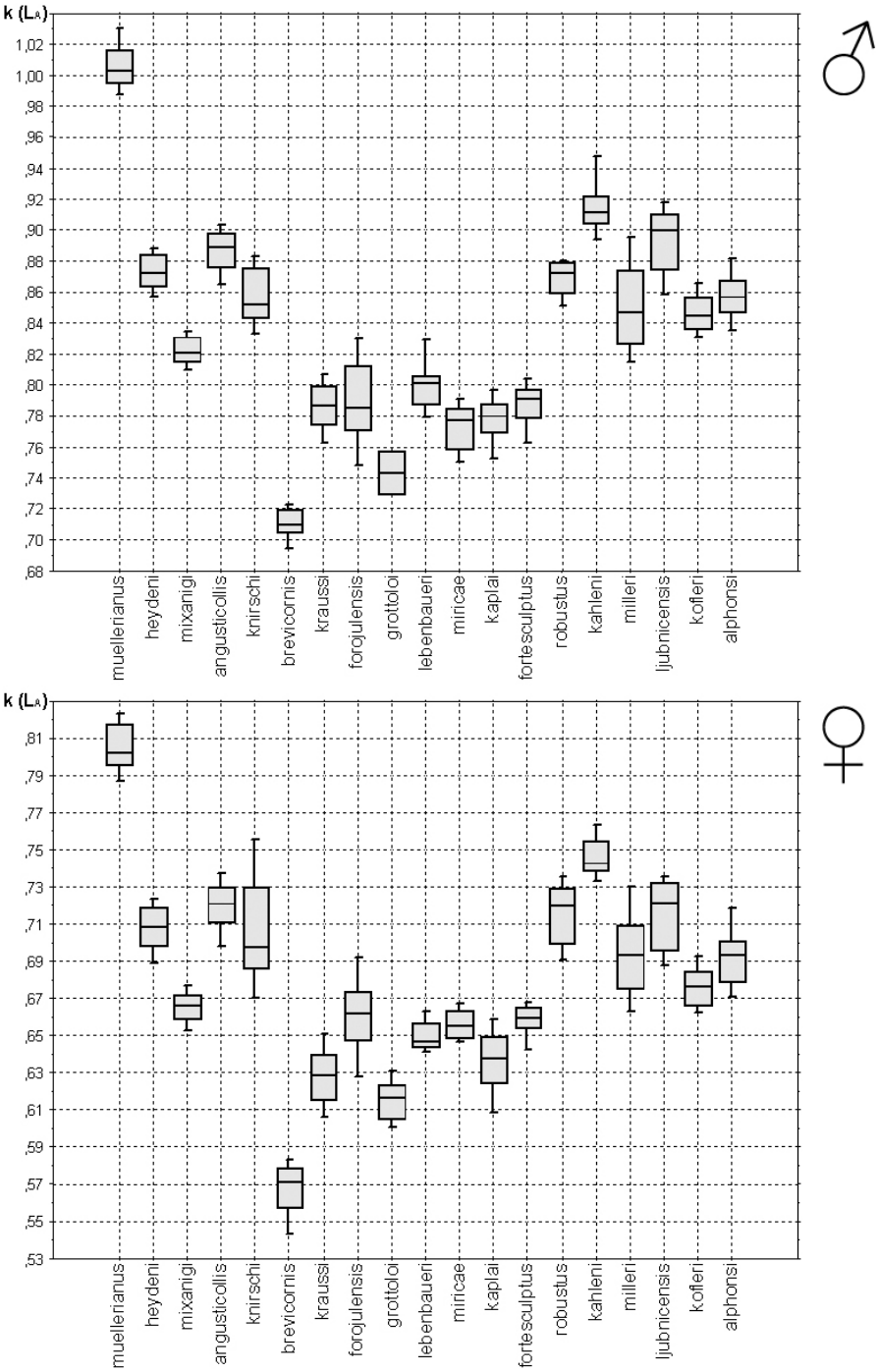

Fig. 22 *Aphaobius* spp.: box plots of k (L_A), length coefficient of antennae.

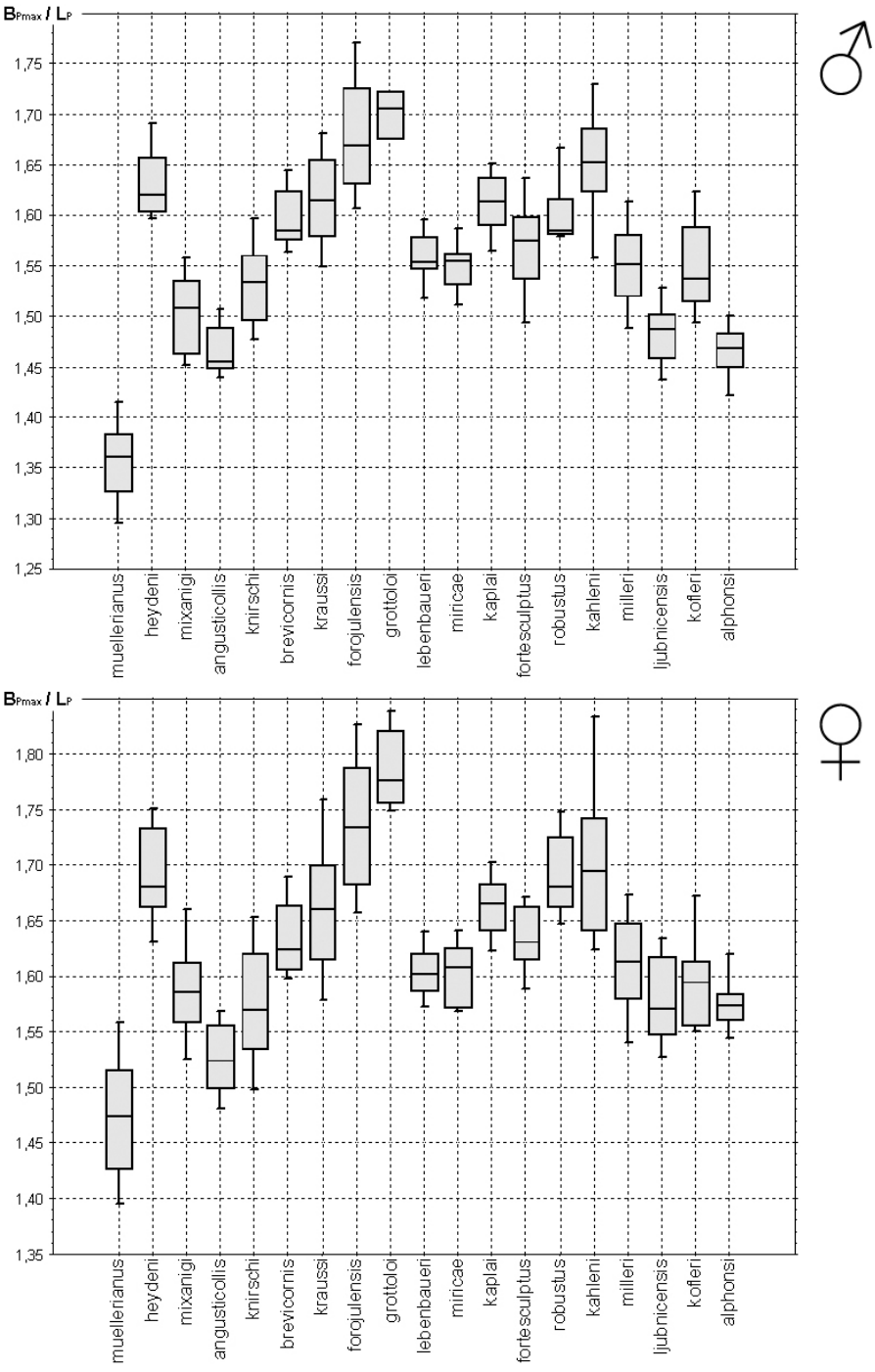

Fig. 23 *Aphaobius* spp.: box plots of B_{Pmax}/L_P, length / width of pronotum.

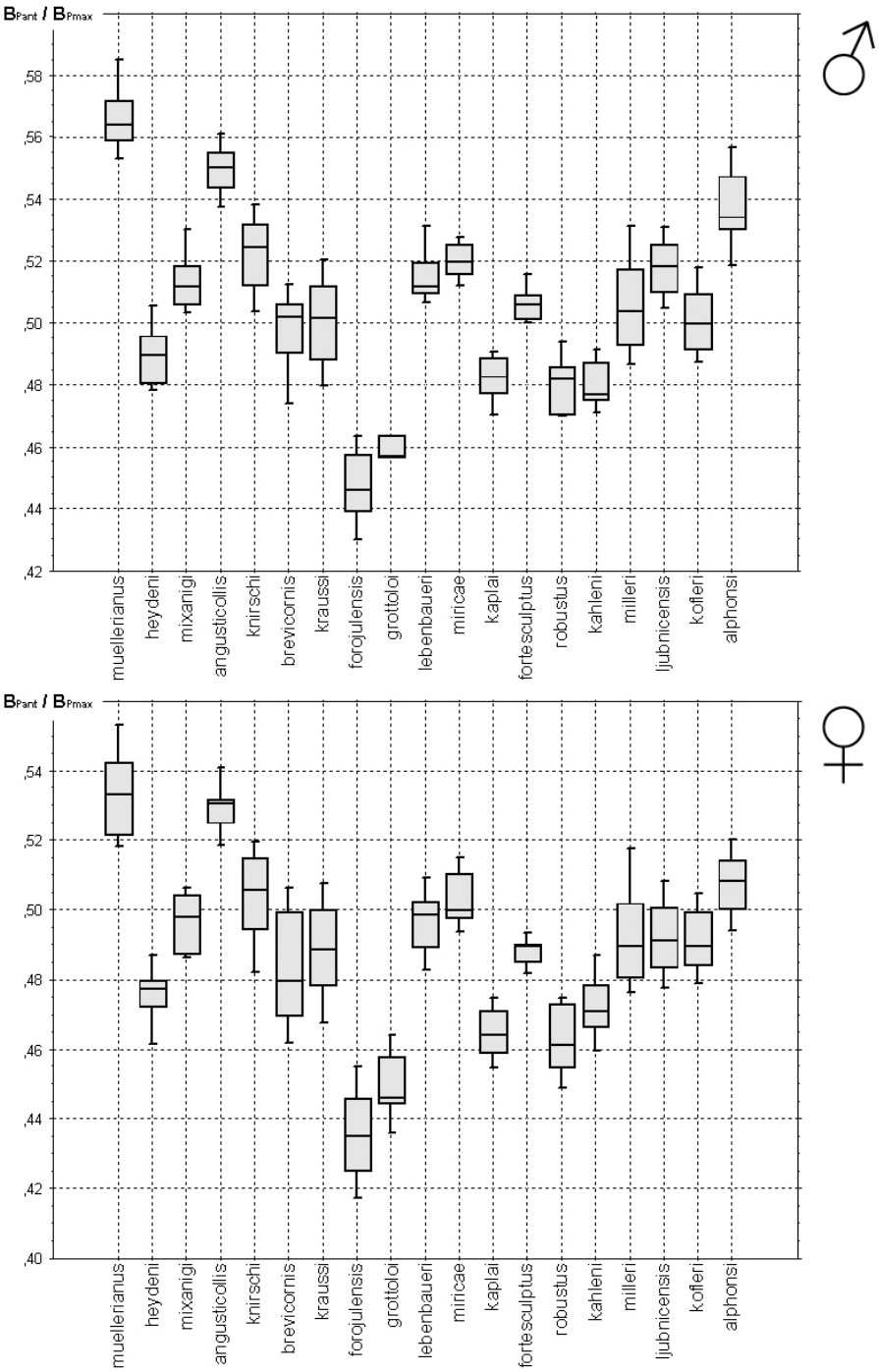

Fig. 24 *Aphaobius* spp.: box plots of B_{Pant}/B_{Pmax}, width of pronotum at the anterior margin / maximum width of pronotum.

