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Source: Revue suisse de Zoologie, 128(2) : 425-438

Published By: Muséum d'histoire naturelle, Genève

URL: https://doi.org/10.35929/RSZ.0054

Revue suisse de Zoologie (September 2021) 128(2): 425-438 ISSN 0035-418

A new cave-dwelling centipede species from Croatia (Chilopoda: Lithobiomorpha: Lithobiidae)

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Abstract: A new species of minute cave-dwelling centipedes, *Lithobius radjai* sp. nov., is described and illustrated based on specimens collected from a cave in Croatia (Balkan Peninsula). A detailed account of the morphology of specimens of both sexes is provided. Furthermore, a brief comparison with other morphologically similar species is presented, and the type locality of the new species is mapped.

Keywords: "*Monotarsobius*" - troglomorphic - endemic - Dinaric karst - Dalmatia - Balkan Peninsula.

INTRODUCTION

As the largest limestone region in Europe, the Dinaric karst is one of the world's richest hotspots of subterranean biodiversity, inhabited by more than 900 troglobitic species (Sket *et al.*, 2004). This extraordinary number of troglobites increases every year, mostly as a result of cooperation between biologists and speleologists (Simičević, 2017). A large number of these taxa show a high degree of endemism, some of them having been recorded only from a single cave, pit and/or mountain massif. Even today, two and a half centuries after the description of the famous cave olm *Proteus anguinus* Laurenti, 1768, nearly 330 years after its first find (Valvasor, 1689), and almost 190 years after the description of the first cave-adapted blind arthropod (*Leptodirus hochenwartii* Schmidt, 1832), there still are new "major" discoveries from the Dinarides. Such are, e.g. the recent discovery and description of the first troglobitic scorpion in Europe (Karaman, 2020), a new millipede family (Antić *et al*., 2018), etc. "Large" troglobitic and stygobitic species in different animal groups are still being discovered from Dinaric subterranean habitats, while the number of tiny arthropods, like the new species described here, is even higher (e.g. Antić *et al*., 2016; Akkari *et al*., 2017; Bedek *et al*., 2019a, b; Lukić *et al.*, 2018; Pavićević *et al*., 2020; Stoev *et al*., 2015; Švara *et al*., 2015).

In this study, we describe a tiny new cave-dwelling species of *Lithobius* Leach, 1814 on the basis of specimens collected from the cave Velika Ćulumova Pećina on the Kijevo karst plateau (part of the central Dinarides, southern Croatia, Balkan Peninsula).

MATERIAL AND METHODS

The type series of the new species includes 10 specimens (five females, four males and one larva III; labeled as L1-L10). Each analysed specimen is preserved in a single labeled vial with 70% ethanol. The material is deposited in the collection of the Natural History Museum, Split, Croatia (NHMSC), and in the collection of the Institute of Zoology, University of Belgrade, Faculty of Biology, Serbia (IZB).

After preparation of temporary microscope slides with glycerin, photos of body parts and whole specimens were made with a Canon PowerShot A80 digital camera connected to a Carl Zeiss Axioscope 40 compound microscope, as well as with a Nikon DS-Fi2 camera with a Nikon DS-L3 camera controller attached to a Nikon SMZ 1270 binocular stereo microscope. For processing of the final images we used the Zerene Stacker software (for focal stacking) and Adobe Photoshop CS6. The drawings were created from photos using tracing paper and a computer monitor. The specimens were measured using a Carl Zeiss Stemi 2000-C dissecting stereomicroscope with an AxioCam MRc camera and integrated Axio Vs40 software packages. The distribution map was created using the blank simple map of Croatia (downloaded from

Manuscript accepted 30.06.2021
DOI: 10.35929/RSZ.0054

the web site "d-maps.com") and Adobe Photoshop CS6. The terminology of external morphology used in the description follows Bonato *et al*. (2010). The developmental stage of the only collected larval specimen (IZB ChL027-L9) was identified using the proposition for larval stage separation given by Andersson (1979). The description of antennal sensilla follows the terminology recommended by Müller *et al*. (2011). Finally, we used the ChiloBase electronic database (Bonato *et al*., 2016) to make a list of European species of the "subgenus *Monotarsobius* Verhoeff, 1905" [see the recommendations for selected *Lithobius* subgenera given by Ganske *et al*. (2021)] for the purpose of comparison with other morphologically similar species.

Abbreviations following Eason (1964) are used in the text and in the tables: a = anterior, C = coxa, D = dorsal, F = femur, m = median, p = posterior, Pf = prefemur, T, TT = tergite, tergites, Ti = tibia, Tr = trochanter, V = ventral. Other abbreviations in the figures used to mark some of the morphological structures are explained directly in the figure legends.

TAXONOMY

Lithobius radjai Stojanović, Antić & Makarov, sp. nov.

Figs 1-4

Holotype: NHMSC L10; female; Croatia, Šibenik-Knin County, Municipality of Kijevo, the cave Velika Ćulumova Pećina, under stones in dark part of the cave, 43.98925°N, 16.37227°E, 451 m a.s.l.; 15.04.2006; leg. T. Rađa.

Paratypes: NHMSC; 1 male, 1 female (NHMSC L1 and L4); same data as for holotype. – IZB; 3 males, 3 females, 1 larva III (IZB ChL027-L3, -L6 and -L7; IZB ChL027-L2, -L5 and -L8; and IZB ChL027-L9, respectively); same data as for holotype.

Diagnosis: The new species is distinguished from its congeners by a unique combination of characters: the translucent cuticle of its whitish body; small size (ca 5-6 mm in adults); antennae composed of 20-22 articles; two partly depigmented ocelli in a horizontal line; Tömösváry's organ slightly smaller or equal to adjoining ocellus; 2+2 coxosternal teeth; porodonts moderately slender; no triangular projections on posterior angles of all tergites; tarsi of legs 1-13 undivided; 1-2 (usually 2) roundish coxal pores; female gonopods with 2+2 coniform spurs and a tridentate apical claw; male gonopods short, with one long seta; no sexual dimorphism in terminal legs; posterior accessory spines on penultimate and ultimate legs present, without anterior accessory spines.

