Zootaxa 4790 (2): 375–386
https://www.mapress.com/j/zt/

Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

https://doi.org/10.11646/zootaxa.4790.2.11
http://zoobank.org/urn:lsid:zoobank.org:pub:4D7A9C7C-AAD3-4C2B-8A46-A7AB229D13B0

Description of a new species of *Plutomurus* Yosii (Collembola: Tomoceridae) from Georgia, Caucasus and notes on the morphology of *Plutomurus birsteini* Djanashvili & Barjadze

SHALVA BARJADZE[1,*], ROSANNA GIORDANO[2] & FELIPE SOTO-ADAMES[3]
[1]*Institute of Zoology, Ilia State University, Giorgi Tsereteli 3, 0162, Tbilisi, Republic of Georgia*
[2]*Puerto Rico Science, Technology and Research Trust 105 Carr. #21, Bo. Monacillo, PR 00927, San Juan, Puerto Rico*
rgiordano500@gmail.com; https://orcid.org/0000-0002-6175-2981
[3]*Florida State Collection of Arthropods, Division of Plant Industry, Florida Department of Agriculture and Consumer Services, Gainesville, FL 32608, USA. felipe.soto-adames@fdacs.gov; https://orcid.org/0000-0002-9492-9691*
[*]*Corresponding author. shalva.barjadze@yahoo.com; https://orcid.org/0000-0001-8992-4987*

Abstract

Plutomurus jordanai **sp. nov.** from Zeda Kvilishori Cave (Tskaltubo Municipality, Imereti region, Western Georgia) is described, illustrated and differentiated from other morphologically similar species—*P. kelasuricus* Martynova, 1969 and *P. eristoi* Barjadze, Baquero, Soto-Adames, Giordano & Jordana, 2016. In addition, morphological characters omitted or erroneously provided in the original description of *Plutomurus birsteini* Djanashvili & Barjadze, 2011 are described and illustrated from the specimen sampled in the type locality—Sakishore Cave (Racha region, Western Georgia). An identification key to the species of the genus *Plutomurus* reported from the Caucasus is presented. A list of the invertebrate communities for Zeda Kvilishori and Sakishore caves is provided.

Key words: New taxon, springtail, cave, Palaearctic

რეზიუმე

Plutomurus jordanai **sp. nov.** ზედა ქვილიშორის მღვიმიდან (წყალტუბოს მუნიციპალიტეტი, იმერეთის რეგიონი, დასავლეთ საქართველო) აღწერილია, ილუსტრირებულია და დიფერენცირებულია მორფოლოგიურად მსგავსი სახეობებისაგან – *P. kelasuricus* Martynova, 1969 და *P. eristoi* Barjadze, Baquero, Soto-Adames, Giordano & Jordana, 2016. გარდა ამისა, აღწერილი და ილუსტრირებულია *Plutomurus birsteini* Djanashvili & Barjadze, 2011-ის თავდაპირველ აღწერაში გამოტოვებული ან შეცდომით უზრუნველყოფილი მორფოლოგიური ნიშან–თვისებები ეგზემპლარიდან, რომელიც მოპოვებულია ტიპის ადგილმდებარეობაში – საკიშორეს მღვიმეში (რაჭის რეგიონი, დასავლეთ საქართველო). უზრუნველყოფილია კავკასიაში ნანახი გვარ Plutomurus–ის სახეობების სარკვევი. მოცემულია ზედა ქვილიშორისა და საკიშორის მღვიმეების უხერხელო ცხოველთა საზოგადოებები.

Introduction

The genus *Plutomurus* Yosii, 1956 comprises 32 species found in caves, soils and leaf litter across the northern hemisphere (Yosii 1956; Christiansen & Bellinger 1998; Kniss & Thibaud 1999; Barjadze *et al.* 2016, 2018; Chang & Park 2020). Ten species are known from the Caucasus, mostly cave forms (Martynova 1969; Kniss & Thibaud 1999; Djanashvili & Barjadze 2011; Barjadze & Djanashvili 2014; Jordana *et al.* 2012; Barjadze *et al.* 2016, 2018). As only a fraction of caves in the region have been explored for the presence of these arthropods, it is to be expected more species of *Plutomurus* remain to be discovered.

Here we report on a new species of *Plutomurus* collected during explorations of the Zeda Kvilishori Cave in the Sataplia-Tskaltubo karst massif of Western Georgia. We also revisit the description of *Plutomus birsteini* Djanash-

Accepted by W.M. Weiner: 15 May 2020; published: 11 Jun. 2020

vili & Barjadze, 2011, rectifying misinterpretations or omission of morphological characters provided in the original description (Djanashvili & Barjadze 2011).

Material and methods

Zeda Kvilishori (Tsikhe) Cave (42°21'39.49"N, 42°37'54.91"E, 249 m alt.) is near Zeda Kvilishori village, Tskaltubo Municipality, Imereti Region, Sataplia-Tskaltubo karst massif, Georgia (Figs 1–3). The cave was formed in Upper Cretaceous limestones (Tatashidze *et al.* 2009), currently has two entrances, is 300 m long, poor in speleothems and has a permanent water stream (Tatashidze *et al.* 2009).

