Zootaxa 3341: 32–45 (2012)
www.mapress.com/zootaxa/

Article

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

Redescription of two troglobiotic species of the genus *Pseudosinella* Schäffer, 1897 (Collembola, Entomobryidae) from the Western Carpathians

ĽUBOMÍR KOVÁČ[1] & JOSEF RUSEK[2]

[1]*Department of Zoology, Institute of Biology and Ecology, Faculty of Science, P. J. Šafárik University, Moyzesova 11, 040 01 Košice, Slovak Republic. E-mail: lubomir.kovac@upjs.sk*
[2]*Institute of Soil Biology BC AS CR, Na Sádkách 7, 370 05 České Budějovice, Czech Republic, E-mail: rusek@upb.cas.cz*

Abstract

Two troglobiotic species of the genus *Pseudosinella* Schäffer, 1897 from the Western Carpathians are redescribed, *P. aggtelekiensis* (Stach, 1929) and *P. paclti* Rusek, 1961. *P. aggtelekiensis* has endemic distribution restricted to the Slovak-Aggtelek Karst region in Slovakia and Hungary. It shows higher level of troglomorphy (elongation of antennae, basal displacement of ungual teeth concurrent with their reduction) probably representing a descendant of the older phyletic *Lepidocyrtus-Pseudosinella* lineage. *P. paclti*, distributed in caves of several karstic regions in central Slovakia, is characteristic with medium level of troglomorphy.

Key words: cave fauna, troglomorphy, Slovak-Aggtelek Karst, Slovakia, Hungary

Introduction

According to recent biospeleological explorations karstic caves of the Western Carpathians (Slovakia) host several specialized subterranean forms within the genus *Pseudosinella* Schäffer, 1897. We redescribe in this contribution two troglobiotic *Pseudosinella* species since their original descriptions are incomplete and do not correspond with the modern taxonomy.

Pseudosinella aggtelekiensis (Stach, 1929) was entirely inadequately described and its position within the taxonomic framework of the genus remained unclear (Christiansen *et al*. 1983, 2009). The only additional specification of the species status was that of Loksa (1961) who provided the figure of the foot complex. We were kindly provided with material of *P. aggtelekiensis* from type locality (Baradla Cave, Hungary) by Prof. W. M. Weiner (Kraków) labelled as ”Hungaria, Aggtelek Höhle, 19.XII.1929, leg. Dudich, *Lepidocyrtus* (*Pseudosinella*) *aggtelekiensis* (ex coll. Stach)”containing 5 individuals mounted on the same permanent slide. Unfortunately, the status of the material is inappropriate for a detailed study. Therefore we redescribe the species based on recently collected specimens from the Domica-Baradla Cave system. Type locality, Baradla Cave, is a part of the system that reaches its overall length over 25 km and involves several interconnected caves. The cave system is situated on the boundary between Slovakia and Hungary in the Slovak-Aggtelek Karst orographic region.

Similarly, the original description of *Pseudosinella paclti* Rusek, 1961 is incomplete, corresponding with the state of contemporary taxonomy. Paratypes of the species were later examined by Gisin and Gama (1970). Within the description of *P. subdobati* they also specified several characters of *P. paclti*, i.e. pattern of dorsal macrosetae of the body as well as pattern of supplementary microsetae situated in front of anterior trichobothrium on the fourth abdominal segment. The holotype and two paratypes from the Demänovská slobody Cave (Demänovská Valley) in Low Tatra Mountains, Slovakia, are mounted on a permanent slide deposited in the Department of Entomology, Moravian Museum, Brno (Czech Republic). However, important morphological details are not clearly seen on the slide. The redescription of *P. paclti* is therefore based on additional specimens from type locality collected recently.

It is generally accepted that genus *Pseudosinella* is polyphyletic, its different lineages having been derived from different species of *Lepidocyrtus* as the ancestral genus (Christiansen 1961, Gama 1984). Gisin (1964 a,b,

 Accepted by W.M. Weiner: 16 Apr. 2012; published: 11 Jun. 2012

1967) introduced first nomenclatorial system of body setal pattern for Lepidocyrtini. In the genus *Pseudosinella* the system is widely used (e.g. Christiansen & Bellinger 1998, etc.). It was incorporated in an inter-active version of *Pseudosinella* key elaborated by Christiansen *et al*. (2009) to assist in species identification. Nomenclature system of the complete setal pattern of abdominal terga in Lepidocyrtinae (sensu Szeptycki 1979) was developed by Szeptycki (1979) and applied by Mari Mutt (1986), Mateos (2008), Zhang *et al*. (2009) and Soto-Adames (2010). In this paper we use Gisin´s system completed with principal characters of the Szeptycki´s so called "AMS system" (Soto-Adames 2010). Since its great systematic importance we provide entire setal pattern of the fourth abdominal tergum in both *Pseudosinella* species redescribed. Up till now less attention has been paid to setal patterns on antennae which are used in the redescriptions of both species.

Material and methods

The specimens of *Pseudosinella aggtelekiensis* and *P. paclti* have been collected during biospeleological explorations of the Western Carpathian caves since 1996 within research projects conducted by the Department of Zoology, Faculty of Science, P. J. Šafárik University, Košice, Slovakia.

Specimens were separately mounted on permanent slides in Swann medium, following procedure after Rusek (1975), and studied in Leica DM 2500 microscope equipped with drawing arm. Macrosetal pattern of head is applied according to Jordana and Baquero (2007) since it more properly denominates position of particular macrosetae in *Pseudosinella* compared to the system of Mateos (2008). We considered few short, thin and smooth structures on Th.II–Abd.V terga as smooth mesosetae after Mateos (2008) contrary to Zhang *et al*. (2009) who denoted them as s-chaetae. Indeed, study of micromorphology of these structures is necessary.

Abbreviations: Ant.—antennal segment, Th.—thoracal tergum, Abd.—abdominal tergum, as—anterior smooth mesoseta on Abd.IV tergum, cm—modified conical microsetae on antennae, s—smooth mesosetae on Th.II–Abd.V terga, ms—microsensilla on on Th.II–Abd.V terga, ps—posterior smooth mesoseta on Abd.IV tergum, IBE FS UPJŠ—Institute of Biology & Ecology, Faculty of Science, P. J. Šafárik University Košice, Slovakia, ISEA—Institut of Systematics and Evolution of Animals, Polish Academy of Sciences Kraków, Poland.

Redescriptions

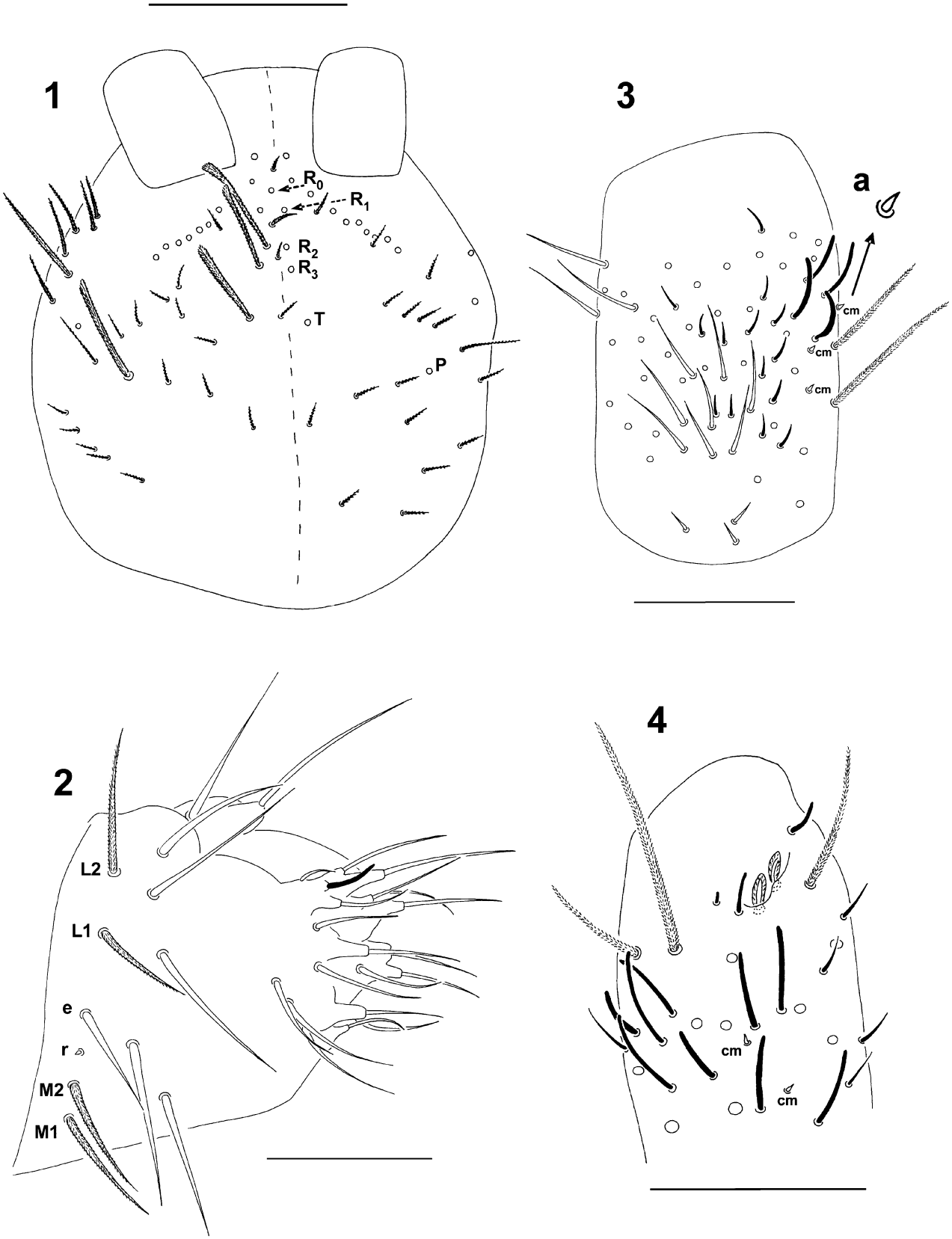
***Pseudosinella aggtelekiensis* Stach, 1929**
Figs 1–9