Lithobius radjai sp. nov. can be clearly distinguished from morphologically similar European *Lithobius* species by the combination of characters presented in Table 1.

Etymology: The new species is named in honour of our friend and colleague Tonći Rađa (Split, Croatia), a well-known biospeleologist and the collector of the type material of the new species. The epithet, a name in the genitive case, is a patronym.

Description:

Measurements: Female holotype 4.8 mm long, ca 0.5 mm in widest part of the trunk. Body length of female paratypes (n = 4), male paratypes (n = 4), and larva III (n = 1): 4.7-6 mm, 4.9-5.3 mm and 2.4 mm, respectively.

Colouration (Figs 1C, 4C): Whitish, with pale yellowish, slightly sclerotized parts (cephalic capsule, forcipular coxosternite, tergites, leg claws and antennae), translucent over entire surface, especially on legs and trunk; possible slight discolouration after nearly 15 years in ethanol.

Antennae: - $^1/_5$-$^1/_4$ of body length in adults, and $^1/_3$ of body length in larval specimen; ca 2.5 times longer than cephalic capsule, narrowing distad (Figs 1C-D, 2A). Mostly 20-22 antennal articles in adults (in holotype 22+20), larva III with 14 articles in both antennae. Terminal article ca 2.5 times as long as broad (Fig. 2A). In female holotype total length of left and right antenna 1.3 mm and 1.1 mm. Length of the antennae in male paratypes 1.2-1.4 mm; in female paratypes 1.0-1.2 mm; in larva III specimen each antennae ca 0.9 mm. All antennal articles with numerous sensilla trichodea. Additionally, last antennal article with sensilla microtrichodea distally and with two long sensilla basiconica laterally, one each on opposite sides of article (present also in larva III) (Fig. 2B).

Cephalic plate: Generally smooth, with few setae mostly scattered on plate margin. Posterior margin almost straight; cephalic plate slightly narrowing anteriad (Fig. 2A). Plate length and width in holotype 0.47 mm and 0.49 mm, respectively; in male paratypes length 0.46-0.52 mm, width 0.45-0.51 mm; in female paratypes length 0.47-0.52 mm, width 0.47-0.51 mm; in larva III length 0.29 mm, width 0.34 mm (length/width ratio: holotype 0.96:1; male paratypes 1.02:1; female paratypes 1:1 to 1.04:1; larva III 0.85:1).

Ocelli: Two roundish ocelli on each side in a horizontal line (Fig. 1A-B); anterior ocellus almost twice as large as posterior one; both depigmented in the centre, with pale brown to chestnut brown pigmented ring around them.

Tömösváry's organ: Oval; slightly smaller or of same size as anterior ocellus; lying anteroventral to ocelli on anterolateral margin of cephalic capsule (Fig. 1A-B).

Forcipular segment (Fig. 2C): Coxosternite sub-trapezoidal; its anterior margin narrow, with external sides slightly higher than internal sides; dental margin with 2+2 small teeth of same size; medial diastema moderately deep, U-shaped, with approximately same width and depth; porodont moderately slender, positioned posterolateral to lateral tooth; no shoulders of forcipular coxosternite lateral to teeth; a few setae scattered in anterior part of coxosternite.

