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# A new, morphologically and ecologically unusual *Lasioseius* mite (Acari: Blattisociidae) associated with *Diaperis boleti* (Coleoptera, Tenebrionidae) and wood-decomposing fungi in Slovakia

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## Original research

### ABSTRACT

On the basis of females and males found on the adult beetles of the mycophagous tenebrionid *Diaperis boleti* (L.) and on the polypore fungi *Fomitopsis betulina*, *Laetiporus sulphureus*, and *Cerioporus squamosus* infested with this beetle, which serve as a specific phoretic host for the new species, a new blattisociid mite, *Lasioseius boleti* sp. nov. was described. The new species is characterised by a pronounced sexual dimorphism of the dorsal chaetotaxy, which is unusual for the genus, and by several features more typical of other highly specialized fungicoles among the mesostigmatic mites than of other species of *Lasioseius* Berlese, such as the genera *Hoploseius* Berlese (Blattisociidae), *Mycomelichares* Mašán & Joharchi (Melicharidae), and *Bulbolaelaps* Faraji, Zare & Rahmani (Digamasellidae). The new species is unusual among the known congeners mainly because of its unusual bionomy, sexual dimorphism, presence of unequal setae that vary greatly in length and form in both sexes, moderately shortened peritremes, sharp cheliceral teeth, and brush-like tritosternum.

**Keywords** arboricolous habitat; description; Mesostigmata; morphology; phoresy; Slovakia; systematics

**Zoobank** <http://zoobank.org/C4B2BD88-8FFF-4AA0-9BCB-83D3D7A726B6>

## Introduction

Wood-decomposing fungi growing on living or dead trees provide microhabitat for only a relatively limited diversity of mesostigmatic mites. Especially in temperate areas of Europe, such as Slovakia, the diversity of mites specifically found in fungal sporocarps is not particularly rich. The mesostigmatic mites with a high degree of mycophily in wood-decomposing fungi are mostly predators, and only a few genera include truly fungivorous species (Walter and Proctor 2013) with some special adaptations that have evolved to live intimately with fungal bodies or tissues (Lindquist 1995). Among these genera, only *Hoploseius* Berlese, 1914 (Blattisociidae) and *Mycomelichares* Mašán & Joharchi, 2021 (Melicharidae) appear to be exclusively associated with various fungi, with all species strictly associated with various fungal hosts and fungivorous insects (Lindquist, 1963; Mašán *et al.*, 2021; Mašán, 2022).


Members of the genus *Lasioseius* are found primarily in heterogeneous decaying organic material, such as soil substrate and raw humus, but also under the bark of trees or in galleries of bark beetles or other wood-boring insects, where they feed on small arthropods, nematodes, and even fungi (Moraes *et al.*, 2016). *Lasioseius* is the most diverse and species-rich genus in the family Blattisociidae. Keys to its 156 species were provided by Christian and Karg (2006),

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and 193 valid species were listed in the catalogue of Moraes *et al.* (2016). Recently, other taxonomically oriented papers have been published describing new species (Abo-Shnaf *et al.* 2016; Argolo *et al.* 2018; Ma and Lin 2018; Ma *et al.* 2018; Moraza and Lindquist 2018; Quintero-Gutiérrez *et al.* 2020; Faraji 2021; Merlin *et al.* 2021).

The aim of this study is to describe a new species of the subgenus *Lasioseius* (*Lasioseius*) from arboricolous habitats in Slovakia, contributing to the knowledge of the Blattisociidae fauna of the European region. This work is part of a project aimed at increasing our collective knowledge of the mite fauna of Slovakia.

## Material and methods

Mites were extracted from decomposing wood detritus using a modified Berlese-Tullgren funnel equipped with a 40-watt lamp and preserved in ethyl alcohol. For identification, the mites were mounted on microscope slides with Swan's medium (gum arabic/chloralhydrate). A Leica DM 1000 light microscope with a Leica EC3 digital camera was used for measurements and micrographs. Multiple images were combined and processed using Adobe Photoshop Elements 8 software. Measurements were made on specimens mounted on a microscope slide. Idiosoma and shield lengths were measured along the midline, and widths were measured at the widest point (unless otherwise noted in the description). Lengths of ventral idiosomal shields were measured along the midline from the anterior to posterior margin of each structure, including the hyaline anterior extension of the epigynal shield. Legs were measured without the ambulacral apparatus. Setae were measured from the base of their attachment to their tip. Measurements are usually expressed as ranges (minimum to maximum). The number of teeth on the chelicera does not include the apical hook. Notation symbols for the idiosomal setae follow Lindquist and Evans (1965), slightly modified by Lindquist (1994), and notation symbols for the leg setae follow Evans (1963). Terminology for the other anatomical structures follows Evans and Till (1979). The chaetotaxy symbols used here are shown in Figures 1A, 1D, 6A, and 6D. The type material is deposited in the Institute of Zoology, Slovak Academy of Sciences, Bratislava, Slovakia.

## Results

### *Lasioseius boleti* sp. nov.

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(Figures 1–7)

### Type material examined

Holotype female: SW Slovakia, Borská Nížina Lowland, Tomky Village, Lásek Forest, elev. 190 m, on *Diaperis boleti* (L.) (Coleoptera, Tenebrionidae) and on *Fomitopsis betulina* (Fungi, Polyporales) growing on a dying birch (*Betula* sp.), in a pine forest (with *Pinus sylvestris*), 24 Nov. 2019. Paratypes: two females, with the same data as the holotype; ten males, on *F. betulina* infested with *D. boleti*, other data as the holotype; eleven females, Little Carpathians, Bratislava Capital, Železná Studnička Forest, elev. 430 m, on *D. boleti* and on *Laetiporus sulphureus* (Fungi, Polyporales) growing on a dying wild cherry (*Cerasus avium*), deciduous forest, 11 June 2007; 15 females, one male, Pernek Village, Pezinská Baba Saddle, elev. 550 m, on *D. boleti* and on *L. sulphureus* growing on an old willow (*Salix* sp.), on the edge of a deciduous forest, 2 July 2019; three males, on *L. sulphureus* infested with *D. boleti*, other data as in the previous record; twelve females, Podunajská Rovina Flatland, Rusovce Village, Rusovecký Park, elev. 140 m, on *D. boleti* and on *L. sulphureus* growing on a dead poplar (*Populus* sp.), in a floodplain forest, 1 June 2019; one female, Bratislava Capital, Sad Janka Kráľa Park, elev. 135 m, on *Ceriporus squamosus* (Fungi, Polyporales) infested with *D. boleti*

and growing on an old maple (*Acer* sp.), 6 Sept. 2020; six females, Horský Park, elev. 220 m, on *D. boleti* and on *F. betulina* growing on an old birch (*Betula* sp.), 7 May, 2019 (all specimens collected by P. Mašán).

