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Oribatid mite fossils from pre-Quaternary sediments in Slovenian caves III. Two new species of *Dissorhina* (Oppiidae) from the Pliocene

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ABSTRACT — Two new fossil species of the extant genus *Dissorhina* Hull, 1916 (Oribatida, Oppiidae) are described from Pliocene clastic sediments in Trhlovca cave of the Slovenian Classical Karst (Kras): *Dissorhina paleokrasica* **n. sp.** and *Dissorhina nuda* **n. sp.**. Diagnoses of both new species are given on the basis of detailed study of few damaged adult individuals obtained by sieving. Relationships to recent species of the genus and the possible importance of the Balkan Peninsula for the speciation of *Dissorhina* are discussed.

KEYWORDS — Fossil oribatid mites; Pliocene sediments; Slovenian Classical Karst (Kras); Trhlovca cave

INTRODUCTION

The presence of oribatid fossils in Pleistocene and early Pliocene cave sediments of Slovenian Classical Karst, first reported by Moldovan *et al.* (2011), represents until now a rather unique record of oribatid fauna of these periods. The first paper of this series (Miko *et al.*, 2012) dealt with two new species and genera of Oppioidea and presented a short overview of known oribatid fossils. The next paper dealt with the description of a new species of the newly established genus *Amiracarus* (Microzetidae), found in several fossil profiles of Slovenian caves (Miko *et al.* 2013). The present paper represents the last part of this series in which descriptions of two new fossil species of the extant genus *Dissorhina* Hull, 1916 are given. These species, found in upper and lower Pliocene sediments of Trhlovca cave (Slovenian Classical Karst), were reported for the first time by Moldovan *et al*. (2011) as *Dissorhina* sp. and *Rhinoppia* sp..

MATERIALS AND METHODS

All fossils of *Dissorhina* described here were collected by Oana Moldovan, Andrej Mihevc and Ioana Meleg from sediments in Trhlovca cave, Slovenia (45°40'18,8"N; 13°56'45"E). Details about the location of findings and age of relevant sediments are given for each individual within description of species in the section "Material examined".

For extraction of fossil oribatid material, approximately 1 kg of sediment was removed and placed in sealed, labelled plastic bags. In the laboratory, the sample was immersed in 10 % KOH for 30 min, and then washed successively through sieves of 250 μm, 125 μm and 40 μm aperture sizes. Sub-samples

for each sieve dimension were examined separately under an Olympus SZX2 stereomicroscope in 90° alcohol and mites were removed.

All specimens were studied and documented by drawings in open cavity-slide preparations with lactic acid as a medium under a compound light microscope equipped with camera lucida. Given the poor state of the specimens and the limited number of individuals, SEM photography was not attempted.

Light microscope photos were taken by Jan Mourek (Prague, Czech Republic) and by Oana Moldovan (Cluj-Napoca, Romania).

Measurements of all individuals were made as in previous works (see Miko *et al.*, 2012; Miko *et al.*, 2013 for details). All measures are given in μm. For morphological terminology and meaning of setal formulas see Miko (2006).

DESCRIPTION OF THE NEW SPECIES

Dissorhina paleokrasica n. sp. (Figures 1A-C, 2A-E, 4A-G, and 5D-E)

Diagnosis — *Dissorhina* (see Miko, 2006) with broadly pentagonal rostrum, fine and rather straight lamellar costula. Interbothridial tubercles small and not fused with anterior border of notogaster. Notogaster in axial part protruding anteriad and notogastral as well as interlamellar setae with about 3-5 bristles unilaterally.

Measurements — Available specimens partly crushed, not allowing precise measurements. Body length of holotype about 300 μm, length of prodorsum about 100 μm, maximum notogaster width about 150 μm (actual values for damaged specimen).

General characters — Original colour difficult to estimate, available fossil material pale, yellowish brown, partly covered with debris and dirt, making observation of finer structure difficult. Cuticle smooth as far as possible to observe, prodorsum laterally with granular microstructure.