Tergites (Fig. 1C-D): All transparent, smooth; setae

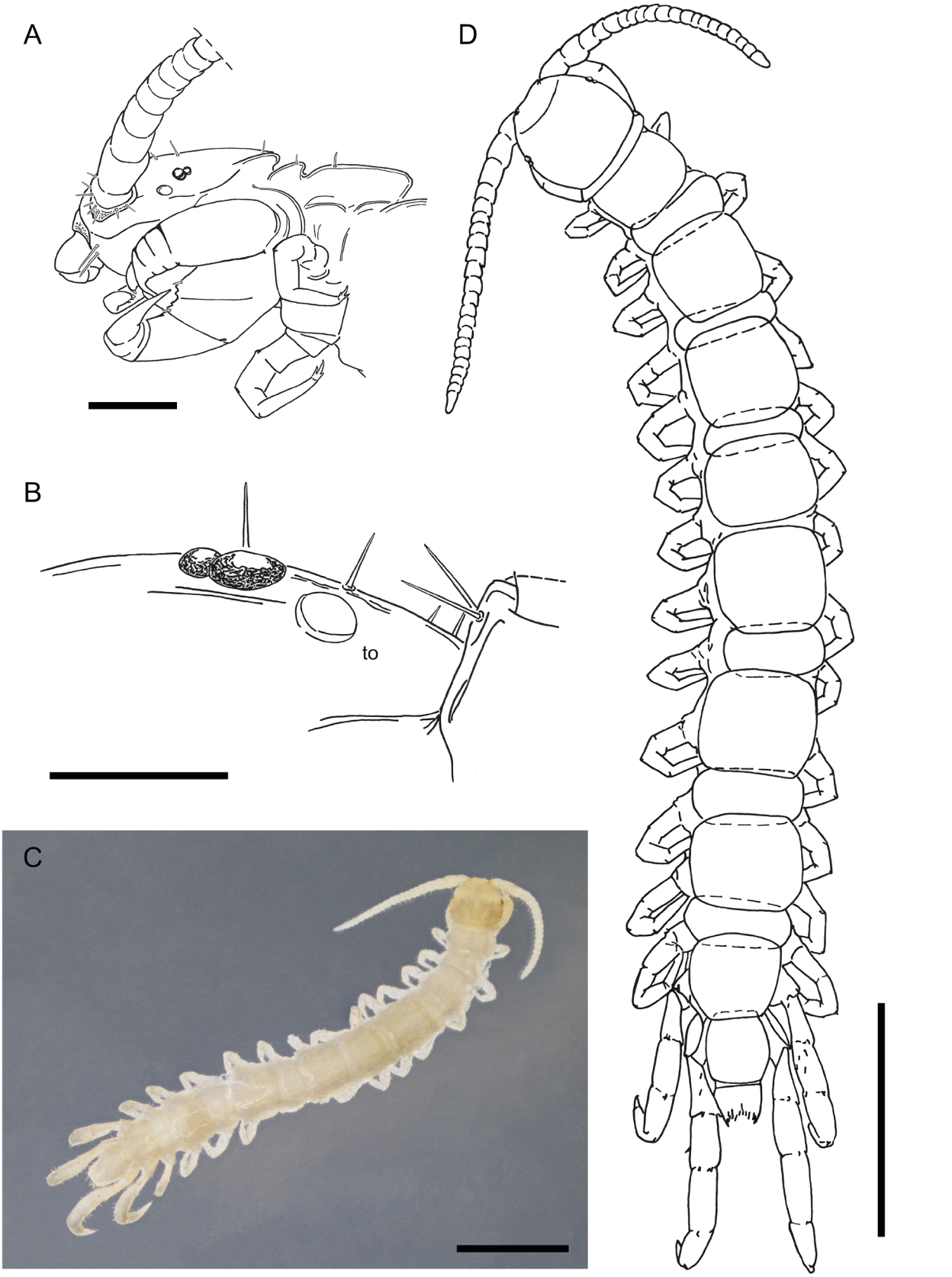

Fig. 1. *Lithobius radjai* sp. nov., ♀ paratype IZB ChL027-L5 (A), ♂ paratype IZB ChL027-L7 (B), ♀ holotype NHMSC L10 (C-D). (A) Head, ventrolateral view. (B) Ocelli and Tömösváry's organ on right side of cephalic capsule, ventrolateral view. (C) Habitus, dorsal view. (D) Habitus, dorsal view. Abbreviation: to = Tömösváry's organ. Scale bars: 1 mm (C-D); 0.5 mm (A); 0.1 mm (B).

