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**ANOPHTHALMUS ANNAMARIAE SP. N. (COLEOPTERA: CARABIDAE)
AND NOTES ON THE BEETLES OF THE CAVE LEDENICA PRI DOLU
(TRNOVSKI GOZD, SLOVENIA)**

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Abstract – *Anophthalmus annamariae* sp. n. from Slovenia is described. The new species, discovered in the endogean environment of a deep doline near Predmeja (Trnovski Gozd, Slovenia), differs from related species by the external morphology and shape of the copulatory piece of the male genital organ. Beetles, recorded in the karst system of the cave Ledenica pri Dolu, are listed in this paper also.

KEY WORDS: Coleoptera, Carabidae, *Anophthalmus*, new species, cave Ledenica pri Dolu.

Izveleček – *ANOPHTHALMUS ANNAMARIAE* SP. N. (COLEOPTERA: CARABIDAE) IN ZAPISKI O HROŠČIH JAME LEDENICA PRI DOLU (TRNOVSKI GOZD, SLOVENIJA)

Opisan je *Anophthalmus annamariae* sp. n. iz Slovenije. Nova vrsta, ki smo jo odkrili v podzemnem okolju globoke kraške vrtače pri Predmeji (Trnovski Gozd, Slovenija), se razlikuje od podobnih vrst po zunanji morfologiji ter obliki kopulacijskega dela samčevega genitalnega organa. V delu predstavljamo tudi pregled hroščev, ki smo jih ugotovili v kraškem sistemu jame Ledenica pri Dolu.

KLJUČNE BESEDE: Coleoptera, Carabidae, *Anophthalmus*, nova vrsta, jama Ledenica pri Dolu.

Introduction

Between May and November 2001 a systematic survey had been carried out, with the aim of improving the knowledge of the beetles living in the cave Ledenica pri

Dolu (Slovene cave register no. 751). The cave entrance is situated near Predmeja, at the south-eastern edge of the forest of Trnovo (Trnovski gozd); the Ledenica pri Dolu karst system is actually consisting of the cave itself and the entrance doline, which is deeper than thirty metres.

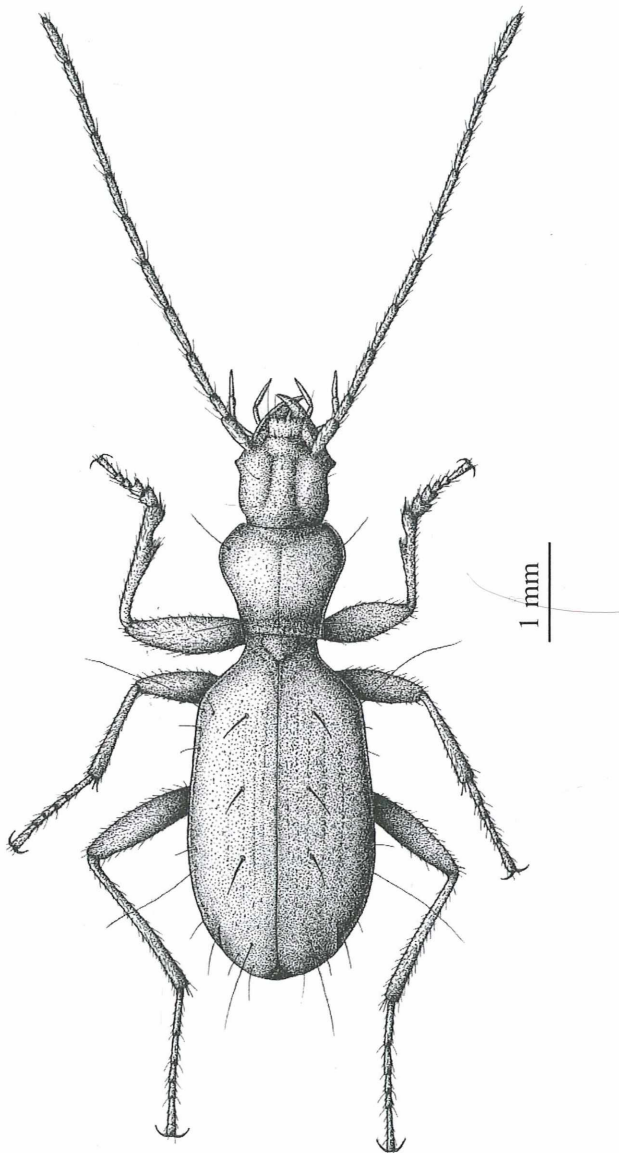


Fig. 1: *Anophthalmus annamariae* sp. n. (holotype ♂; Slovenija: Ledenica pri Dolu), habitus