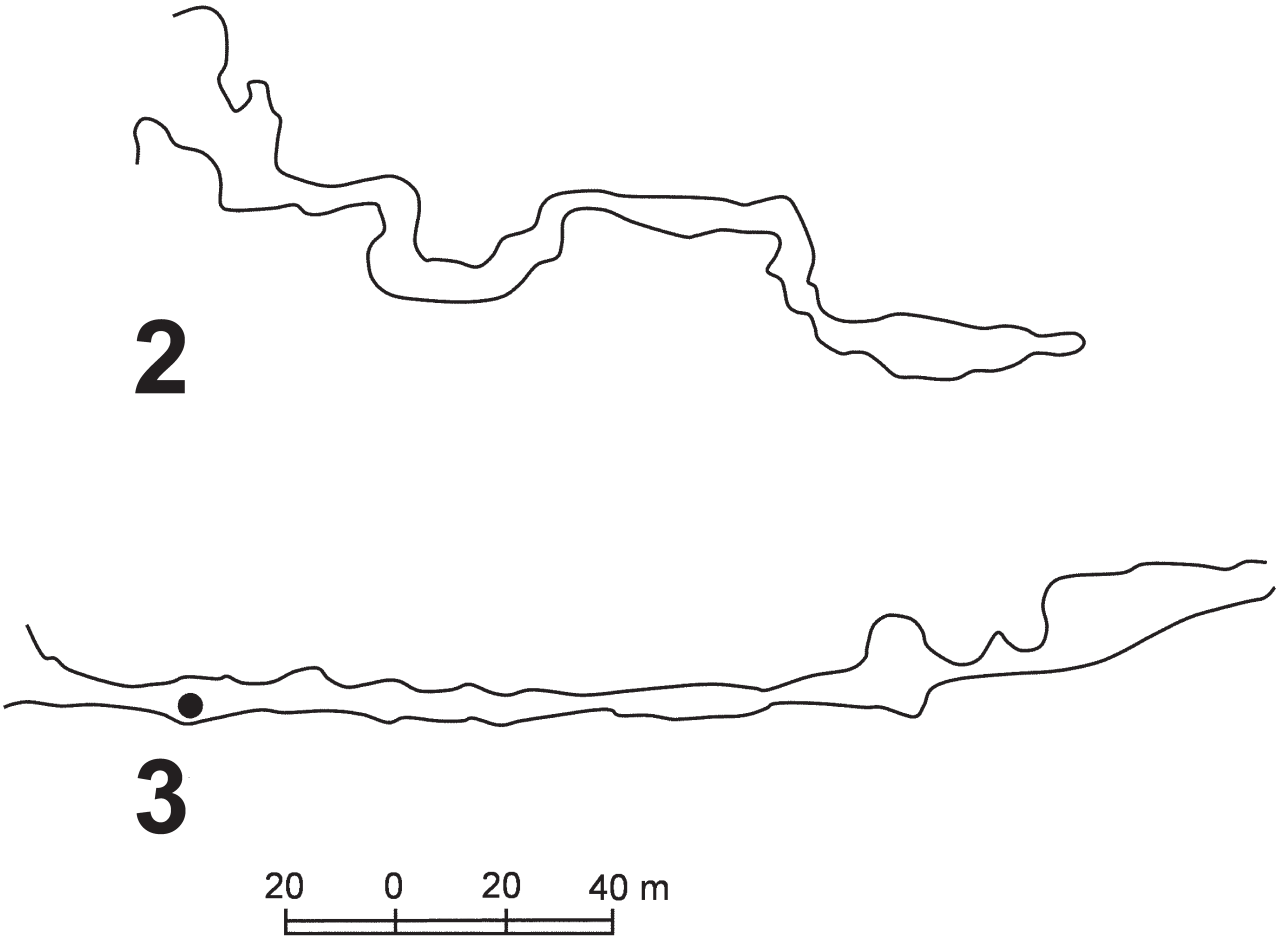
Sampling and slide mounting: Springtails were collected in 2017 (Fig. 1) either in cheese-baited traps or directly on the cave floor or walls using an aspirator. Specimens preserved in 95% ethanol were cleared in Nesbitt solution and slide mounted in Hoyer.

FIGURE 1. Entrance of Zeda Kvilishori Cave.

Observation on slide mounted specimens: Observation and measurements of slide mounted specimens were done on a Nikon Eclipse E400 phase-contrast compound microscope; drawings were prepared with drawing tube Nikon Y-IDT. Photographs were made with a Zeiss Axiocam HRc digital camera fitted on Zeiss SteREO Discovery V20 dissecting microscope.

SEM investigation: Details on the specimen preparation are as in Barjadze *et al.* 2016. Observations and SEM microphotographs were done on a JEOL JSM-5510LV Scanning Electron microscope.

Abbreviations. Abd.—abdominal tergite, Ant.—antennal segment, Mc—macrochaeta, Th.—thoracic segment, IZISU— Institute of Zoology at Ilia State University (Georgia), FSCA—Florida State Collection of Arthropods (USA).



FIGURES 2–3. Zeda Kvilishori Cave. 2, Plan (modified from Tatashidze *et al.* 2009); 3, Profile (modified from Tatashidze *et al.* 2009). Black circle marks approximate collection site.

Taxonomy

Plutomurus jordanai Barjadze & Soto-Adames sp. nov.

(Figs 4–19)

Type locality. GEORGIA, Imereti region, Tskaltubo district, near Zeda Kvilishori village, Sataplia-Tskaltubo karst massif, Zeda Kvilishori Cave, 4221’39.49”N, 4237’54.91”E, 249 m alt.

Type material. Holotype, male on slide: twilight zone, 23.vii.2017, leg. G. Nebieridze (code GEOZQV20170723-01). Paratypes (same data as holotype): three males on slides, leg. G. Nebieridze (code GEOZQV20170723-02, 03 and 04). One specimen mounted on SEM stub, leg. G. Nebieridze (GEOZQV20170723-05).

Repository. Holotype GEOZQV20170723-01 and paratype GEOZQV20170723-02 are deposited at FSCA and paratypes GEOZQV20170723-03, 04 and 05 are deposited at ISIZU.

Description. Body length up to 3.00 mm, excluding antennae and furcula.

Colour. Body grey, habitus as in Fig. 4.

Scale Distribution. Scales are present dorsally on Ant. I–II, head, body, all leg segments, both faces of collophore and ventral face of furcula. Postlabial region of head with few or no scales.

Head. Ratio body length to antennae length up to 1.05. Eye number difficult to ascertain under compound microscope, apparently varying from 1 to 5, cornea poorly differentiated, vestigial (Fig. 7). Head dorsally with 1 unpaired (A_0), and 6 paired Mc: 2 anterior (A_2, A_3), 2 interocular (S_1, S_4) and 2 postocular (Pa_3, Pa_5) distributed as in Fig. 7. Posterior margin of head with a row of evenly size mesochaetae. Prelabral and labral chaetae smooth (Fig. 5): prelabral chaetae 6 (3+3); labrum with 554 papillate chaetae as typical for genus; distal margin of labrum with 4 elongate, thin-walled, flexible papillae (Fig. 5). Sclerotized head of maxilla with 2 large and 2 or 3 small teeth; maxillary lamellas as in *Plutomurus shurubumuensis* Barjadze, Jordana & Soto-Adames in Barjadze *et al.* 2018. Outer maxillary lobe trifurcate, basal chaetae shorter than apical process; sublobal plate with 4 chaeta-like processes, one chaeta-like process is distinctly reduced and shorter than others (arrow in Fig. 19).