Lepidocyrtus (Pseudosinella) aggtelekiensis Stach, 1929: 296.

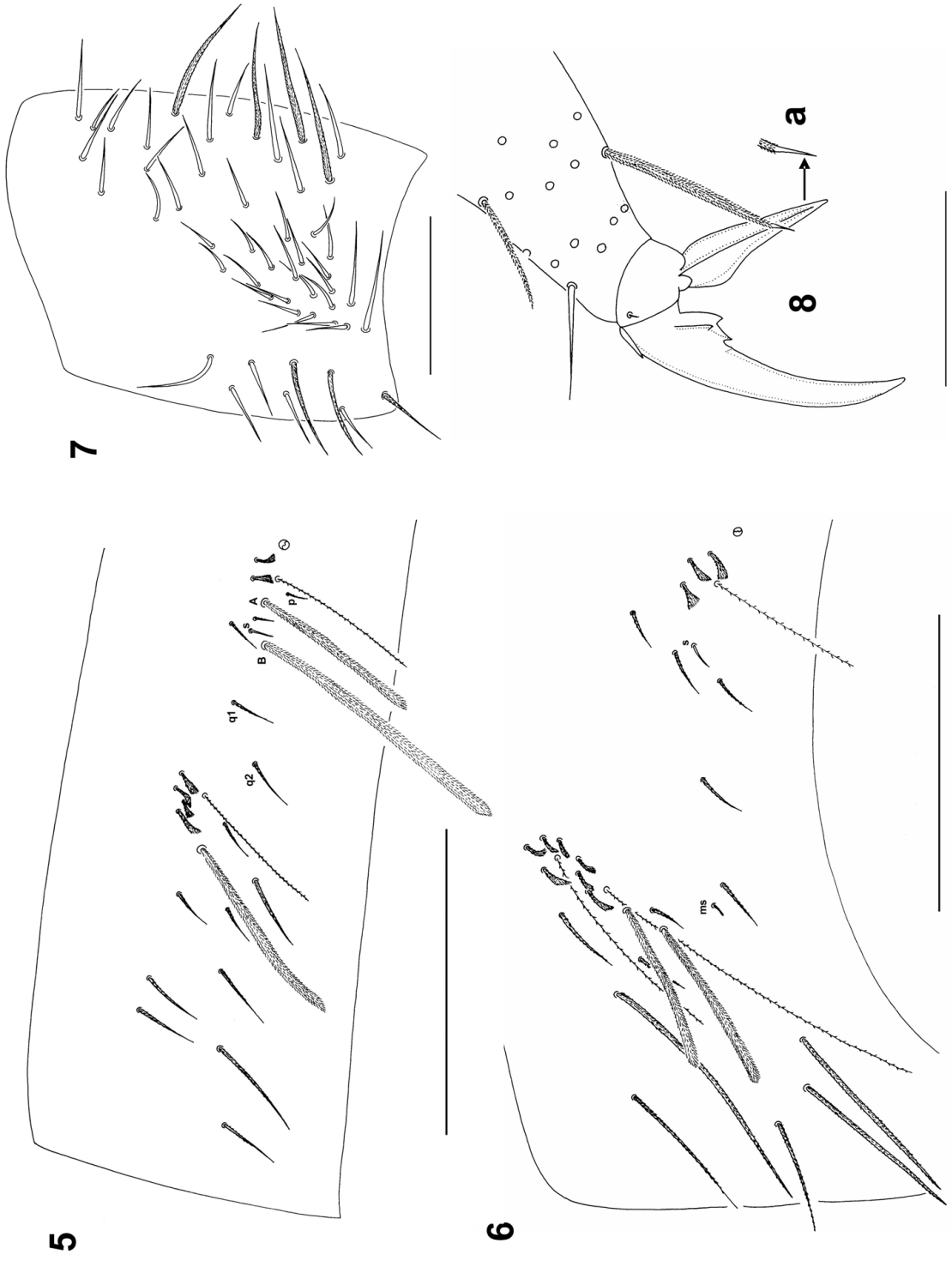
Diagnosis. Eyes and pigmentation absent. Labium with $\mathbf{M_1M_2reL_1L_2}$ basal setae, **r** strongly reduced. Dorsal macrosetae: **R111/32/0201+3**. On Abd.IV proximal macroseta in position A4. Setal pattern of abdominal tergite II: $\mathbf{pABq_1q_2}$. Abd.IV with supplementary microseta **s** in front of anterior trichobothrium and 3+3 smooth mesosetae. Antennal segments with conical microsetae **cm**. Apical half of Ant.III segment without additional leaf-like setae, Ant.II apically with 1 such modified seta. Foot complex as in Fig. 8. Unguiculus without any tooth on outer lamella. Tibiotarsal tenent hair pointed. Trochanteral organ with 18–22 smooth setae.

Type material. Hungary, Domica-Baradla cave system, Baradla Cave, 18–20.viii.1924, leg. E. Dudich & E. Bokor; ibid. 1.xi. and 5.xii.1928, leg. E. Dudich (not examined, number of specimens and place of deposition unknown).

Examined material from type locality. Hungary, Slovak-Aggtelek Karst, Domica-Baradla cave system, Baradla Cave, 5 specimens mounted on a permanent slide, 19.xii.1929, leg. Dudich. ISEA, Polish Academy of Sciences Kraków, Poland. Slovakia, Slovak-Aggtelek Karst, Domica-Baradla cave system, Čertova diera Cave, "Dóm netopierov" Hall and "Vstupná sieň" Hall, 5 specimens (3 females, 2 males), collected by pitfall traps, 23.x.–9. xii.1997, leg. Ľ. Kováč; ibid. Líščia diera Cave, "Veľká sieň" Hall, 1 specimen (female), 1.xii.2000, leg. P. Ľuptáčik. 6 specimens saved in collection of the Muséum Nationalle d´Histoire Naturelle (MNHN) in Paris.



FIGURES 1–4. *Pseudosinella aggtelekiensis*: **1,** head, dorsal side (setae of p-row not drawn); **2,** labial triangle setae and labial palps, lateral side; **3,** Ant.I segment, ventral side (empty circles: serrated meso- and macrosetae), a—conical microseta (cm), enlarged; **4,** apical part of Ant.III segment, ventral side (empty circles: serrated meso- and macrosetae). Scale bars:: 200 μm (Fig. 1), 50 μm (Figs 2–4).



FIGURES 5–8. *Pseudosinella aggtelekiensis*: **5,** Abd.II segment, dorsally, left side; **6,** Abd.III, dorsally, left side; **7,** trochanter of leg III, internal side; **8,** unguis of leg II, a—tip of internal macroseta, enlarged. Scale bars: : 200 µm (Figs 5–6), 50 µm (Figs 7–8).