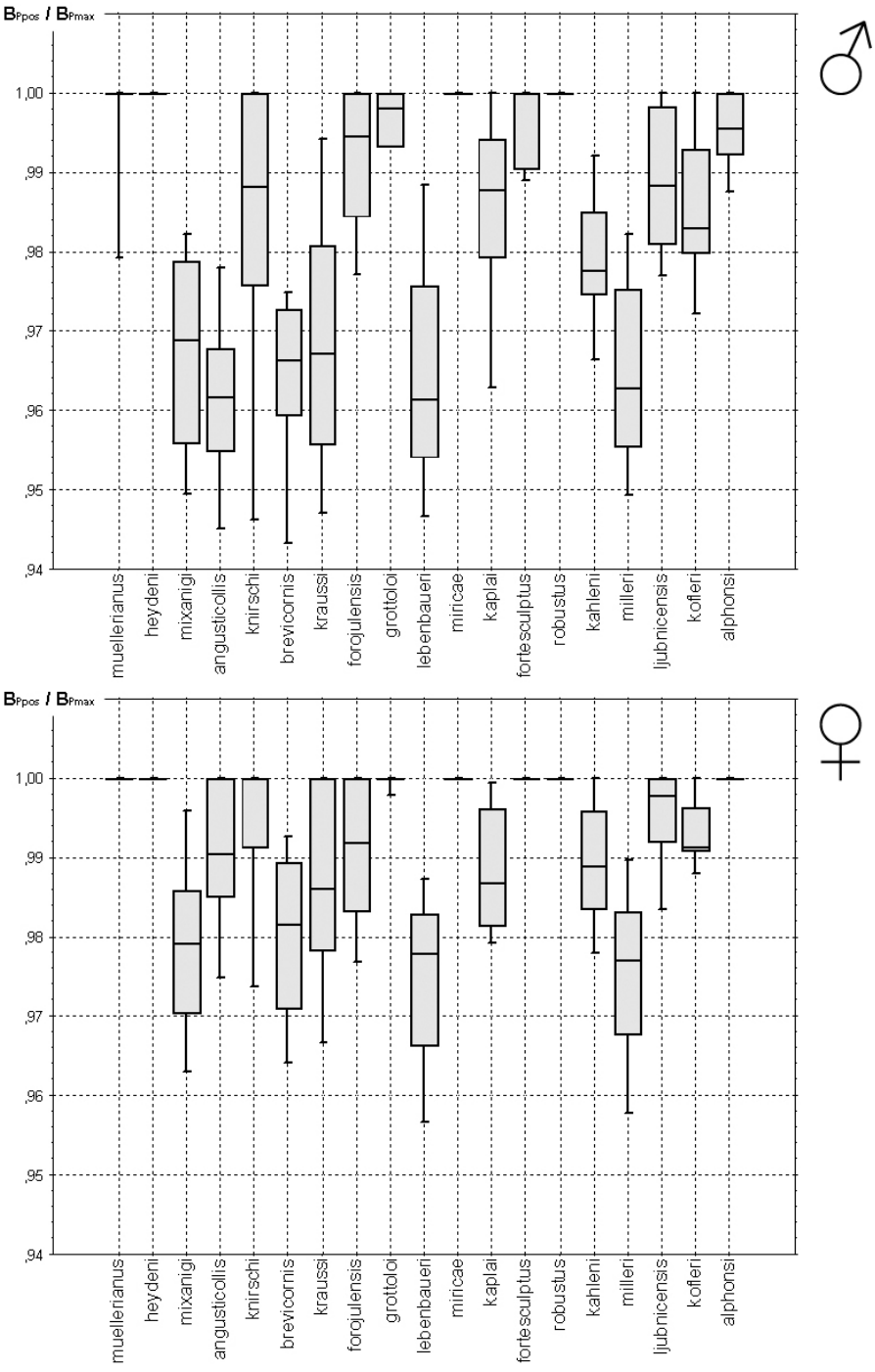

Fig. 25 *Aphaobius* spp.: box plots of B_{Ppos}/B_{Pmax}, width of pronotum at base / maximum width of pronotum.

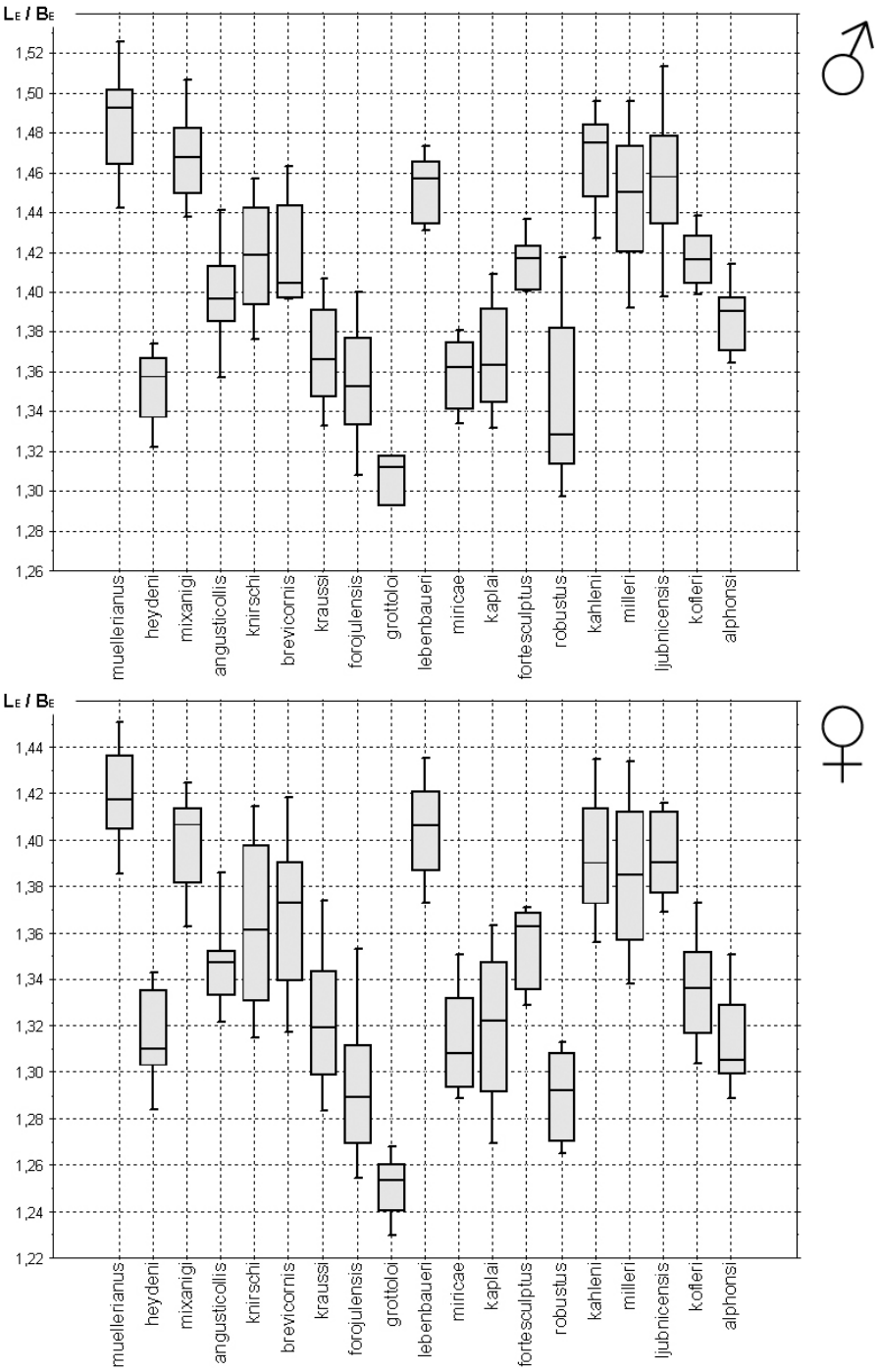

Fig. 26 *Aphaobius* spp.: box plots of L_E/B_E, length / width of elytra.