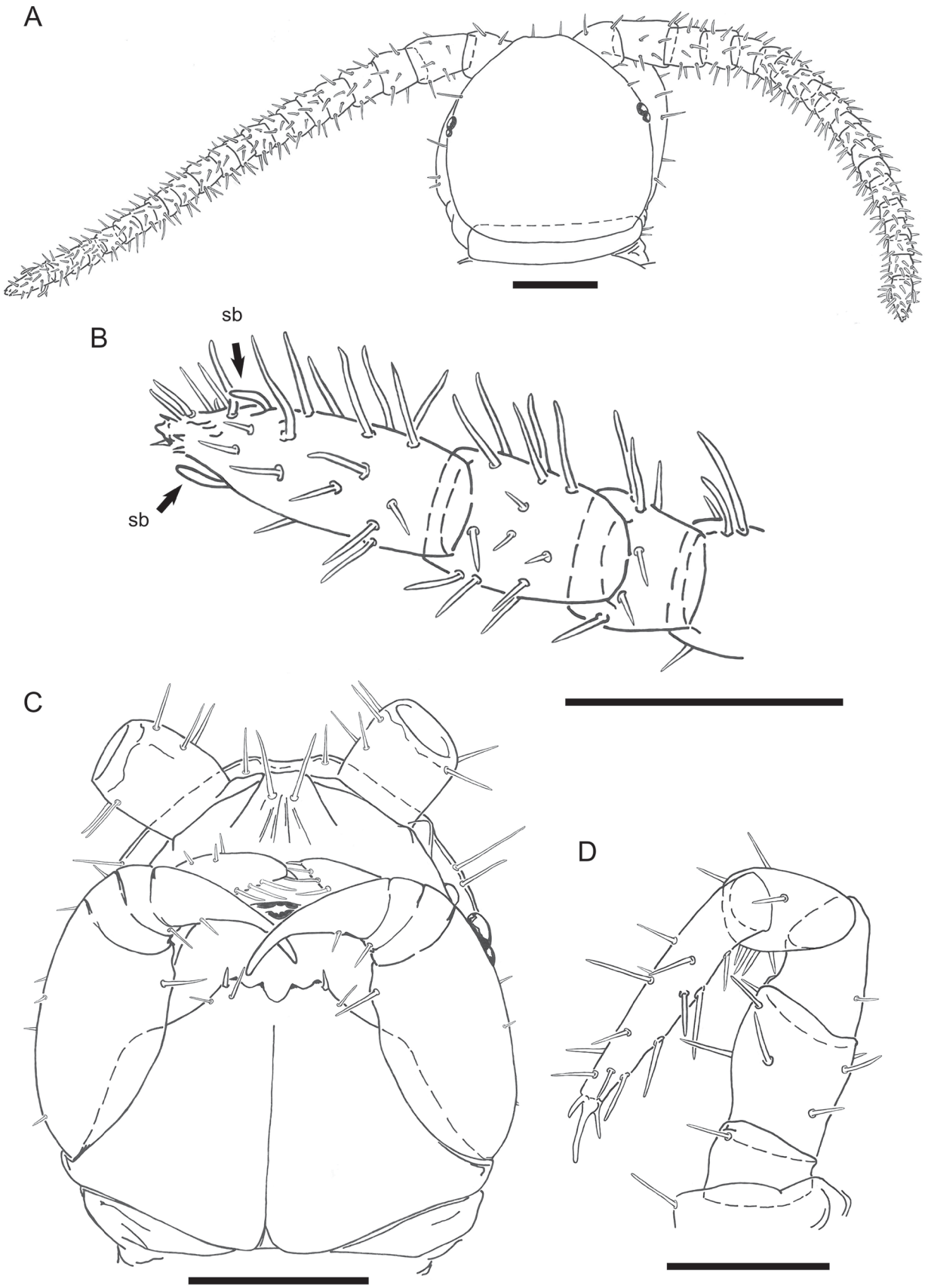

Fig. 2. *Lithobius radjai* sp. nov., ♀ holotype NHMSC L10 (A), larva III paratype IZB ChL027-L9 (B), ♂ paratype NHMSC L1 (C-D). (A) Head, dorsal view. (B) Distal part of right antenna, ventral view. (C) Head, ventral view. (D) Right leg 1, anteroventral view. Abbreviation: sb = sensilla basiconica. Scale bars: 0.2 mm (A, C); 0.1 mm (B, D).

Table 1. Comparison between *Lithobius radjai* sp. nov. and morphologically most similar species of European "*Monotarsobius*" [(?)* = type of accessory spines (anterior or posterior) on leg-pairs 14 and/or 15 not specified in species description].

Species	*Lithobius radjai* sp. nov.	*L. aeruginosus* L. Koch, 1862	*L. anacanthinus* (Matic, 1976)	*L. beshkovi* (Matic & Stavropoulos, 1988)	*L. biunguiculatus* Loksa, 1947
Body length (in mm)	4.7-6	6-11	5-6	9	6
Body colouration	whitish, translucent	orange-yellow	uniformly yellow	light brown	uniformly light yellow
Number of antennal articles	20-22	19-21	19-21	20	20
Cephalic plate length/width (ratio)	≈ 1:1	slightly longer than wide	1:1	1:1	wider than long
Ocelli	1-2 (in one row); partly depigmented	3-6 (usually in one row)	2 (in one row); black	2 (in one row); poorly visible	3-4 (in one row)
Tömösváry's organ	slightly smaller or of same size as terminal ocellus	of same size as terminal ocellus	significantly smaller than ocelli	significantly larger than ocelli	no data
Coxal pores	1-2 (usually 2)	2-4 (usually 3)	1-2 (usually 1)	2-3 (usually 2)	3-4
Plectrotaxy of 14th leg pair	V: -, m, m, m, -; D: -, -, p, -, -	V: -, m, amp, amp, -; D: a, -, mp, p, -	without spines	V: -, -; mp, m, -; D: -, -, mp, -, -	V: -, m, mp, m, -; D: -, -, mp, -, -
Plectrotaxy of 15th leg pair	V: -, m, m, m, -; D: -, -, p, -, -	V: -, m, amp, m, -; D: a, -, mp, p, -	without spines	V: -, -; mp, m, -; D: -, -, mp, -, -	V: -, m, mp, m, -; D: -, -, p, -, -
Accessory spines (anterior/posterior) of 14th leg pair	one (p)	absent	one (?)*	one (?)*	no data
Accessory spines (anterior/posterior) of 15th leg pair	one (p)	absent	one (?)*	absent	one (?)*
Gonopodal spurs (in female)	2+2	2+2	unknown	unknown	2+2
Number of gonopodal claws (in female)	3	3	unknown	unknown	3
Distribution	Croatia	widespread throughout Europe	Greece	Greece	Hungary, Poland, Romania, Slovakia
Habitat	Cave (troglobiont)	Epigeic; several records from caves (troglophile)	thermophilous forests; epigeic	caves and mesophilous forests	mesophilous forests; epigeic
Sources	this study	Loksa, 1947; Koch, 1862; Koren, 1992	Matic, 1976	Matic & Stavropoulos, 1988; Zapparoli, 1994, 2002	Loksa, 1947; Matic, 1966

scarce and irregularly scattered; posterior angles of all tergites rounded, without triangular projections; T1 rectangular in shape, with narrower posterolateral side; posterior margins of TT 1, 2, 4, 6, 8, 11 and 13 straight, in TT 5, 7, 9, 11 and 12 slightly convex, and in TT 3 and 10 slightly concave; anterior margin of TT 1, 5, 7, 8, 9, 11 and 13 straight, slightly convex in TT 3, 6, 10, 12 and 14, and slightly concave in TT 2 and 4; T9 widest of all tergites; intermediate tergites in both sexes with straight posterior margin.

Sternites: Smooth, translucent, with few setae mostly scattered on margins. Generally trapeziform, from more elongate (longer than wide in anterior part of the body) to more stockily trapezoidal (equal in length and width to wider than long in posterior part of body).

Legs: Moderately short and robust; their size progressively increasing toward posterior part, terminal legs noticeably larger than leg-pair 13 (Fig. 1D). Tarsi of legs 1-13 undivided (Fig. 2D). Tarsal articulation well defined in leg-pairs 14 and 15 (Figs 3A, C; 4A).

Table 1. (Continued)