Body. Dorsal bothriotrichal formula 2,1/0,0,1,2,0 (Figs 8–10). Dorsal Mc formula 5,1/3,3,4,2,3 (Figs 8–10). Thorax macrochaetotaxy as in Fig. 8: Th. II with 3 anterior and 2 posterior Mc; Th. III with 1 posterior Mc. Abdominal macrochaetotaxy as in Figs 9 and 10: Abd. I–II each with 3 posterior Mc; Abd. III with 2 anterior and 2 posterior Mc as typical for genus; Abd. IV with 9 or 10 differentiated elements along posterior margin (labelled as 1–9 in Fig. 9), element 9 always a large Mc, element 6 developed into a small Mc, all other elements always have small mesochaeta-like sockets; Abd. V with 3 posterior Mc, 1 additional lateral Mc always present, but often hidden by slide mounting induced deformation of cuticle, and segment may appear as having only 3 Mc (Fig. 10).

Legs. Hind legs (Fig. 11) with well-developed trochanteral (30 chaetae) and femoral (24 chaetae) organs (holotype); posterior face of tibiotarsus with 1 outstanding inner, basal spine-like chaeta, (arrow in Fig. 17) resulting in a 001 tibiotarsal spine formula. Tenent hair acuminated (Fig. 16). Ratio hind unguis: unguiculus: tenent hair as 1.95–2.73: 1.55–2.10: 1 (n=3). Inner edge of unguis on all legs with one characteristically minute proximal unpaired tooth (a in Fig. 16), and 1–3 larger distal unpaired teeth (b–d in Fig. 16). Unguis III with lateral teeth 0.25–0.61 as long as length of inner edge (n=4). Unguiculus lanceolate, tapered, with 2 internal lamellae bearing 0–4 teeth (Figs 6 and 16).

Collophore. Anterior, posterior and lateral faces with 19, about 50 and 47 smooth chaetae respectively (Fig. 14).

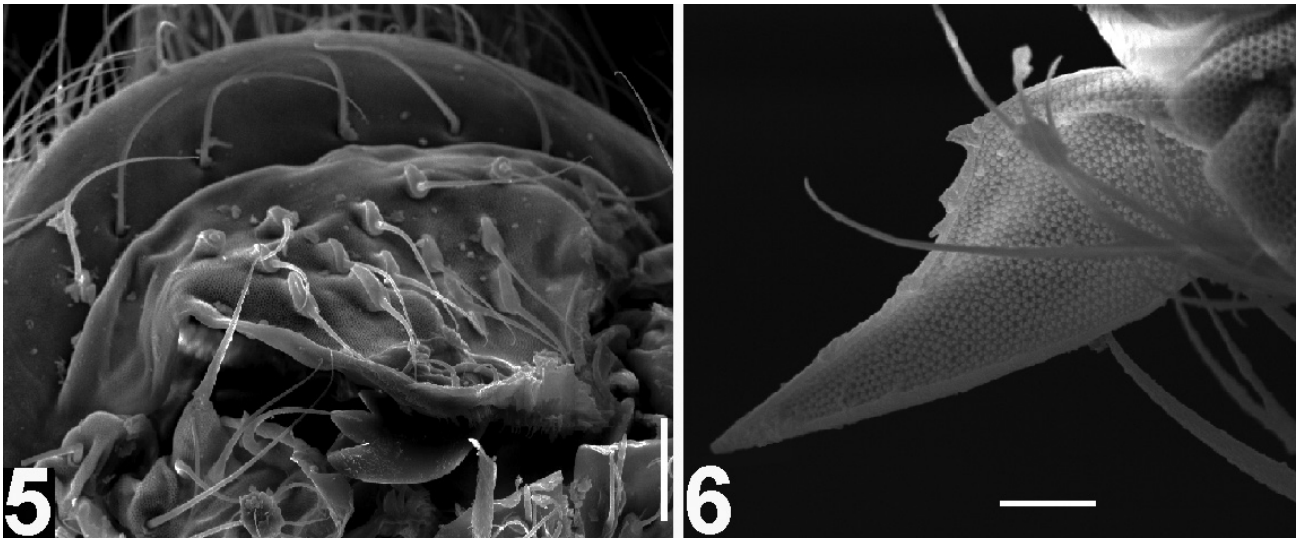
Tenaculum. Corpus with one smooth chaeta; rami with 4 + 4 teeth (Fig. 12).

Furcula. Ratio manubrium: dens: mucro as 4.03–4.61: 7.84–9.56: 1 (n=3 including holotype). Outer margin of basal segment of dens with 2–4 apically acuminate macrochaetae, distal macrochaeta largest, proximal shortest. Inner edge of dens basally with well differentiated spine-like chaetae (Fig. 18); spines on basal segment of dens forming 2–3 short and poorly organized rows, upper row usually formed by 2 large, well-differentiated spines; spines on distal segment of dens forming a single row extending between 0.34–0.37 of length of distal segment of dens; spines on proximal portion of distal segment of dens always small, terminal spine always largest in row; long spines intercalated between short spines. Total dental spines number (Fig. 18) as 6–10 ***II–III***/ 9–13 ***III–VI*** (Arabic numbers represent small spines; Roman numerals in bold Italics represent large spines, on proximal/distal segments of dens). Dental spines have minute spinules on basal third (Fig. 15). Mucro with 2 basal and 2 distal teeth (202 formula) (Fig. 13).