The microclimate is characterized by low temperature (thermal inversion in the doline) and high humidity. During winter, ice stalactites and stalagmites are present in the cave; at the entrance the snow normally lasts from late autumn till middle spring. From biological point of view, the abundance of organic matter represents an important source of food for the endogean and troglobiontic beetles. Therefore it is not surprising that a lot of species have already been recorded in the past (Pretner, 1955). Some of them are endemic of the forest of Trnovo, some even limited to the cave Ledenica only.

The research added some interesting data to the knowledge of the beetles of the Ledenica pri Dolu karst system; particularly, a new species of the genus *Anophthalmus* had been found. The description of the new taxon is the subject of this paper.

Anophthalmus annamariae sp. nov.

Type locality: Slovenija, Trnovski gozd, Predmeja (Nova Gorica), dolina jame Ledenica pri Dolu.

Type series: Holotype ♂, Slovenija, Trnovski gozd, Predmeja (Nova Gorica), dolina jame Ledenica pri Dolu, 29. 9. 2001, M. Bognolo leg., coll. (PMSL) Prirodoslovni muzej Slovenije, Ljubljana (Slovenija). Paratypes: Slovenija, Trnovski gozd, Predmeja (Nova Gorica), dolina jame Ledenica pri Dolu, 3 ♀♀, 30. 6. 2001, 4 ♀♀, 15. 8. 2001, 3 ♂♂ and 9 ♀♀, 29. 9. 2001, 1 ♀, 11. 11. 2001, M. Bognolo leg. (coll. Prirodoslovni muzej Slovenije, Ljubljana; coll. Biološki Inštitut Jovana Hadžija, Ljubljana; coll. (NMPO) Notranjski muzej Postojna, Postojna; coll. M. Bognolo, Trieste).

Diagnosis: A medium-sized *Anophthalmus* (Fig. 1) belonging to the *mariae* group (Daffner, 1998), which is characterized by short and thin pubescence on the body.