### Diagnosis (Adults)

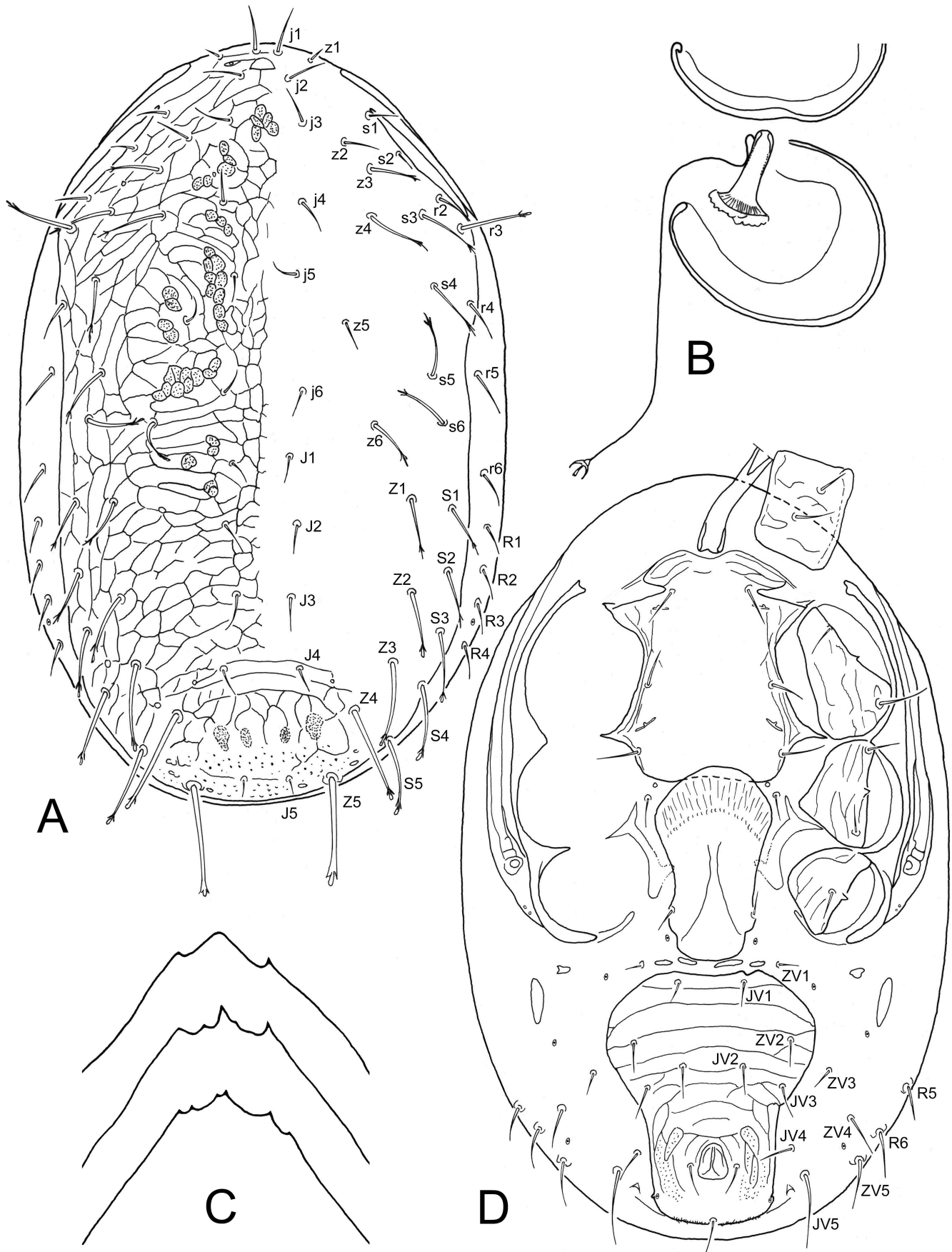
Female with 36 pairs of setae on dorsal shield, including only two pairs of marginal rows (*r2–r4*); setae of submarginal rows completely absent; dorsal setae conspicuously variable in length and form, short and needle-like setae present together with long and tricarinate setae; some of tricarinate setae on posterior surface (*Z2–Z5*, *S3–S5*) with short terminal part expanded and flattened, spatulate, with rounded apex; dorsal setae notably sexually dimorphic, with most posterior dorsal shield setae (*J2–J4*, *Z2–Z5*, *S3–S5*) each formed as long, broad, and lanceolate structure; male dorsal shield with 38 pairs of setae (including *r5* and *r6*, which lie on soft cuticle in females). Ventral *JV*- and *ZV*-setal rows complete in female, including four pairs on ventrianal shield (*JV1–JV3*, *ZV2*), but *SV*-setae absent; male ventrianal shield with six pairs of preanal setae: *JV1–JV3*, *JV5*, *ZV1*, and *ZV2* (*JV4*, *ZV3*, and *ZV4* absent). Tritosternum robust and brush-like (laciniae with long and dense pilosity). Sternal, epigynal, and sternitogenital shields largely smooth, without reticulate pattern; ventrianal shield transversely lineate (in females) or lineate-reticulate (in males). Peritremes moderately shortened, not reaching paravertical setae (*z1*). Anterior margin of epistome with three short cusps, or irregularly denticulate. Movable digit of chelicerae tridentate (in females) or unidentate (in males), fixed digit with 7–10 teeth in addition to bidentate hook; teeth usually sharply pointed.

