GENUS BELBOGOSOMA ĆURČIĆ AND MAKAROV, 2008, WITH DESCRIPTIONS OF NEW TROGLOBITIC SPECIES FROM EAST SERBIA, BALKAN PENINSULA (DIPLOPODA: CHORDEUMATIDA: ANTHROLEUCOSOMATIDAE)

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Abstract – A second member of the genus Belbogosa Ćurčić & Makarov, 2008, the troglobitic B. stribogi n. sp., is described, illustrated and diagnosed. A brief discussion of anthroleucosomatids from Serbia and a distribution map of the genus are provided.

Key words: Diplopoda, Anthroleucosomatidae, Belbogosoma, new species, cave, Serbia.

INTRODUCTION

The karst regions of Serbia, which are the most widely distributed in the Carpatho-Balkanides of eastern Serbia and Inner Dinarides of western Serbia, are characterized by a great wealth of underground habitats. These extreme settlements are inhabited by numerous endemic and relict cave animals belonging to the Paleo-Mediterranean, Laurasian, Paleo-Aegean and South or North-Aegean (or Proto-Balkan) phyletic series. These interesting forms are descendants of a tropical epigean fauna living in Europe and North America at the end of Cretaceous and at the beginning of the Tertiary periods (Ćurčić, 1998; Ćurčić and Decu, 2008). Such extraordinary creatures, from the territory of Serbia, mainly belong to the following groups: Isopoda, Aranea, Pseudoscorpiones, Collembola, Coleoptera, as well as Diplopoda.

Within the underground millipede fauna of Serbia, numerous interesting taxa exist: one of the smallest millipede representatives Hyleoglomeris faberi Makarov et al., 2013, julid genera Lamellotyphlus Tabacaru, 1976, Serboiulus Strasser, 1962 and Typhloiulus Latzel, 1884, as well as one specific complex of anthroleucosomatid genera.

In the order Chordeumatida, with about 50 families (Shear, 2011), Anthroleucosomatidae is one of the most heterogeneous and least understood “wastebasket families” (Ćurčić et al., 2008; Shear & Leonard, 2004). Currently, this group includes 23 genera with about 50 species and 6 recognized complexes of genera, inhabiting a few disjunctive regions in the Holarctic: one in Europe, two in Asia and one in North America, with the greatest diversity on the European continent (Ćurčić et al., 2007, 2008; Golovatch & Makarov, 2011; Makarov et al., 2012). In Ser-
nia, the family Anthroleucosomatidae is represented by five genera and nine species (Antić et al., 2013) limited to underground habitats on several mountain systems, in the eastern part of the country.

MATERIALS AND METHODS

Anthroleucosomatid material preserved in 70% ethanol was analyzed in the laboratories of the Institute of Zoology and Institute of Physiology and Biochemistry, Faculty of Biology, University of Belgrade. Whole specimens were examined under a Carl Zeiss Jena Technival 2 binocular stereomicroscope and Carl Zeiss Stemi 2000-c binocular stereomicroscope with an AxioCam MRc camera. Gonopods and legs were mounted in glycerin for temporary microscope preparations and observed and captured with a Carl Zeiss Axioskop 40 microscope with a Nikon D3200 digital camera, and confocal laser-scanning microscope (LSM 510, Carl Zeiss GmbH, Germany) equipped with Ar Multi-line (457, 478, 488, and 514 nm) and HeNe (543 and 633 nm) lasers. The HeNe 543 nm laser at 50% output strength, HFT 458/543 beam splitters, LP 560 filter and Plan-Neofluar 20/0.5l objective were used for image acquisition. Following acquisition, images were processed using the Zeiss LSM 510 Basic software package version 3.2. Drawings of the legs and gonopods were made using a Carl Zeiss Jenamed 2 microscope with a special monitor, and computer monitor and pictures made by Nikon D3200 connected to Axioscope 40 microscope. A Canon PowerShot SX130 IS digital camera was used for photographing living specimen in the natural habitat. Final images were processed with Adobe Photoshop CS4.