Species	*L. dobrogicus* Matic, 1962a	*L. dudichi* Loksa, 1947	*L. hadzii* Matic & Dărăbanţu, 1968	*L. lagrecai* Matic, 1962b	*L. nudus* (Matic, 1976)
Body length (in mm)	5.5-7	8	4-5	3-3.5	3.5
Body colouration	yellowish	dark greenish brown	fawn yellowish	whitish	yellowish white
Number of antennal articles	20	19	20	19-20	17-18
Cephalic plate length/width (ratio)	≈ 1:1	wider than long	1:1	1:1	slightly longer than wide
Ocelli	4-6 (in 1-2 rows); clearly pigmented	6 (irregularly arranged)	5 (in 2 rows)	4 (in 2 rows); clearly pigmented	absent
Tömösváry's organ	same size as ocelli	almost twice as large as adjacent ocellus	same size as ocelli	smaller than largest ocellus	no data
Coxal pores	1-2 (usually 2)	1-3	1-2 (usually 2)	1-2 (usually 1)	1
Plectrotaxy of 14th leg pair	V: -, m, mp, m, -; D: -, -, mp, -, -	V: -, -, -, m, -; D: -, -, mp, -, -	V: -, m, amp, m, -; D: -, -, mp, -, -	V: -, -, m, m, m; D: -, -, p, -, -	without spines
Plectrotaxy of 15th leg pair	V: -, m, mp, m, -; D: -, -, mp, -, -	V: -, m, m, m, -; D: -, -, mp, -, -	V: -, m, amp, m, -; D: -, -, mp, -, -	V: -, -, (a)m, m, -; D: -, -, p, -, -	without spines
Accessory spines (anterior/posterior) of 14th leg pair	no data	both (a+p)	no data	both (a+p)	absent
Accessory spines (anterior/posterior) of 15th leg pair	absent	both (a+p)	one (?)*	absent	absent
Gonopodal spurs (in female)	2+2	unknown	unknown	unknown	unknown
Number of gonopodal claws (in female)	3	unknown	unknown	unknown	unknown
Distribution	Bulgaria, Romania	Poland, Romania	Croatia	Italy (Sicilia)	Greece
Habitat	epigeic	epigeic	epigeic	cave (presumed troglobiont)	epigeic; coniferous forest
Sources	Matic, 1962a, 1966	Loksa, 1947; Matic, 1966; Leśniewska *et al.*, 2015	Matic & Dărăbanţu, 1968	Matic, 1962b	Matic, 1976; Zapparoli, 2002

All legs with moderately long and curved claws. Long and slender anterior accessory spines present on claws of leg-pairs 1-13 (Fig. 2D). Anterior accessory spines absent on penultimate and ultimate legs. Posterior accessory claw present on all legs, relatively smaller on leg-pairs 14 and 15 (Fig. 3D-E). Glandular pores on inner side in penultimate and ultimate legs absent in both sexes. Plectrotaxy of female holotype and its variation in paratypes are summarized in Tables 2-8.

Coxal pore: Small, rounded, in a shallow gutter-like depression; poorly visible due to translucent cuticle of coxae; usually 2222, otherwise 1222 and 1221.

Male sexual characters (Fig. 3A-B): Sternite of ultimate leg-bearing segment trapeziform, with narrower posterior side; first genital sternite wider than long, with scattered short setae, posterior margin convex between the gonopods, without a medial bulge. Gonopods short, developed as small hemispheres, bulge-like, distally with a long seta. Penis moderately long, bilobed, with two long setae on each side. Telson wider than long, with several long setae on posterior margin. Leg-pairs 14 and 15 without any modifications.

Female sexual characters (Fig. 4): Ultimate sternite of same shape as in males; first genital sternite deeply concave in middle part of posterior margin between condyles of gonopods, with a well sclerotized small medial bulge within this incision. Gonopods: first gonopodal articles broad, each with 5-6 long setae on

Table 1. (Continued)

Species	*L. pasquinii* Matic, 1967	*L. paucispinus* (Matic, 1976)	*L. sivasiensis* (Matic, 1983)	*L. zveri* (Matic & Stentzer, 1977)
Body length (in mm)	5	6	7-9	3
Body colouration	yellowish white	fawn-yellow to fawn-brown	light yellow	whitish yellow
Number of antennal articles	20-21	20	20	20
Cephalic plate length/width (ratio)	no data	no data	≈ 1:1	≈ 1:1
Ocelli	1-2 (in one row); clearly pigmented	4 (in 2 rows); clearly pigmented	5 (in 2 rows); clearly pigmented	absent
Tömösváry's organ	more than twice as large as ocelli	smaller than ocelli	smaller than ocelli	extraordinarily large
Coxal pores	2	2	1-2	no data
Plectrotaxy of 14th leg pair	V: -, -, mp, m, m; D: -, -, mp, -, -	V: -, m, m, m, -; D: -, -, p, -, -	V: -, -, -, m, -; D: -, -, mp, -, -	V: -, -, m, m, -; D: -, -, p, -, -
Plectrotaxy of 15th leg pair	V: -, m, mp, m, -; D: -, -, mp, -, -	V: -, m, m, m, -; D: -, -, p, -, -	V: -, -, -, m, -; D: -, -, mp, -, -	V: -, -, m, m, -; D: -, -, p, -, -
Accessory spines (anterior/posterior) of 14th leg pair	one (?)*	one (?)*	one (?)*	one (?)*
Accessory spines (anterior/posterior) of 15th leg pair	absent	one (?)*	absent	one (?)*
Gonopodal spurs (in female)	unknown	unknown	2+2	unknown
Number of gonopodal claws (in female)	unknown	unknown	3	unknown
Distribution	Italy	Turkey	Turkey	Slovenia
Habitat	cave (presumed troglobiont)	epigeic	epigeic	cave (troglobiont)
Sources	Matic, 1967	Matic, 1976	Matic, 1983	Matic & Stentzer, 1977

ventral surface arranged in two rows and 1-2 moderately shorter dorsolateral setae; 2+2 sharp coniform spurs, inner spurs slightly smaller than outer ones; second gonopodal articles with 2-3 long ventral setae and 3-4 medium-short to long dorsolateral setae each; third articles with 2-3 medium-short to long dorsolateral setae; gonopodal claws moderately curved, tridentate, inner denticles smaller than outer ones, median and external denticles of approximately same size; without secondary sexual characters on penultimate and ultimate legs.

Type locality: The cave Velika Ćulumova Pećina, municipality of Kijevo, Šibenik-Knin County, Croatia (Fig. 5A).