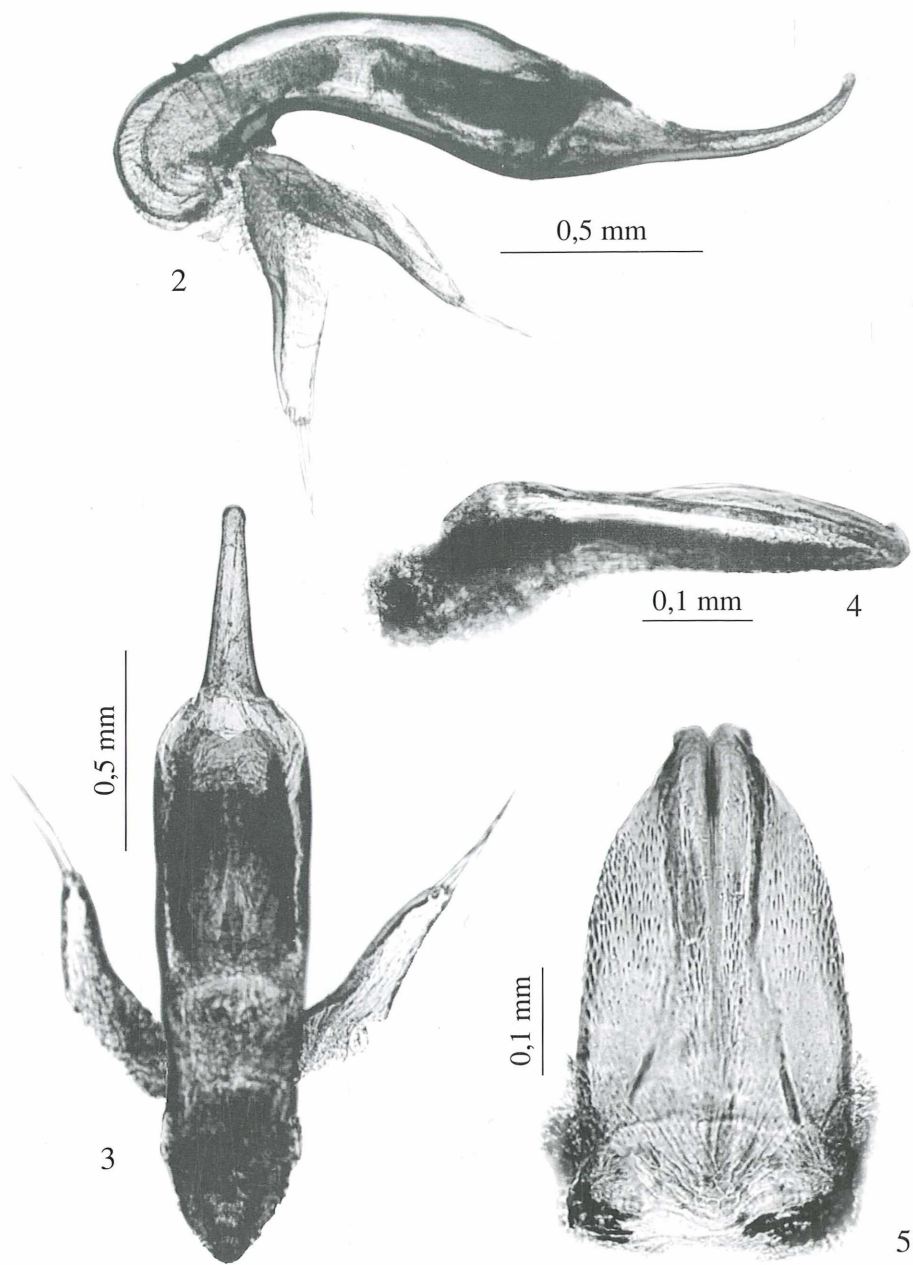
The main differential character is the shape of male genital organ. Lateral sides of the copulatory piece converge toward apex. The apical median incision is much shorter compared to other species of the *mariae* group. In the external morphology, the new species is distinguished by the shape of pronotum: in the posterior half the lateral sides are concave, while they are almost straight in related species. Elytra are wide, with the maximum width posteriorly.

Description: Length: ♂♂ 5.9 – 6.2 mm (holotype 5.9 mm), ♀♀ 5.5 – 6.3 mm (from apices of mandibles to apices of elytra).

Pubescence short and thin on pronotum and elytra, nearly absent on the head, more dense on the antennomeres.

Microsculpture in the form of isodiametric microreticulation, irregularly distributed on head and pronotum. On the elytra the reticulation is transversally elongated.

Body reddish brown; head and pronotum shiny, elytra shiny in males and opaque in females.



Figs. 2-5: *Anophthalmus annamariae* sp. n., 2: aedeagus in lateral view (paratype), 3: aedeagus in dorsal view (paratype), 4: copulatory piece in lateral view (holotype), 5: copulatory piece in dorsal view (holotype)

Head robust, narrower than pronotum. Frontal furrows deep and complete, posteriorly divergent, almost reaching the neck. Frons and supraorbital areas convex; two pairs of supraorbital setae present. Labrum transverse, anteriorly thickened, with lateral sides convergent toward the base. Mandibles strong, arcuate at apex. Labial and maxillary palpi thin. Antennae long and slender, reaching two thirds of elytra in males and three fifths of elytra in females. The 10th antennomere is nearly 3.5 times longer than wide.

Pronotum cordate, slightly wider than long (length/width ratio: ♂♂ 0.90 – 0.94; holotype 0.94; ♀♀ 0.89 – 0.93), with the maximum width at about three fourths from the base. The basal margin is straight, feebly sinuate at middle, a little narrower than the anterior margin; lateral sides strongly curved in the anterior half, sinuated in the posterior one. Front and hind angles obtuse. Basal impression deep, transversally extending from the median line. Dorsum convex, with evident median line. Two marginal setae are present on each side; the first one near the anterior fourth, the second near hind angle.