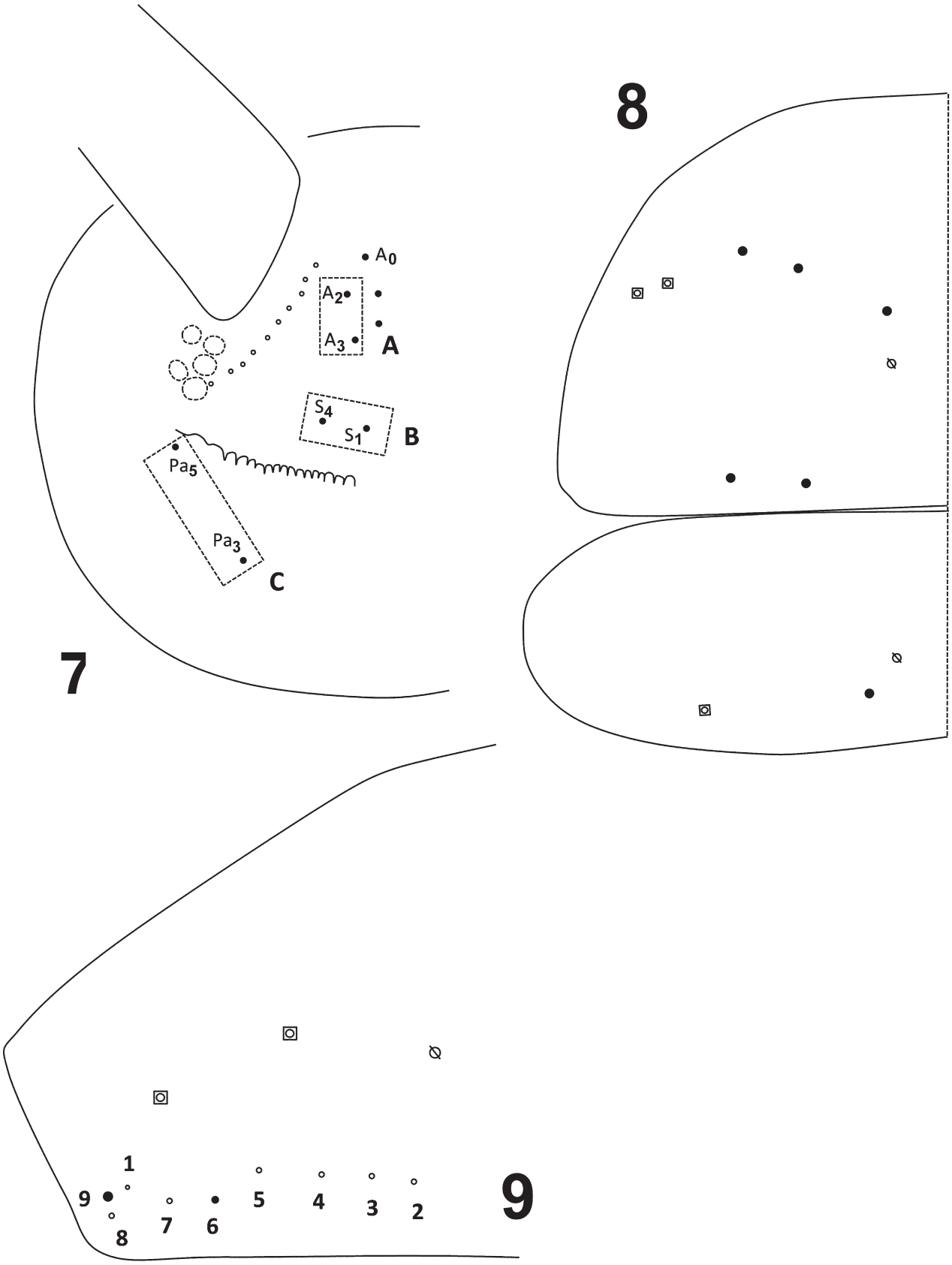
Variation. The vestigial condition of most eyes makes it difficult to determine the number of corneas on slide mounted specimens. The number of teeth on the inner lamellae of the unguiculus varies from 0 to 4 and the number of teeth on the unguis varies between 2 to 4.

Discussion. The new species is the only member of *Plutomurus* with 3+3 prelabral chaetae, acuminate tenent hair, 001 tibiotarsal spine-like chaeta, an evidently reduced process on the sublobal plate of the outer maxillary lobe and five dorsal macrochaetae on Th II. Only two other species (*Plutomurus kelasuricus* Martynova, 1969, and *P. eristoi* Barjadze, Baquero, Soto-Adames, Giordano & Jordana, 2016) share with the new species the acuminate tenent hair, 3+3 prelabral chaetae and tibiotarsi with 001 outstanding spine-like chaeta. From *P. kelasuricus* the new species differs in having minute empodial teeth (large in *P. kelasuricus*), and in having one chaeta-like process on the sublobal plate of the outer maxillary lobe much reduced (arrow in Fig. 19) (normally developed in *P. kelasuricus* from type locality—Kelasuri Cave (Tsebelda karst massif, Gulripshi Municipality, Abkhazia, Georgia) (Fig. 20). In addition to the fact that they occupy different, isolated cave massifs, the new species is found in the Sataplia-Tskaltubo karst massif, whereas *P. kelasuricus* inhabits the Tsebelda karst massif, located nearly 140 km away.

FIGURE 4. Habitus of *Plutomurus jordanai* **sp. nov.** (bar: 0.5 mm).



FIGURES 5–6. *Plutomurus jordanai* **sp. nov.** 5, Labral and prelabral chaetae (bar: 0.02 mm); 6, Unguiculus of mesothoracic leg (bar: 0.005 mm).



FIGURES 7–9. Dorsal chaetotaxy in *Plutomurus jordanai* **sp. nov.** 7, Head. A: Anterior macrochaetae, B: interocular Mc, C: postocular Mc; 8, Th. II–III; 9, Detail of differentiated chaetae on Abd. IV (dashed lined circles represent eyes; large black circle—macrochaeta; open circles—ariable meso- or macrochaeta; squares with dots—bothriothricha; circles with a slash represent pseudopores).