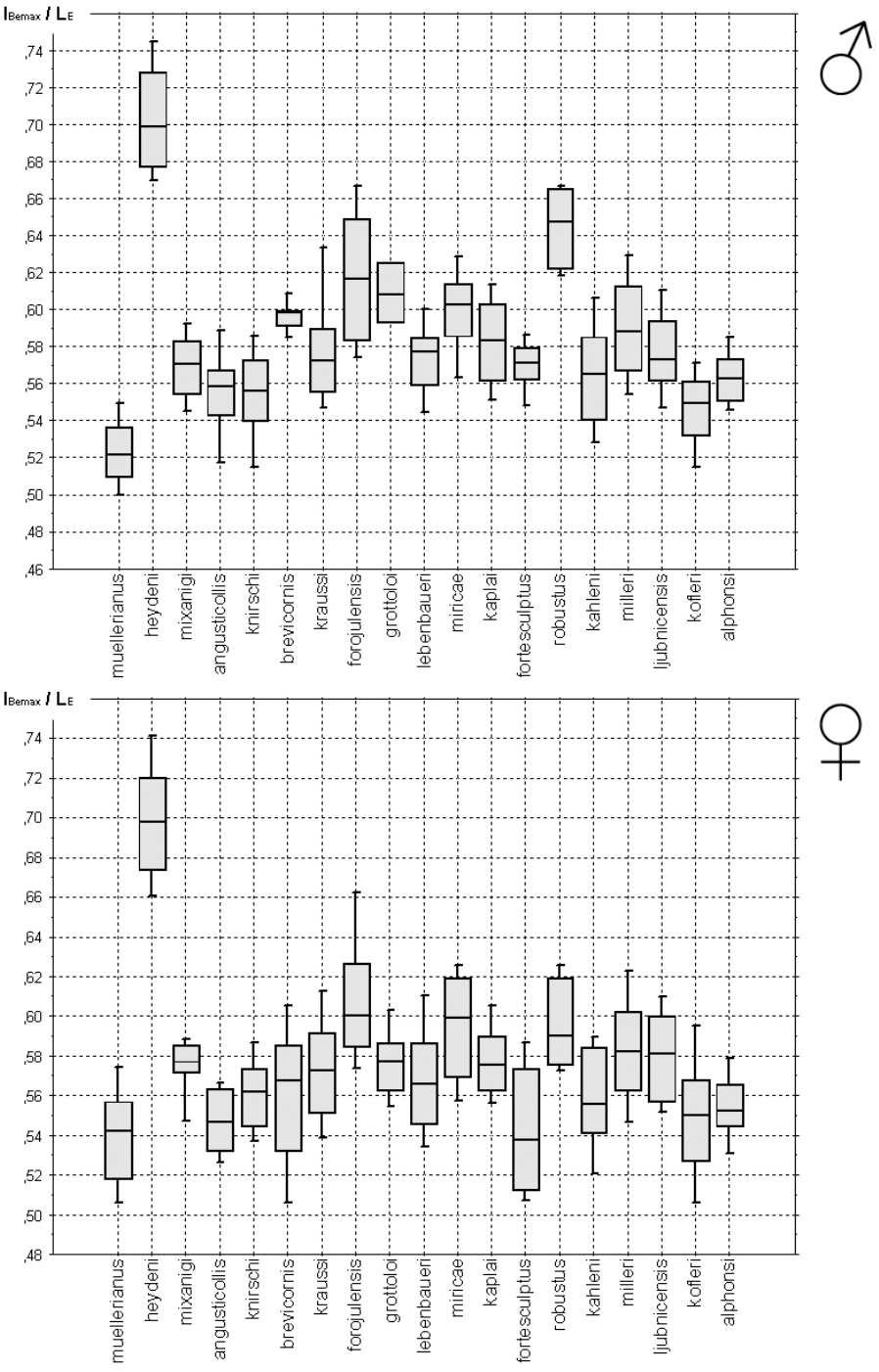

Fig. 27 *Aphaobius* spp.: box plots of l_{Bemax}/L_E, distance of widest point of elytra from apex / length of elytra.

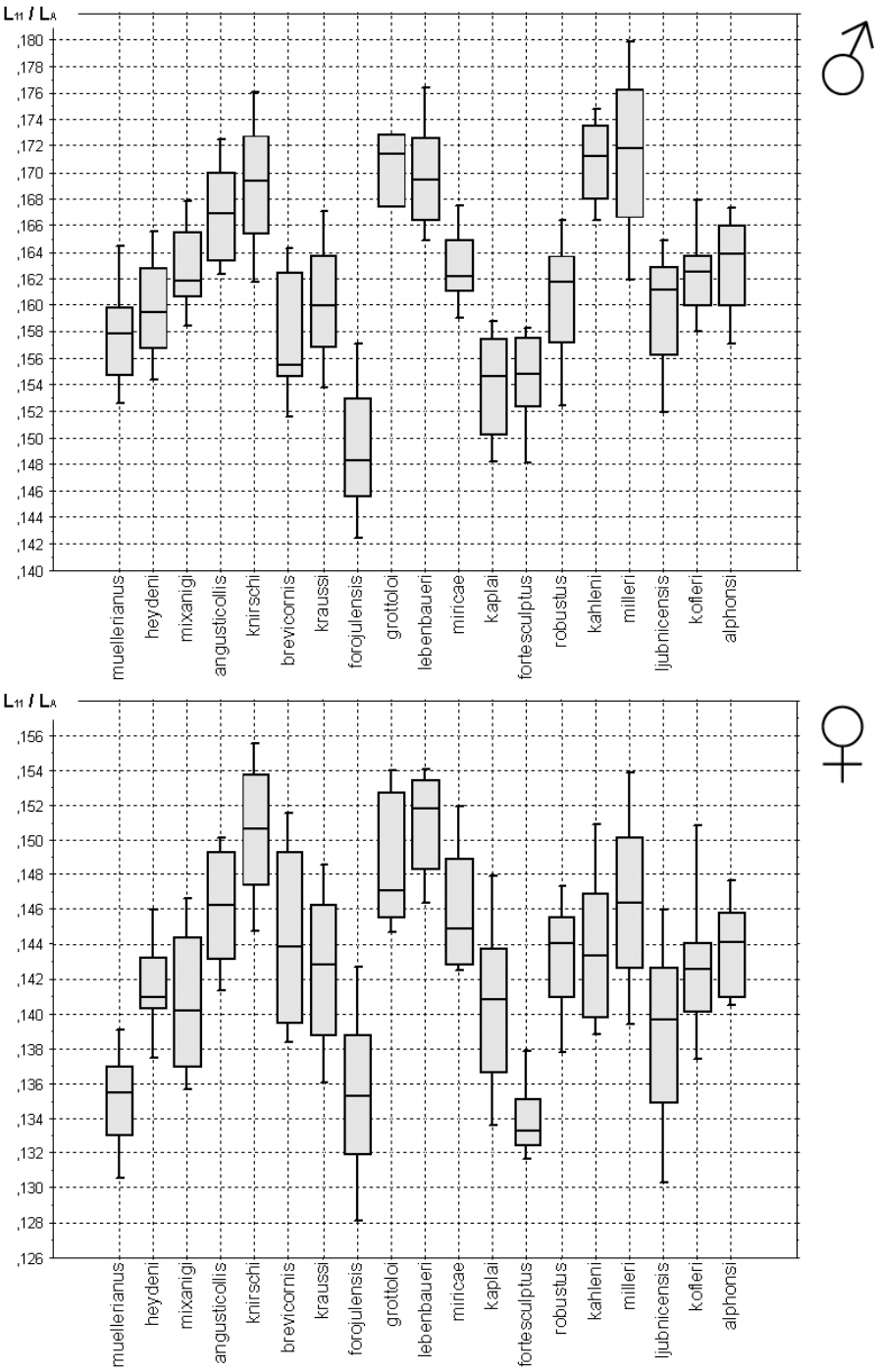

Fig. 28 *Aphaobius* spp.: box plots of L_{11}/L_A, length of 11th antennomere / length of antenna.

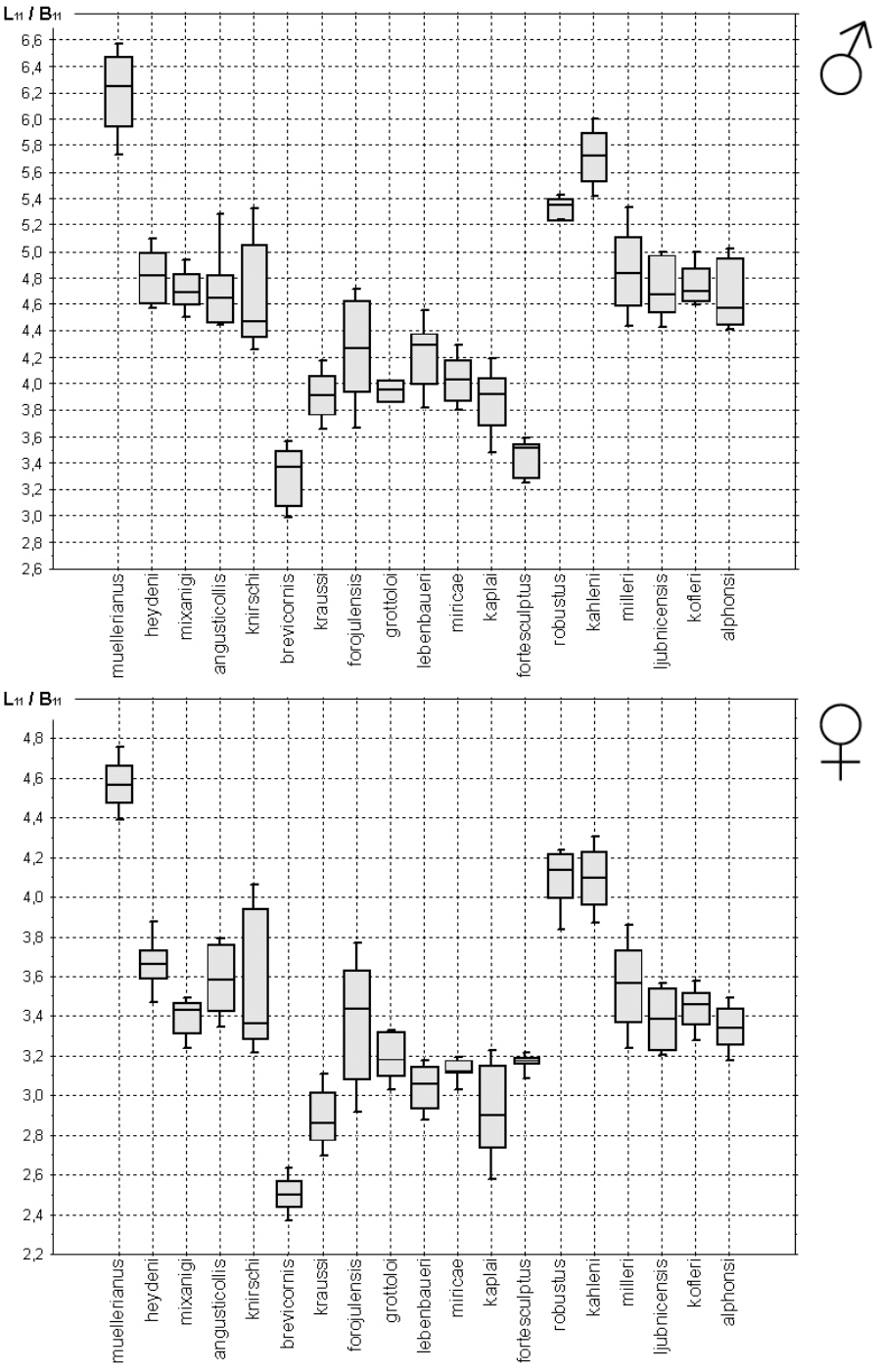

Fig. 29 *Aphaobius* spp.: box plots of L_{11}/B_{11}, length / width of 11th antennomere.