Other examined material. Slovakia, Slovak-Aggtelek Karst, Ardovská Cave, "Zrútený dóm" Dome, 2 specimens, pitfall trap, 29.iv.–13.vi.1997, leg. Ľ. Kováč; ibid., main cave passage in upper level, 6 specimens, pitfall traps, 4.iv.–30.x.1997, leg. Ľ. Kováč; ibid., "Rozprávková sieň" Hall, 11 specimens, collected on bat guano, 31.iii.2011, leg. Ľ. Kováč; ibid., "Zrútený dóm" Dome, 2 specimens, collected on rotten wood, 10.x.2008, leg. P. Ľuptáčik; Gombasecká Cave, "Blatistá chodba" Passage, 7 specimens, 22.x.1999, hand collecting on surface of water pool and on rotten wood, leg. Ľ. Kováč; ibid., 4 specimens, collected on rotten wood, 8.x.2008, leg. P.

Ľuptáčik; Hačavská Cave, 3 specimens, pitfall trap, 24.v.–23.vi.1996, leg. Ľ. Kováč; Majkova Cave, 4 specimens, pitfall trap, 5.iii.–15.v.1998, leg. Ľ. Kováč and A. Mock; Milada Cave, "Dóm Vysokých Tatier" Dome, 5 specimens, collected on bait, 8.ix.2010. leg. P. Ľuptáčik. Other material kept in the Institute of Biology & Ecology, Faculty of Science, P. J. Šafárik University (IBE FS UPJŠ) Košice.

Redescription. Body 2.1–2.4 mm long. White, without traces of pigmentation. Scales on antennae and legs absent; ventral side of manubrium with scales.

Head. Eyes absent. Dorsal macrosetae **R111** or **R** (**R_0 R_1 R_2**) + **R_3 T P**. Macrosetae ciliated (65–85 μm) with blunt apex (dorsal ones) or sharply pointed (lateral ones); mesosetae finely ciliated (15–40 μm, Fig. 1). Posterior row with finely ciliated and sharply pointed mesosetae (55 μm). Short trichobothrium (35 μm) situated laterally to ocular macroseta. Praelabral setae ciliated, labral setae smooth. Setal pattern of labrum: **4/554**. Labium in adults with **$M_1M_2reL_1L_2$** basal setae; **M_1, M_2, L_1** and **L_2** finely ciliated, seta **r** strongly reduced, smooth (Fig. 2); in juveniles and subadults seta **e** finely ciliated (i.e. **E**) as others. Frontal row of labial setae smooth.

Thorax and abdomen (Figs 5, 6 and 9). Dorsal macrosetae: **/32/0201+3**. Microsensillar formula 10/10100, microsensilla (**ms**) strong and placed laterally (5 μm), on Th.II and Abd.I anteriorly, on Abd.III posteriorly. Formula of smooth mesosetae 11/01133, mesosetae (**s**) progressively elongated from Th.II (10 μm) to Abd.V (17 μm). Smooth mesoseta on Th.II in anterior position placed laterally to **ms**. Abd.IV with 3 smooth mesosetae, 2 anterior **as** (medial and lateral) and 1 posterior **ps**. Setal pattern of abdominal tergite II: **pABq$_1$q$_2$** (Fig. 5); macroseta A 0.63% of the length of macroseta B (90 and 145 μm, respectively). Abd.IV with 4 supplementary microsetae (blunt, ciliated) in front of anterior trichobothrium (microseta **s** present) and 3 such microsetae in front of posterior trichobothrium (Fig. 9a, b). Medial macrosetae of Abd.IV: anterior **A4** broad with blunt apex (190 μm), medial **B5** and posterior **B6** more slender, equally long (300 μm) with apex sharply pointed devoid of ciliation. Entire setal pattern of Abd.IV shown in Figs 9a and 9b.

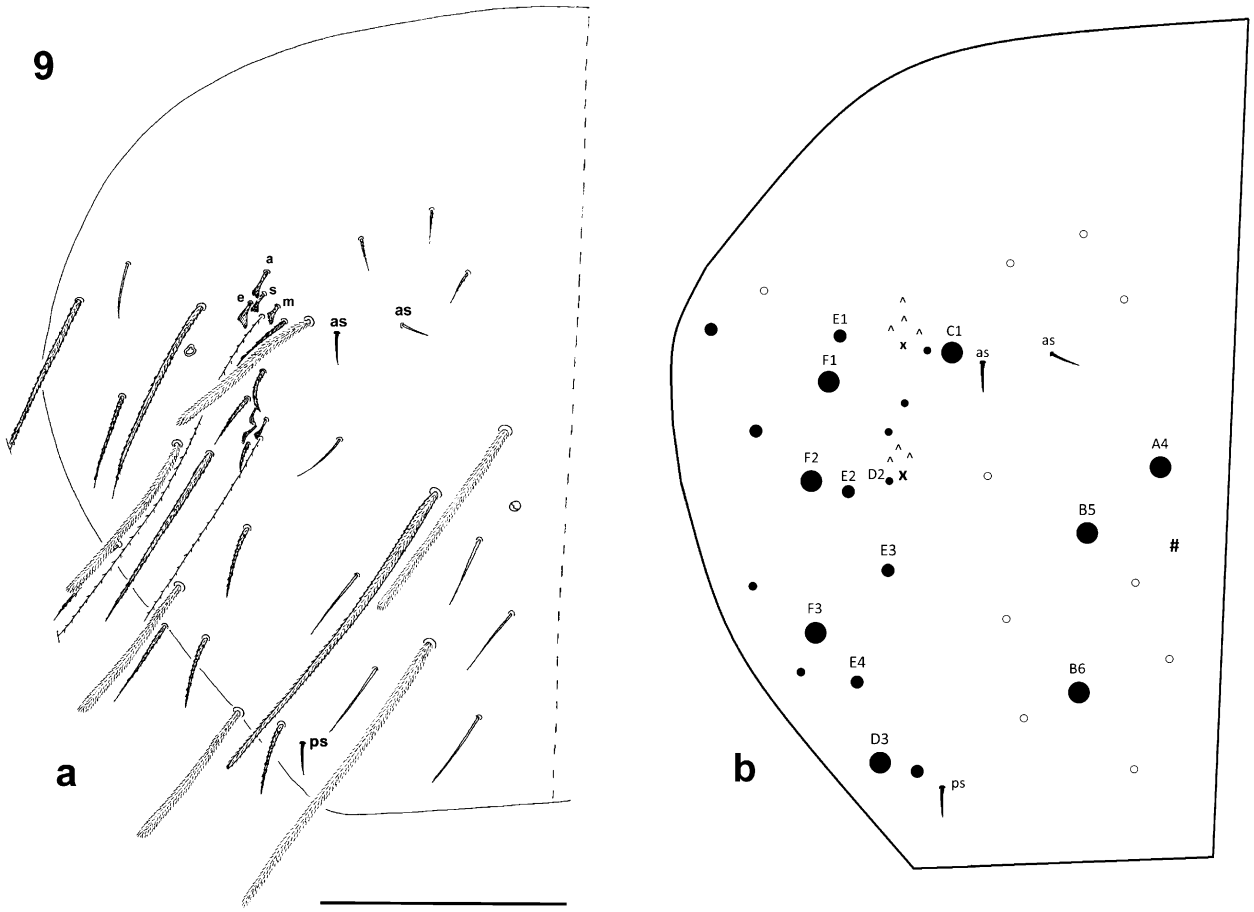


FIGURE 9. *Pseudosinella aggtelekiensis*: **9a,** Abd.IV segment complete setal pattern; **b**,—Abd.IV schematic setal pattern. Black circles: large—broad ciliated macrosetae with blunt apex, medium—ciliated macrosetae with sharp apex, small—ciliated meso-/microsetae; white circles—finely ciliated thin mesosetae; #—pseudoporus; x—trichobothrium; ^—supplementary microsetae with blunt apex; as, ps—smooth mesosetae. Scale bar: 200 μm (Fig. 9a,b).

Appendages. Antennae longer than head (1280 : 600 µm). Antennal segments I : II : III : IV as 140 : 300 : 340 : 500 (µm); densely covered with ciliated meso- and macrosetae (25–70 µm), numerous curved sensilla (15–20 µm) and thin microsensilla (10–12 µm). Ventral side of segments with groups of conical microsetae **cm** (2.5 µm; Figs 3 and 4). Apical bulb on Ant.IV absent, subapical organite not seen. Apical part of Ant. III with antennal organ consisting of 2 wrinkled, leaf-like sensory setae (10 µm) partly hidden behind cuticular folds, 2 guard sensilla (10 µm) and short rod (4 µm; Fig. 4). Ant. III without additional leaf-like setae; several modified sensilla with thickened basal part (15 µm): 3 ventral and 3–4 internal situated in vertical rows, and 5–6 dorsal grouped together. Apical part of Ant.II with 1 dorso-external leaf-like seta (10 µm); segment externally with 4–5 sensilla with thickened base (15 µm), internal side with 1 such seta. Ant.I with 3 dorsal and 3 ventral basal microsetae (8–10 µm); ventrally with group of 8–14 thin microsensilla (10 µm) and 8–10 smooth setae (20–25 µm); 4–6 external sensilla (18–20 µm), 1 or 2 of which thicker and shorter (14 µm); (Fig. 3). Conical microsetae **cm** (2.5 µm) present on ventral side of Ant.II–IV, on Ant.I 3–4 such microsetae situated externally (Figs 3 and 4).