Prodorsum — Prodorsum relatively narrow, delicate. Rostrum with two incisions as usual for *Dissorhina*, central tooth broadly pentagonal, blunt anteriorly, bearing a pair of rostral setae, inserted close to each other. Lateral teeth of rostrum short, broad, with blunt, rounded tips. Pedotectum I weakly developed as triangular projection with rounded tip, only slightly projecting over prodorsal outline. Another blunt projection visible on the place of pedotectum II. Only proximal part of lamellar costulae developed (*i.e.* reaching from bothridium to prodorsal groove and not beyond), costulae finely developed, oblique, straight or only slightly bent. Bothridia relatively small, rounded, with no or only indistinct posterior lobe. Postbothridial tubercle separated from bothridia, developed as small round tubercle. Interbothridial tubercles rather small and fine, not fused with anterior border of notogaster, their mutual distance same or smaller than distance between them and bothridia. Longitudinal, laterally rounded and flat "ear-like" carina developed in lateral part of prodorsum, above insertion of leg II. Sensillus moderately long (65 – 70 μm), lanceiform, smooth, stalk about one half of the length or slightly longer, lanceiform head about 2,5 times broader than stalk. Prodorsal setae of different lengths and forms. Rostral setae rather fine, slightly bent or straight, smooth or with one bristle, about 27 μm long. Lamellar setae shortest, fine, straight, about 15 μm long. Interlamellar setae stronger, straight, slightly over 30 μm long with about 5-6 small bristles unilaterally, better visible in lateral view. Exobothridial setae not observed, their insertions nevertheless positioned on small tubercles. Another small tubercle may be present in close vicinity to them.

Notogaster — Broadly oval in shape, with anterior border protruding anteriad, darker in transmitted light. Notogastral crista present, short, bearing short setae *c1*. Other notogastral setae longer, fine, attenuated towards the end, adhering to the surface. Setae *h1* inserted closely to each other, distally divergent. Not all setae observable on available material, but at least setae *la*, *lp*, *h2* and *h3* with about 3-4 fine bristles unilaterally. Setae *h1* and *p1* smooth, without bristles. Approximate length of setae *la* 21 μm, *lp* 29 μm, *h1* and *h2* 32 μm and *p1* 19 μm.