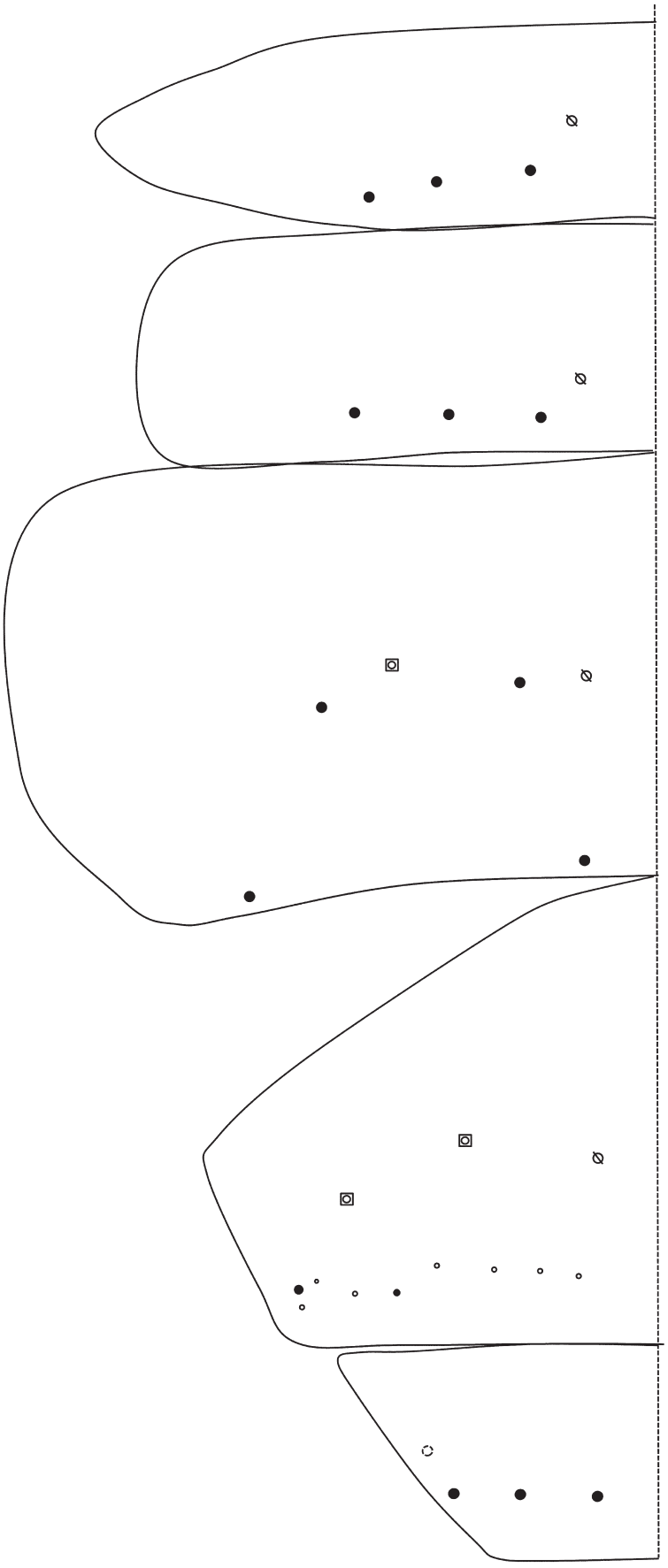


FIGURE 10. Dorsal chaetotaxy of Abd. I–V in *Plutomurus jordanai* **sp. nov.** (symbols as in Figs 7–9).

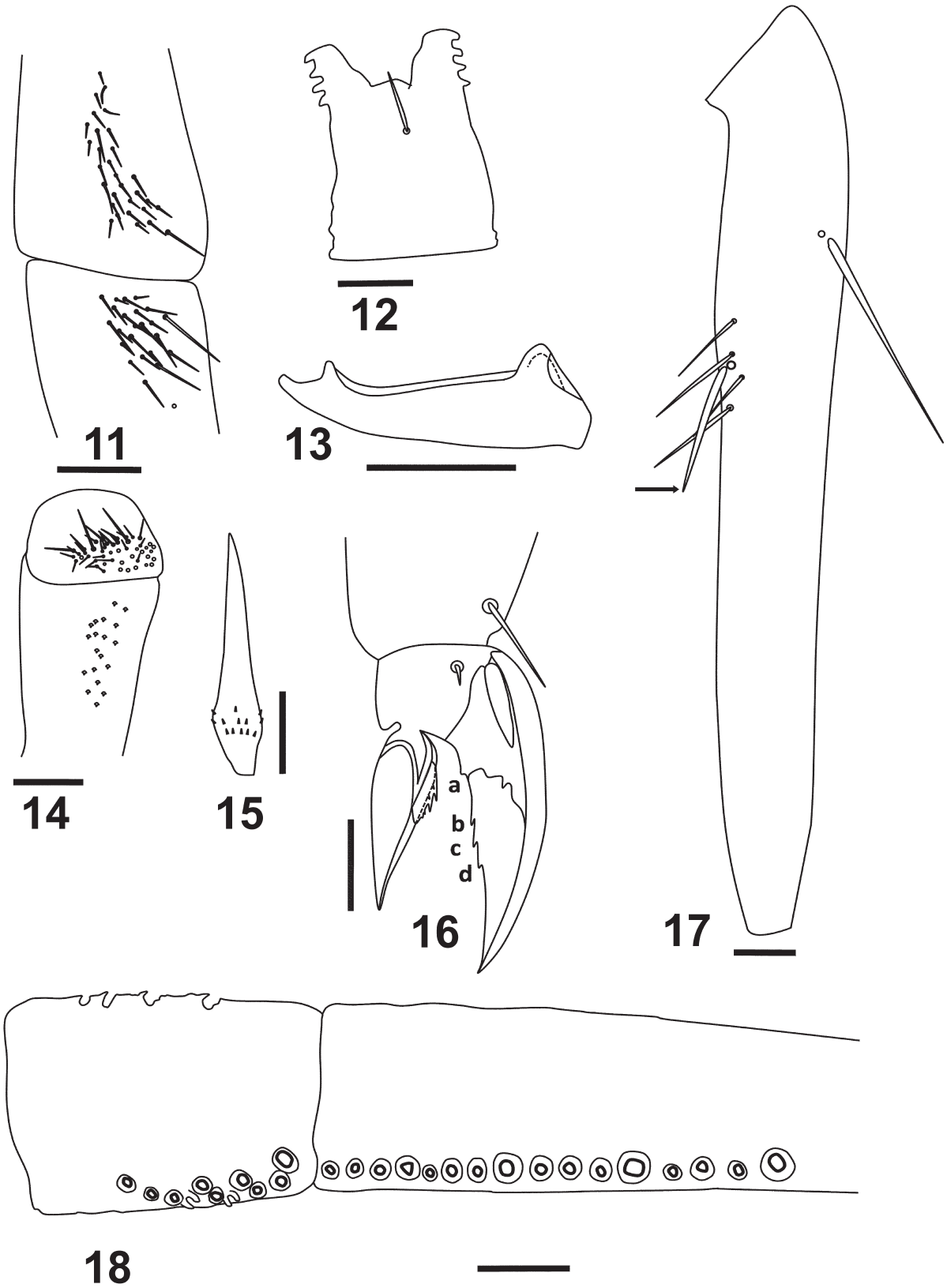
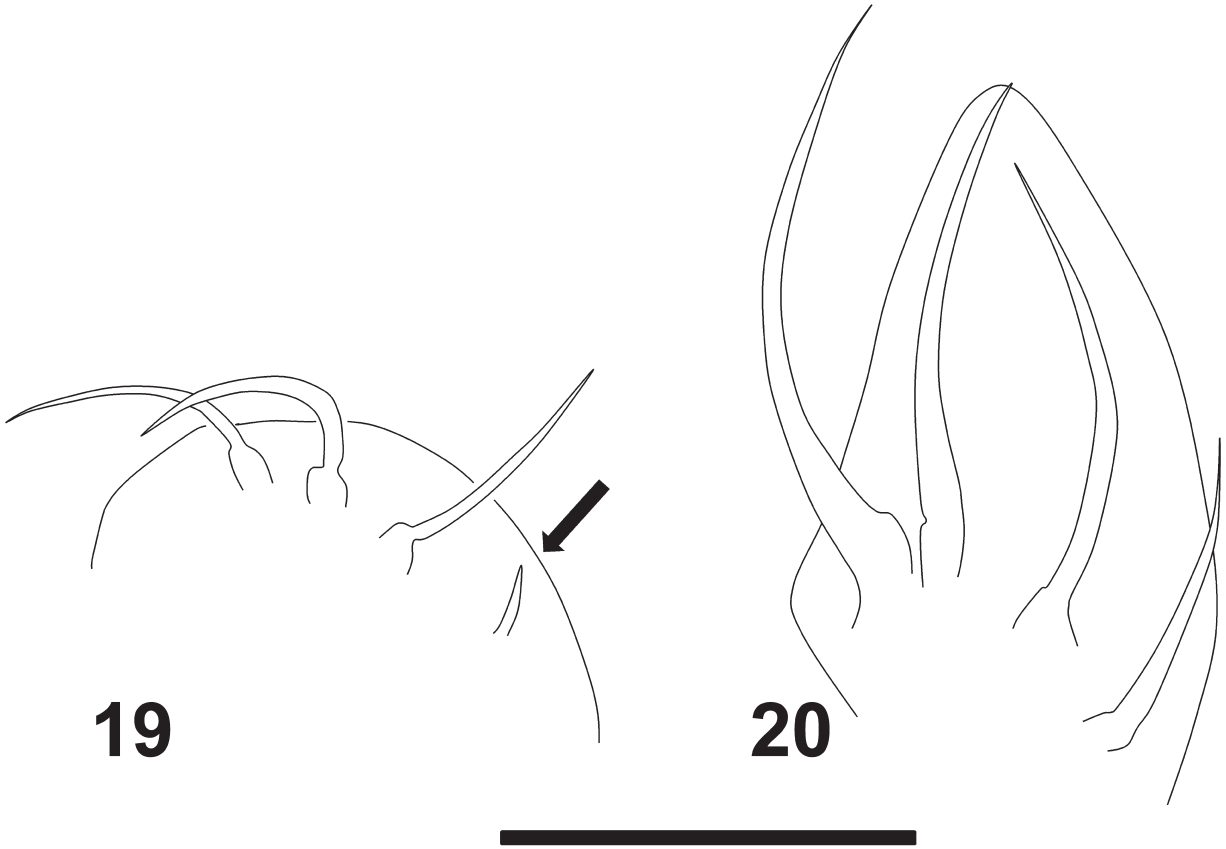