Descriptions of the new species follow a pattern proposed for Chordeumatida by Spelda (2001) and Golovatch and Wytwier (2003) and for Anthroleucosomatidae by Makarov et al. (2003) and Ćurčić et al. (2008).

TAXONOMY

ANTHROLEUCOSOMATIDAE VERHOEFF, 1899

GENUS BELBOGOSOMA ĆURČIĆ & MAKAROV, 2008

TYPE SPECIES: BELBOGOSOMA BLOWERI ĆURČIĆ & MAKAROV, 2008

Diagnosis: Body with 30 segments in adults. Head with ocellae. Color whitish to pale yellow. Lateral keels small and rounded. In adult males, leg-pairs III-VII modified, leg-pair X and XI with coxal glands, leg-pair XI with prominent horn. Coxae of leg-pairs XII-XVII enlarged. Syncoxite of anterior gonopods with bottle-like basal part, and apical part, which can be completely or incompletely divided into two branches. Unpaired central process basally connected with syncoxite possesses a central lobe with three spinose horns; caudally with spinose branches. Posterior gonopods with lanceolate colpocoxites and sigmoid angiocoxites with hyaline lamellae in the base.

BELBOGOSOMA STRIBOGI ANTIĆ & MAKAROV, NEW SPECIES

Material examined – Type material: Holotype: male from the Jelenja Propast Pit, Rtanj Mt., east Serbia; collected from pit-fall traps on December 08, 2006 by S. Ognjenović. Paratypes: two males, same data as holotype; one male and two females from the Golema Porica Pit, Rtanj Mt., east Serbia, collected by hand and from pit-fall traps on March 27, 2008 by S. Ognjenović; one juvenile male, same place but collected from pit-fall traps on September 22, 2012 by D. Antić and S. Ćurčić; five juvenile females from the Sesalačka Pećina Cave, village of Sesalac, near Sokobanja, east Serbia, collected on September 26, 2009 by S. Ćurčić and B. Ilić; about 40 fragmented males and 15 fragmented females (only anterior parts of body with gonopods and vulvae) from the Zvečani Propas Pit, Rtanj Mt., east Serbia, collected from pit-fall traps on November 14, 2007 by S. Ognjenović. Type material is deposited in the collection of the Institute of Zoology, Faculty of Biology, University of Belgrade, Serbia.
**Table 1.** Differences in structures of anterior gonopods between *B. bloweri* and *B. stribogi* n. sp.

<table>
<thead>
<tr>
<th><em>B. bloweri</em></th>
<th><em>B. stribogi</em> n. sp.</th>
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<tbody>
<tr>
<td>syncoxite suddenly recurving cephalad</td>
<td>syncoxite gradually recurving cephalad</td>
</tr>
<tr>
<td>syncoxite branches are completely devided, longer and looks slimmer</td>
<td>syncoxite branches can be completely devided or more or less fused medially, it looks more robust</td>
</tr>
<tr>
<td>basal part of syncoxite branches with small triangular hyaline membranes on the caudal side</td>
<td>without triangular hyaline membranes on caudal side of syncoxite branches</td>
</tr>
<tr>
<td>additional spinose outgrowths (so) at the base of syncoxite branches absent</td>
<td>additional spinose outgrowths (so) at the base of syncoxite branches present</td>
</tr>
<tr>
<td>process c apically strongly denticulated</td>
<td>process c only with indication of denticulation</td>
</tr>
<tr>
<td>process d robust and C-shaped</td>
<td>process d not robust and not C-shaped, sometimes sabre-like from lateral view</td>
</tr>
<tr>
<td>process e lamellar, without two additional claw-like processes e1 and e2</td>
<td>process e not lamellar, with two additional claw-like processes e1 and e2</td>
</tr>
<tr>
<td>lamello-tuberculated lateral process f strongly developed and strongly expanded laterad</td>
<td>lamello-tuberculated lateral process f developed but only slightly showing laterad</td>
</tr>
<tr>
<td>lateral horns of unpaired central process strongly elongated and recurved caudad</td>
<td>lateral horns of unpaired central process much shorter, directed upwards and slightly caudad</td>
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</table>

**Etymology** – In Slavic mythology, Stribog is the god of rivers and streams swollen by rain, and the god of water and air flow (Gajić, 2011).