Unguis of legs I, II and III as 64, 62 and 60 µm; tibiotarsi 25 µm wide. Unguis with 2 short proximal (basal) teeth in 16% length and 1 short internal tooth in 26 % length of unguis (positions in % measured on leg I); 1 short external tooth (12 µm); apical and lateral teeth on unguis absent (Fig. 8). Unguiculus 46 µm long, external tooth absent. Tibiotarsal tenent hair pointed, 30 µm long, inner macrosetae of tibiotarsi differentiated (except of proximal setae whorl)—thick, apically smooth, obliquely cut and sharply pointed (Fig. 8). Metatibiotarsus (leg III) with 1 differentiated internal seta placed in first whorl, smooth, pointed, rather long (50 µm). Trochanteral organ (leg III) consists of 18–22 smooth setae (12–30 µm; Fig. 7). Ventral tubus with 14–16 ciliated setae on lateral flap. Manubrial plaque on each side with 2 pseudopores, 2 internal and 2 external ciliated setae. Manubrium : dens : mucro as 410 : 530 : 30 (µm). Apical part of dens (0.1 of the length) not crenulated. Mucro elongated with apical teeth apparently longer than anteapical one, 1 short basal seta reaching anteapical tooth.
Both sexes known.

Discussion. There are another two species of the genus *Pseudosinella* without eyes and identical macrosetae formula **R111/32/0101+3**, *P. antennata* Bonet, 1929 and *P. unguilonginea* Jordana & Beruete, 1983. Both represent cave adapted species distributed in karst of the Navarra province in Spain. They also share other characters with *P. aggtelekiensis*, i.e. supplementary microseta **s** on Abd.IV segment present, tenent seta on tibiotarsus pointed, and external tooth on unguiculus absent. However, *P. aggtelekiensis* has different pattern of head macrosetae (**R_0 R_1 R_2 R_3 T P**) compared to *P. antennata* and *P. unguilonginea* (both with **R_0 R_1 R_2 S T P**). Other difference between *P. aggtelekiensis* and both species from Navarra is in pattern of basal labial setae (**M_1M_2reL$_1$L$_2$** in *P. aggtelekiensis*; **$m_1m_2$rel$_1$l$_2$** in *P. antennata* and *P. unguilonginea*). *P. aggtelekiensis* and *P. antennata* have very similar shape of unguis and unguiculus (unguis with short teeth - 2 proximal, 1 internal and 1 lateral). *P. unguilonginea* has, in the contrary, apparently elongated and narrowed unguis with very short proximal teeth, and minute internal and lateral teeth. Presence of spiniform, smooth ventral seta on tibiotarsus of the third leg is common character for *P. aggtelekiensis* and *P. unguilonginea*, its status in *P. antennata* being unknown.

Pseudosinella aggtelekiensis has several other characters unique among species of the genus. For example 3–4 external conical microsetae, resembling rests of broken scales, are present on Ant.I segment. In the contrary to remnants of scales, these microsetae have regular sharp apex and apparent basal circle. Abd.IV tergum has 3 blunt and supplementary microsetae in front of posterior trichobothrium (instead of usually 2) and 2 anterior smooth mesosetae **as**, medial and lateral (instead of only medial **as**). Moreover, of medial macroseta the anterior one is placed in longitudinal row **A** (position **A4**). Medial macrosetae **B5** and **B6** are rather long with apex unusually sharply pointed and devoid of ciliation.

Distribution. The species was described by Stach (1929) from the Baradla Cave, a part of the Domica-Baradla cave system (approx. length 25 km) situated in the Slovak-Aggtelek Karst in the border region of Slovakia and Hungary. It was later detected also in the Szabadság and Béke caves in the same region (Loksa 1961, Dányi 2011). Strouhal and Vornatscher (1975, p. 512) listed *P. aggtelekiensis* in the catalogue of cave fauna of Austria. The species was considered to inhabit the Bärenhöhle Cave in NE Alps (Hartelsgraben near Hieflau, Austria). However, Christian (1987) stressed that conspecifity of Styrian taxon with *P. aggtelekiensis* is unprobable. We also had possibility to study slide labelled as ”Kärnten, Hartelsgrabenhöhle in Gesäure cca 1200 m, 1940, leg. H. Franz, *Pseudosinella aggtelekiensis*“ deposited in the Institute of Systematics and Evolution of Animals, Polish Academy of Science, Kraków. Unfortunately the slide contains only legs and antennae of several *Pseudosinella* specimens. However, the shape and composition of unguis is different from that of *P. aggtelekiensis* (more slender shape,

proximal teeth very short, internal and external teeth minute). Two slides of the same collection are labelled as "Austria, Gasslhöhle bei Ebensee an Traun, det. Stach, *Lepidocyrtus* (*Pseudosinella*) *aggtelekiensis*" with one specimen each. However, the status of the specimens does not allow observation of principal taxonomic characters, except for the shape and arrangement of unguis that is apparently different from that of *P. aggtelekiensis* (more slender shape and ungual teeth as in previous case). Finally, the species has been reported also from Romania as a member of soil communities (Fiera 2007).

Pseudosinella aggtelekiensis represents an obligate cave species with endemic distribution restricted to the Slovak-Aggtelek Karst region located between Slovakia and Hungary. The species has been found to inhabit the Domica-Baradla cave system (type locality) and caves Ardovská, Drienka, Krásnohorská, Majkova, Milada, Szabadság and the Obrovská Abyss (Stach 1929, Dudich 1932, Loksa 1961, Kováč *et al*. 2005a,b, Papáč *et al*. 2006, 2007). Literature data referring the occurrence of *Pseudosinella aggtelekiensis* in caves or soils of other regions are un-probable and should be verified.

Troglobionts *P. unguilonginea* and *P. antennata*, very similar by their morphology, inhabit caves of the Navarra region in northern Spain. Their distribution ranges are vicariant, the first species being restricted to Aralar ridge karstic area, the second one to adjacent Urbasa–South area, respectively. *P. aggtelekiensis*, *P. antennata* and *P. unguilonginea* are example of parallelisms in evolution of subterranean species in different "*Pseudosinella*" lineages (Christiansen 1961). *Pseudosinella aggtelekiensis* may be considered as a form derived from older fauna of Tertiary origin based on its distribution restricted to caves, small (endemic) distribution range, level of troglomorphy and several conspicuous morphological characters.

Remarks to biology. Mixture of clay particles and fungal hyphae usually prevails in content of the gut. Moreover, we observed characteristic spores of micromycete genera *Alternaria*, *Fusarium*, *Ulocladium* and *Tetracoccosporium* in the gut of several specimens (A. Nováková, det.).

***Pseudosinella paclti* Rusek, 1961**

Figs 10–21

Pseudosinella cavernarum (Moniez, 1893) in : Paclt (1957a,b)