Elytra ovate (length/width ratio: ♂♂ 1.76 – 1.80; holotype 1.77; ♀♀ 1.81 – 1.89), convex, widest in the posterior half. Prehumeral and posthumeral borders straight, shoulders rounded. Apices of elytra separately rounded, sutural angle obtuse. Discal series consisting of three setiferous pores aligned on the fourth interstria; the first pore is situated near the basal fifth of elytra, the second pore approximately at middle, the third as distant from the second as the first pore from the second. Humeral group consisting of four pores, the first placed inward at the same level with the second pore. Pores 2 to 4 adjoining the marginal gutter. Third pore distant from the second 1.5 times the distance between the first and the second pore. The distance between the third and the fourth nearly equal to the distance between the second and the third. Other pores of the lateral umbilicate series as in Fig. 1.

Legs stout and long, covered by dense and short pubescence; the first two protarsomeres of males dilated.

Male genital organ (Figs. 2, 3) relatively large (holotype: 1.9 mm), with the basal part rounded and enlarged. The median lobe enlarged in the basal three fourths, straight and symmetrical in dorsal view, regularly curved in lateral view; the apex very long and thin, curved upwards in lateral view. The inner sac densely covered with small chitinized scales.

Copulatory piece symmetrical in dorsal view (Fig. 5), with lateral sides convergent toward the apex, apical teeth very small, median incision short; nearly flat in lateral view (Fig. 4), longitudinal carina low, small apical tooth hardly visible.

Ligula sclerotized, bilobed, with sides largely rounded. Parameres usually bearing four apical setae.

Derivatio nominis: The new species is dedicated to the memory of my mother Annamaria; no word could ever express my neverending thanks for her love and precious teaching.

Distribution and ecology: *Anophthalmus annamariae* sp. n. is known so far only from the type locality (Fig. 6), where it can be found in the rock fissures of the endo-

gean environment, in the lower half of the doline, which leads to the cave Ledenica pri Dolu; in this habitat the new species had been found using pitfall traps placed at depths between 10 and 30 cm. The findings refer to the period from May to October. As the season advances and the snowy deposit melts, *A. annamariae* sp. n. becomes more frequent near the entrance of the cave; in this place the optimal humidity and temperature last longer. The frequency of findings in the traps is highest in September, after the late summer rains. In this period the temperature at the entrance of the cave is about 10 °C and the relative humidity reaches the highest level (over 80 %). These are likely the ideal conditions for *A. annamariae* sp. n. in the upper layer of the endogean environment.

Simultaneous collecting by hand and using traps had been carried out inside the cave Ledenica pri Dolu, where not a single specimen of the new taxon was found. Such a result could be explained by the competitive presence of two other species of *Anopthalmus* in the inner spaces of the cave.

Notes and comparisons

Anopthalmus annamariae sp. n. belongs to the *mariae* group, as recently defined by Daffner (1998). *A. mariae* (Schatzmayr, 1904), *A. baratellii* Sciaky, 1985, *A. egonis* (Müller, 1923), *A. tolminensis* (Müller, 1922), *A. besnicensis* Pretner, 1949, *A. besnicensis frater* Daffner, 1998, *A. bojani* Daffner, 1998 and *A. kahleni* Daffner, 1998 also belong to this group.

Except for *A. mariae* and *A. baratellii*, all species, including *A. annamariae* sp. n., form a rather homogeneous sub-group, regarding their distribution (Fig. 6), as well as the external and aedeagic morphology; in particular, the median lobe of the aedeagus is characterized by a markedly enlarged shape in the basal three fourths, while the apex is thin and extremely lengthened (Fig. 2). The sub-group just defined will be referred to as *tolminensis*, after the name of the first species described.

In addition to the morphological differences, which have been pointed out in the description of the new species, *A. annamariae* sp. n. differs from the related taxa by the preference of the endogean environment, rather than the hypogean one. All other species of the *tolminensis* sub-group have been found so far only inside caves. With reference to the shape of the copulatory piece, *A. annamariae* sp. n. is more closely related to *A. egonis*, which is the northernmost taxon. Further research in hypogean and endogean environments could fill the gap between the northern and southern taxa; such a hypothesis is strengthened by recent discovery of *A. kahleni* on the Matajur and *A. bojani* in a couple of caves near Žiri. As a matter of fact, the discovery of *A. annamariae* sp. n. enlarges further the range of the *tolminensis* sub-group as the whole (Fig. 6). Moreover, the new finding puts the attention once again toward a group of species, which is still not studied enough. Concerning both the external morphology and the colonized habitat, the *mariae* group can be considered a link between the endogean *Anopthalmus* (like the species *A. scopolii* and *A. kaufmanni*)