Ventral characters — Infracapitulum as usual in

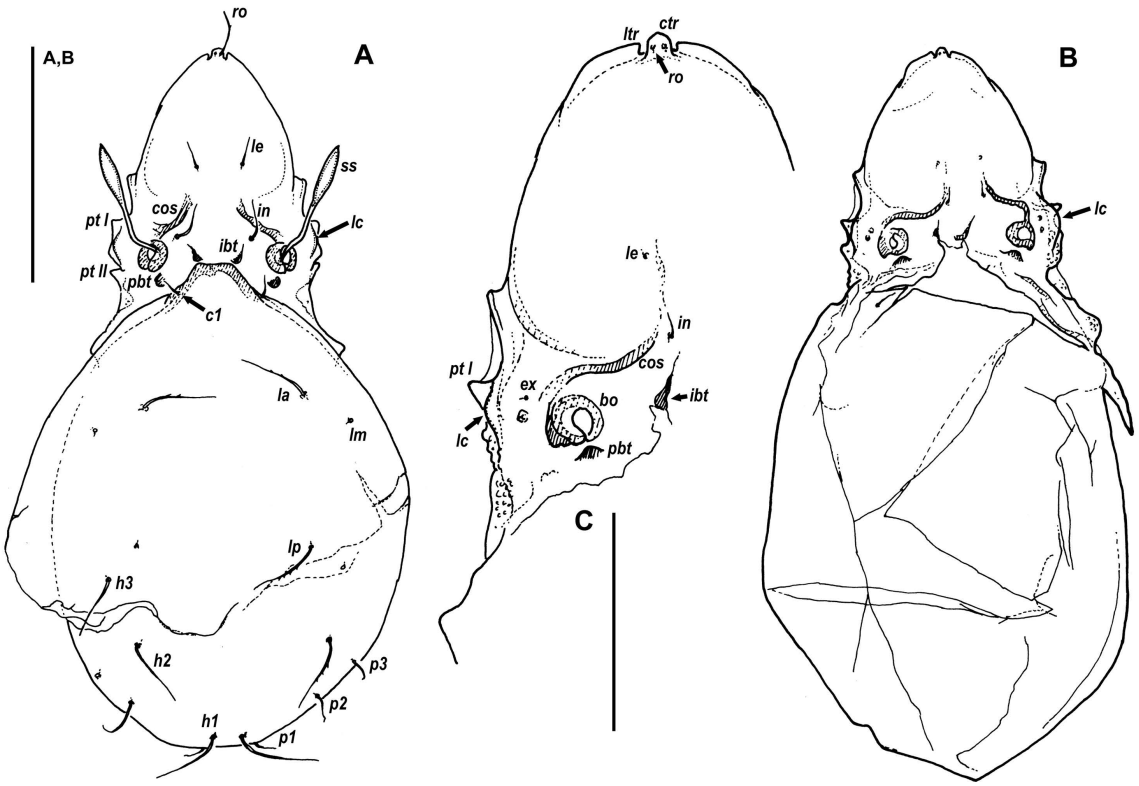


FIGURE 1: *Dissorhina paleokrasica* **n. sp.**: A – dorsal view of holotype; B – dorsal view of paratype; C – detail of the prodorsum of paratype. Scale bar: A, B – 100 μm, C – 50 μm. Acronyms: bo – bothridium, cos – lamellar costula, ctr – central tooth of rostrum, ibt – interbothridial tubercle, lc – lateral carina, ltr – lateral tooth of rostrum, pbt – postbothridial tubercle, pt I – pedotectum I, pt II – pedotectum II, ss – sensillus. Setae are labeled by name.

Dissorhina, setae of infracapitulum and palps fine and smooth. Epimeral setation 3-1-3-3, epimeral setae straight, smooth, about 11 – 12 μm long, *1c* and *3c* and *4b-c* being the longest. Trochanteral setae I and II very long, bent, with few short bristles. Epimeral area with several lighter maculae in central part. Discidium developed as small, blunt tubercle. Anogenital formula as usual (*5g*, *1ag*, *2an*, *3ad*), setae smooth and narrow, mostly a bit longer than epimeral ones (*g1* 8 μm, *g6* 13 μm, *ag* 14 μm, *an2* 15 μm). Adanal setae longer, *ad1* posterior, *ad3* anterior to anal opening.

Legs — One of the two individuals (holotype) was relatively well preserved, with almost all legs present, even if incomplete. Due to the risk of further destruction, only leg I was investigated. As far as possible to observe, leg setation formula corresponds to those of *Dissorhina* as usual *i.e.* setation of leg I: 1-5-2(1)-4(2)-20(2). Setae moderately long, at least some of them with several short bristles. Tarsal solenidia ω_1 and ω_2 of about same length, ω_1 blunt and bent towards the tarsal surface. Tibial solenidion φ_1 setiform, longer than the length of tibia. Solenidion φ_2 much shorter, blunt. Genual solenidion σ long, setiform, more than two times longer than the length of the segment.

Material examined — Two individuals were available from the clastic sediments of Trhlovca cave in Karst, Slovenia. Individual from sample T5 from Pliocene red clay sediments (about 3,8 millions