Remarks: Jalžić (1974) described the cave Velika Ćulumova Pećina (its entrance shown in Fig. 5B-C) as one of the most beautiful speleological objects in all of Dalmatia, with approximately 360 m of tunnels. Located on the flattened Kijevo karst plateau in the municipality of Kijevo (Šibenik-Knin County, Croatia) (Fig. 5A), it is a well-known tourist attraction. Due to the presence of a reproductive colony of a protected bat species, this cave is protected by the "Natura 2000" ecological network (Natura code HR2000020) (Barišić, 2010). The cave is also known as the locality of *Alpioniscus* (*Illyrionethes*) *balthasari* (Frankenberger, 1937), an endemic Dinaric species of troglobitic trichoniscid woodlice (Bedek *et al*., 2019b). The type material of *Lithobius radjai* sp. nov. was collected under stones in the dark part of the cave (Rađa, pers. comm.).

DISCUSSION

Due to the presence of more than 9000 registered caves and pits in Croatia, with some estimates that there are at least twice as many, the discovery of new species

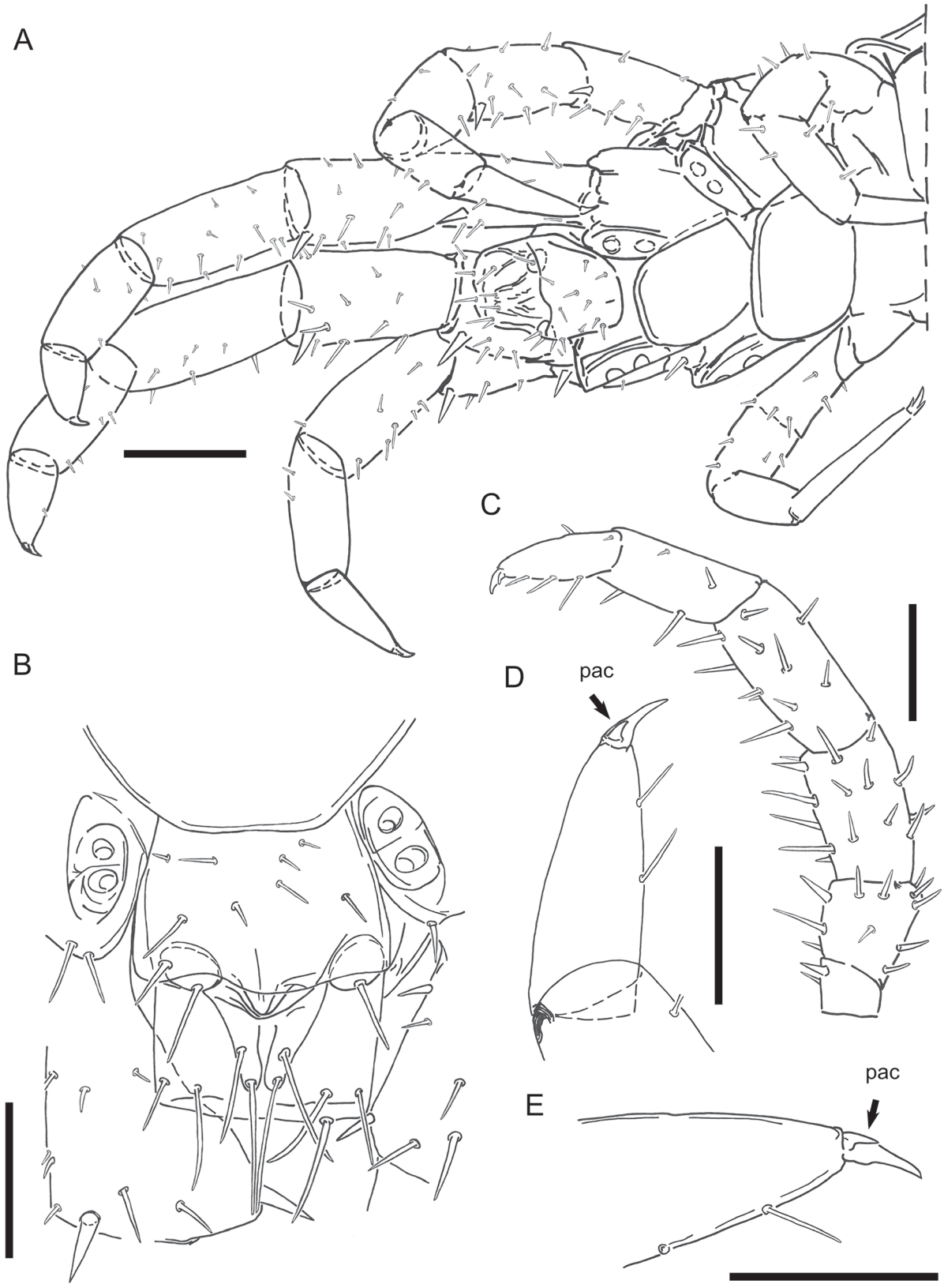

Fig. 3. *Lithobius radjai* sp. nov., ♂ paratype IZB ChL027-L3 (A), ♂ paratype NHMSC L1 (B, D-E), ♀ paratype NHMSC L4 (C). (A) Posterior part of body, ventrolateral view. (B) Posterior segments and gonopods, ventral view. (C) Right ultimate leg, posteroventral view. (D) Tarsus and pretarsus of right penultimate leg, posteroventral view. (E) Pretarsus of right ultimate leg, posteroventral view. Abbreviation: pac = posterior accessory claw. Scale bars: 0.2 mm (A, C); 0.1 mm (B, D-E).