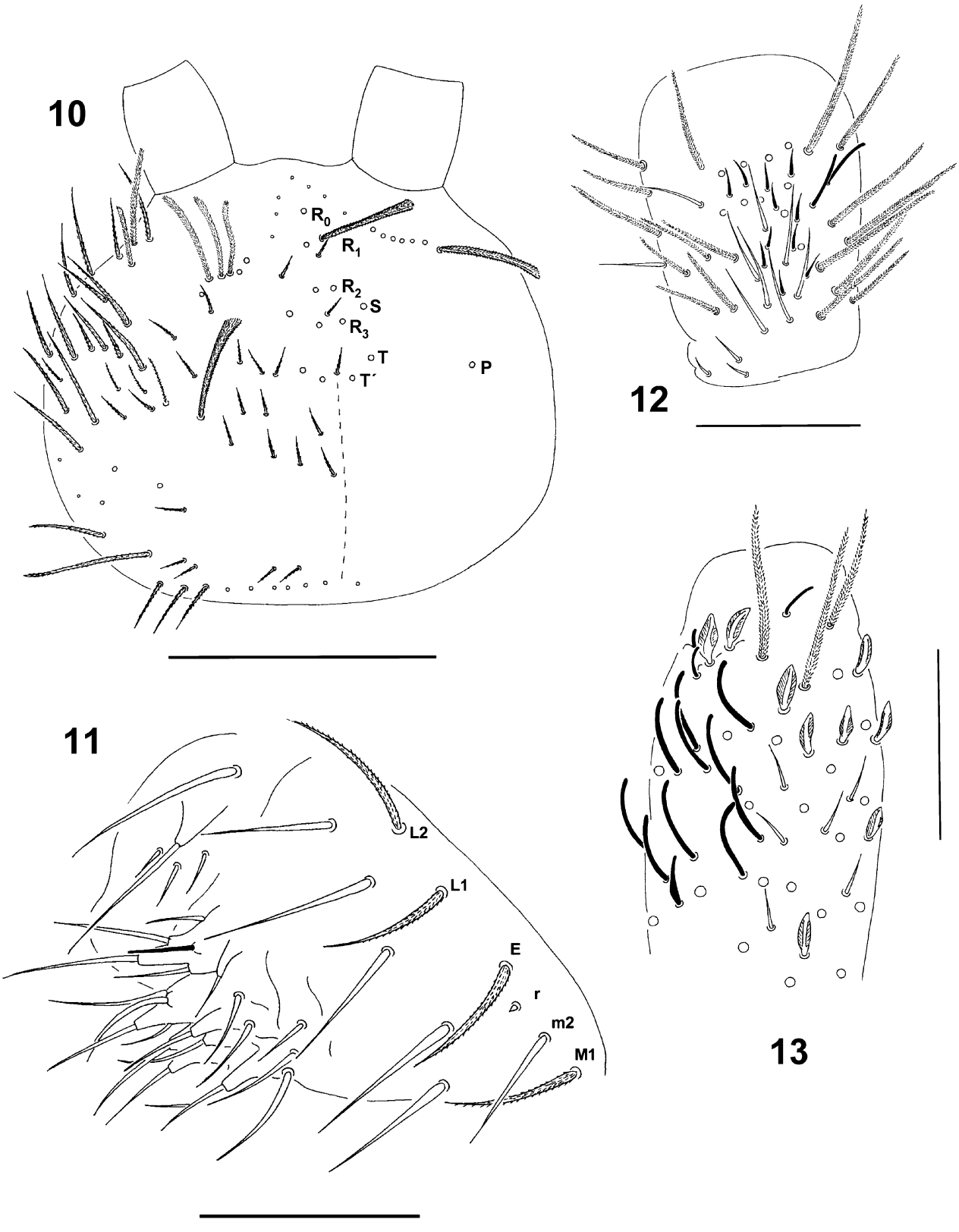
Diagnosis. Eyes and pigmentation absent. Labium with $\mathbf{M_1m_2rEL_1L_2}$ basal setae, **r** strongly reduced. Dorsal macrosetae: **R221/32/0201+2**. Setal pattern of abdominal tergite II: $\mathbf{pABq_1q_2}$. Abd. IV with supplementary microseta **s** in front of anterior trichobothrium and 2+2 smooth mesosetae. Conical microsetae on antennal segments absent. Apical half of Ant.III segment with 8–9 additional leaf-like setae placed ventro-externally. Foot complex as in Figs 19–21. Unguiculus with well developed external tooth. Tibiotarsal tenent hair pointed. Trochanteral organ with 10–13 smooth setae.

Type material. Holotype and two paratypes on permanent slide: Slovakia, Low Tatra Mts., Demänovská cave system, Demänovská slobody Cave (Demänovská Cave of Liberty), 27.xi.1956, leg. J. Paclt. Type material deposited in the Department of Entomology, Moravian Museum, Brno (Czech Republic).

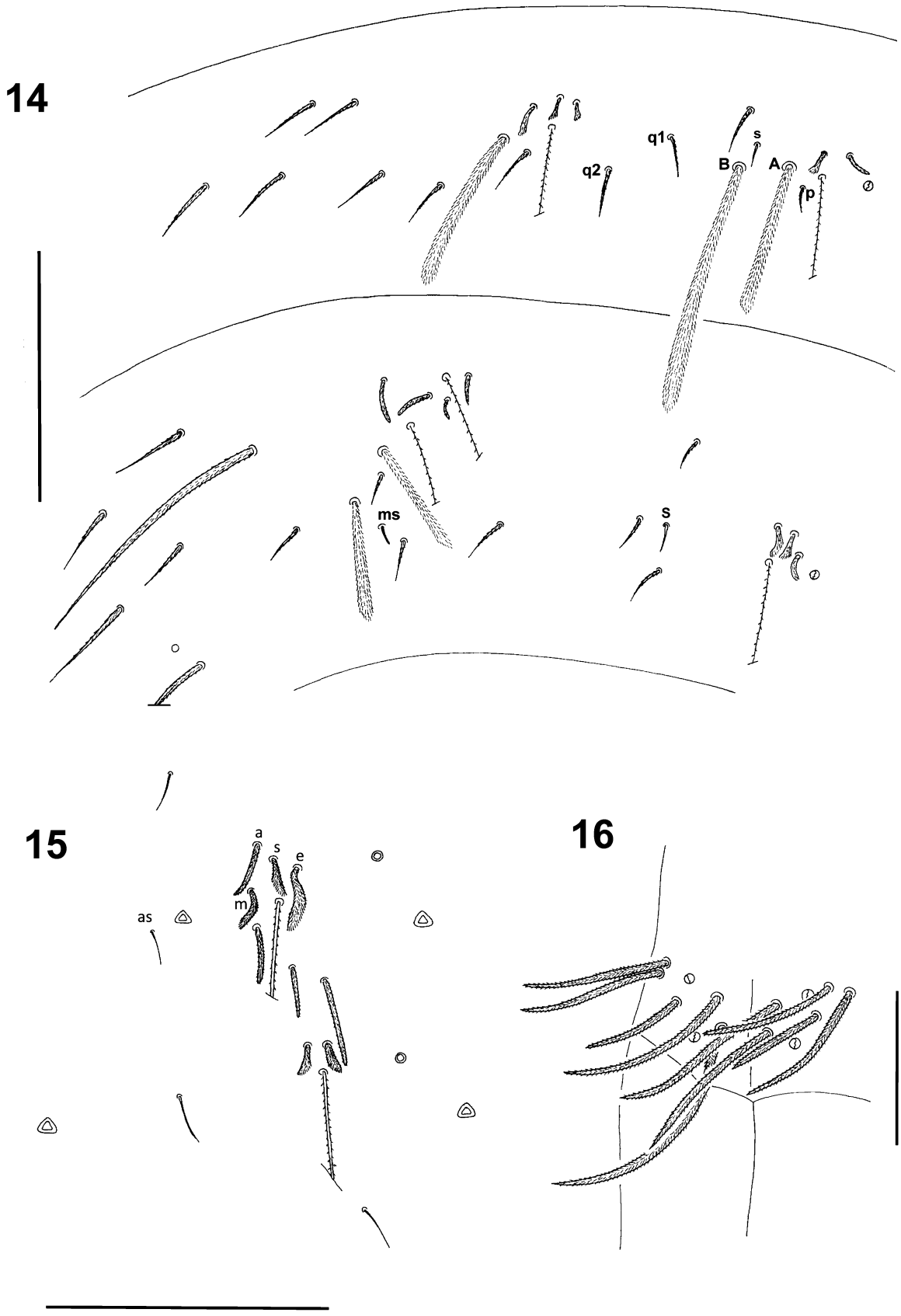
Examined material from type locality. Slovakia, Demänovská jaskyňa slobody (Demänovská Cave of Liberty), "Sieň speleoterapie" Hall, 15 specimens, collected on rotten wood and by pitfall trap, 11.v.–27.ix.2000, leg. Ľ. Kováč; ibid., "Mramorové riečisko" Passage, 7 specimens, pitfall trap, 11.v.–27.ix.2000, leg. Ľ. Kováč; Demänovská jaskyňa mieru (Demänovská Cave of Peace), 5 specimens, collected on rotten wood and surface of water pool, 11.v.2000, leg.P. Ľuptáčik, A.Mock & Ľ. Kováč. 6 specimens from type locality saved in collection of MNHN in Paris, 21 specimens saved in collection of IBE FS UPJŠ, Košice.

Other examined material. Slovakia, Horehronské podolie Basin, Bystrianska Cave, "Vstupná chodba" Passage, 4 specimens, collected on bat guano, 8.v.2002, leg. A. Mock & Ľ. Kováč; Veľká Fatra Mts., Harmanecká Cave, "Riečište" Passage, 8 specimens, collected on rotten wood and surface of standing water, 7.v.2002, leg. P. Ľuptáčik & Ľ. Kováč, ibid. "Bludný dóm" Dome, 3 specimens, pitfall trap, 7.v.–22.x.2002, leg. Ľ. Kováč; Kozie chrbty Mts., Važecká Cave, "Zrútený dóm" Hall, 2 specimens, 17.v.2001, collected on rotten wood, leg. Ľ. Kováč. Other material kept in collection of IBE FS UPJŠ, Košice.