**Diagnosis** – The new species clearly differs from *B. bloweri* in numerous aspects of the gonopod structure, presented in Table 1.

**Description** – Body with 30 segments (including telson) in adults. Collected juveniles with 23, 26 and 28 segments (including telson), respectively. Color whitish to pale yellow (Fig 1) (almost brown in specimens from pit-fall traps). Measurements: body length (material from pit-fall traps): 14.55-15.80 mm in males and 17.90 mm in female; vertical diameter of the largest pleurotergites: 0.92-1.01 mm in males and 0.93 mm in female. Body length (material collected by hand): 12.38-13.82 mm in males and 10.98-14.46 mm in females; vertical diameter of the largest pleurotergites: 0.91-1.01 mm in males and 0.90-0.96 mm in females. Material from Zvečani Propas Pit is not measured.

**Head:** Juvenile with 23 body segments with one and two ocellae in one row; juveniles with 26 segments with 4-5 ocellae in two rows; juveniles with 28 segments with 4-6 ocellae in two rows; adults with 6-12 ocellae in two or three rows. In adult males, frontal side of the head with two paramedian depressions. One row of four long setae is present between the antennal sockets. Two long setae are present between a row of four long setae and paramedian depression. Labrum with eight labral and four supra-labral setae. Promenium triangular, without setae. Stipites each with seven marginal setae (three long, two shorter and two microsetae), one long apical setae, 1-2 shorter median setae, 3-5 median microsetae and 10 basal microsetae. Lingual plates each with one row of 3 robust setae and 4 minute ones. Antennal length 2.10 mm (holotype male); antennomeres
II and IV-VII with a few long sensitive setae. Length/breadth ratios of antenomeres I-VII: 1.20 (I), 1.87 (II), 4.92 (III), 2.40 (IV), 3.40 (V), 1.67 (VI), and 1.23 (VII), respectively.

*Collum:* narrower than head, with six macrosetae.

*Pleurotergites:* lateral keels of metazonites small, pronounced on the first third of the body, after that lateral keels gradually getting smaller and finally disappearing from somite XXVI. Border between pro- and metazonites clear. Macrosetae are longer and trichoid on the anterior part of the body, becoming rather short and blunt toward the telson (on pleurotergite VII the length of macrosetae is 0.23 mm, while on pleurotergite XV it is 0.12 mm). Macrochaetal index CIX (on pleurotergite 15), i.e., (distance between exterior and median macrochaetae)/(distance between interior and median macrochaetae) = 0.70. Median index MIX (on pleurotergite 15), i.e., (distance between interior macrochaetae and axial suture) / (distance between interior and median macrochaetae) = 1.15. The macrochaetal angle between the arm created by the median and exterior macrochaetae and the arm formed by the median and interior macrochaetae, MA (on pleurotergite 15) ~100°.

*Telson:* Epiproct with a pair of spinnerets and six setae arranged in two rows (2+2 marginal setae and 1+1 dorsomedian setae). Hypoproct subquadruangular with two long apical setae. Paraprocts semicircular, with 3+3 marginal setae.

*Walking legs:* Maximal length of midbody legs is 1.86 mm (holotype male). First and second leg-pairs with tarsal combs.