### Description

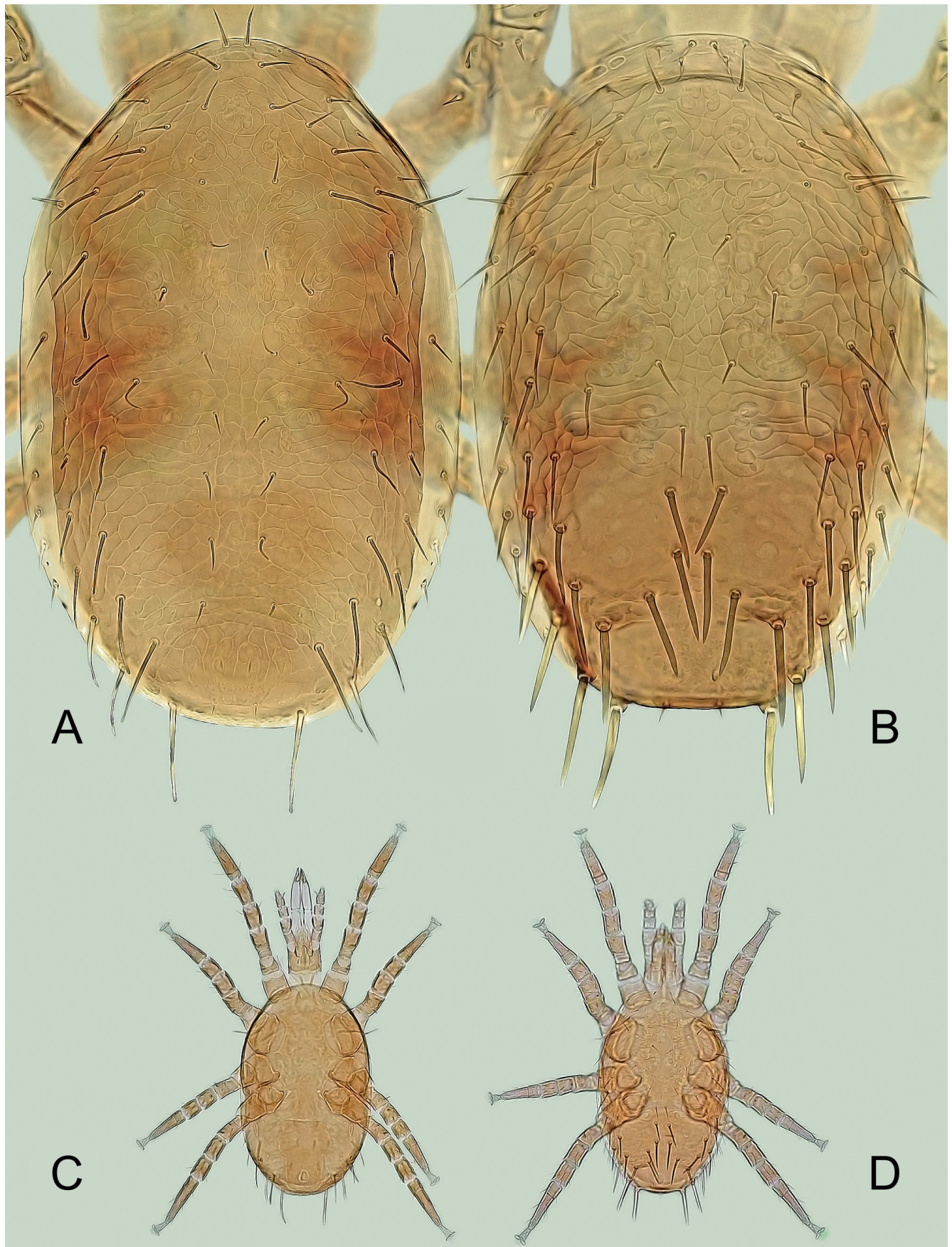
**Female** — (Figures 1, 2A, 2C, 3, 4B–D, 5, 6C, 7A, and 7D).

*Dorsal idiosoma* – (Figures 1A and 2A). Idiosoma 425–485 µm long and 245–310 µm wide (15 measured specimens), almost regularly oval, completely (in specimens shortly after ecdysis) or incompletely (in mature specimens) covered by dorsal shield in lateral parts. Dorsal shield elongate, 425–480 µm long and 220–270 µm wide at level of humeral setae (*r3*) or 235–280 µm at widest point at level of setae *J2*, with slightly concave lateral margins in middle part and 36 pairs of setae; surface completely ornamented with fine reticulate pattern, reticular cells mostly polygonal or elongate, usually quadrangular and oriented transversely at level between setae *j6* and *J1* and *J4* and *Z4*. Podonotum of dorsal shield with 21 pairs of setae (*j1–j6*, *z1–z6*, *s1–s6*, *r2–r4*), opisthonotum with 15 pairs of setae (*J1–J5*, *Z1–Z5*, *S1–S5*); eight pairs of simple marginal setae (*r5*, *r6*, *R1–R6*) on soft cuticle adjacent to shield margin (submarginal setae completely absent) and each on a small suboval and well-sclerotized platelet. Dorsal shield setae differently formed: some setae on medial and anterolateral parts of shield simple, short, smooth and needle-like (*j4–j6*, *J1–J5*, *z1*, *z2*, *z5*, *s1*, *s2*, *r2*, and *r4*, of which *z1*, *s2*, and *J5* are shortest); the other setae longer and thicker than the preceding ones, vestigially (*j1–j3*) to distinctly tricarinate, apically acute (*z3*, *z4*, *z6*, *Z1*, *s3–s6*, *S1*, and *S2*, of which *Z5* is longest) or rounded and spatulate (*Z2–Z5*, *S3–S5*; Figures 5E and 6C); setal carinae smooth, without serration or denticulation. The lengths of the dorsal setae are as follows: *j1* 26–32 µm, *j2*, *j3*, and *z2* 22–34 µm, *j4* 17–23 µm, *j5*, *j6*, and *J1* 14–21 µm, *z1* 10–14 µm, *z3* 31–38 µm, *z4* and *s3* 40–51, *z5* 19–25 µm, *z6* 25–34 µm, *s1* 19–25 µm, *s2* 11–17 µm, *s4* 37–50 µm, *s5* and *s6* 35–46 µm, *r2* and *r4* 25–31 µm, *r3* 41–51 µm, *r5* 31–37 µm, *r6* 24–29 µm, *J2* and *J3* 18–25 µm, *J4* 14–19 µm, *J5* 8–14 µm, *Z1* 31–42 µm, *Z2* 37–47 µm, *Z3* 48–59 µm, *Z4* 54–68 µm, *Z5* 62–77 µm, *S1* 27–33 µm, *S2* 30–36 µm, *S3* 40–47 µm, *S4* 44–52 µm, *S5* 48–58 µm, and *R1–R6* 18–25.