Redescription. Body 2.0–2.3 mm long. White, without traces of pigmentation. Scales on antennae and legs absent; on manubrium scales present on its ventral side.



FIGURES 10–13. *Pseudosinella paclti*: **10,** head, dorsal side; **11,** labial triangle setae and labial palps, lateral side; **12,** Ant.I segment, ventral side (empty circles: serrated meso- and macrosetae); **13,** apical part of Ant.III segment, ventral side (empty circles: serrated meso- and macrosetae). Scale bars: 200 µm (Fig. 10), 50 µm (Figs 11–13).



FIGURES 14–16. *Pseudosinella paclti*: **14,** Abd.II and III segments, dorsally, left side; **15,** Abd.IV segment dorsally, setal pattern around anterior trichobothria, right side; **16,** apical part of manubrium, ventral side. Scale bars:—100 µm (Figs 14–15), 40 µm (Fig. 16).

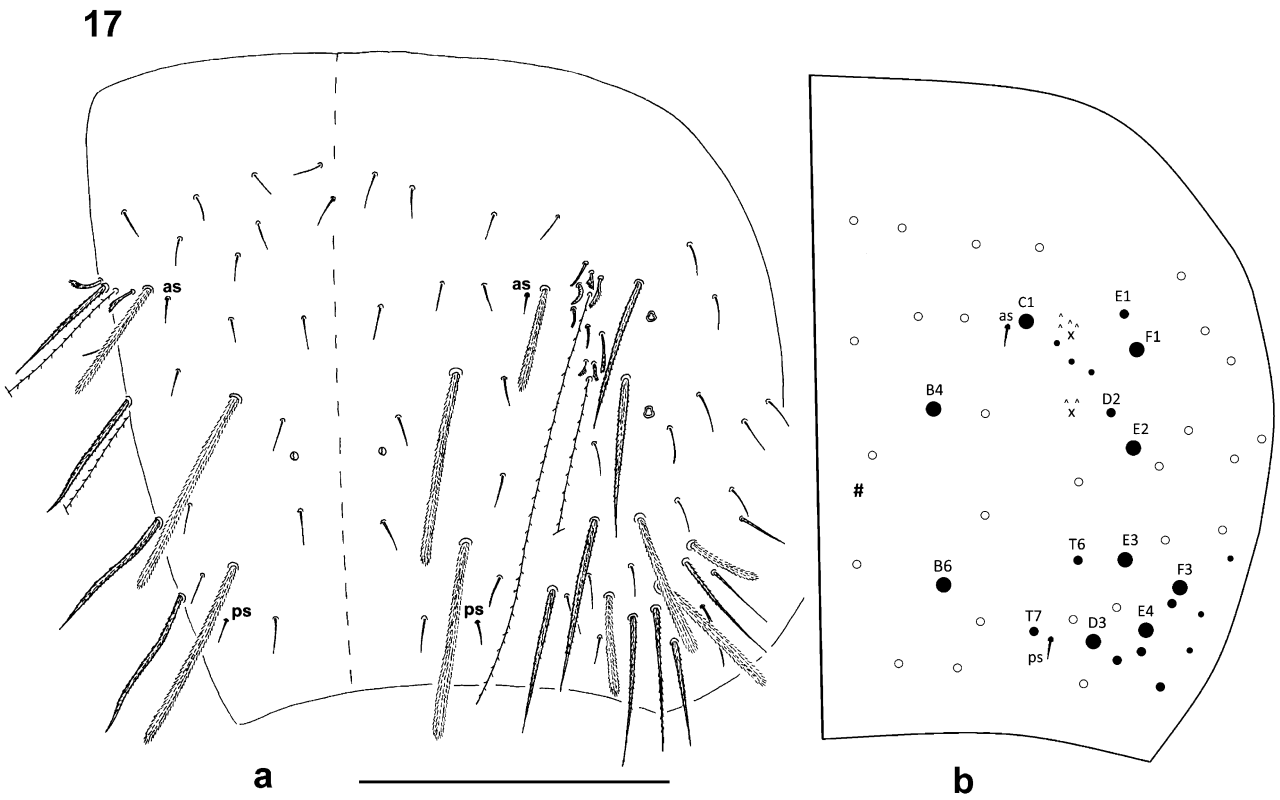
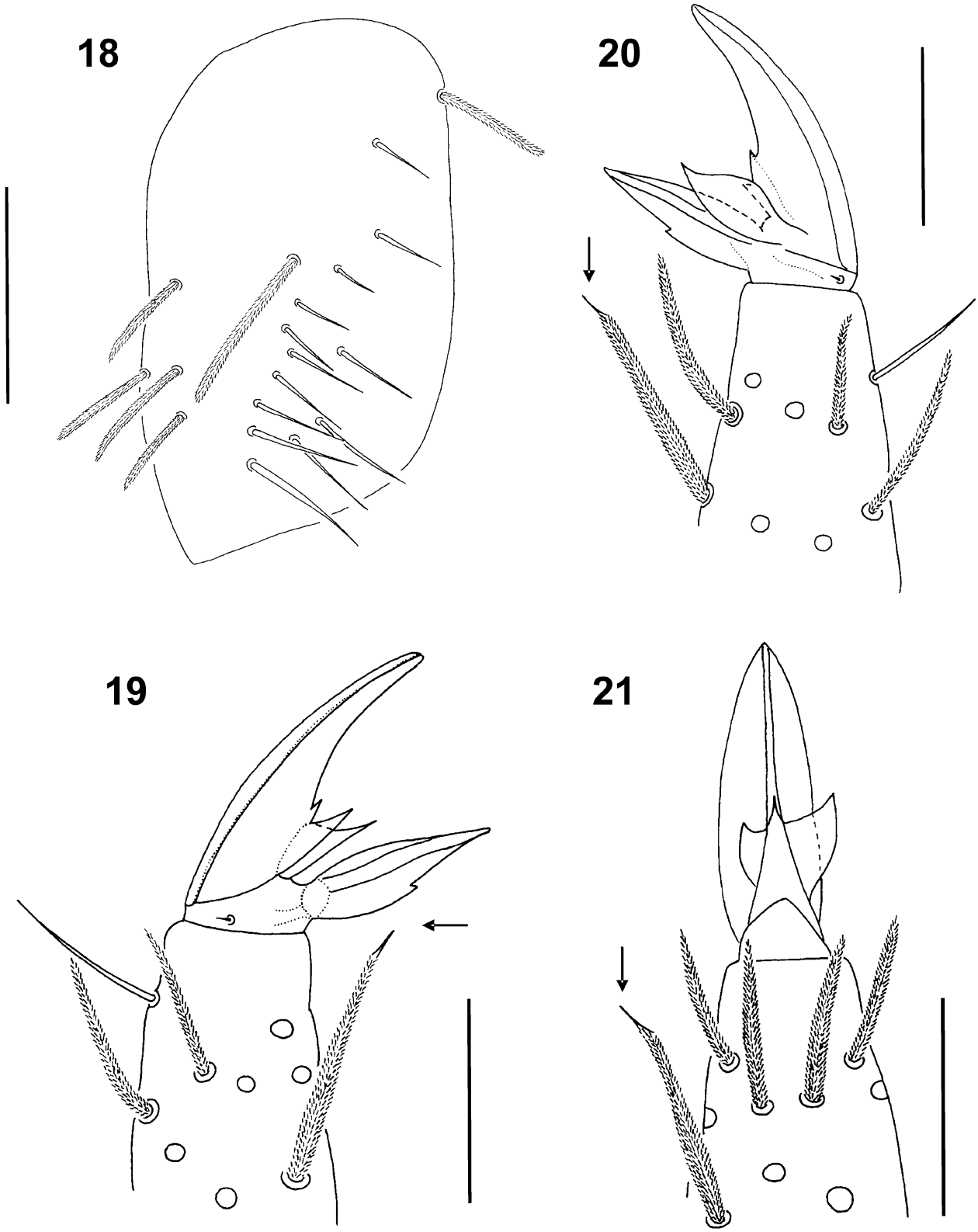


FIGURE 17. *Pseudosinella paclti*: **17a,** Abd.IV segment complete setal pattern, **b**—Abd.IV schematic setal pattern, symbols as in Fig. 9. Scale bar: 200 μm (Fig. 17a, b).