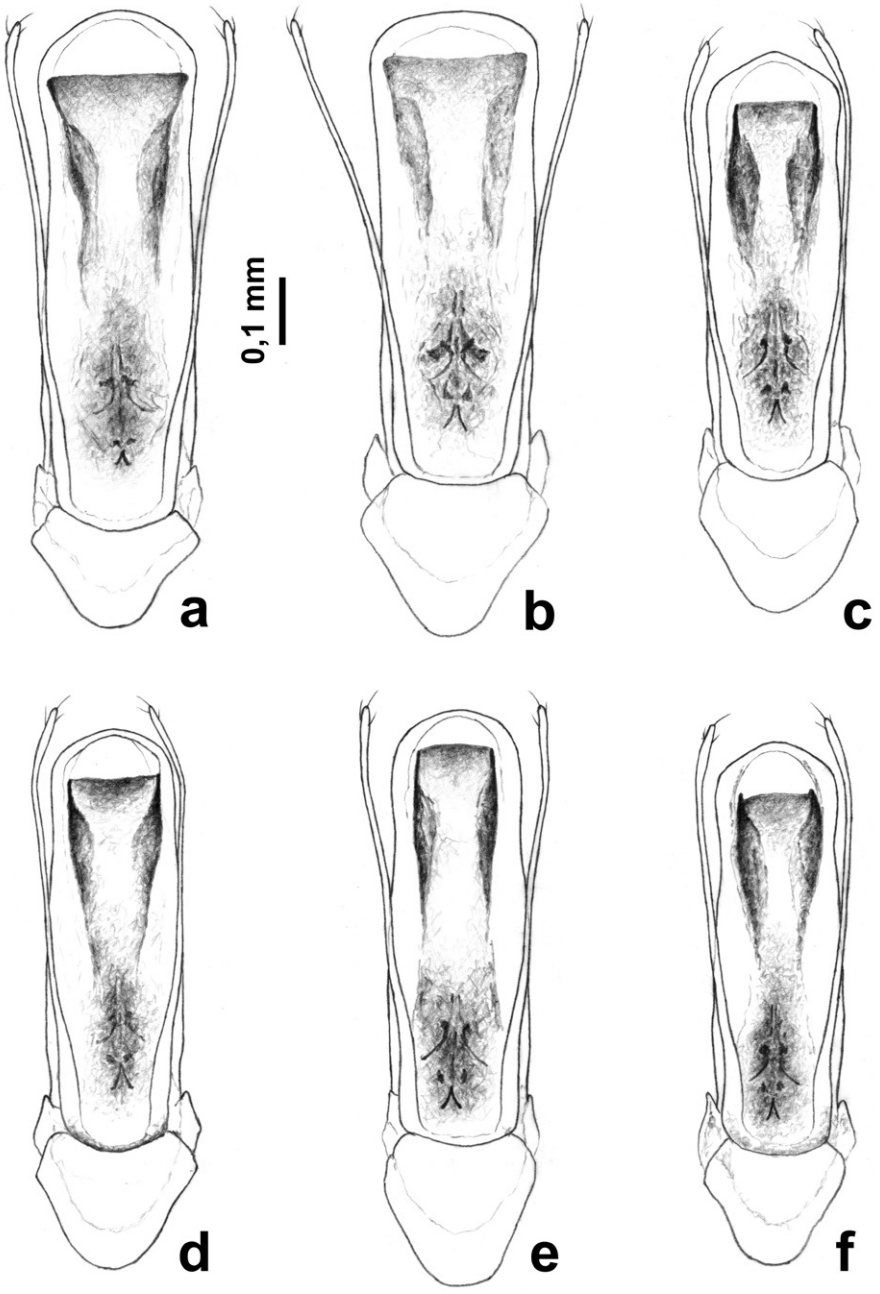

Fig. 30 *Aphaobius* spp.: aedeagus, median lobe in dorsal view. *A. muellerianus* from Bidovčeva luknja (a); *A. heydeni* from Marijino brezno (b); *A. mixanigi* n. sp. from Lobnigschacht, Paratype (c); *A. angusticollis* n. sp. from Arneševa luknja, Paratype (d); *A. knirschi* from Covška prepad (e); *A. brevicornis* from Obir (f).

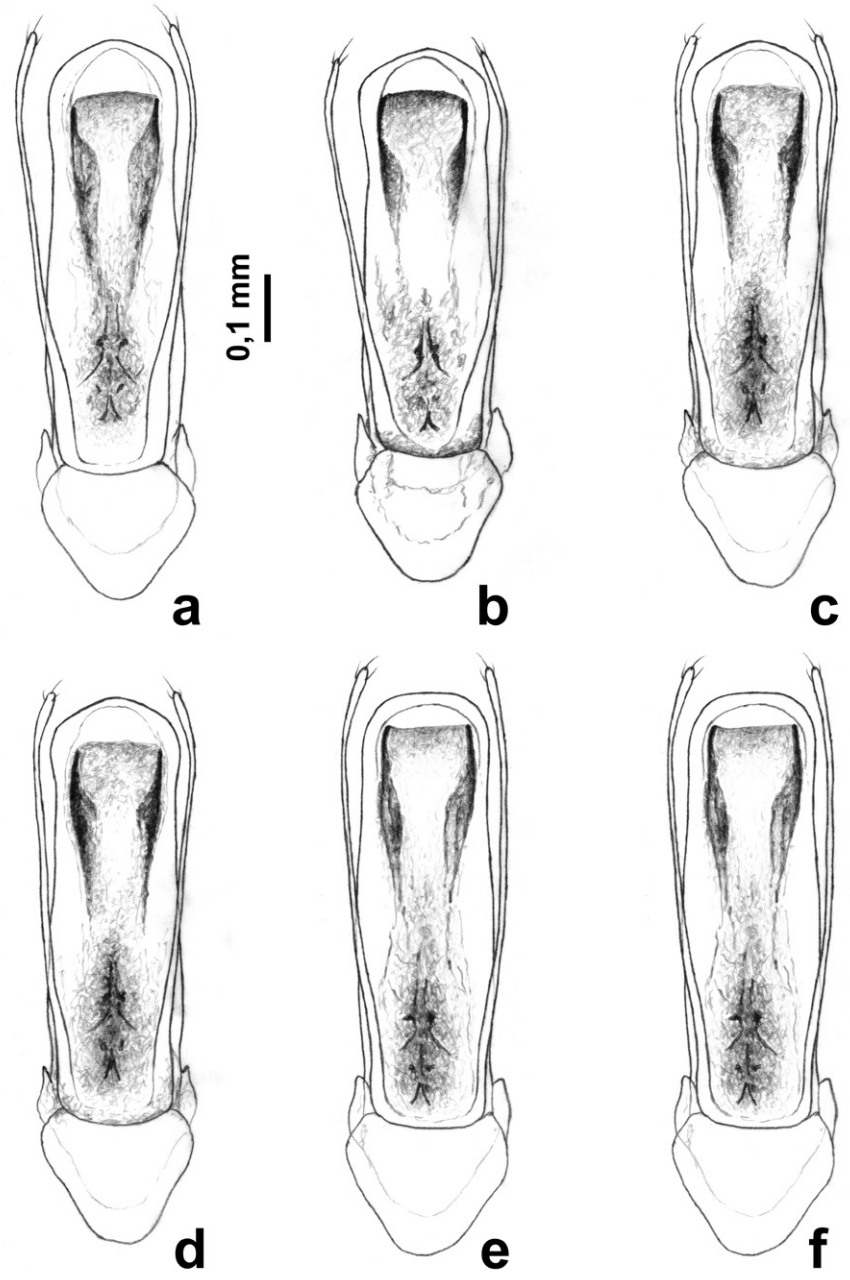

Fig. 31 *Aphaobius kraussi*: aedeagus, median lobe in dorsal view. Specimens from Trbiška zijalka (a), Begunščica (b), Hafnerhöhle (c), Kamniška jama (d), Peca (e) and Snežna jama na planini Arto (f).

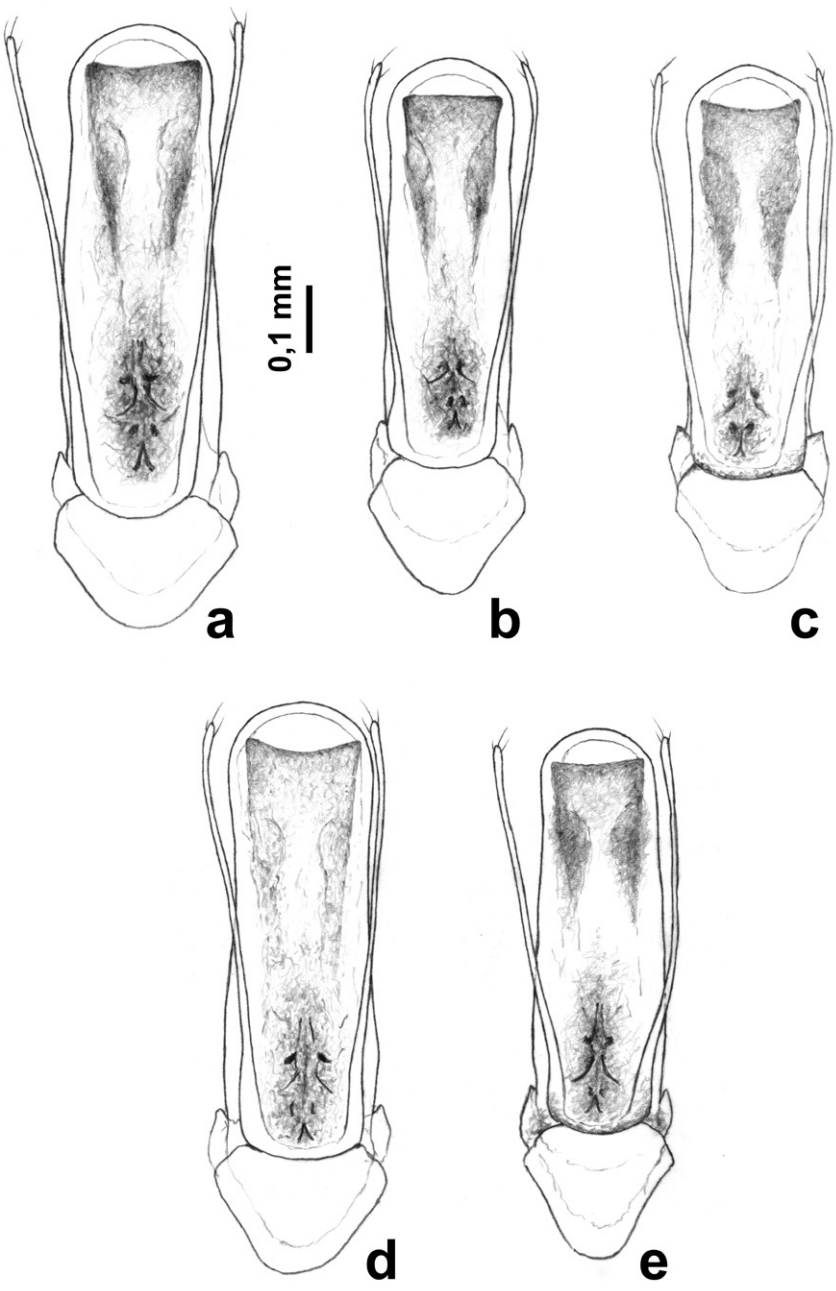

Fig. 32 *Aphaobius* spp.: aedeagus, median lobe in dorsal view. *A. forojulensis* from Grotta di Villanova (a); *A. grottoloi* from Grotta di Taipana (b); *A. lebenbaueri* n. sp. from Ledenica pri Dolu, Paratype (c); *A. miricae* n. sp. from Slugov brezen, Paratype (d); *A. fortesculptus* from Matjaževa jama (e).