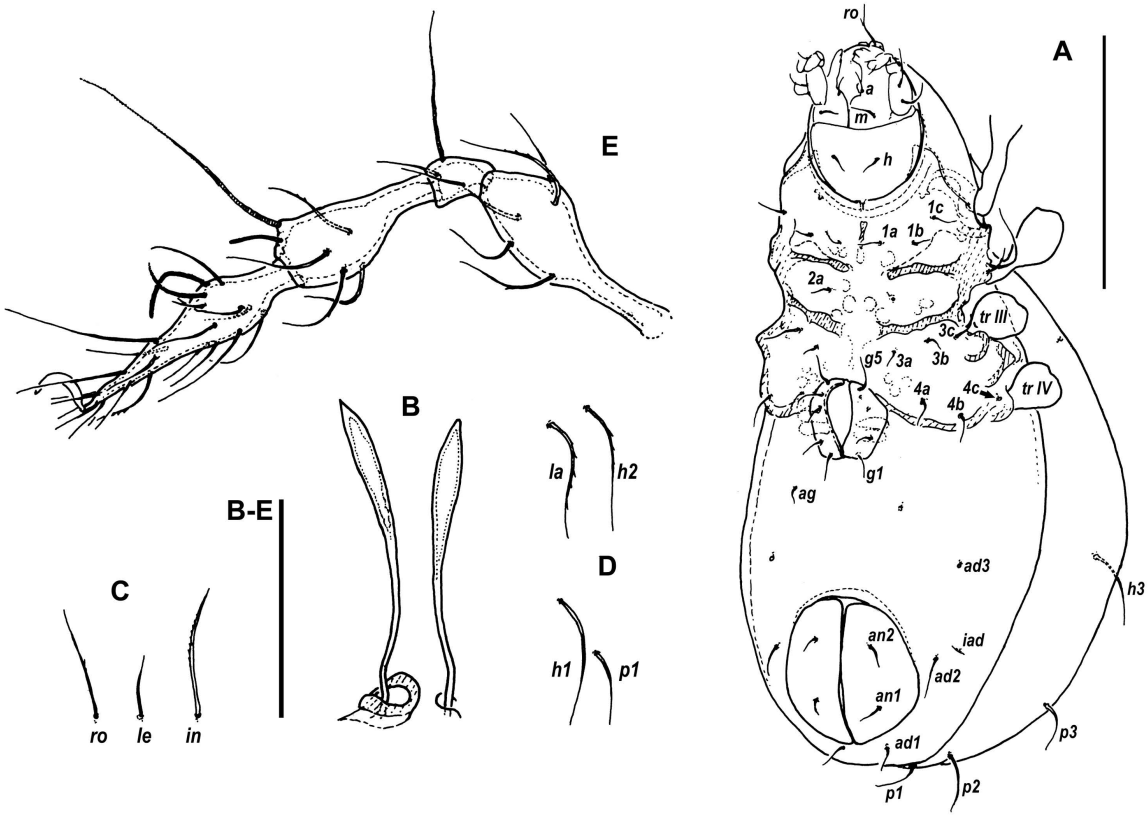


FIGURE 2: *Dissorhina paleokrasica* **n. sp.**: A – ventral view; B – sensillus; C – prodorsal setae; D – notogastral setae; E – leg I. Scale bar: A – 100 μm, B–E – 50 μm. Acronyms: tr III – trochanter of leg III, tr IV – trochanter of leg IV. Setae and lyrifissurae are labelled by name.

of years old; see Moldovan *et al.*, 2011 for further details) was much better preserved, and is designed as holotype. Individual (paratype) from sample T2 from Pliocene beige clay sediments (about 2,7 million years old) was damaged, in poor condition, without legs and practically without observable setation. Notogaster was largely damaged and dirty, not allowing more detailed study. Specific identity of the two individuals is judged on the basis of the same development of the rostrum, bothridia and lamellar costula, interbothridial and postbohridial tubercles and lateral part of prodorsum, and due to its occurrence in the same locality. Individuals are preserved in the collection of Emil Racovita Institute of Speleology in Cluj-Napoca, Romania.

Derivatio nominis — The name "paleokrasica" is derived from "Kras", the name of the Slovenian geomorphological unit where is the type locality, Trhlovca cave. Prefix paleo- refers to the fossil character of the material.

Remarks — *Dissorhina paleokrasica* **n. sp.** bears all important characters of the genus, and is close to the widely distributed and common species *D. ornata*. Our own studies showed that several characters of *D. ornata* may be rather variable (see also figures in Miko, 2006), so differences of the newly described fossil species needed to be carefully analysed against that variability.

However, the newly described species can be distinguished from all other *Dissorhina* species by a combination of some specific characters, namely: (a) interbothridial tubercles are fine, weakly developed and not fused with anterior margin of noto-