*Male sexual characters:* Leg-pair III with slightly enlarged podomeres (Fig 2); leg-pair IV with enlarged coxa, prefemur, femur, postfemur and tibia; prefemur IV with inner concavity; basal part of femur IV also with concavity that is covered with setae, proximal part of femur, postfemur and tibia IV with pillow-like swelling (Fig 3). Leg-pair V with a prominent prefemoral basal lobe; femur V with concavity, tarsus V short and C-shaped (Fig 4). All podomeres of leg-pair VI enlarged, especially femur; tarsus VI C-shaped (Fig 5). Leg-pair VII is the longest (Fig 6); tarsus VII is very elongated and saber-like (0.78 mm); length/breadth ratio of tarsus VII is 5.21; length of tarsal claw is 0.09 mm; length of tarsus VII to length of tarsal claw VII ratio is 8.67. Leg-pairs X and XI with massive coxal glands; coxa XI with prominent horn (Figs 7 and 8). Leg-pairs XII-XVII with enlarged coxa, especially coxa XIII (Fig 9 a-f).

*Anterior gonopods* (Figs 10-15 and 19 a, b): Syncoxite (a) with more or less bottle-like basal half; the apical half split into two branches which can be completely separated and parallel-sided or in some males fused basally or even only split on the
Fig. 2-9. *Belbogosoma stribogi* n. sp., holotype male from the Jelenja Propast Pit, Rtanj Mt., east Serbia. 2. leg III, oral view; 3. leg IV, caudal view; 4. leg V, oral view; 5. leg VI, caudal view; 6. leg VII, caudal view; 7. leg X, caudal view; 8. leg XI, caudal view; 9. coxae of legs XII-XVII and XXV. Scale line = 0.5 mm.
Figs. 10-13. *Belbogosoma stribogi* n. sp. 10-12. Holotype male from the Jelenja Propast Pit, Rtanj Mt., east Serbia: 10. anterior gonopods, oral view; 11. anterior gonopods, caudal view; 12. anterior gonopods, lateral view. 13. Paratype male from the Zvečani Propas Pit, Rtanj Mt., east Serbia: syncoxite with unpaired central process, lateral view. Designations: a – syncoxite; b – unpaired central process; c – basal process; d – inner process; e – median process (with additional claw-like processes e1 and e2); f – lamello-tuberculated lateral process; h – lamello-foliaceous process; i – additional lamellar process; j – outer process; ap – acuminate process; fp – flagelliform process; sb – spinose branches; so – additional spinose outgrows; ts – triangular structure; w – winged structure. Scale line = 0.3 mm.
Figs. 14-18. 14-16. Belbogosoma striboi n. sp. 14. Paratype male from the Zvečani Propas Pit, Rtanj Mt., east Serbia: syncoxite, caudal view; 15. Paratype male from the Sesalačka Pećina Cave, near Sokobanja, east Serbia: syncoxite, caudal view; 16. Holotype male from the Jelenja Propast Pit, Rtanj Mt., east Serbia: posterior gonopod, caudal view. 17 and 18. Belbogosoma bloweri Ćurčić & Makarov, 2008 (After Ćurčić et al., 2008). Holotype male from the Gornja Lenovačka Pećina Cave, village of Lenovac, Tupižnica Mt., east Serbia. 17. anterior gonopods, oral view; 18. anterior gonopods, caudolateral view. Designations: a – syncoxite; b – unpaired central process; c – basal process; d – inner process; e – median process; f – lamello-tuberculated lateral process; h – lamello-foliaceous process; i – additional lamellar process; so – additional spinose outgrows. Scale line = 0.3 mm for 14 and 15; 0.25 mm for 16; 0.2 mm for 17 and 18.
top (Fig. 15); gradually recurving cephalad (Figs 11, 13-15 and 19 a). Spines on branches mainly present. Unpaired central process (b) basally connected with syncoxite (Fig 13); central lobe with three spinose horns directed upwards (Figs 10 and 19 b). Caudal side of central process with few to a dozen divided or undivided spinose branches (sb); present on entire length of medial part (Figs 12 and 13). Near the point of contact between syncoxite branches and unpaired process there are two additional spinose outgrowths (so) (shorter than the syncoxite branches and longer and more robust than the spinose branches of unpaired process) with cephalad orientation (Figs 13-15). These spinose outgrowths can be parallel or directed laterad (Figs 14 and 15). In some specimens, on the base of the syncoxite branches a pair of triangular structures (ts) directed cephalad can be noticed (Fig 13). The symmetric lateral parts of anterior gonopods possess few processes (Figs 10 and 12). On the oral side, several processes can be noticed (Fig 13). The symmetric lateral parts of anterior gonopods possess few processes (Figs 10 and 12). On the oral side, several processes can be observed (Figs 10 and 12). Processes c (= lanceolate process after Ćurčić et al., 2008) (Fig 17) are the most basal; these two processes are concave, forming a cavity on the oral side of the anterior gonopods and connected with rest of the oral side. After reexamination of holotype of Belbogosoma bloweri Ćurčić and Makarov, 2008, we noted that the situation is the same as in the new species; basal process c is not separated from rest of the oral side as is presented in the drawing after Ćurčić et al. (2008) (Fig 17). Inner process d (= inner C-shaped process after Ćurčić et al., 2008) (Fig 17)) is situated above basal process c and is connected with the previously mentioned, with a shallow rift between. In some males, this process is saber-like from full lateral view. The foremost processes on the oral side of the anterior gonopods are median processes e (= median finger-like process after Ćurčić et al. 2008) (Figs 17 and 18)), each carrying two additional claw-like processes (e1 and e2) (Fig 12). The most lateral on the oral side is outer process j that is connected with median process e on the oral side and with lamello-tuberculated lateral process f (= lateral tuberculated process after Ćurčić et al. 2008) (Figs 17 and 18)) (Figs 10 and 12). There is a pair of large lamello-folaceous processes (h) (= large folaceous process after Ćurčić et al., 2008) on the caudal side of the anterior gonopods (Figs 10-12, 17 and 18) forming with syncoxite cavity for the accommodation of colpocoxites of the posterior gonopods. The apical part of process h is lamellar, and in the middle, from a caudal view, possess additional, also lamellar, process i (Figs 10 and 12) (= flagelliform process after Ćurčić et al. 2008)). In Ćurčić et al. (2008), the flagelliform process was wrongly marked with two letters i and g. In drawings and confocal photos after Ćurčić et al. (2008) these two letters, in fact, represent lamellar process i which is part of lamello-folaceous process h, while the flagelliform process is not visible from the previously mentioned pictures. In order to prevent confusion, in this paper we are excluding the letter g and introducing the letters fp for the flagelliform process that is hardly visible and situated on both sides of the unpaired process (Figs 10 and 11). Lamello-folaceous process h is connected with lamello-tuberculated lateral process f (Fig 12). “Inside” the gonopods, apart from the flagelliform process, there is a pair of winged structures (w) and a more orally pair of apically acuminate processes (ap) (Fig 10).