FIGURE 11–18. *Plutomurus jordanai* **sp. nov.** 11, Trochanteral and femoral organs (bar: 0.05 mm); 12, Tenaculum (bar: 0.03 mm); 13, Mucro, chaetae and chaetal sockets omitted (bar: 0.04 mm); 14, Collophore without posterior chaetae (bar: 0.08 mm); 15, Dental spine (bar: 0.025 mm); 16, Metathoracic claw complex (scale: 0.035 mm) (a, basal tooth to internal lamellae; b, c and d, additional unpaired teeth; 17, Hind tibiotarsus, showing location of spine-like chaeta with arrow (bar: 0.04 mm); 18, Dens with sockets of dental spines (scale: 0.044 mm).

The new species differs from *P. eristoi* by the presence of five Mc on Th. II, while *P. eristoi* lacks Mc on Th. II; and by the presence of two posterior Mc on Abd. IV, whereas *P. eristoi* carries only 1 posterior Mc.

Etymology. The species is named after Prof. Rafael Jordana (University of Navarra, Spain), in recognition of his contributions disentangling the Gordian Knot of species level taxonomy in *Plutomurus,* and in gratitude for his work on the springtail fauna of Georgia.

Ecology. The body and eye patch pigmentation, together with the thick, toothed unguis suggest that this is a troglophilous species.



FIGURES 19–20. Sublobal plate of outer lobe of maxillary palp. 19, *Plutomurus jordanai* **sp. nov.** (scale: 0.005 mm) (Arrow indicates reduced chaeta-like process); 20, *Plutomurus kelasuricus* Martynova, 1969 (scale: 0.005 mm).

Note on the morphology of *Plutomurus birsteini* Djanashvili & Barjadze, 2011

Plutomurus birsteini was described from eleven caves located in Imereti and Racha-Lechkhumi regions of Western Georgia (Djanashvili & Barjadze 2011). In the original description, there is no information on dorsal bothriotrichal and Mc formulas. Besides, information on the number of spine-like chaetae on the inner side of the tibiotarsi and a number of teeth on the empodium was given erroneously. We examined one specimen of *P. birsteini* sampled in the type locality—Sakishore Cave in 2014 (Racha karst massif, Ambrolauri Municipality, Racha region, Georgia) and here provide additions to the original description.

Complementary description. Head dorsally with one unpaired (A_0), and 6 paired Mc: 2 anterior (A_2, A_3), 2 interocular (S_1, S_4) and 2 postocular (Pa_3 and Pa_5). Head Mc distributed as in Fig. 21. Posterior margin of head with a single row of undifferentiated mesochaetae. Trunk dorsally with 2(?),1/0,0,1,2,0 bothriotricha (Figs 22 and 23) and 4,2/3,3,4,3,2 Mc (Figs 22 and 23). Thorax macrochaetotaxy as in Fig. 22: Th. II with 2 anterior and 2 posterior Mc; Th. III with 2 posterior Mc. Abdominal macrochaetotaxy as in Fig. 23: Abd. I–II each with 3 posterior Mc; Abd. III with 2 anterior and 2 posterior Mc as typical for genus; Abd. IV with 7 differentiated elements (labelled as 1–7 in Fig. 23), element 7 always a large Mc, followed by element 4; element 2 is a small Mc. Elements 3, 5, 6 are large mesochaetae, while element 1 is a small mesochaeta. Abd. V has 2 dorso-posterior Mc and 1 lateral Mc always present. Spine-like chaeta formula on tibiotarsi was reported as 001, but this species has 2 internal spine-like chaetae

on III tibiotarsi (002) (arrows Fig. 25). In the original description it was stated that the empodium lacked teeth, but in fact there are 0–3 small teeth (Fig. 25).