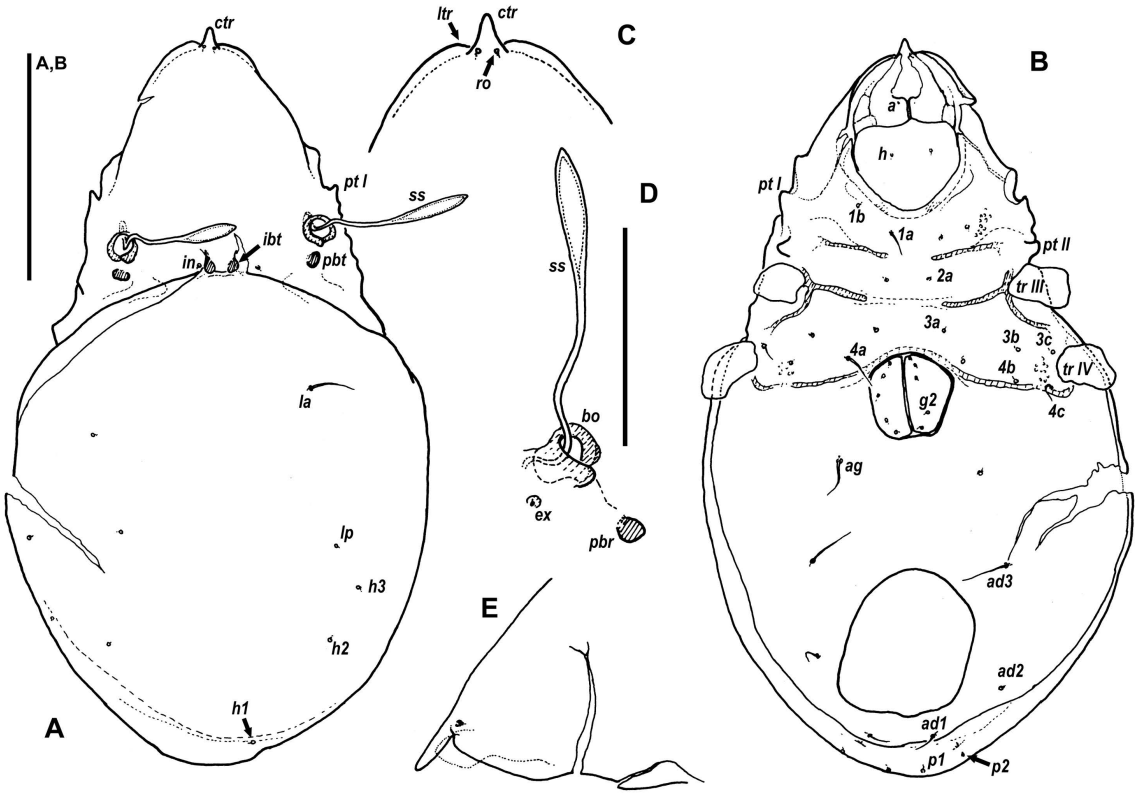


FIGURE 3: *Dissorhina nuda* **n. sp.**: A – dorsal view of holotype; B – ventral view of holotype; C – detail of rostrum, dorsal view; D – bothridial area with sensillus; E – detail of rostrum, lateral view. Scale bar: A,B – 100 μm, D – 50 μm. Acronyms: bo – bothridium, ctr – central tooth of rostrum, ibt – interbothridial tubercle, ltr – lateral tooth of rostrum, pbt – postbothridial tubercle, pt I – pedotectum I, pt II – pedotectum II, ss – sensillus, tr III – trochanter of leg III, tr IV – trochanter of leg IV. Setae (or their insertions) are labelled by name.

gaster (developed as separate tubercles); (b) anterior part of notogaster between setae *c2* is arched and protruding anteriad; (c) central tooth of rostrum is broad, bluntly pentagonal or almost quadrangular, not trapezoid as in *D. ornata* or some other species; (d) notogastral setae except *c2* and *p1–p3* are quite long, and at least *la*, *lp* and *h2* with small bristles.

Dissorhina nuda n. sp.
(Figures 3A-E and 5A-C)

Diagnosis — *Dissorhina* with prolonged central tooth of the rostrum and prodorsum without lamellar costulae. Interbothridial sclerites near to each other, small, touching the anterior border of notogaster, but not fully fused with it. Insertions of interlamellar setae shifted backwards, near anterior margin of notogaster, laterally to interbothridial sclerites.

Measurements — Damaged individual does not allow precise measurement, the values therefore represent actual values at damaged individual. Length of the body about 325 μm, length of the prodorsum about 105 μm. Maximum width of notogaster about 180 μm.

General characters — Original colour difficult to judge, available material pale, yellowish brown, partly covered with debris and dirt, making obser-