*Ventral idiosoma* – (Figures 1D and 3). Tritosternum well developed and relatively robust, 117–131 µm long (distinctly longer than gnathosoma), brush-shaped, with columnar base (15–18 µm wide) and proximally fused laciniae; laciniae relatively short and thick, with long and dense pilosity (Figures 5A and 5F). Presternal area with a pair of weakly sclerotized and finely and transversely lineated platelets fused together and completely connected to anterior margin of sternal shield. Sternal shield oblong, distinctly longer than wide (110–125 µm



**Figure 1** *Lasioseius boleti* sp. nov., female. A – Idiosoma (dorsal view); B – Sperm-reception structures; C – Epistome, variant forms; D – Idiosoma (ventral view). Not to scale.



**Figure 2** *Lasioseius boleti* sp. nov. A – Female idiosoma (dorsal view); B – Male idiosoma (dorsal view); C – Female habitus (ventral view); D – Male habitus (dorsal view). Not to scale.



**Figure 3** *Lasioseius boleti* sp. nov., female idiosoma (ventral view). Not to scale.

long, 75–85  $\mu\text{m}$  wide at narrowest point between coxae II and 81–93  $\mu\text{m}$  wide at level of *st2*), and with straight or slightly concave posterior margin; surface largely smooth, except for a few longitudinal lines near lateral margins of shield; three pairs of sternal setae thin and needle-like, and together with two pairs of slit-like poroids (*iv1*, *iv2*), all located on slightly more sclerotized lateral areas of shield (these areas darker compared to medial surface of shield; Figure 3). Metasternal setae (*st4*) and associate rounded poroids (*iv3*) on soft cuticle behind posterior margin of sternal shield. Endopodal platelets between coxae III and IV relatively small, not extending beyond level of *st4*. Epigynal shield elongate, 110–125  $\mu\text{m}$  long and 51–58  $\mu\text{m}$  wide (at level of *st5*), with slight lateral constrictions in middle part and posteriormost part behind genital setae (*st5*), rounded anterior and slightly curved posterior margins, and



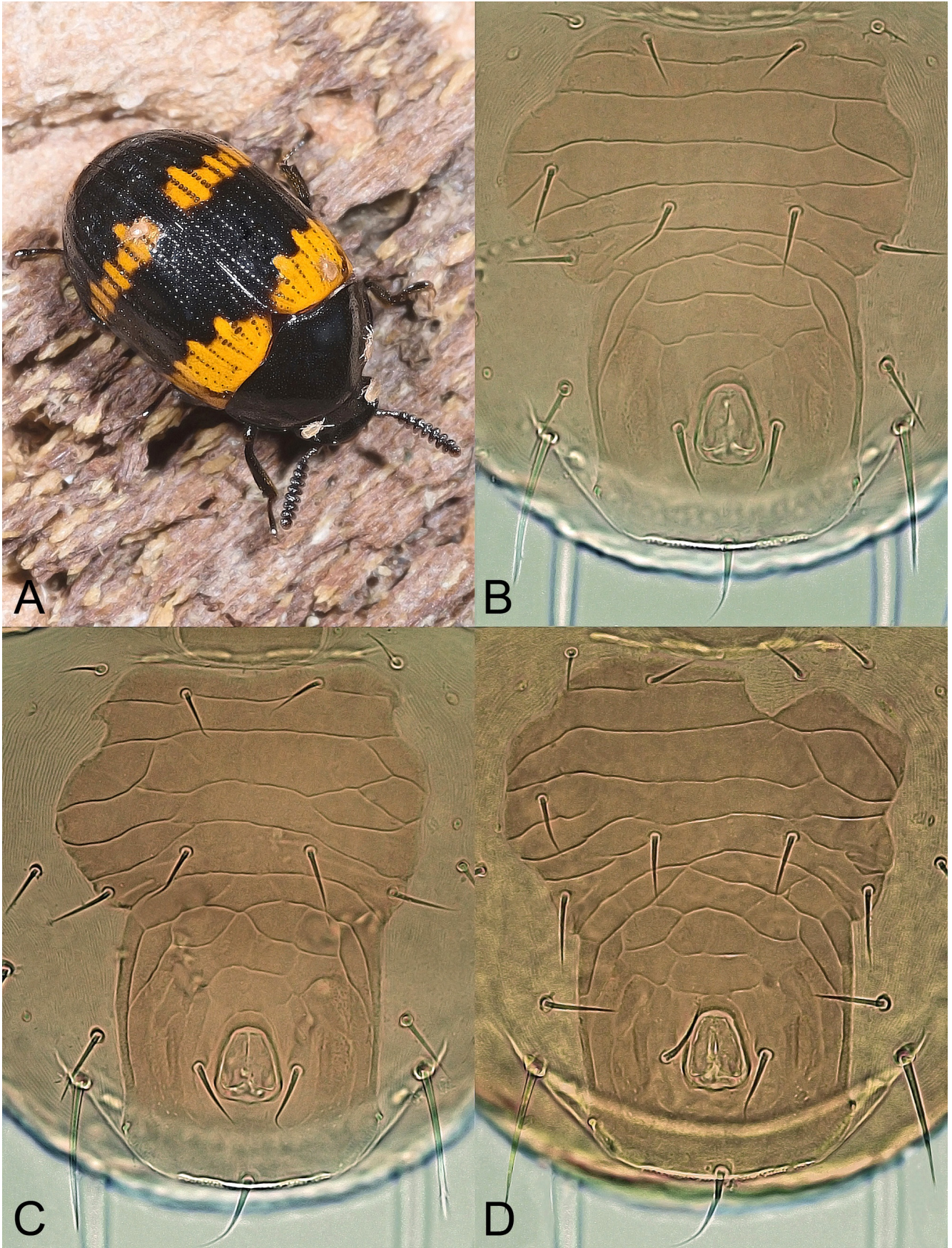
largely smooth surface except for two converging diagonal lines in posterior part; a pair of *st5* on posterolateral shield margins; genital poroids (*iv5*) on soft cuticle behind *st5*. Four distinct postgenital bacilliform sclerites (inner pair usually longer than outer pair). Exopodal platelets I–IV joined to form longitudinal stripe narrowly fused with short poststigmatic part of peritrematal shield. Peritrematal shields normal, fused with podonotal part of dorsal shield at level of setae *s1*; peritremes slightly shortened, clearly not reaching bases of paravertic setae (*z1*) at dorsal idiosomal vertex. Two pairs of metapodal platelets present, irregular anteromedial pair smaller (6–10 µm in longest size) than suboval to nearly fusiform posterolateral pair (25–35 x 6–10 µm). Ventrianal shield relatively small, inversely pear-shaped, distinctly longer than wide (143–162 µm long, 110–135 µm wide at widest anterior part, and 71–83 µm wide in narrow posterior part at level of adanal setae), expanded anteriorly, narrowed posteriorly (posterior margins parallel or only slightly divergent anteriorly), concave anteriorly and laterally and broadly convex posteriorly, transversely lineate over entire preanal surface, finely punctate over circum-anal and postanal regions, with four (*JV1–JV3*, *ZV2*) of ten pairs of preanal setae (*JV1–JV5*, *ZV1–ZV5*) in addition to three circum-anal setae (but various irregularities in shape and chaetotaxy of ventrianal shield present, as in Figures 4B–D); gland pores *gv3* near posterolateral margins at level between *ad* and *pa*; postanal seta longer than adanal setae (*pa* 23–28 µm, *ad* 15–21 µm); anus small (20–25 x 16–19 µm in size), with posterior position on shield; cribrum almost along entire posterior margin behind postanal seta. All ventral setae short, smooth and needle-like, except long and tricarinate setae *JV5*, with following lengths: *st1* and *st2* 22–28 µm, *st3* 19–26 µm, *st4* 17–23 µm, *st5* 15–21 µm, *JV1* 13–17 µm, *JV2–JV4* 16–24 µm, *JV5* 38–47 µm, *ZV1* 11–16 µm, *ZV2* 15–21 µm, *ZV3* 13–19 µm, *ZV4* 21–28 µm, and *ZV5* 26–33 µm.