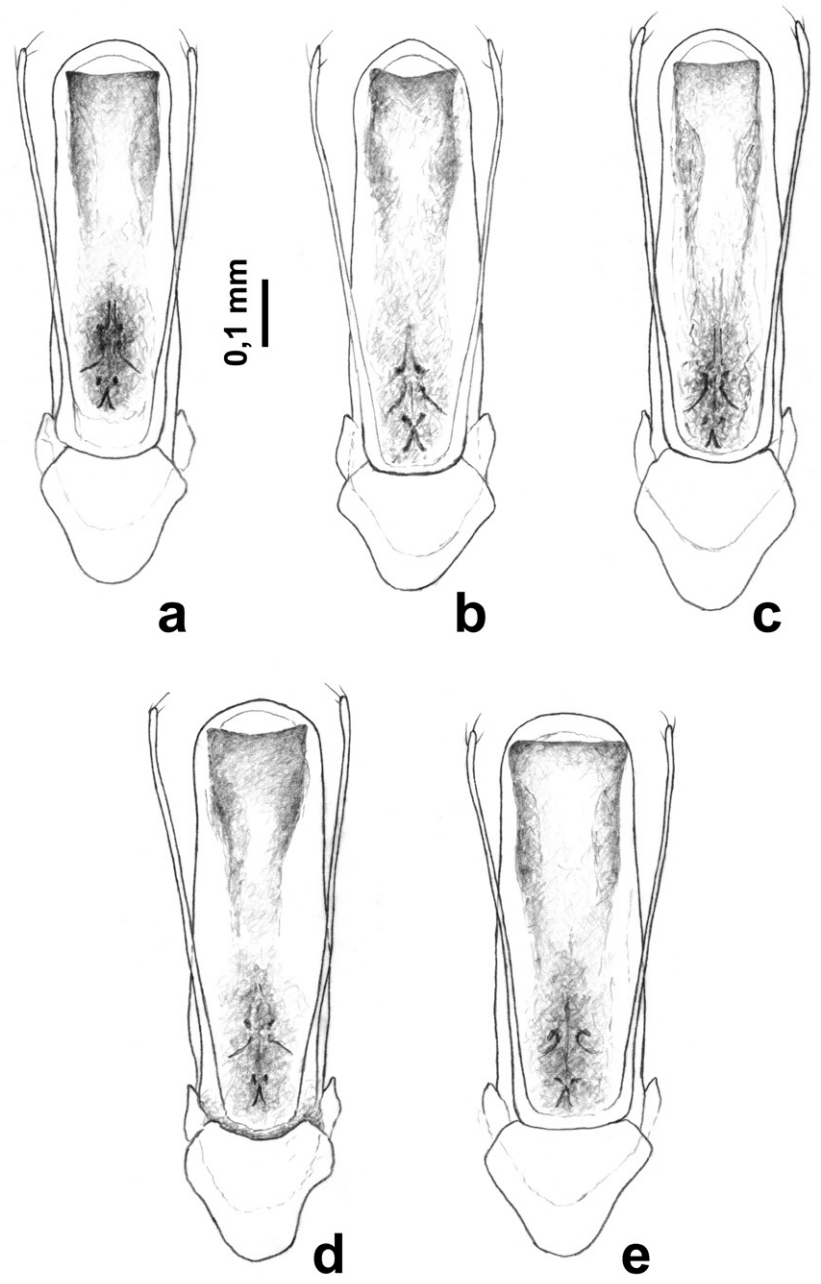

Fig. 33 *Aphaobius* spp.: aedeagus, median lobe in dorsal view. *A. kaplai* n. sp. from Častitljiva luknja, Paratype (a); *A. kaplai* n. sp. from Štoln na Altemavru, Paratype (b); *A. kaplai* n. sp. from Planina Viševnik, Paratype (c); *A. robustus* from Jama pri Lipniški skali (d); *A. kahleni* n. sp. from Krasnica, Paratype (e).

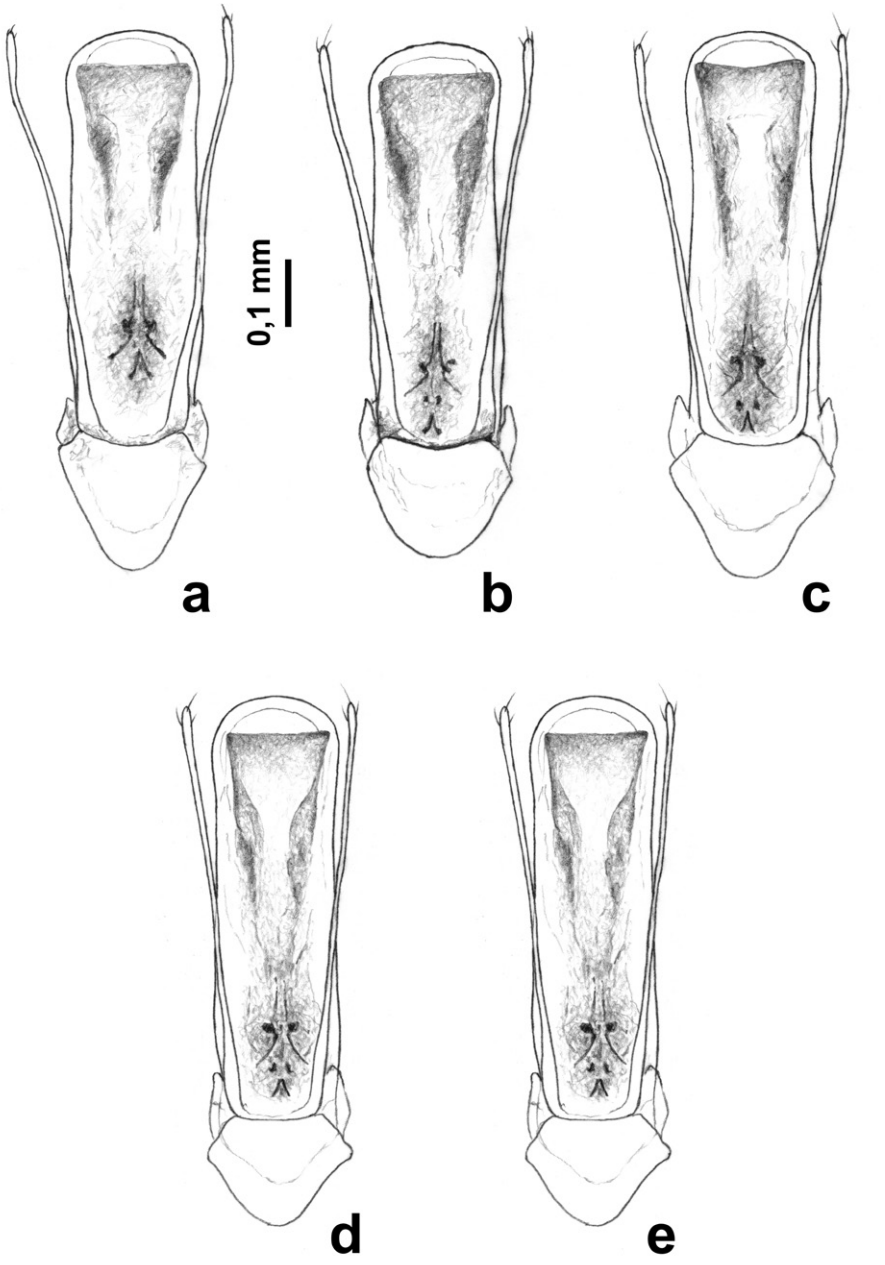

Fig. 34 *Aphaobius milleri*: aedeagus, median lobe in dorsal view. Specimens from Velika Pasica (a), Divja jama v Zamelšah (b), Gradišnica (c), Petnjak (d) and Jama Treh bratov pri Kočevju (e).

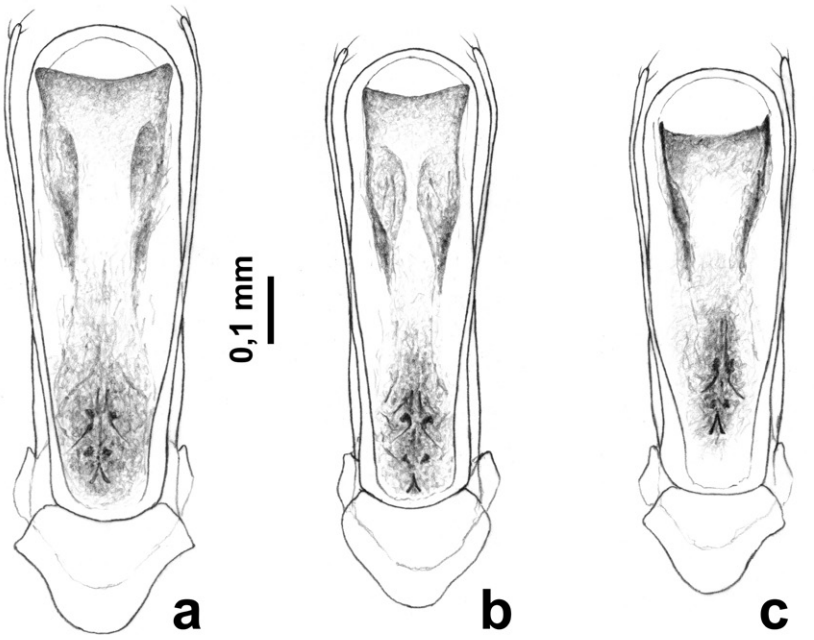

Fig. 35 *Aphaobius* spp.: aedeagus, median lobe in dorsal view. *A. ljubnicensis* from Kevderca na Lubniku (a); *A. kofleri* n. sp. from Rudnik pri Graparju, Paratype (b); *A. alphonsi* from Babja luknja (c).