Head. Eyes absent. Dorsal macrosetae **R221** or **R** (**R_0 R_1 R_2**) + **R_3 S T T´ P** (setal notation after Jordana & Baquero 2007). Macrosetae ciliated (75–80 μm), with blunt apex (dorsal ones) or sharply pointed (lateral ones); mesosetae finely ciliated (20–35 μm, Fig. 10). Posterior row with finely ciliated and sharply pointed mesosetae (45 μm). Short trichobothrium (50 μm) situated laterally to ocular macroseta. Praelabral and labral setae smooth, setal pattern of labrum: **4/554**. Labium with **$M_1$$m_2rEL_1$$L_2$** basal setae; **$M_1$**, **E**, **$L_1$** and **$L_2$** ciliated, **$M_2$** smooth in adults (in juveniles ciliated), seta **r** strongly reduced (Fig. 11). Frontal row of labial setae smooth.

Thorax and abdomen (Figs 14, 15 and 17). Dorsal macrosetae: **/32/0201+2**. Microsensillar formula 10/10100, microsensilla (**ms**) strong and placed laterally (6 μm), on Th.II and Abd.I anteriorly, on Abd.III posteriorly. Formula of smooth mesosetae 11/01133, mesosetae (**s**) progressively elongated from Th.II (10 μm) to Abd.V (14 μm). Smooth mesosetae on Th.II in anterior position placed laterally to **ms**. Abd.IV with 2 smooth mesosetae, 1 anterior (**as**) and 1 posterior (**ps**). Setal pattern of abdominal tergite II: **pABq$_1$q$_2$** (Fig. 14); macroseta A 0.56% of the length of macroseta B (75 and 132 μm, respectively). Abd.IV with 4 supplementary microsetae (blunt, ciliated) in front of anterior trichobothrium (microseta **s** present) and 2 such microsetae in front of posterior trichobothrium (Fig. 15). Medial macrosetae of Abd.IV **B4** and **B6** with blunt apex, apically ciliated, equally long (190 μm). Complete setal pattern of Abd.IV tergum provided in Figs. 17a and 17b.

Appendages. Antennae longer than head (925 : 520 μm). Antennal segments I : II : III : IV as 95: 240 : 225: 365 (μm); densely covered with ciliated meso- and macrosetae (35–70 μm), numerous smooth microsetae (12 μm), thin and curved sensilla (20–25 μm), and thin, straight microsensilla (10 μm). Apical bulb on Ant.IV absent; subapical organite as minute, fusiform rod (1.5 μm). Apical part of Ant. III with antennal organ consisting of 2 wrinkled, leaf-like sensory setae (12 μm), 2 guard sensilla (10 μm) and short rod (4 μm). Apical half of the segment with 8-9 additional leaf-like setae (12 μm) placed ventro-externally; segment with row of 4 external sensilla with thickened base (12 μm; Fig. 13). Ant.II apically with 2 dorso-external leaf-like setae (12 μm). Ant.I with 3 dorsal and 3 ventral basal microsetae (6–8 μm). Ventrally with a group of 10–12 thin, straight microsensilla (8–10 μm) accompanied with 7–8 smooth setae (20–25 μm) and 2 external sensilla (18–20 μm; Fig. 12). Conical microsetae **cm** on antennal segments absent.



FIGURES 18–21. *Pseudosinella paclti*: 18, trochanter of leg III, internal side; 19, unguis of leg II, internal side; 20, unguis of leg II, external side; 21, unguis of leg II, view from below. Scale bars: 50 μm (Fig. 18), 30 μm Figs (19–21).

Unguis (claw) of legs I, II and III 40 μm long; tibiotarsi 20 μm wide. Unguis with 2 proximal (basal) teeth in 15% length of different size, external one developed in form of wing tooth, 1 short internal tooth in 38 % length of ventral lamella (positions in % measured on leg I); apical, lateral and external teeth on unguis absent (Figs 19–21).

Unguiculus (30 µm) with well developed external tooth situated in the middle of lamella. Tibiotarsal tenent hair acuminate, 28 µm long, inner macrosetae of tibiotarsi differentiated (except of proximal setae whorl): thick, apically smooth, obliquely cut and sharply pointed (Figs 19–21). Metatibiotarsus (leg III) with 1 differentiated internal seta placed in the first whorl, smooth and pointed (35 µm). Trochanteral organ (leg III) consists of 10–13 smooth setae (20–25 µm; Fig. 18). Ventral tubus with 10 ciliated setae on lateral flap. Manubrial plaque on each side with 2 pseudopores, 2 internal and 3 external ciliated setae (Fig. 16). Manubrium : dens : mucro as 340 : 360 : 15 (µm). Apical part of dens (0.15 of the length) not crenulated. Mucro elongated with apical teeth slightly longer than anteapical one, 1 short basal seta reaching anteapical tooth.

Both sexes known.

Discussion. *Pseudosinella paclti* is similar to *P. pyrenaea* Bonet, 1931 sensu Beruete and Jordana (2002), *P. subdobati* Gisin & Gama, 1970 and *P. jeanpierrei* Beruete & Jordana, 2002. All share pattern of body dorsal macrosetae (**R221/32/0101+2**), although in *P. subdobati* cephalic macrosetae have slightly different position, see Fig.3 in Gisin and Gama (1970). Moreover, they share two other characters: pointed tibiotarsal tenent hair and Abd.IV tergum with supplementary microseta **s**. According to Gisin and Gama (1970) this seta on Abd.IV is absent in *P. paclti*. However, the study of *P. paclti* from the type locality (Demänovská cave system) revealed presence of the seta **s** on Abd.IV in this species.

The group of species also shares the same setal pattern on Abd.II (**pABq$_1$q$_2$**). *P. paclti* differs from other species by pattern of basal labial setae **M$_1$m$_2$rEL$_1$L$_2$** (**M$_1$m$_2$rel$_1$l$_2$** in *P. subdobati* and *P. jeanpierrei*, **m$_1$m$_2$rel$_1$l$_2$** in *P. pyrenaea*). The other differences between four species are in modifications of shape and arrangement of unguis and unguiculus. In *P. paclti* unguis is relatively short with strong and unequal basal teeth of which external one is wing-like, internal tooth is present and unguiculus has apparent external tooth (in other three species the tooth is absent). In the contrary, *P. jeanpierrei* shows higher level of troglomorphy in elongated antennae and elongated and narrowed unguis with reduced proximal teeth and a rounded expansion substituting internal tooth. And finally, *P.paclti* is peculiar with 8–9 additional leaf-like setae in apical half of Ant.III (in *P. pyrenaea* there is 1 and in *P. jeanpierrei* 3 of such modified setae on the segment).

P. styriaca Neuherz & Nosek, 1975 from Raudner Cave in Styria (Austria) is probably belonging to the same phyletic lineage with *P. paclti* having similar pattern of dorsal macrosetae on thorax and abdomen (**R001/32/0201+2**) and the shape and structure of unguis and unguiculus. However, in this species many important characters remained undescribed.

Distribution. *Pseudosinella paclti* is inhabiting karstic caves of central part of the Western Carpathians, i.e. Low Tatra Mts. (Demänovská cave system, Veľká Stanišovská Cave), Horehronské podolie Basin (Bystrianska Cave), Strážovské vrchy Mts. (Dúpna diera Cave), Veľká Fatra Mts. (Harmanecká Cave), Kozie chrbty Mts. (Važecká Cave) (Rusek 1961, Kováč *et al*. 2002, Mock *et al*. 2002). Recently, forms closely related to *P. paclti* have been discovered in the neighbouring karstic regions, e.g. in the Bobačka Cave, Muránska Plateau karstic region (Kováč *et al*. 2002). Their taxonomic status is necessary to be specified since they potentially represent new troglobiotic *Pseudosinella* species for science.

Acknowledgements

The study was supported by the grant of the Slovak Scientific Grant Agency VEGA No. 1/0139/09. Dr. Vladimír Papáč (Slovak Caves Administration, Rimavská Sobota) is acknowledged for the substantial data on the distribution of *Pseudosinella paclti*. We are very much indebted to Prof. W. M. Weiner (ISEZ PAS, Kraków, Poland) for loan of type material of *Pseudosinella aggtelekiensis* and similarly labelled specimens from Austria. Prof. R. Jordana (University of Navarra, Pamplona, Spain) is acknowledged for the loan of *Pseudosinella unguilonginea* paratypes. Dr. P. Ľuptáčik and Dr. A. Mock (P. J. Šafárik University, Košice) are acknowledged for their kind help during collecting of *Pseudosinella* specimens in caves. Dr. A. Nováková (Institute of Soil Biology BC AS CR, České Budějovice, Czech Republic) is appreciated for identification of microfungi spores in the gut of *Pseudosinella aggtelekiensis*. Prof. Dr. W. M. Weiner, Dr. G. Buşmachiu (Moldova) and an anonymous reviewer are acknowledged for critical comments to the manuscript.