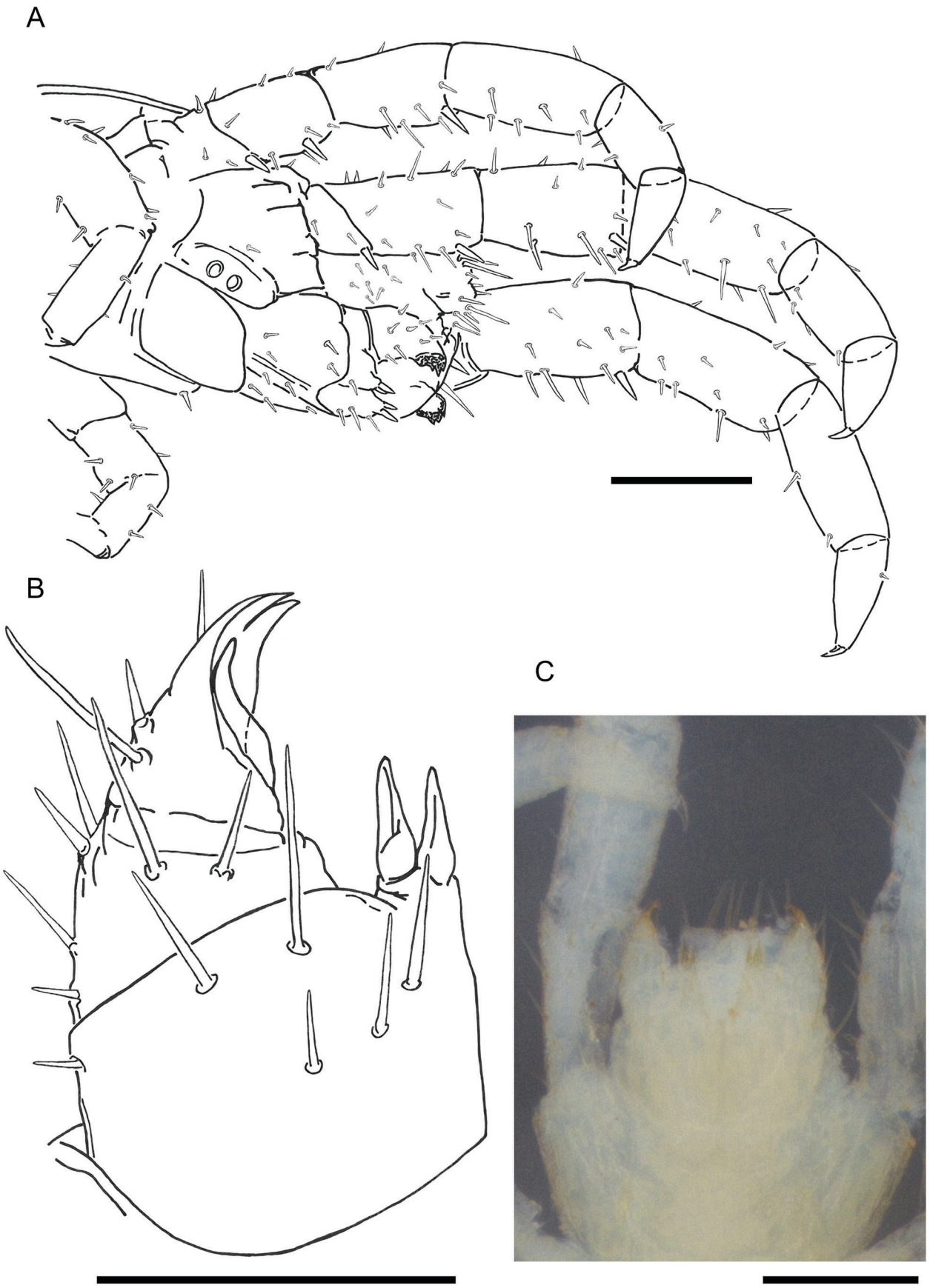

Fig. 4. *Lithobius radjai* sp. nov., ♀ paratype NHMSC L4 (A-B), ♀ holotype NHMSC L10 (C). (A) Posterior part of body, ventrolateral view. (B) Left gonopod, ventral view. (C) Gonopods, ventral view. Scale bars: 0.2 mm (A, C); 0.1 mm (B).

Table 2. Leg spinulation in *Lithobius radjai* sp. nov., female holotype (NHMSC L10).

Legs	Ventral side					Dorsal side				
	C	Tr	Pf	F	Ti	C	Tr	Pf	F	Ti
1-3					m					a
4-5					m					ap
6				(m)	m					ap
7-9				m	m					ap
10				m	m					a(p)
11				m	m					a
12-13				m	m					
14-15		m	m	m				p		

Table 3. Leg spinulation in *Lithobius radjai* sp. nov., male paratype (NHMSC L1).

Legs	Ventral side					Dorsal side				
	C	Tr	Pf	F	Ti	C	Tr	Pf	F	Ti
1					m					a(p)
2-3					m					ap
4-9				m	m					ap
10-11				m	m					a
12				m	m					
13			(m)	m	m					
14-15		m	m	m				p		

Table 4. Leg spinulation in *Lithobius radjai* sp. nov., female paratype (IZB ChL27 L2).

Legs	Ventral side					Dorsal side				
	C	Tr	Pf	F	Ti	C	Tr	Pf	F	Ti
1					m					(a)
2					m					a
3				(m)	m					ap
4-11				m	m					ap
12				m	m					a(p)
13			m	m						a
14-15		m	m	m				p		

Table 5. Leg spinulation in *Lithobius radjai* sp. nov., male paratype (IZB ChL27 L3).

Legs	Ventral side					Dorsal side				
	C	Tr	Pf	F	Ti	C	Tr	Pf	F	Ti
1-2					m					a
3				(m)	m					ap
4-11				m	m					ap
12-13				m	m					
14-15		m	m	m				p		

Table 6. Leg spinulation in *Lithobius radjai* sp. nov., female paratype (NHMSC L4), female paratype (IZB ChL27 L5) and male paratype (IZB ChL27 L7).