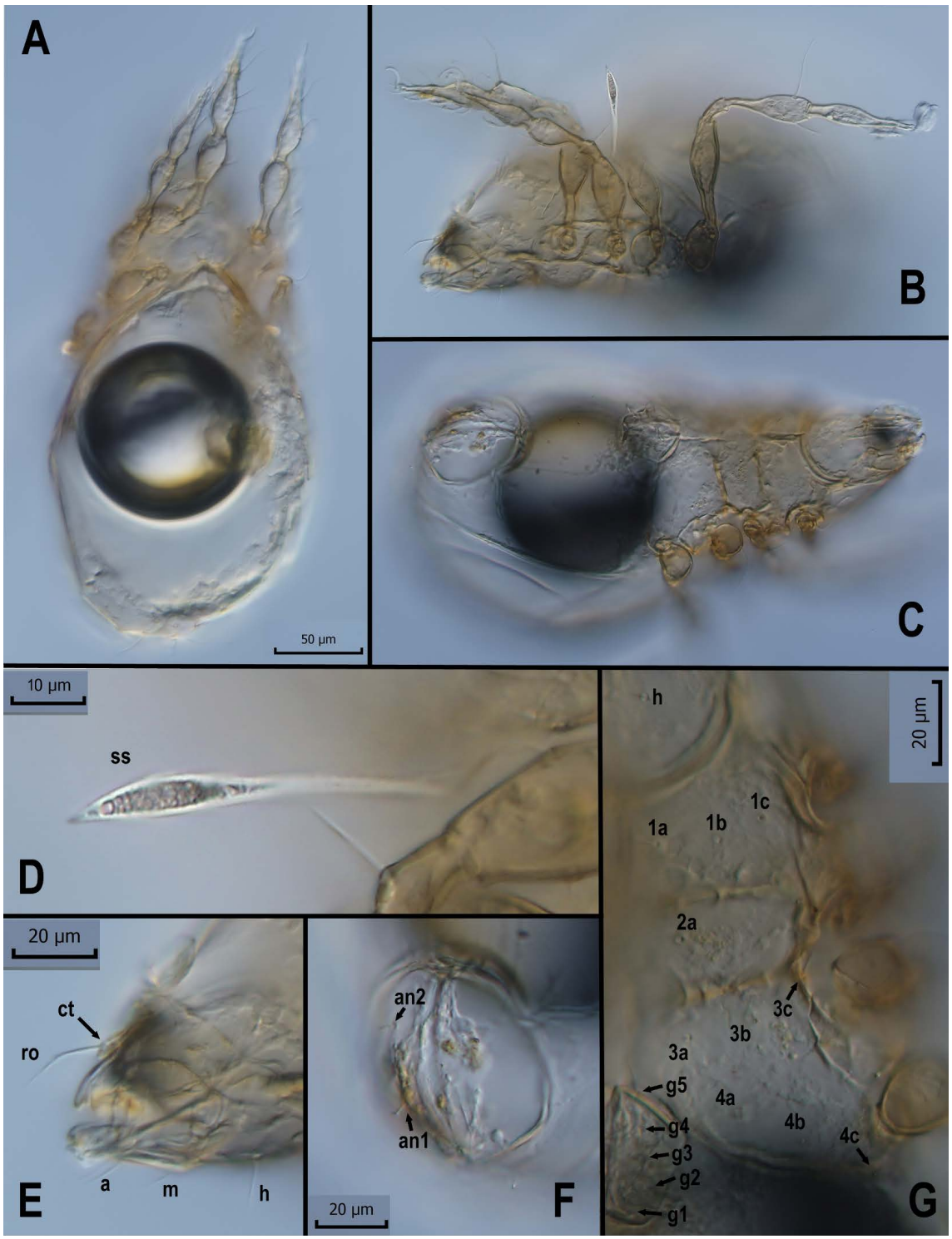


FIGURE 4: *Dissorhina paleokrasica* **n. sp.**, photographs of holotype: A – dorsal view (scale bar applicable to A-C); B – lateral view; C – (latero-)ventral view; D – detail of sensillus; E – rostrum and gnathosoma in lateral view; F – anal plates; G – epimeral area and genital plate. Acronyms: ss – sensillus, ct – central tooth of the rostrum, rest are names of setae aligned to their insertions. Photos courtesy of Jan Mourek.