*Sperm-reception structures* – (Figures 1B and 5B). Major duct unsclerotized and not discernible; calyx well sclerotized and in form of a short tubular structure, with almost parallel or only slightly divergent sides toward the funnel-shaped distal part; minor duct distinct, thin, conspicuously long (extending far beyond coxa IV), and shortly trifid terminally.

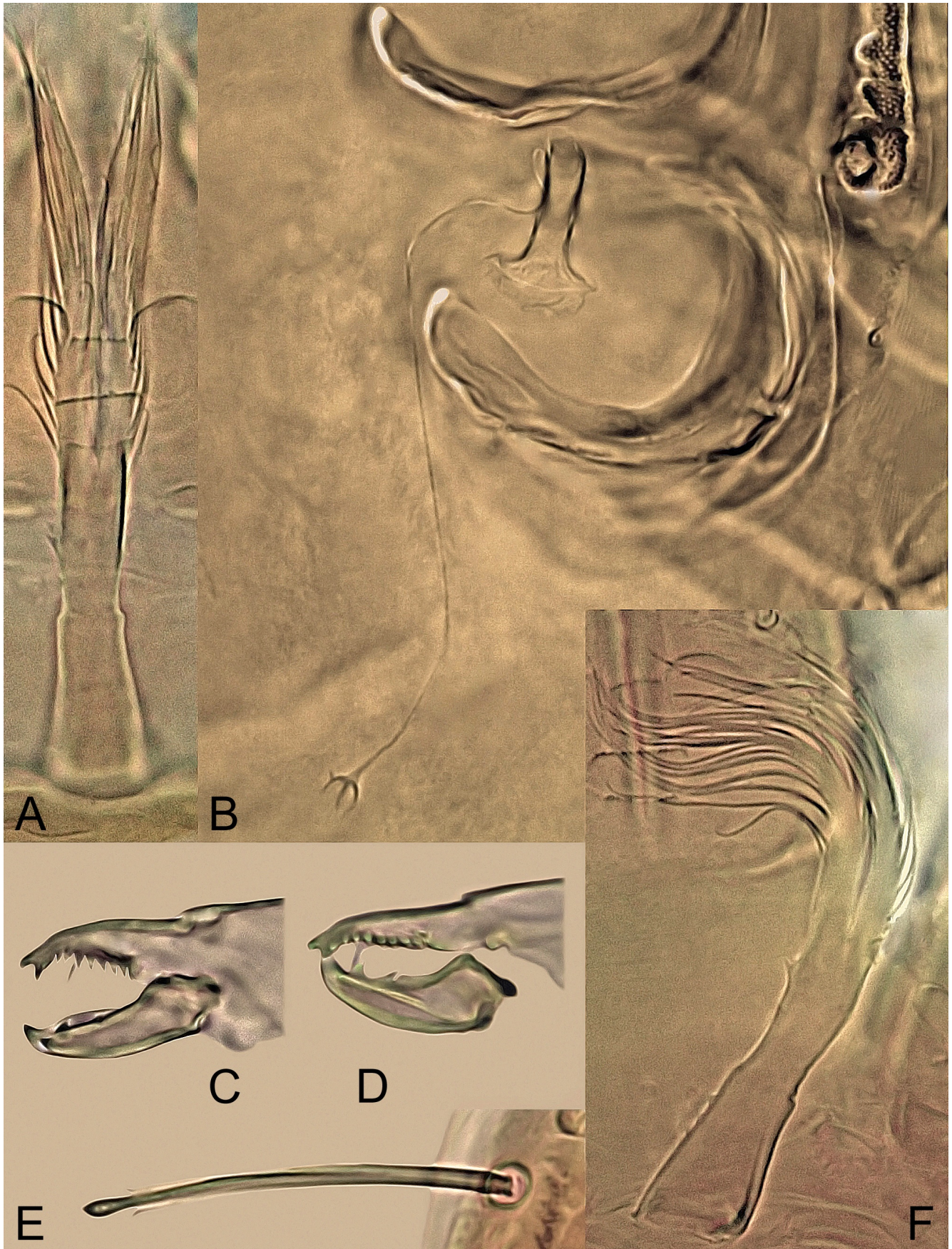
*Gnathosomal structures* – (Figures 1C, 5C–D, 7A, and 7D). Middle article of chelicera 85–98 µm long, cheliceral digits similar in length, dentate; movable digit tridentate (subterminal tooth not aligned with others) and fixed digit with 7–9 teeth in addition to strong and bifid terminal hook; *pilus dentilis* short and small, setiform (Figures 5C–D and 7D). Gnathosoma 100–115 µm long (from posterior margin to tip of corniculus), corniculi horn-like, normal in size and spacing; internal malae formed as curved, pointed and apparently smooth projections directed laterally and extending well beyond corniculi; hypognathal groove with seven rows of denticles, six rows of which connected laterally by longitudinal lines, each row with many denticles and sixth row slightly wider than other rows; subcapitular setae smooth and needle-like, setae *h2* shortest and *h3* longest (Figure 7A). Anterior margin of epistome broadly convex, usually tricuspid, rarely irregularly denticulate; median cusp smooth and rounded or variously denticulate, larger than indistinct lateral cusps, each usually formed as a small denticle (Figure 1C). Palptrochanter with five setae, palptarsal apotele two-tined.