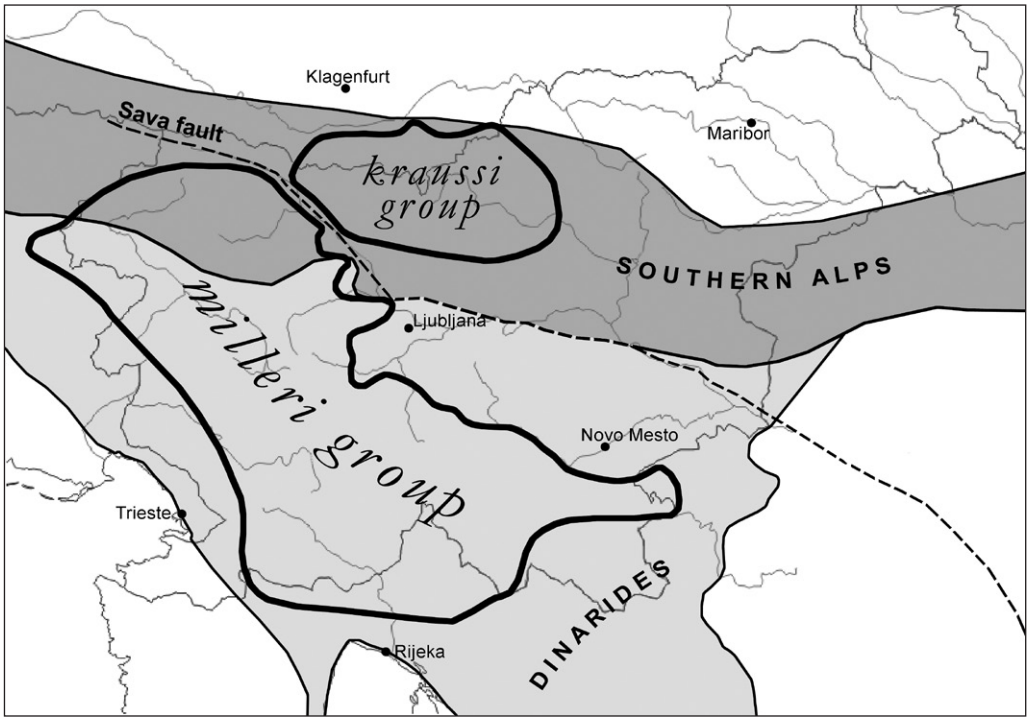

Fig. 36 Distribution map of *Aphaobius* species groups.

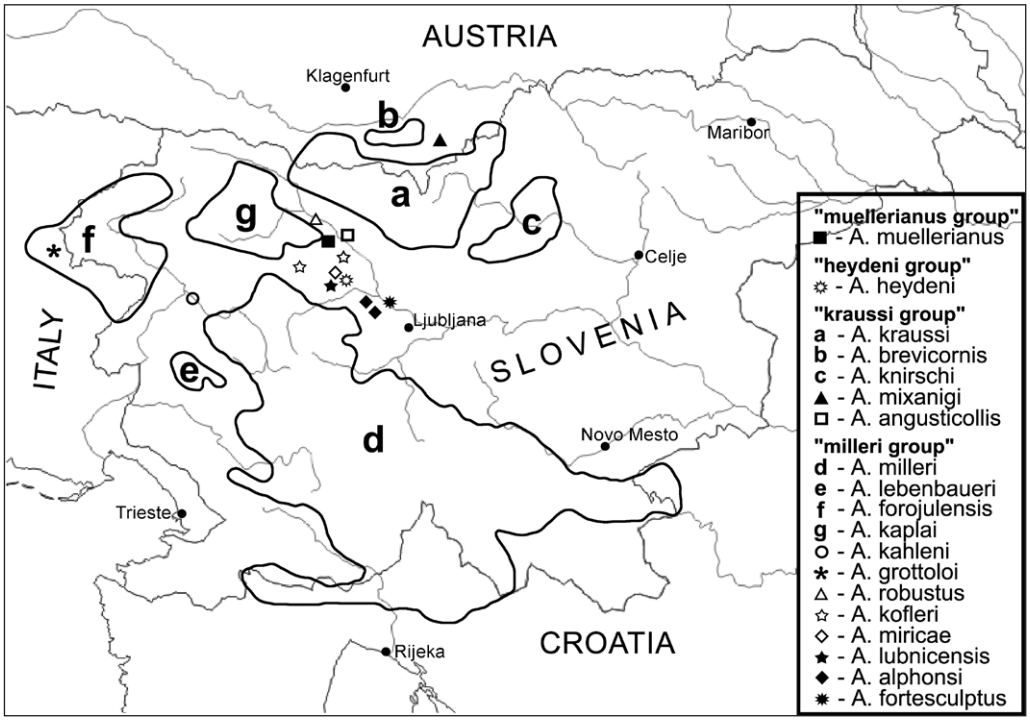

Fig. 37 Distribution map of *Aphaobius* spp.

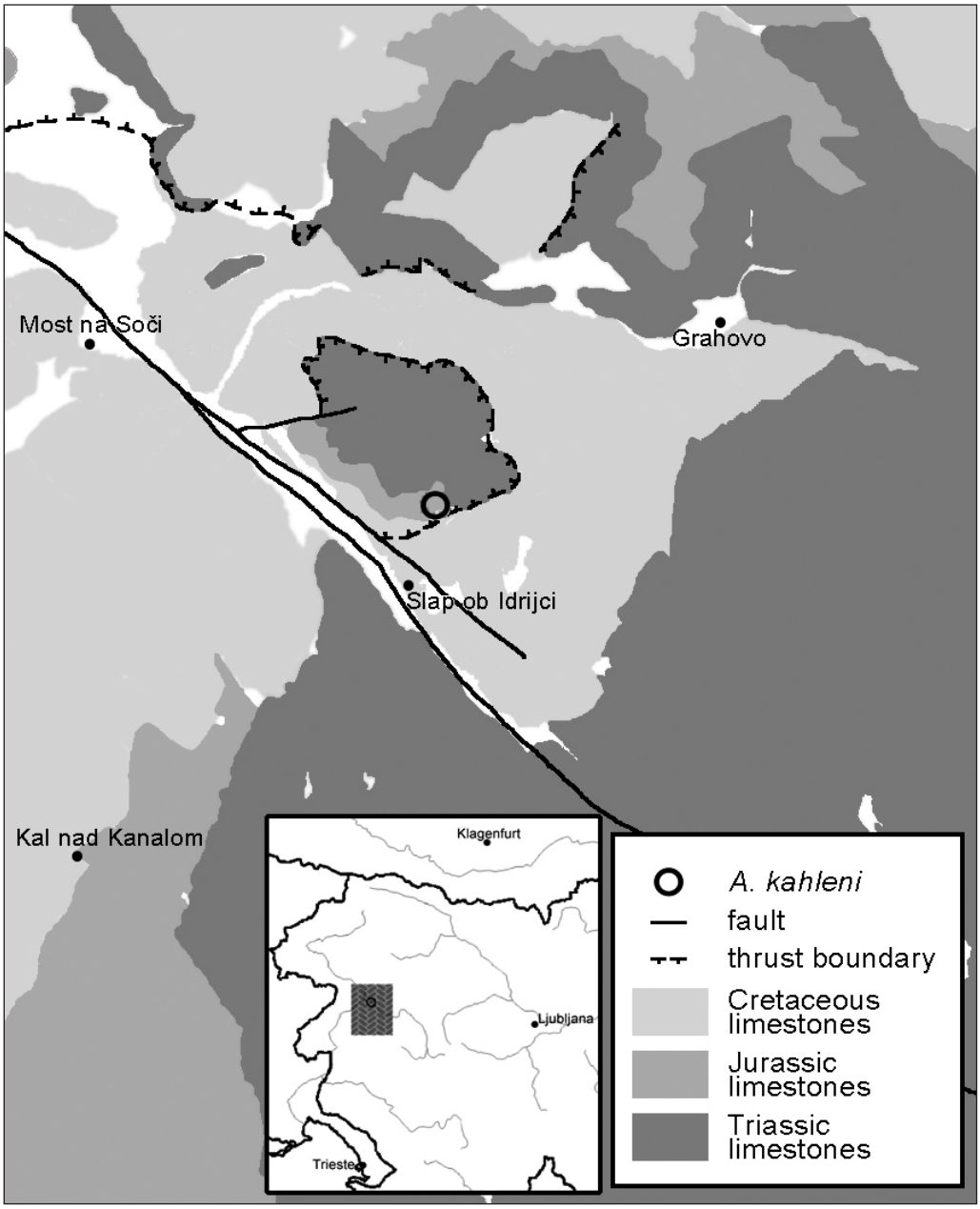

Fig. 38 Detailed distribution area of *A. kahleni* n. sp. and correlation with the local geological features.

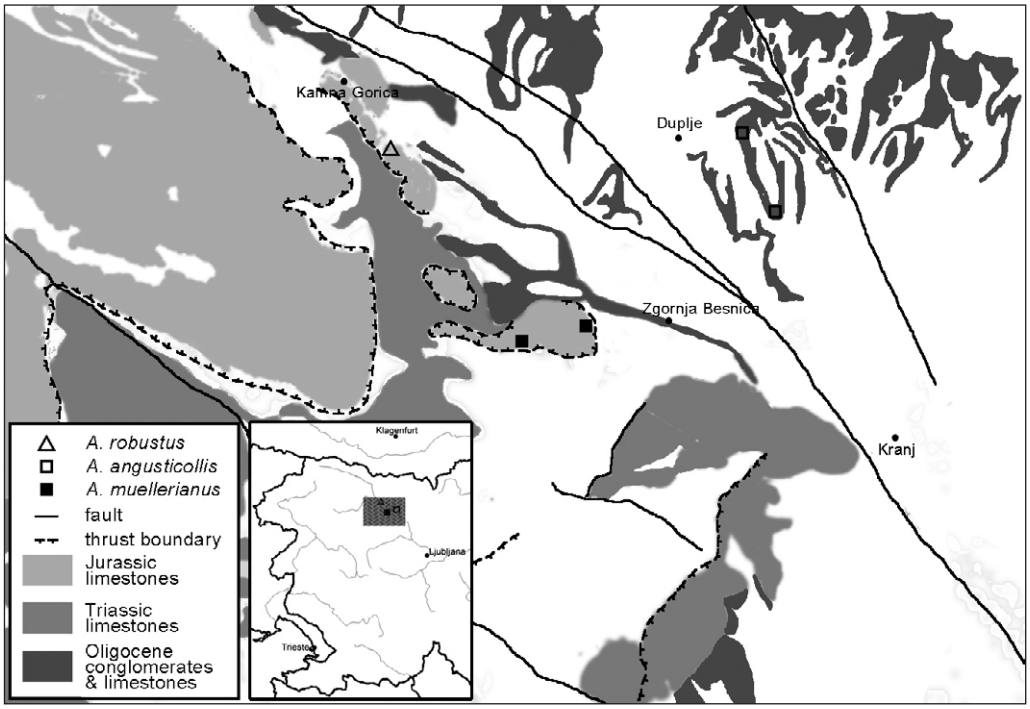

Fig. 39 Detailed distribution area of *A. robustus*, *A. angusticollis* n. sp. and *A. muellerianus*, and correlation with the local geological features.