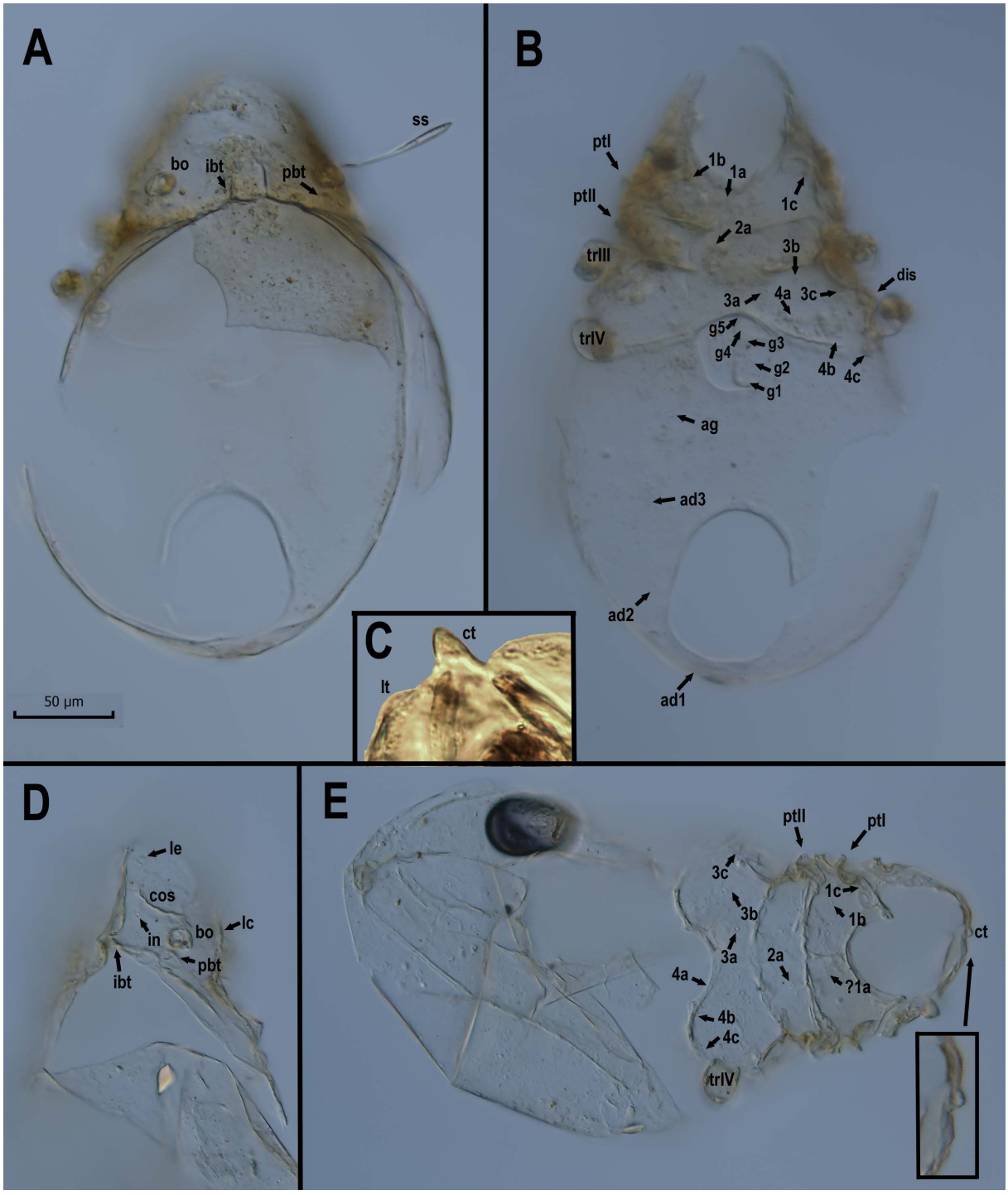


FIGURE 5: *Dissorhina nuda* **n. sp.**, photographs of holotype: A – dorsal view (scale bar applicable to all photos except details on C and E); B – ventral view; C – rostrum of holotype in detail (ventral view). *Dissorhina paleokrasica* **n. sp.**, photographs of paratype: D – laterodorsal view; E – ventral view (rostral part enlarged in small frame). Acronyms: bo – bothridium, cos – lamellar costula, ct – central tooth of the rostrum, dis – discidium, ibt – interbothridial sclerite (tubercle), lc – lateral carina of prodorsum, lt – lateral tooth of the rostrum, pbt – postbothridial sclerite (tubercle), ptI – pedotectum I, ptII – pedotectum II, ss – sensillus, trIII – trochanter of leg III, trIV – trochanter of leg IV, rest are names of setae aligned to their insertions. Photos courtesy of Oana Moldovan (C) and Jan Mourek (rest).

vation of finer structure difficult. Cuticle smooth as far as possible to observe.