References

Beruete, E., Baquero, E. & Jordana, R. (2002) New species of *Pseudosinella (*Collembola: Entomobryidae) from karst caves of the Basque bio-speleologic district. *Annales de la Société Entomologique de France (n.s.)*, 38 (4), 385–398.

Bonet, F. (1929) Colémbolos cavernícolas de España. *Eos, Madrid*, 5, 5–32.

Bonet, F. (1931) Estudios sobre Colémbolos cavernícolas con especial referencia a los de la fauna española. *Memorias de la Sociedad Española de Historia Natural*, 14, 231–403.

Christian, E. (1987) *Catalogus Faunae Austriae, Teil XIIa.: U.-Kl.: Collembola (Springschwänze).* Verlag der Österreichischen Akademie der Wissenschaften, Wien, 83 pp.

Christiansen, K.A. (1961) Convergence and parallelism in cave Collembola. *Evolution*, 15, 288–301.

Christiansen, K.A., Gama, M.M. da & Bellinger, P. (1983) A catalogue of the species of the genus *Pseudosinella*. *Ciência Biológica. Ecology and Systematics (Portugal)*, 5, 13–31.

Christiansen, K., Jordana, R. & Ariño, A.H. (2009) *Pseudosinella* species of the world database and identification key. Available from http://www.unav.es/unzyec/collembola/ [accessed 29/11/2011]

Dányi, L. (2011) Cave dwelling springtails (Collembola) of Hungary: a review. *Soil Organisms*, 83 (3), 419–432.

Dudich, E. (1932) *Biologie der Aggteleker Tropfsteinhöhle "Baradla" in Ungarn*. Speläologische Monographien 13, Wien, 246 pp.

Fiera, C. (2007) Checklist of Romanian springtails (Collembola). *Folia Entomologica Hungarica*, 68, 5–40.

Gama, M.M. da (1984) Phylogénie des espèces européennes de *Pseudosinella* (Collembola: Entomobryidae). *Annales de la Société royale zoologique de Belgique*, 114 (1), 59–70.

Gisin, H. (1964a) Collemboles d´Europe VI. *Revue Suisse de Zoologie*, 71, 383–400.

Gisin, H. (1964b) Collemboles d´Europe VII. *Revue Suisse de Zoologie*, 71, 649–678.

Gisin, H. (1967) Espéces nouvelles et lignées évolutives de *Pseudosinella* endogés. *Memórias e Estudos do Museu Zoológico da Universidade de Coimbra*, 301, 1–25.

Gisin, H. & Gama, M.M. da (1970) *Pseudosinella* cavernicoles de France (Insecta: Collembola). *Revue Suisse de Zoologie*, 77 (1), 161–188.

Jordana, R. & Baquero, E. (2007) New species of *Pseudosinella* Schäffer, 1897 (Collembola, Entomobryidae) from Spain. *Zootaxa*, 1465, 1–14.

Jordana, R. & Beruete, E. (1983) Cavernicolous Collembola from karst caves in the west of Navarra (Spain). *Mitteilungen der Schweizerischen Entomologischen Gesselschaft*, 56, 303–315.

Kováč, Ľ., Hudec, I., Ľuptáčik, P., Mock, A., Košel, V. & Fenďa, P. (2002) Spoločenstvá kavernikolných článkonožcov (Arthropoda) Demänovských jaskýň. In: Bella P. (ed.) *Výskum, využívanie a ochrana jaskýň.* Správa slovenských jaskýň, Liptovský Mikuláš, 155–164.

Kováč, Ľ., Mock, A., Ľuptáčik, P., Košel, V., Fenďa, P., Svatoň, J. & Mašán, P. (2005a) Terrestrial arthropods of the Domica Cave system and the Ardovská Cave (Slovak Karst) – principal microhabitats and diversity. In: Tajovský K., Schlaghamerský J., Pižl, V (eds.) *Contributions to Soil Zoology in Central Europe I.* Institute of Soil Biology AS CR, České Budějovice, 61–70.

Kováč, Ľ., Mock, A., Ľuptáčik, P., Hudec, I., Nováková, A., Košel, V., Fenďa, P. & Višňovská, Z. (2005b) Živé organizmy. In: Stankovič J., Cílek V. (eds.) *Krásnohorská jaskyňa*. Regionálna rozvojová agentúra, Rožňava, 88–95.

Loksa, I. (1961) Ökologisch-Faunistische Untersuchungen in der Freiheitshöhle bei Égerszög (Biospeleologica Hungarica XIII.). *Acta Zoologica Academiae Scientiarum Hungariae*, 7, (1–2), 219–231.

Mari Mutt, J.A. (1986) Puerto Rican species of *Lepidocyrtus* and *Pseudosinella* (Collembola: Entomobryidae). *Caribbean Journal of Science*, 22 (1–2), 1–48.

Mateos, E. (2008) The European *Lepidocyrtus* Bourlet, 1839 (Collembola: Entomobryidae). *Zootaxa*, 1769, 35–59.

Mock, A., Kováč, Ľ., Ľuptáčik, P., Košel, V., Hudec, I. & Fenďa, P. (2002) Bezstavovce Važeckej jaskyne a vyvieračky Teplica (Kozie chrbty). *Aragonit, Liptovský Mikuláš*, 7, 30–32.

Neuherz, H. & Nosek, J. (1975) *Pseudosinella styriaca* sp. n. (Collembola: Entomobryidae), a new collembolan species from the Styrian cave „Raudner-Höhle" (Austria). *International Journal of Speleology*, 7, 399–401.

Paclt, J. (1957a) Collembola z kvapľovej jaskyne "Dupná diera" v Strážovských vrchoch. *Acta Rerum Naturalium Museorum Slovenicum, Bratislava*, 3(2), 1–6.

Paclt, J. (1957b) Über die Collembolen-Fauna der slowakischen Höhlen. *Beiträge zur Entomologie*, 7 (3/4), 269–275.

Papáč, V., Ľuptáčik, P. & Fenďa, P. (2007) Terestrické bezstavovce Obrovskej priepasti (Slovenský kras, Dolný vrch). *Aragonit, Liptovský Mikuláš*, 12, 51–53.

Papáč, V., Kováč, Ľ., Mock, A., Košel, V. & Fenďa, P. (2006) Terestrické článkonožce (Arthropoda) vybraných jaskýň Silickej planiny. In: Bella P. (ed.) *Výskum, využívanie a ochrana jaskýň.* Správa slovenských jaskýň, Liptovský Mikuláš, 187–199.

Rusek, J. (1961) Eine neue Collembolenart aus den slowakischen Höhlen. *Beiträge zur Entomologie*, 11 (1/2), 21–23.

Rusek, J. (1975) Eine Präparationstechnik für Springschwänze und ähnliche Gliederfüsser. *Mikrokosmos*, 12, 376–381.

Soto-Adames, F.N. (2010) Two new species and descriptive notes for five *Pseudosinella* species (Hexapoda: Collembola: Entomobryidae) from West Viginian (USA) caves. *Zootaxa*, 2331, 1–34.

Soto-Adames, F.N., Barra, J.A., Christiansen, K. & Jordana, R. (2008) Suprageneric classification of Collembola Entomobryomorpha. *Annals of the Entomological Society of America*, 101 (3), 501–513.

Stach, J. (1929) Verzeichnis der Apterygogenea Ungarns. *Annales Musei Nationalis Hungarici*, 26, 269–312.

Strouhal, H. & Vornatscher, J. (1975) Katalog der rezenten Höhlentiere Österreichs. *Annales Naturhistorisches Museum Wien*, 79, 401–542.

Szeptycki, A. (1979) *Chaetotaxy of the Entomobryidae and its phylogenetical significance. Morpho-systematic studies on Collembola. Chaetotaxy of the Entomobryidae and its phylogenetical significance. IV.* Polska Akademia Nauk, Zakład Zoologii Systematycznej i Doświadczalnej, Państwowe Wydawnictwo Naukowe, Warszawa, Kraków, 218 pp.

Zhang, F., Chatterjee, T., & Chen, J.-X. (2009) A new species of the genus *Lepidocyrtus* Bourlet and a new record of *Seira delamarei* Jacquemart (Collembola: Entomobryidae) from the east coast of India. *Zootaxa*, 2310, 43–50.