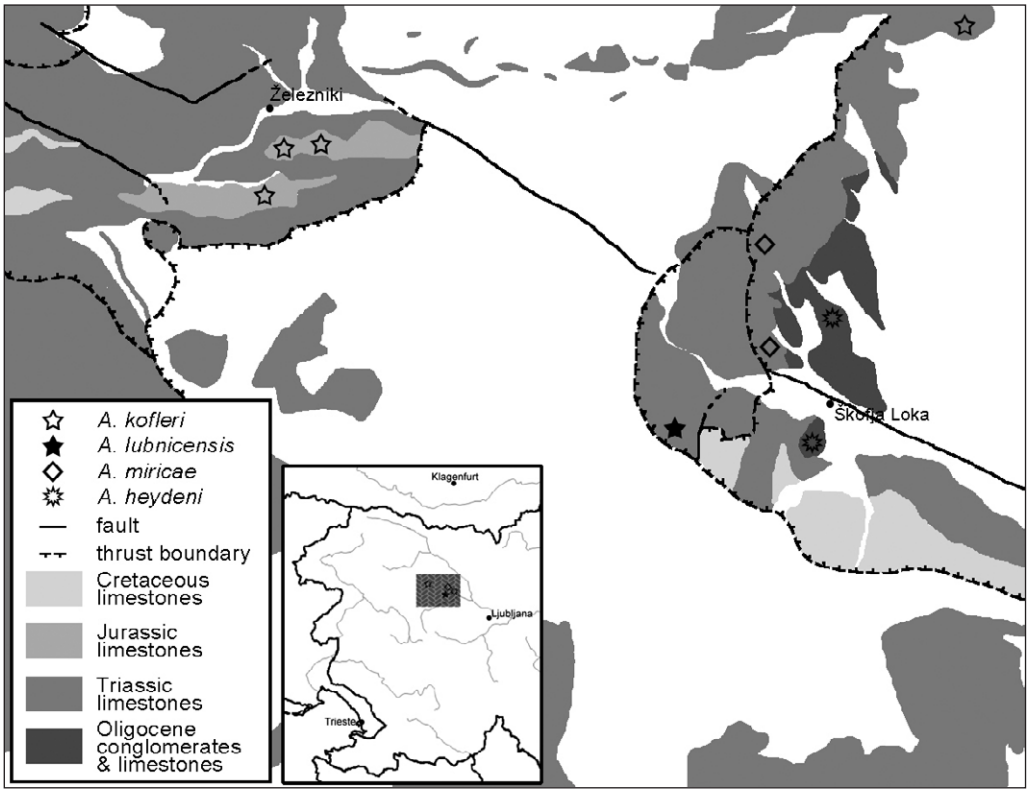

Fig. 40 Detailed distribution area of *A. kofleri* n. sp., *A. ljubnicensis*, *A. miricae* n. sp. and *A. heydeni*, and correlation with the local geological features.

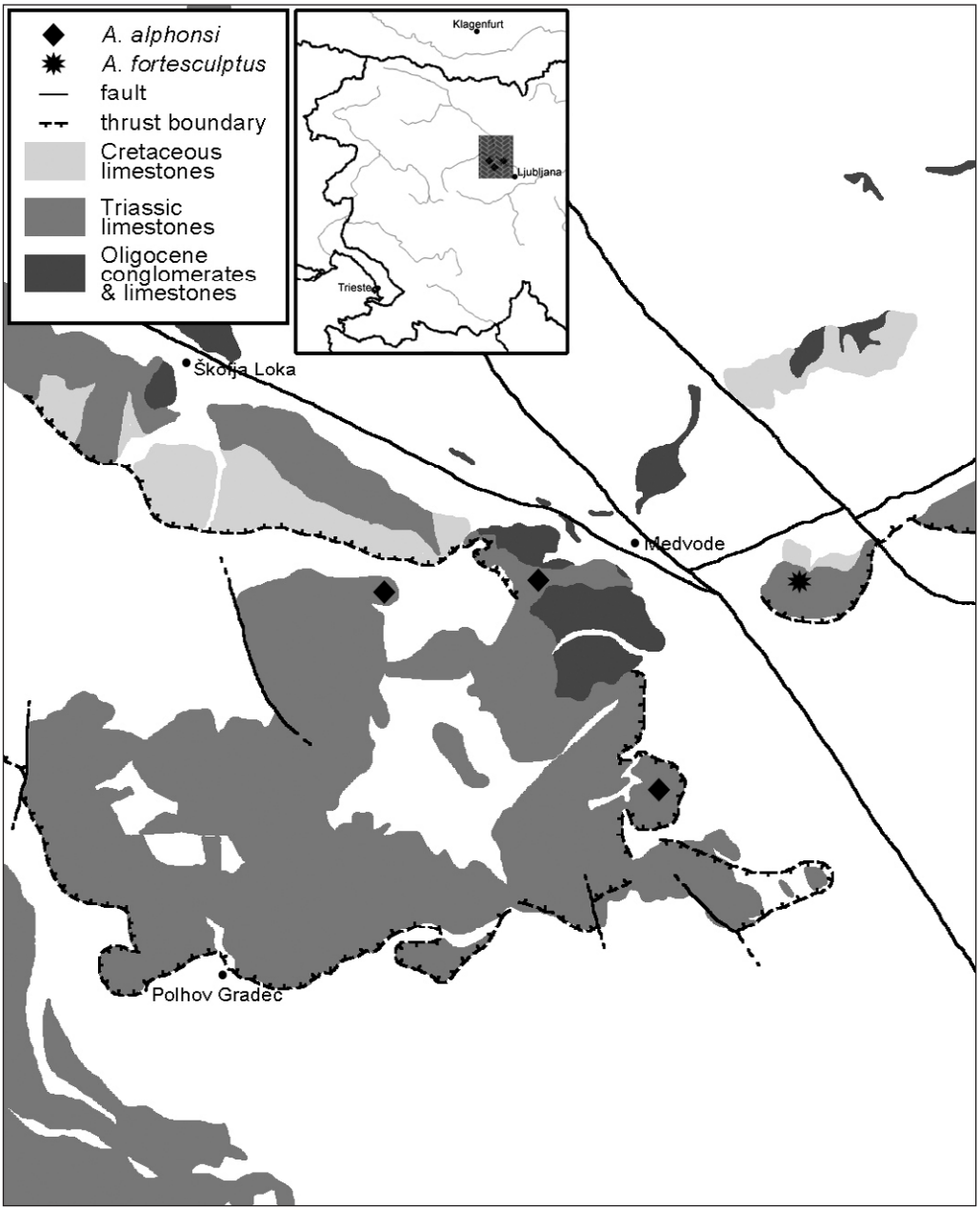

Fig. 41 Detailed distribution area of *A. alphonsi* and *A. fortesculptus*, and correlation with the local geological features.

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We would like to warmly thank all friends and colleagues who, by either giving their specimens on loan or adding useful comments and suggestions, provided a fundamental contribution to the completion of this study, and in particular: Savo Brelih, Andrea Colla, Božidar Drovenik, Pier Mauro Giachino, Mario Grottolo, Branko Jalžić, Manfred Kahlen, Andrej Kapla, Bojan Kofler, Thomas Lebenbauer, Harald Mixanig and Slavko Polak.

Summary

The genus *Aphaobius* was established in 1878 by Abeille de Perrin to taxonomically segregate the species *Adelops milleri* (Schmidt, 1855), known only from the cave Velika Pasica, about 15 km southwards from Ljubljana (Slovenia). A few years later, the species *A. heydeni* Reitter, 1885 was described from the surroundings of Škofja Loka (Slovenia).

It was only after the first decade of the 20th century that the intense research into the subterranean fauna of Slovenia led by J. Müller gave rise to a remarkable increase on the knowledge of this genus. In several publications, this author described eleven taxa from various caves and old mines of Slovenia and Italy, attributing to almost all of them the rank of subspecies of *A. milleri*.

Further three subspecies of *A. milleri* were described in the ensuing decades by Mandl and then a new, remarkably distinct species from the cave Bidovčeva luknja near Kranj (Slovenia) was found and described by Pretner as *A. muellerianus* (Pretner, 1963).

Only recently, new investigations led to the discovery of *A. milleri alpinus* (Drovenik, Mlejnek & Moravec, 1995), as well as of a new species in Italy, *A. grottoloi*, from the cave Grotta di Taipana, about 20 km north-eastwards from Udine (Vailati, 2004). The latter author, underlining the syntopy of the new species with *A. milleri forojulensis*, put forward some doubts on the correct ranking of several subspecies of *A. milleri* and expressed the need for a thorough revision of the genus *Aphaobius*.

Meanwhile, in the last years, the notable efforts on field research carried out by one of the authors (M. Bognolo) and other friends and colleagues from Slovenia and Austria (B. Kofler, S. Polak, A. Kapla, T. Lebenbauer, H. Mixanig, M. Kahlen) led to the recording of many populations, thus providing useful material for the long waited revision.

As it was to be expected, some subspecies of *A. milleri* were acknowledged as valid species, others as synonyms, whilst the discovery of new species added further information to the complex systematics and distribution of this genus.

The genus *Aphaobius* is distributed mainly in Slovenia, with some populations reaching the southern Austria (Kärnten), north-eastern Italy (Friuli) and the north-western regions of Croatia (Istra, Gorski Kotar and Žumberačka gora). The *Aphaobius* species are normally found in caves, both at entrances and in the deepest parts; in the northern part of the distribution area, however, many specimens have been found in old abandoned mines or even outside caves, in the subterranean superficial environment.

All collecting localities, either caves or superficial subterranean habitat sites, lie within limestones or conglomerate rocks, at altitudes ranging from 300 m up to the alpine zones over 2,000 m above sea level.

The genus is composed of four species groups: *muellerianus*, *heydeni*, *kraussi* and *milleri*.

The northern *kraussi* group is a cluster of species distributed on the left-hand side, downriver, of the river Sava, which includes *A. mixanigi* n. sp., *A. angusticollis* n. sp., *A. knirschi* Müller, 1913 n. stat., *A. brevicornis* Mandl, 1940 n. stat. and *A. kraussi* Müller, 1910.

The southern *milleri* group is a cluster of species distributed on the right-hand side of the river Sava, which includes *A. forojulensis* Müller, 1931 n. stat., *A. grottoloi* Vailati, 2004, *A. lebenbaueri* n. sp., *A. miricae* n. sp., *A. kaplai* n. sp., *A. fortesculptus* Müller, 1910 n. stat., *A.*

robustus Müller, 1914 n. stat., *A. kahleni* n. sp., *A. milleri* (Schmidt, 1855), *A. ljubnicensis* Müller, 1914 n. stat., *A. kofleri* n. sp. and *A. alphonsi* Müller, 1914 n. stat..