Legs	Ventral side					Dorsal side				
	C	Tr	Pf	F	Ti	C	Tr	Pf	F	Ti
1-2					m					a
3				(m)	m					a(p)
4-9				m	m					ap
10-11				m	m					a
12-13				m	m					
14-15		m	m	m				p		

Table 7. Leg spinulation in *Lithobius radjai* sp. nov., male paratype (IZB ChL27 L6) and female paratype (IZB ChL27 L8).

Legs	Ventral side					Dorsal side				
	C	Tr	Pf	F	Ti	C	Tr	Pf	F	Ti
1-2					m					a
3				(m)	m					ap
4-10				m	m					ap
11				m	m					a
12-13				m	m					
14-15		m	m	m				p		

Table 8. Leg spinulation in *Lithobius radjai* sp. nov., larva III (IZB ChL27 L9).

Legs	Ventral side					Dorsal side				
	C	Tr	Pf	F	Ti	C	Tr	Pf	F	Ti
1-4										
3-7					m					a
8					(m)					
9-10										

from subterranean habitats of this country is not a rare event (Jalžić *et al*., 2010). The majority of recorded subterranean species in Croatia are troglobionts, with 70% of them being endemic to Croatia (Gottstein Matočec *et al*., 2002). The last reported number of subterranean type localities in Croatia is 271, with a total of 427 animal species described from them (Jalžić *et al*., 2013), but this number increased in the decade after the publication of that paper. The present study adds one more endemic and presumed troglobitic species and one new type locality for Croatia (until now the cave Velika Ćulumova Pećina has not been reported as the type locality of any species). Based on several troglomorphic features such as the depigmented translucent cuticle due to its thinning (a common characteristic in cave species) (see Figs 1C and 4C), a reduced number of partly depigmented ocelli (Fig. 1B), as well as the fact that it is known only from the dark parts of the cave, at places with high humidity (under stones), we consider *Lithobius radjai* sp. nov. to be a troglobiont.

In light of a large number of morphological characters and existing sets of differing molecular data (both nuclear and mitochondrial markers), a recent study of Lithobiidae phylogeny conspicuously demonstrated the problematic taxonomic status of the subgenera *Monotarsobius*, *Lithobius* Leach, 1814 and *Sigibius* Chamberlin, 1913 (Ganske *et al*., 2021). The polyphyly of these subgenera was proven in that publication, and it was proposed to avoid using them in taxonomical studies. In other words, the diagnostic features of these *Lithobius* subgenera are results of homoplasy.

The new species presented here could be classified in the subgenus "*Monotarsobius"* on the basis of morphology.

Regardless of the validity and status of this subgenus, the congeners most similar to *Lithobius radjai* sp. nov. should be sought among species previously described under "*Monotarsobius*". The diagnostic characters common for all these species are: small size, usually short antennae with around 20 articles, coxosternite with 2+2 forcipular teeth, no posterior triangular projections on tergites, and undivided tarsi in leg-pairs 1-12(13) (summarized in Voigtländer *et al.,* 2017). In total, there are ca 120 species with such features, generally with a Palaearctic distribution (35 species in Europe and more than 80 in Asia (data extracted from Bonato *et al*.,

Fig. 5. Type locality of *Lithobius radjai* sp. nov. (A) Position on the map of Croatia. (B-C) Entrance to the cave Velika Ćulumova Pećina (photos by T. Rađa).

2016). For the purpose of this paper, the new species is compared with all European "*Monotarsobius*" species, and a detailed comparison with the 13 most similar ones from southeastern Europe, the Apennine Peninsula and western Turkey is provided.

Lithobius radjai sp. nov. shares many similarities with the compared species, but there are also certain differences to each of them. Unquestionably, the most interesting for comparison are species from the Dinarides, viz., *L. hadzii* Matic & Dărăbanţu, 1968 (an epigeic species endemic to Croatia) and *L. zveri* Matic & Stentzer, 1977 (a subterranean species endemic to Slovenia). For a detailed comparison with these two and other similar species, see Table 1.

Finally, one of the significant problems existing in *Lithobius* taxonomy is visible in Table 1. The descriptions of a large number of *Lithobius* species are incomplete and/or imprecise in treating some morphological structures of more or less strong taxonomical importance, and sometimes it is even the case that those characters are not included at all. All the mentioned shortcomings have resulted in inadequate descriptions of many taxa today, which leads to many problems in identification and comparison. Fortunately for the present study, this is not so much the case in the descriptions of most European "*Monotarsobius*" species. There are certain inaccuracies in the descriptions of the species included here that affect their comparability, but these mostly concern characters that are currently not recognized as taxonomically very important. For example, statements on the presence or absence of one or both accessory spines on the penultimate and the ultimate legs are often missing. Furthermore, even when it is provided, in cases where only one accessory spine is present, there is no specification as to whether it is an anterior or a posterior spine (summarized in Table 1). Similar examples, often dealing with much more significant morphological characters (such as the number of antennal articles, the number and/or arrangement of ocelli, the presence of coxosternal teeth and porodonts, features of the genital apparatus, plectrotaxy, etc.), point to the need for a detailed redescription of a significant percentage of *Lithobius* species.

ACKNOWLEDGEMENTS

This study was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia (Grant 451-03-9/2021-14/ 200178). We wish to thank our friend and colleague Tonći Rađa (Split, Croatia), who provided us with the material of the new species and photos of the type locality. We are deeply grateful to the reviewer Dr László Dányi (Budapest, Hungary) for useful comments and suggestions, as well as to the subject editor Dr Peter Schwendinger (Geneva, Switzerland). The authors are also grateful to Mr Raymond Dooley (Belgrade, Serbia) for his help in preparing the English version of the manuscript.

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