Prodorsum — Triangular, shaped as usual in *Dissorhina*. Rostrum with elongated "naso"-like central tooth, protruding significantly beyond the anterior margin of rostral tectum. Lateral teeth reduced, broadly rounded. Pedotectum I present but weakly developed, protruding anteriad as a small rounded projection. Projection in the place of pedotectum II also present, but invisible in dorsal view. Costulae completely reduced, central part of prodorsum without visible cuticular structures, ridges or furrows. Postbothridial tubercles present, disctinct, and as usual for *Dissorhina* not fused with posterior end of bothridia. Interbothridial tubercles small, fine, positioned near to each other. These tubercles posteriorly not fused with but only touching anterior border of notogaster. Prodorsal setae missing on observed individual. Insertions of rostral setae positioned on the base of central tooth of rostrum. Positions of lamellar setae impossible to observe, insertions of interlamellar setae positioned close to the anterior border of notogaster, laterally to interbothridial sclerites. Insertions of exobothridial setae on small, but distinct tubercle, as usual in *Dissorhina*. Sensillus quite long (about 70 μm), with narrow elongated head of typical *Dissorhina* shape.

Notogaster — Broadly ovate, anterior border arched, without projections. Only some insertions of setae observable, insertions of both *c2* setae, left *la*, right *lm*, left *h1* and *h3* and both *p3* not observed. Single seta *la* preserved on right side, rather short (18 μm), smooth, without visible bristles. Other characters of notogaster very hard to detect.

Ventral characters — Infracapitulum and anal plates missing. Small but distinct pedotectum I and II visible. Epimeral area laterally with coarse granulation. Epimeral setation incomplete, even insertions not all visible. Nevertheless, epimeral setal formula can be reconstructed as 3-1-3-3. Only three epimeral setae preserved, smooth and fine, of different length (*1a* 11 μm, *4b* 17 μm long). Anal opening visibly larger than genital opening, distance between them about as long as anal opening. Anal plates missing, and only incomplete set of setae and/or their insertions can be observed in anogenital region, anogenital formula except anal setae may be reconstructed as 5g, 1ag, 3ad. Adanal setae *ad3* longest of all ventral setae (about 22 μm), aggenital setae only slightly shorter. Insertions of setae *p1* and *p2* also visible in ventral view, close to each other.

Legs — Only trochanters of legs III and IV preserved, setation or insertions of setae invisible.

Material examined — Single damaged individual (holotype) was available from the clastic sediments of Trhlovca cave in Karst, Slovenia, sample T2 from Pliocene beige clay sediments (about 2,7 million years old). Individual is preserved in the collection of Emil Racovita Institute of Speleology in Cluj-Napoca, Romania.

Derivatio nominis — The specific name "nuda" reflects the absence of costular structures on prodorsum.

Remarks — This species, due to the absence of prodorsal structures, was originally determined and recorded as *Oppiella (Rhinoppia)* sp., potentially a new undescribed species (see Moldovan *et al.*, 2011). However, the position of the rostral setae, shape of sensillus, presence of isolated postbothridial tubercles not attached to bothridium and 5 genital setae place this species clearly within *Dissorhina*. The trend of the disappearance of prodorsal costulae and prodorsal furrow is common within Oppiellinae, and can be observed also in recent *Dissorhina* species, e.g. *D. tricarinatoides* (Dubinina, 1966). The new species can be easily distinguished from all known species of the genus by the unique shape of the interbothridial tubercles, combined with the absence of lamellar costulae and peculiar shape of the central tooth of the rostrum.

DISCUSSION

Genus *Dissorhina* is widely distributed in Europe, mostly represented by common species *D. ornata* (Oudemans, 1900). Other European species with broader distribution are *D. tricarinatoides* (Dubinina, 1966) and *D. signata* (Schwalbe, 1989). While species richness of this genus seems to be limited in large parts of the continent, several other species were described from south-east part of Europe, mostly from Balkan Peninsula (Kunst, 1958;

Mahunka, 1974; Mahunka, 2006; Mahunka, 2007; Mahunka et Mahunka-Papp, 2008). This may indicate the importance of this area as a possible centre of speciation of *Dissorhina*. The finding of two more species of this genus in sediments of Tertiary age from this area supports this hypothesis

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