*Legs* – (Figure 2C). Legs each with well-developed pretarsus and ambulacral apparatus (including pulvillus with three rounded lobules and two claws), distinctly shorter than idiosoma: legs I 340–395 µm, legs II 270–325 µm, legs III 260–325 µm, and legs IV 345–390 µm long; legs I usually slightly longer or equal in length to legs IV, only rarely slightly shorter than legs IV. Leg setae uniform, simple, smooth, needle-like, and usually similar in length. Chaetotactic formulae for each leg segment as follows: leg I – coxa (2), trochanter (6), femur 2-3/1, 2/2-2 (12), genu 2-3/2, 3/1-2 (13), tibia 2-3/2, 3/1-2 (13); leg II – coxa (2), trochanter (5), femur 2-3/1, 2/2-1 (11), genu 2-3/1, 2/1-2 (11), tibia 2-2/1, 2/1-2 (10); leg III – coxa (2), trochanter (5), femur 1-2/1, 1/0-1 (6), genu 2-2/1, 2/1-1 (9), tibia 2-1/1, 2/1-1 (8); leg IV – coxa (1), trochanter (5), femur 0-2/1, 1/1-1 (6), genu 2-2/1, 3/0-1 (9), tibia 2-1/1, 3/1-2 (10). Tarsi II–IV without conspicuously enlarged, elongated, or otherwise modified setae.

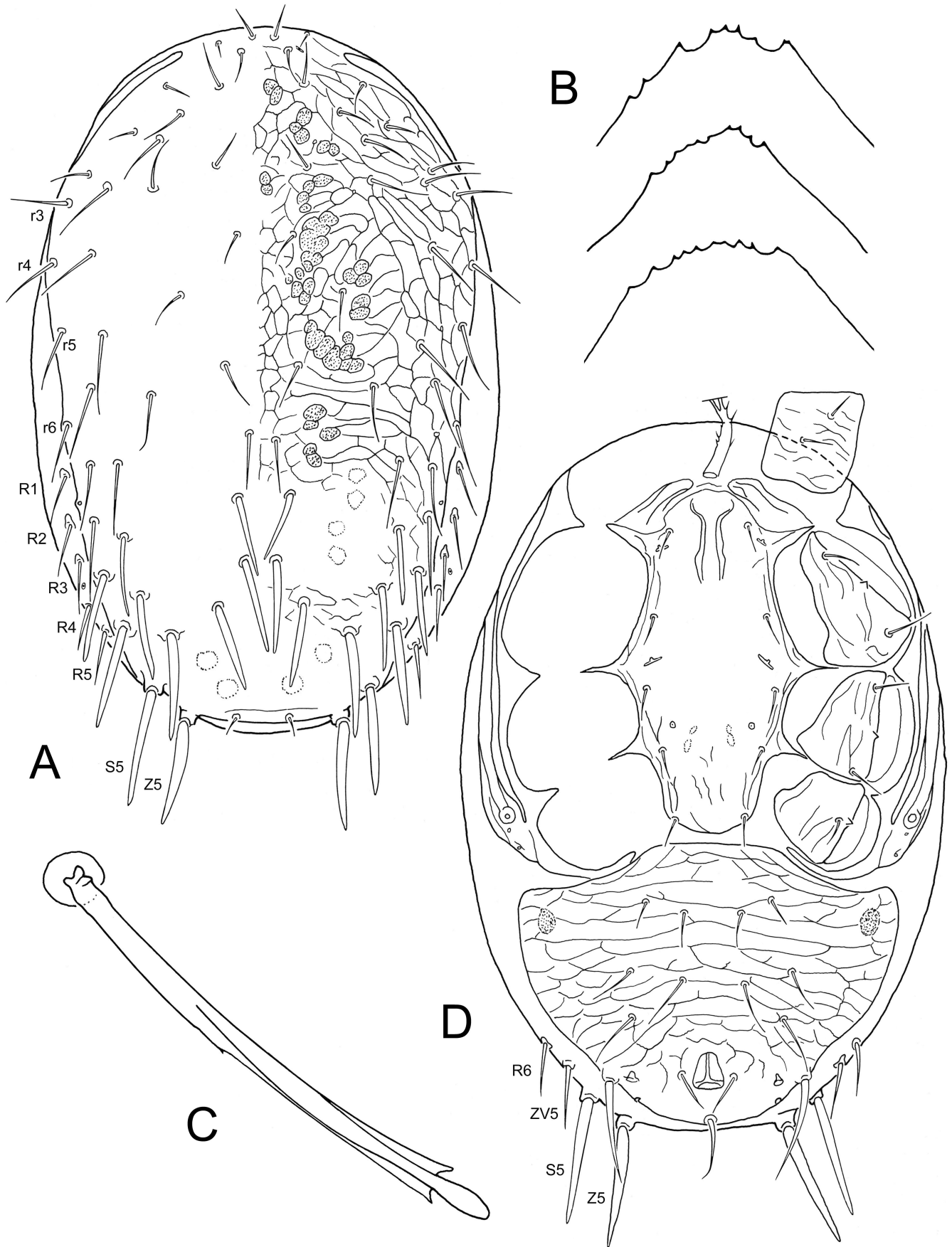
**Male** — (Figures 2B, 2D, 6A–B, 6D, and 7B–C).