Key to species of *Plutomurus* Yosii from the Caucasus

1 Prelabral chaetae 2+2 . . . 2
- Prelabral chaetae 3+3 . . . 5
2 Spine–like chaetae on tibiotarsus I, II, and III as 002 . . . 3
- Spine–like chaetae on tibiotarsus I, II, and III as 001 . . . 4
3 Tenent hair acuminate. . . . *P. abchasicus* Martynova, 1969 (Georgia: soil)
- Tenent hair clavate . . . *P. birsteini* Djanashvili & Barjadze, 2011 (Georgia: caves)
4 Eye patch with 4–5 eyes; tenaculum with 1 chaeta . . . *P. sorosi* Kniss & Thibaud, 1999 (Russia: North Caucasus: cave)
- Eye patch with 6 eyes; tenaculum with 3–4 chaetae . . . *P. jeleznovodski* Kniss & Thibaud, 1999 (Russia: North Caucasus: cave)
5 Tenent hair clavate . . . *P. revazi* Barjadze, Baquero, Soto-Adames, Giordano & Jordana, 2016 (Georgia: caves)
- Tenent hair acuminate. . . . 6
6 Spine–like chaetae on tibiotarsus I, II, and III as 002 . . . 7
- Spine–like chaetae on tibiotarsus I, II, and III as 001 . . . 9
7 Eyes absent; Th. II with 6 (anterior, medial & posterior) Mc . . . *P. ortobalaganensis* Jordana & Baquero, 2012 in Jordana *et al*. 2012 (Georgia: caves)
- Eyes present; Th. II with 4 (medial & posterior) Mc . . . 8
8 Abd. IV with 1 large lateral and sometimes a second smaller medial Mc . . . *P. shurubumuensis* Barjadze, Jordana & Soto-Adames in Barjadze *et al.* 2018 (Georgia: cave)
- Abd. IV with 3 Mc: 1 large lateral and 2 smaller medial Mc. . . . *P. pichkhaiai* Barjadze, Jordana & Soto-Adames in Barjadze *et al.* 2018 (Georgia: caves)
9 Eyes present and distinct; empodium with a large tooth . . . *P. kelasuricus* Martynova, 1969 (North Caucasus and Georgia: caves)
- Eyes absent or indistinct; empodium with small teeth . . . 10
10 Th. II with 5 (medial & posterior) Mc; one chaeta–like process on the sublobal plate is much shorter than others (Fig. 19) . . . *P. jordanai* **sp. nov.** (Georgia: cave)
- Th. II with without Mc; all chaeta-like process on the sublobal plate normally developed. . . . *P. eristoi* Barjadze, Baquero, Soto-Adames, Giordano & Jordana, 2016 (Georgia: cave)

Invertebrate communities of Zeda Kvilishori (=Tsikhe) Cave

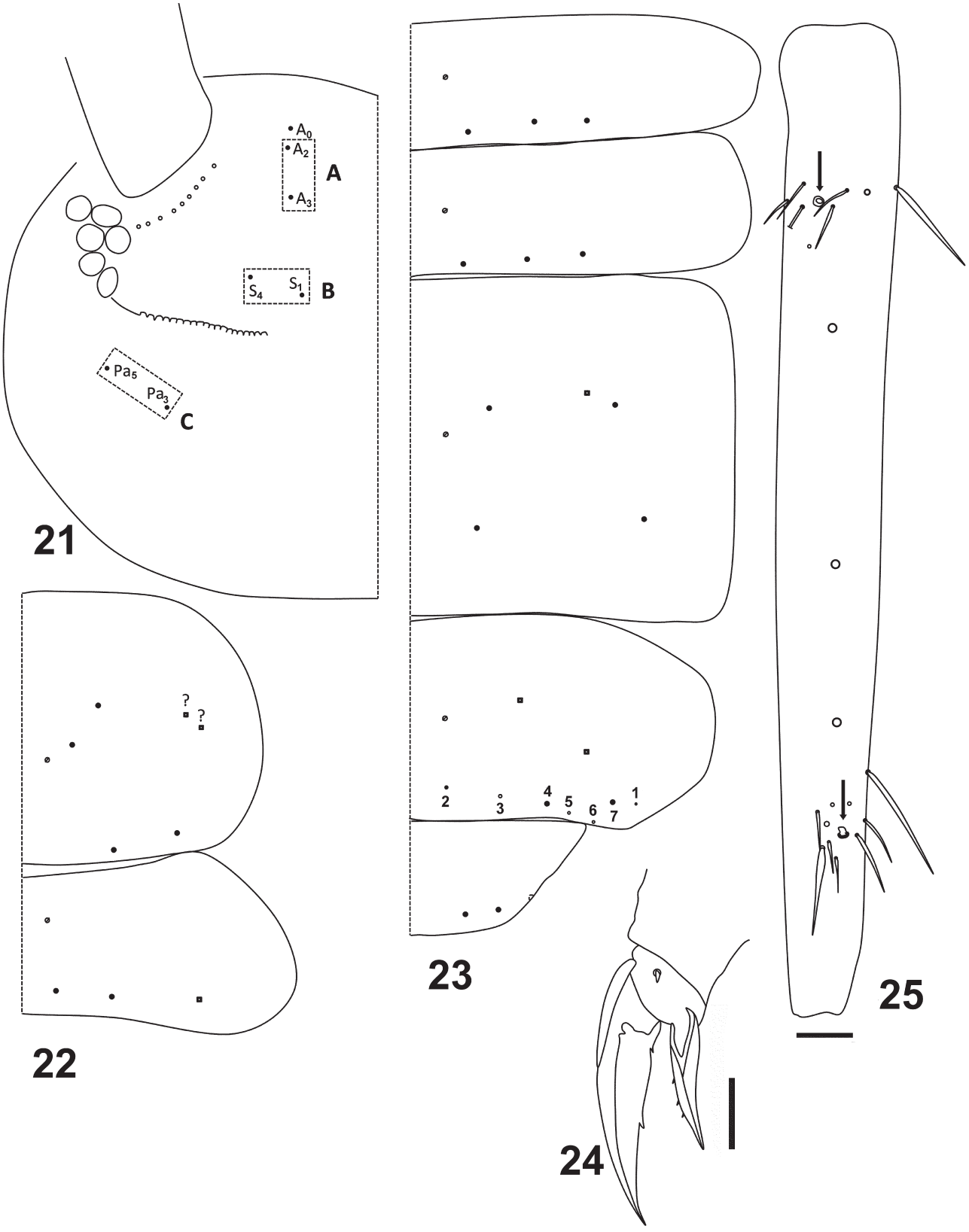
Sataplia-Tskaltubo karst massif, Tskaltubo Municipality, Imereti region, Georgia