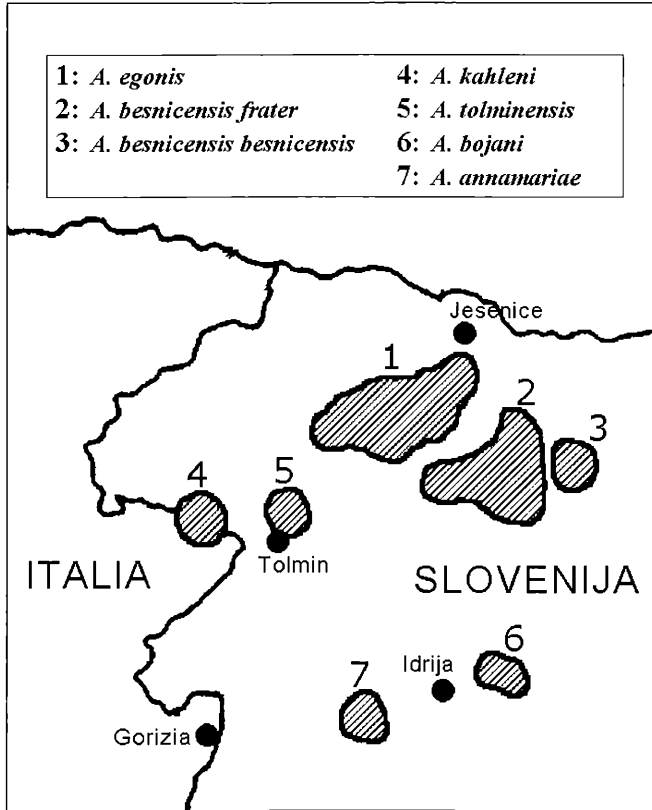


Fig. 6: Distribution of the *tolminensis* sub-group

and the hypogean ones, mainly belonging to the groups *micklitzi*, *ajdovskanus* and *hirtus* (Daffner, 1996).

The beetles of the cave Ledenica pri Dolu

The Ledenica pri Dolu (reg. no. 751) karst system is consisting of two main habitats: the endogean environment in the entrance depression and the inner spaces of the cave.

Outside the cave, temperature and humidity change according to the seasonal average values, strongly influenced by the thermal inversion in the doline as well; the latter effect causes the air to be cooler, during spring and summer, in the lower position, near the cave entrance. Inside the cave temperature and humidity are nearly steady and also the seasonal variation is usually not exceeding 5 °C for temperature and 10% for relative humidity.

The research had been carried out mainly with pitfall traps, regularly inspected every six weeks in the period from May to November 2001. Ten traps were put in

Location	Family	Species	n. of specimens	Frequency
Middle part of the entrance doline	Carabidae	<i>Trechus croaticus</i>	27	35,1%
		<i>Anophthalmus schmidti insignis</i>	15	19,5%
		<i>Anophthalmus scopolii glacialis</i>	14	18,2%
		<i>Anophthalmus annamariae</i>	6	7,8%
		<i>Orotrechus globulipennis chendai</i>	6	7,8%
		<i>Stomis rostratus</i>	4	5,2%
		<i>Abax ovalis</i>	2	2,6%
		<i>Nebria diaphana bohiniensis</i>	2	2,6%
	<i>Laemostenus schreibersi</i>	1	1,3%	
	Cholevidae	<i>Bathyscimorphus byssinus</i>	178	37,7%
		<i>Aphaobius milleri</i>	138	29,2%
		<i>Bathysciola silvestris</i>	98	20,8%
		<i>Bathyscimorphus sp.</i>	58	12,3%
Silphidae	<i>Necrophilus subterraneus</i>	21	—	
Lower part of the entrance doline	Carabidae	<i>Anophthalmus annamariae</i>	15	30,0%
		<i>Laemostenus schreibersi</i>	15	30,0%
		<i>Anophthalmus schmidti insignis</i>	9	18,0%
		<i>Trechus croaticus</i>	7	14,0%
		<i>Nebria diaphana bohiniensis</i>	3	6,0%
		<i>Anophthalmus scopolii glacialis</i>	1	2,0%
	Cholevidae	<i>Aphaobius milleri</i>	163	76,9%
		<i>Bathyscimorphus byssinus</i>	39	18,4%
		<i>Bathyscimorphus sp.</i>	10	4,7%
	Silphidae	<i>Necrophilus subterraneus</i>	3	—
	Twilight zone of the cave	Carabidae	<i>Anophthalmus ravasinii</i>	101
<i>Anophthalmus sanctaeluciae fabioi</i>			19	14,4%
<i>Nebria diaphana bohiniensis</i>			11	8,3%
<i>Laemostenus schreibersi</i>			1	0,8%
Cholevidae		<i>Premeria latitarsis</i>	439	59,1%
		<i>Aphaobius milleri</i>	141	19,0%
		<i>Astagobius angustatus laticollis</i>	78	10,5%
		<i>Oryotus schmidti</i>	76	10,2%
		<i>Bathyscimorphus byssinus</i>	7	0,9%
		<i>Leptodirus hochenwarti</i>	2	0,3%
Silphidae		<i>Necrophilus subterraneus</i>	6	—
Dark zone of the cave	Carabidae	<i>Anophthalmus ravasinii</i>	5	83,3%
		<i>Anophthalmus sanctaeluciae fabioi</i>	1	16,7%
	Cholevidae	<i>Astagobius angustatus laticollis</i>	41	52,5%
		<i>Premeria latitarsis</i>	21	26,9%
		<i>Oryotus schmidti</i>	13	16,7%
		<i>Leptodirus hochenwarti</i>	2	2,6%
		<i>Aphaobius milleri</i>	1	1,3%
	Silphidae	<i>Necrophilus subterraneus</i>	1	—