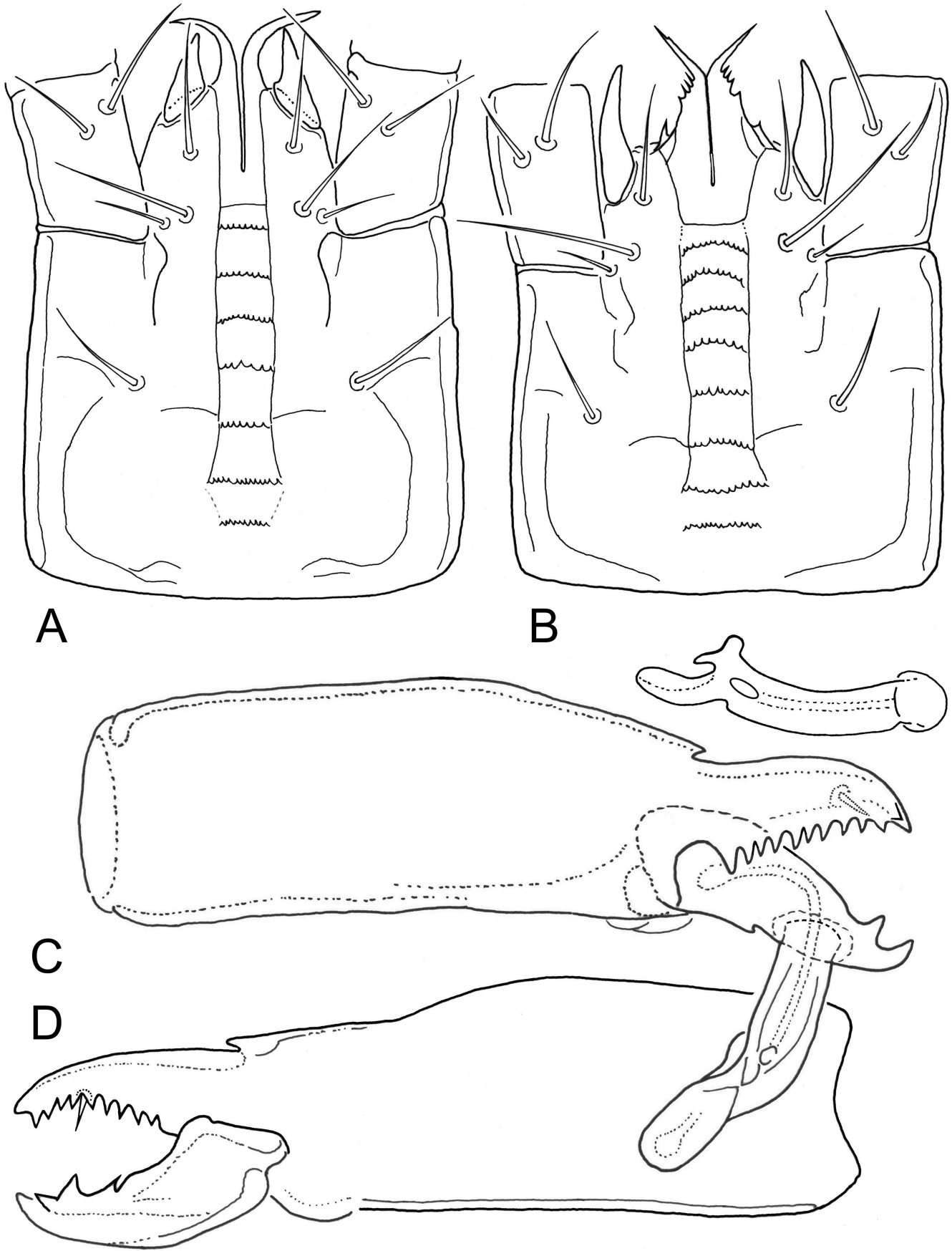
**Figure 4** *Lasioseius boleti* sp. nov., female. A – Phoretically active specimens (most likely) on their specific host beetle, *Diaperis boleti* (photo: Didier Descouens); B, C and D – Ventrianal shield, variant anomalies. Not to scale.



**Figure 5** *Lasioseius boleti* sp. nov., female. A – Tritosternum; B – Sperm-reception structures; C and D – Cheliceral digits (two variant specimens); E – Seta Z5; F – Tritosternum, variant specimen. Not to scale.



**Figure 6** *Lasioseius boleti* sp. nov. A – Male idiosoma (dorsal view); B – Male epistome, variant forms; C – Seta Z5 of female; D – Male idiosoma (ventral view). Not to scale.



**Figure 7** *Lasioseius boleti* sp. nov. A – Female gnathosoma (ventral view); B – Male gnathosoma (ventral view); C – Male chelicera (lateral view) with spermatodactyl (dorsoventral, lateral view); D – Female chelicera (lateral view). Not to scale.

*Dorsal idiosoma* – (Figures 2B and 6A). Idiosoma regularly oval. Dorsal shield 340–380 µm long and 200–240 µm wide (10 measured specimens), widest in anterior part at level between setae *r3* and *r4*, gradually narrowing posteriorly, with truncate posterior margin between setae *Z5*, and usually not covering narrow strips of lateral soft cuticle posterior to setae *r4*; shield with 38 pairs of setae (*j1–j6*, *z1–z6*, *s1–s6*, *r2–r6*, *J1–J5*, *Z1–Z5*, *S1–S5*); surface largely ornamented with reticulate pattern, except for small smooth areas between setae *J2–J4* and *Z1–Z3* and behind level of setae *Z4*. Posterior marginal setae (*R1–R6*) each on a small basal platelet and soft cuticle adjacent to shield margin. Most posterior dorsal setae conspicuously modified, strongly thickened and moderately elongate, lanceolate (*J2–J4*, *Z2–Z5*, *S3–S5*; *R2–R6* also thickened and spur-like rather than needle-like, but relatively short); other dorsal setae needle-like, smooth or finely to vestigially tricarinate, with relative lengths as in female. Lengths of some selected dorsal setae are as follows: *J1* 20–30 µm, *J2* 26–43 µm, *J3* 35–54 µm, *J4* 28–49 µm, *Z2* 34–47 µm, *Z3* 36–51 µm, *Z4* 50–66 µm, *Z5* 56–67 µm, *S3* 46–56 µm, *S4* 52–62 µm, and *S5* 54–66 µm.