Posterior gonopods (Fig 16): Colpocoxites lanceolate, apically pilose. In situ colpocoxites are in the cavities on both sides of syncoxite. There is a clearly visible channel that passes through the central part of the colpocoxite, with an opening at the top. An-giocoxites sigmoid, basally with truncate hyaline lamellae; apical part recurved and directed cephalad.

Postembryonic development: In the analyzed samples of B. stribogi n. sp., we noted stadia with 23, 26 and 28 segments (including telson). These specimens have corresponding VI, VII, and VIII stadia, as noted for other chordematids with 30 segments (including telson). This means that the postembryonic development in the new species includes nine stadia and this type of anamorphosis is teloanamorphosis.

Remarks – In our observation of the specimens from the Zvečani Propas Pit, we have noticed a variability of syncoxite branches from fully separated (as in the holotype from the Jelenja Propas Pit (Fig 11))
to partially fused (Fig 14). In addition, there is a variability in the position of additional syncoxite outgrowths (so), which can be almost parallel and not visible from caudal view (Figs 13 and 15) to directed lateral and “V” shaped (Fig 14). Other parts of the anterior gonopods are the same. Only one collect-
ed male from the Sesalačka Pećina Cave possesses anterior gonopods with almost fully fused syncoxite branches (Fig 15) (something like the syncoxite branches in *Dazbogosoma*). Because of the almost identical other parts of the anterior gonopods with other observed specimens, and because of such variability of syncoxite branches within the same population in the Zvečani Propas Pit, for now we can consider this condition as an interpopulational variability (Sesalačka Pećina Cave is isolated in relation to the three other pits, which are situated on the same plateau of Rtanj Mt.; Map 1).