Tab. 1: Beetles recorded in the karst system of the cave Ledenica pri Dolu (the frequency is to be referred to each family)

the endogean environment, five of them covering the area in the middle part of the doline, the remaining five traps in the way to the cave entrance. Another ten traps were placed inside the cave, respectively half of them in the twilight zone and the other half in the dark zone, corresponding to the inner spaces of the cave. Temperature and relative humidity, as well as the species and their occurrence, have been recorded for each trap and on each visit to the cave.

As it often happens in most Slovenian karst systems, the Cholevidae are the predominant beetles, compared to Carabidae or other families. In the middle part of the entrance depressure the dominant Cholevidae belong to the genera *Bathyscimorphus*, *Aphaobius* and *Bathysciola* (Tab. 1). These probably represent the main source of food for the carabid beetles. The dominant Carabidae are *Trechus croaticus*, *Anophthalmus schmidti insignis* and *Anophthalmus scopolii glacialis*. Besides, *Orotrechus globulipennis chendai* is recorded for the first time in the forest of Trnovo. At the entrance of the cave both species of the genus *Bathyscimorphus* become less frequent, while there is a relevant increase in the occurrence of *Aphaobius*. Here the dominant Carabids are *Anophthalmus annamariae* sp. n., *Laemostenus schreibersi*, *Anophthalmus schmidti insignis* and *Trechus croaticus*. In the large central hall of the cave Ledenica pri Dolu, where still some daylight penetrates, the fauna clearly changes. *Pretneria latitarsis* becomes the dominant species, combined with a minor presence of *Aphaobius milleri*, *Astagobius angustatus laticollis* and *Oryotus schmidti*. Both here and in the inner spaces the species *Leptodirus hochenwarti* is absolutely exceptional. The dominant Carabid is *Anophthalmus ravasinii*; another concurrent species of the genus *Anophthalmus* is present (*A. sanctaeluciae fabioi*), as well as the troglophile *Nebria diaphana bohiniensis*. In the final parts of the Ledenica pri Dolu, which are completely dark, the organic matters get quite scarce, mainly carried in the cave by means of the water flowing along the walls. This habitat is the optimal one for the species *Astagobius angustatus laticollis*, which can be frequently found where the dripping is stronger, often wandering on wet stones.

In addition to the discovery of a new *Anophthalmus* and a new *Bathyscimorphus* (Bognolo, in print), the data recorded so far (Tab. 1) show the presence of twenty taxa of beetles; there are seven Trechinae (Coleoptera, Carabidae) belonging to three different genera, and eight Leptodirinae (Coleoptera, Cholevidae), belonging to seven genera. Considering this, the karst system of the cave Ledenica pri Dolu and the entrance depressure represent a significant model of biodiversity in a very limited space.

Acknowledgements

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