Annelid: Hirudinea sp. indet.
Maxillopods: *Bryocamptus innominatus* Borutsky, *Bryocamptus zschokkei caucasicus* Kiefer (=*Bryocamptus zschokkei caucasicus* Borutsky), *Nitocrella* sp.
Millipede: *Archileucogeorgia* sp.
Springtails: *Folsomia candida* Willem, *Proisotoma minuta* (Tullberg), *Plutomurus jordanai* **sp. nov.** (
In total: 8 species.
Literature: Barjadze *et al.* 2015, 2019

Invertebrate communities of Sakishore Cave

Racha karst massif, Ambrolauri Municipality, Racha region, Georgia

Annelid: *Dina ratschaensis* Kobakhidze
Harvestman: *Nemaspela femorecurvata* Martens
Insects: *Inotrechus injaevae* Dolzhanskij & Ljovuschkin, *Scoliopteryx libatrix* (Linnaeus), *Triphosa dubitata* (Linnaeus)
Mites: *Ceratozetes* sp., *Eremaeus* sp., *Oribatula* sp.
Mollusks: *Eumilax* cf. *brandti* (Martens), *Schistophallus sucinacius* (Boettger)
Springtail: *Plutomurus birsteini* Djanashvili & Barjadze
In total: 11 species.
Literature: Barjadze *et al.* 2015, 2019



FIGURES 21–25. *Plutomurus birsteini* Djanashvili & Barjadze, 2011. 21, Dorsal chaetotaxy of head. A: Anterior macrochaetae, B: interocular Mc, C: postocular Mc; 22, Dorsal chaetotaxy of Th. II–III; 23, Dorsal chaetotaxy of Abd. I–V; 24, Claw III complex (scale: 0.025 mm); 25, Hind tibiotarsus, showing location of spine-like chaetae with arrows (bar: 0.04 mm) (symbols as in Figs 7–9).

Acknowledgements

We thank to Giorgi Nebieridze (Millenium School, Tbilisi, Georgia) for springtail sample and Gigo Oniani and Valeri Barbakadze (Imereti Cave Protected Areas Administration, village Banoja, Tskaltubo Municipality, Georgia) for the photo of Zeda Kvilishori Cave. We are grateful to Paul Skelley (Division of Plant Industry, Florida Department of Agriculture and Consumer Services, Gainesville, USA) for making available the facilities during the senior author's visit to the above mentioned department. We also thank Wanda Maria Weiner (Institute of Systematics and Evolution of Animals, Polish Academy of Sciences, Kraków, Poland) and the anonymous referees for their valuable comments on our manuscript. This manuscript is published with financial support of the Shota Rustaveli National Science foundation in the frame of the grant: "Biodiversity of the invertebrate animals in Georgian karst caves" (ref. FR/24/7-110/11 (11/27)), the Rufford Small Grant Foundation under the grant: "Cave Investigations and Education of Local People for Caves Conservation in Racha Region of Georgia" (ref. 13537-2), and the Fulbright Scholar Program in the frame of project: "New Contribution to the Springtail (Collembola) Fauna of Georgia."

References

Barjadze, Sh. & Djanashvili, R. (2014) Redescription of *Plutomurus kelasuricus* Martynova, 1969 (Collembola: Tomoceridae) from Georgian Caves. *Zoology in the Middle East*, 60, 251–254.
https://doi.org/10.1080/09397140.2014.939812

Barjadze, Sh., Asanidze, Z., Gavashelishvili, A. & Soto-Adames, F. (2019) The hypogean invertebrate fauna of Georgia (Caucasus). *Zoology in the Middle East*, 65 (1), 1–10.
https://doi.org/10.1080/09397140.2018.1549789

Barjadze, Sh., Baquero, E., Soto-Adames, F., Giordano, R. & Jordana, R. (2016) New diagnosis for species of *Plutomurus* Yosii (Collembola, Tomoceridae), with descriptions of two new species from Georgian caves. *Zootaxa*, 4126 (1), 77–96.
https://doi.org/10.11646/zootaxa.4126.1.3

Barjadze, Sh., Jordana, R., Baquero, E., Giordano, R. & Soto-Adames F. (2018) Two new species of *Plutomurus* Yosii (Collembola, Tomoceridae) from the Caucasus. *Zootaxa*, 4526 (1), 29–40.
https://doi.org/10.11646/zootaxa.4526.1.2.

Barjadze, Sh., Murvanidze, M., Arabuli, T., Mumladze, L., Pkhakadze, V., Djanashvili, R. & Salakaia, M. (2015) *Annotated List of Invertebrates of the Georgian Karst Caves.* Georgian Academic Book, Tbilisi, 120 pp.

Chang, G. & Park, K. (2020) Report on a new species of *Plutomurus* (Collembola, Tomoceridae) from a South Korean limestone cave, with notes on its DNA barcode. *Zootaxa*, 4718 (1), 108–122.
https://doi.org/10.11646/zootaxa.4718.1.9

Christiansen, K. & Bellinger, P. (1998) *The Collembola of North America, North of the Rio Grande. A taxonomic analysis. Part 3.* Grinnell College, Iowa, pp. 877–1173.

Djanashvili, R. & Barjadze, S. (2011) A new species of the genus *Plutomurus* Yosii, 1956 (Collembola, Tomoceridae) from Georgian caves. *Journal of Cave and Karst Studies,* 73, 28–30.
https://doi.org/10.4311/jcks2010lsc0147

Jordana, R., Baquero, E., Reboleira, S. & Sendra, R. (2012) Reviews of the genera *Schaefferia* Absolon, 1900, *Deuteraphorura* Absolon, 1901, *Plutomurus* Yosii, 1956 and the *Anurida* Laboulbène, 1865 species group without eyes, with the description of four new species of cave springtails (Collembola) from Krubera-Voronya cave, Arabika Massif, Abkhazia. *Terrestrial Arthropod Reviews*, 5, 35–85.
https://doi.org/10.1163/187498312X622430

Kniss, V. & Thibaud, J. (1999) Genus *Plutomurus* in Russia and Georgia (Collembola, Tomoceridae). *Revue française d'Entomologie*, New Series, 21, 57–64 [in French]

Martynova, E. (1969) Springtails of the family Tomoceridae (Collembola) from the fauna of the USSR. *Entomological Review*, 43, 299–314 [in Russian]

Tatashidze, Z.K., Tsikarishvili, K.D. & Jishkariani, J.M. (2009) *The Cadastre of the Karst Caves of Georgia.* Petiti Publishing House, Tbilisi, 670 pp. [in Georgian]

Yosii, R. (1956) Monograph about Japanese cave collembolans. *Contribution from the Biological Laboratory Kyoto University*, 3, 1–109 [in German]