The *muellerianus* group and the *heydeni* group include one species each: *A. muellerianus* Pretner, 1963 and *A. heydeni* Reitter, 1885. Due to their unique features, these two species are clearly distinguishable from all species of the genus *Aphaobius* already from their external morphology.

The abundant material and the morphometric data collected led to the clarification of the relationships between all populations known so far. Thus, new synonyms were identified for subspecies which, according to the statistical analyses carried out, did not show any significant deviation from the taxonomical point of view.

The overall distribution of the genus *Aphaobius* shows a combination of species with large distribution areas and other species known from a single site or a very restricted geographic area. Besides, the relative convergence in the external morphology of populations belonging to different species aggravated a comparative approach based only on the qualitative analysis of newly discovered taxa. This is most likely the main driver for the description of many subspecies of *A. milleri* in the past century. As a matter of fact, the analyses carried out within this study proved that identifying a rational taxonomical segregation is not always feasible unless detailed morphometric comparisons are executed on all known geographic populations.

Another remarkable observation, already pointed out by Pretner (1963) and supported by the recent findings (e.g. *A. miricae* n. sp., Škofja Loka), is the outstanding concentration of different species in the restricted area around Škofja Loka. The analysis of paleogeographic data seems to suggest that the higher density of species in the regions between Ljubljana and Železniki is associated with allopatric speciation due to the segregation of specific distribution areas originating in the early Quaternary period.

On the other hand, the southern part of the distribution area of the genus is populated only by the species *A. milleri*, with several local populations which, however, do not show any taxonomically significant differences in either their morphological features or the shape of the aedeagus. Such situation resembles the distribution of the genus *Bathyscimorphus* (Jeannel, 1910); by comparison, the slight differences among populations of southern Slovenia and Croatia, spread in a wide and geologically diverse area, are likely due to a very recent or not yet completed segregation.

The correlation of paleogeographic features and allopatric speciation is more evident when considering the *kraussi* and the *milleri* species groups, rather than concentrating on single species. In particular, the northern *kraussi* group is geographically located within the Southern Alps, whilst the southern *milleri* group is mainly located on the Outer Dinarides. It is therefore clear that, in particular in central Slovenia (the area between Ljubljana and Kranj), such groups have long been isolated due to the movement of respective plates which, according to plate tectonics, are sliding along the contact boundary represented by the Sava fault.

To sum up, the speciation patterns of the genus *Aphaobius* show past isolation in the region between Ljubljana and Železniki, characterised by the complex paleogeographic evolution, as opposed to a high dispersal activity of the southern area, along the typical north-west to south-east orientation of Mesozoic limestones in the northern Balkan area.

Povzetek

Rod *Aphaobius* je leta 1878 odkril in opisal Abeille de Perrin ter tako taksonomsko ločil vrsto *Adelops milleri* (Schmidt, 1855), ki je poznana le iz jame Velika Pasica kakih 15 km južno od Ljubljane. Nekaj let pozneje je bila iz okolice Škofje Loke opisana vrsta *A. heydeni* Reitter, 1885.

Izreden napredek v poznavanju tega rodu je bil dosežen šele po prvem desetletju 20. stoletja med intenzivnim raziskovanjem podzemeljske favne pod vodstvom J. Müllerja. Ta avtor je v več publikacijah opisal enajst taksonov iz različnih jam in starih rudnikov v Sloveniji in Italiji in večini izmed njih pripisal rang podvrste *A. milleri*. Nadaljnje tri podvrste *A. Milleri* je v naslednjih desetletjih opisal Mandl, tem pa je sledila še nova, zelo izrazita vrsta iz Bidovčeve luknje pri Kranju, ki jo je našel in kot *A. muellerianus* (Pretner, 1963) opisal Pretner.

Nedavno pa so nove raziskave pripeljale k odkritju vrste *A. milleri alpinus* (Drovenik, Mlejnek & Moravec, 1995) kot tudi nove vrste v Italiji *A. grottoloi*, najdene v jami Grotta di Taipana kakih 20 km severovzhodno od Vidma (Vailati, 2004). Vendar je Vailati, ki poudarja, da gre za sintopijo nove vrste z *A. milleri forojulensis*, izrazil dvom o pravilnem rangiranju več podvrst *A. milleri* in izrazil potrebo po temeljiti reviziji rodu *Aphaobius*.

Medtem pa so bile med obsežnimi in temeljitimi terenskimi raziskavami, ki so se jim v zadnjih letih posvečali predvsem eden od avtorjev članka (M. Bognolo) ter njegovi kolegi iz Slovenije in Avstrije (B. Kofler, S. Polak, A. Kapla, T. Lebenbauer, H. Mixanig, M. Kahlen), odkrite številne populacije, ki so nazadnje le zagotovile nadvse uporabno gradivo za že dolgo pričakovano revizijo.

Kot je bilo pričakovati, so bile nekatere podvrste *A. milleri* potrjene kot veljavne vrste, druge kot sinonimi, medtem ko so bile z odkritjem novih vrst pridobljene dodatne informacije, potrebne za ugotavljanje kompleksne sistematike in razširjenosti tega rodu.

Rod *Aphaobius* je razširjen predvsem v Sloveniji, pri čemer nekatere populacije dosegajo južno Avstrijo (Koroška), severovzhodno Italijo (Furlanija) in severozahodna območja Hrvaške (Istra, Gorski Kotar in Žumberačka gora). Vrste iz rodu *Aphaobius* so navadno najdene v jamah, tako ob vhodih vanje kot v njihovih najglobljih delih; v severnem delu območja razširjenosti pa so bili mnogi osebki odkriti v starih zapuščenih rudnikih ali celo zunaj jam, v podzemeljskem okolju ali sistemu z manjšimi razpokami.

Vse lokalitete z najdenimi osebki, bodisi jame bodisi podzemeljski sistemi z razpokami, ležijo znotraj apnencev ali konglomeratov na nadmorskih višinah med 300 m do več kot 2000 m v alpskem pasu.

Rod sestavljajo štiri skupine vrst: *muellerianus*, *heydeni*, *kraussi* in *milleri*.

Severno skupino *kraussi* sestavljajo vrste, razširjene vzdolž levega brega reke Save, in sicer *A. mixanigi* n. sp., *A. angusticollis* n. sp., *A. knirschi* Müller, 1913 n. stat., *A. brevicornis* Mandl, 1940 n. stat. in *A. kraussi* Müller, 1910. Južna skupina *milleri* pa je skupek vrst, razširjenih vzdolž desnega brega Save, in vključuje *A. forojulensis* Müller, 1931 n. stat., *A. grottoloi* Vailati, 2004, *A. lebenbaueri* n. sp., *A. miricae* n. sp., *A. kaplai* n. sp., *A. fortesculptus* Müller, 1910 n. stat., *A. robustus* Müller, 1914 n. stat., *A. kahleni* n. sp., *A. milleri* (Schmidt, 1855), *A. ljubnicensis* Müller, 1914 n. stat., *A. kofleri* n. sp. in *A. alphonsi* Müller, 1914 n. stat..

Skupini *muellerianus* in *heydeni* vsebujeta le po eno vrsto, in sicer *A. muellerianus* Pretner, 1963 in *A. heydeni* Reitter, 1885, ki pa ju zaradi njunih posebnih značilnosti zlahka ločimo od vseh vrst iz rodu *Aphaobius* že po njuni zunanji morfologiji.

Bogato zbrano gradivo in morfometrični podatki so omogočili razjasnitev sorodstev med vsemi doslej znanimi populacijami. Tako so bili identificirani novi sinonimi za podvrste, ki glede na opravljene statistične analize niso s taksonomskega vidika pokazale nobenih pomembnejših odklonov.

Celotna razširjenost rodu *Aphaobius* kaže na kombinacijo vrst z velikimi območji razširjenosti in drugih vrst, znanih z ene lokalitete ali iz zelo omejenega geografskega območja. Poleg tega

je relativna konvergenca v zunanji morfologiji populacij, ki pripadajo različnim vrstam, otežila komparativni pristop, ki sloni zgolj na kvalitativni analizi na novo odkritih vrst. To pa je najverjetneje glavno gonilo za opis mnogih podvrst *A. milleri* v minulem stoletju. Dejstvo je, da so analize, opravljene v okviru teh proučevanj, dokazale, da identificiranje racionalne taksonomske segregacije ni vselej možno, razen če ne opravimo podrobnih morfometričnih primerjav pri vseh znanih geografskih populacijah.

Še ena izjemna ugotovitev, ki jo poudarja že Pretner (1963) in so ji v podporo nedavna odkritja (npr. *A. miricae* n. sp., Škofja Loka), je izjemno osredotočenje različnih vrst v omejenem območju okrog Škofje Loke. Zdi se, da analiza paleogeografskih podatkov daje misliti, da je višja gostota vrst v območju med Ljubljano in Železniki povezana z alopatričnim nastajanjem vrst zaradi segregacije določenih območij razširjenosti, izvirajočih iz kvartarja.

Po drugi strani pa južni del območja razširjenosti tega rodu naseljuje samo vrsta *A. milleri* z več lokalnimi populacijami, ki pa ne kažejo kakih taksonomsko pomembnih razlik bodisi po svojih morfoloških značilnostih bodisi po obliki kopulacijskega organa. Takšno stanje spominja na razširjenost rodu *Bathyscimorphus* (Jeannel, 1910); zelo majhne razlike med populacijami v južni Sloveniji in na Hrvaškem, razširjenimi v širokem in geološko različnem območju, so verjetno posledica nedavne ali pa celo še ne zaključene segregacije.

Povezanost paleogeografskih značilnosti in alopatričnega nastanka vrst postane jasnejša, ko preučujemo skupini *kraussi* in *milleri* skupaj, ne pa, da se osredotočamo na eno samo vrsto. Severna skupina *kraussi* je geografsko razširjena znotraj Južnih Alp, južna skupina *milleri* pa predvsem v Zunanjih Dinaridih. Povsem jasno je torej, da sta bili takšni skupini zlasti v osrednji Sloveniji (območje med Ljubljano in Kranjem) daljše obdobje izolirani zaradi premikov plošč, ki glede na njuno tektoniko drsita vzdolž stične meje, ki jo ponazarja savska prelomnica.

Če povzamemo, vzorci nastajanja vrst iz rodu *Aphaobius* kažejo na nekdanjo izolacijo v območju med Ljubljano in Železniki, katere značilnost je zapletena paleogeografska evolucija, v nasprotju z visoko razpršitveno aktivnostjo južnega območja vzdolž značilne severozahodne do jugovzhodne usmerjenosti mezozoičnih apnencev na severnem Balkanu.

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