**DISCUSSION**

The genus *Belbogosoma* includes two species, *B. bloweri* and *B. stribogi* n. sp., and belongs to the “Bulgarosoma” complex of genera, which biogeographically includes Carpatho-Balkan and Rhodopian elements. Apart from *Belbogosoma*, this complex of genera...
consists of the following taxa: Bulgarosoma Verhoeff, 1926, Banatosoma Ćurčić & Makarov, 2000, Dazbosoma Makarov & Ćurčić, 2012, Perunosoma Ćurčić & Makarov, 2007, Rhodoposoma Ćurčić & Makarov, 2000, Serbosoma Ćurčić & Makarov, 2000, Svarogosoma Makarov, 2003, and Troglocicus Gulička, 1967 (Makarov et al., 2012). All of these genera are characterized by the presence of a unique part of the anterior gonopods – syncoxite with a basally connected unpaired central process, as well as the absence of telopodite on both anterior and posterior gonopods. These features are doubtless strongly apomorphic and clearly separate the previously mentioned genera complex from all other anthroleucosomatids. This fact led Ćurčić et al. (2007, 2008) to assume that such structure of gonopods (especially anterior) probably has suprageneric value. Regardless of whether it is just a genera complex or tribe, subfamily, even family, it is clear that this group of genera represent a natural unit with, according to Makarov et al. (2003), a center of divergent differentiation and radiation in eastern Serbia.

The family Anthroleucosomatidae in Serbia is represented by five genera and nine species very limited in distribution and mainly restricted to one or few cave systems in the different mountain regions of east and southeast Serbia, ranking from Homoljske Planine Mts. in the north to Suva Planina Mt. in the south. The western border for the “Bulgarosoma” complex of genera is defined by the presence of the Morava-Vardar tectonic depression (Makarov et al., 2012). The discovery of a new, tenth anthroleucosomatid species in Serbia from Rtanj Mt. confirms the previously mentioned hypothesis about the biogeographical distribution of this complex.

As well as the other representatives of Anthroleucosomatidae in Serbia, the new species is also a troglobitic form known from four underground habitats (Map 1). These underground systems are inhabited by several other organisms: Brachydesmus attensis Verhoeff, 1895 and Haasea guidonvallieri Makarov, 2008 (new record), both from the Jelenja Propast Pit and Zvečani Propas Pit; Melogona broelemanni (Verhoeff, 1897) and Leptoilulus sarajevesensis Verhoeff, 1898 from the Zvečani Propas Pit; Roncus radgost Ćurčić, 2013 and Duvalius ranjensis Vrbica, S. Ćurčić, Antić & B. Ćurčić from the Golema Porica Pit and, finally Neobisium deltshevi B. Ćurčić, Dimitrijević & N. Ćurčić, 2010 from the Sesalačka Pećina Cave (see Antić et al., 2013; Ćurčić et al., 2010, 2013; Vrbica et al., 2013). It is interesting to note that from the Gornja Lenaovačka Pećina Cave on Tupižnica Mt., a type locality of B. bloweri, some new cave-dwellers have recently been described: the completely blind neobiisid pseudoscorpion species Roncus jarevid B. Ćurčić, 2013, new genera and species of the small ground beetle Glabroduvalius tupiznicensis Vrbica, S. Ćurčić, Antić & B. Ćurčić, 2013 as well as the blind julid species Serboiulus kresnik Makarov, 2013 (see Ćurčić et al., 2013; Sekulić et al., 2013; Vrbica et al., 2013).

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REFERENCES


new genus of endemic millipedes (Diplopoda: Chordeumatida: Anthroleucosomatidae) from the Balkan Peninsula. Zootaxa **1743**, 1-16.