*Ventral idiosoma* – (Figure 6D). Sternogenital shield 158–173 µm long and 60–70 µm wide at level of coxae II, with largely smooth surface except for some longitudinal lines along lateral margins; with five pairs of setae (*st1–st5*) and three pairs of poroids (*iv1–iv3*). Ventrianal shield 140–154 µm long and 157–190 µm wide, covering most of opisthogaster and adjacent to but not fused with peritrematal and sternogenital shields; surface entirely reticulate, reticula predominated by transverse lines; with six pairs of preanal setae (*JV1–JV3*, *JV5*, *ZV1*, *ZV2*) in addition to circum-anal setae; other preanal setae absent (*JV4*, *ZV3*, *ZV4*) or located on soft cuticle near posterolateral margins of ventrianal shield (*ZV5*). Setae *JV5* relatively thick and long, simple (not tricarinate as in female). Other characters as in female.

*Gnathosomal structures* – (Figures 6B and 7B–C). Anterior margin of epistome broadly convex and irregularly denticulate (Figure 6B). Corniculi relatively longer, narrower, and more widely spaced than in female; internal malae narrowed and pointed in apical part, directed anterolaterally, extending well beyond corniculi, and with denticulate outer margins; hypognathal groove slightly wider than in female (Figure 7B). Middle article of chelicera 78–85 µm long, cheliceral digits similar in size; movable digit with a single distal tooth and ventrodistal spermatodactyl; spermatodactyl about 27–32 µm long, slightly longer than movable digit (24–28 µm), tubular and formed as in Figure 7C; fixed digit with usually 8 or 9, rarely 10 teeth in addition to bifid terminal hook, of which the most proximal tooth clearly largest (Figure 7C). Other gnathosomal characters as in female.

*Legs* – (Figure 2D). Legs I–IV with claws, pulvilli, and pretarsi; form and relative length of setae and chaetotaxy as in female (no distinct sexual dimorphism developed); legs I 275–310 µm, legs II 230–265 µm, legs III 220–255 µm, and legs IV 285–325 µm long; legs IV slightly longer than legs I.

### **Etymology**

The specific name of the new species is derived from the Latin term *bōlētus* (mushroom, fungus), as is the specific name of its phoretic host from the genus *Diaperis* Geoffroy.

### **Taxonomic notes**

Considering the unreliable homoplastic characters used by Christian and Karg (2006) to diagnose their *Lasioseius* subgenera (and also species complexes), Moraza and Lindquist (2011) synonymized three of five of these subgenera under the nominate subgenus (*Borinquolaelaps*, *Crinidens*, and *Cuspiacus*). The key to 156 species of *Lasioseius* by Christian and Karg (2006) has been criticised by several authors as presenting some difficulties in accounting for some included species. For example, according to Britto *et al.* (2011) or Moraes *et al.* (2015), some nominal species that they had determined to be one and the same species could be assigned to different subgenera in different parts of the key. For this reason, I will not attempt to classify a new species in the system proposed by Christian and Karg (2006). The new species described

in this paper correspond to the characterization of *Lasioseius* (*Lasioseius*) given by Moraza and Lindquist (2011).

The female is easily recognized, mainly by the presence of specifically spatulate ends of some tricarinate posterior dorsal setae (*Z2–Z5*, *S3–S5*), a robust and brush-like tritosternum, and a relatively narrow and inversely pear-shaped ventrianal shield. The male is unusual by long and strongly thickened setae (*J2–J4*, *Z2–Z5*, *S3–S5*) on the posterior part of the dorsal shield, and these setae are differently shaped than in females. The absence of all submarginal setae is also an important diagnostic feature for this new species.

The adults of *Lasioseius boleti* **sp. nov.** share the following often remarkable characters with the other species or genera amidst the diversity of mites obligatorily associated with the fruiting bodies of wood-decomposing fungi: (1) some dorsal setae with a unique spatulate terminal portion that is apically rounded (as in the recently described monotypic digamasellid genus *Bulbolaelaps* Faraji, Zare & Rahmani, 2021); (2) pronounced sexual dimorphism of the posterior dorsal setae, some of which are modified in males into stout lanceolate structures, each inserted into a robust basal tubercle that projects well beyond the surrounding surface or posterior idiosomal margin; such sex-specific setal differences are not so conspicuously pronounced in other *Lasioseius* species (a similar dimorphism is common in the closely related blattisociid genus *Hoploseius*; for further comparison, see the dimorphism of setae *J4*, which are strongly thickened and lanceolate in the male of *Hoploseius oblongus* Mašán & Halliday, 2016); (3) brush-like tritosternum (species of the melicharid genus *Mycomelichares* also have this structure with the thick laciniae covered by long and dense pilosity); (4) sharp cheliceral teeth and bidentate hook on fixed cheliceral digit (these structures are also similarly developed in the genus *Mycomelichares*); (5) dorsal ornamentation and general habitus (relative length of dorsal setae, shape of idiosoma, thickness and length of legs in relation to size of idiosoma) is more similar to those of some species of *Hoploseius* than to those of *Lasioseius*.

## Discussion

There is little information on strictly fungicolous species of the genus *Lasioseius*, although the relationships between mesostigmatic mites and various fungal substrates or microhabitats, including wood-decomposing conks, have been the subject of numerous ecologically oriented studies in the past (e.g., Cobanoglu and Bayram 1998; Gwiazdowicz and Łakomy 2002; Makarova 2004; Gwiazdowicz 2007). So far, the type specimens of only three representatives of the more than 200 described *Lasioseius* species have been found in association with a sporocarp of wood-decomposing fungi, namely *Lasioseius spectabilis* De Leon, 1963 with the sporocarp of *Peniophora* (= *Phlebiopsis*) *gigantea* on a pine tree in the USA, *Lasioseius mumai* De Leon, 1963 with the sporocarp of an unidentified fungus on a magnolia tree in the USA, and *Lasioseius pseudocometa* (Schweizer, 1922) (= *Lasioseius muricatus* C. L. Koch, 1839) with the sporocarp of *Polyporus* sp. in Switzerland.

Members of the genus *Lasioseius* are generally not well represented in the European mite fauna associated exclusively with wood-decomposing fungi, although some of their saproxylic species (dependent on dead or decaying wood) are facultative and more or less abundant on the fruiting bodies of various fungi (Gwiazdowicz and Łakomy 2002; Makarova 2004). As already documented by the above authors in Europe, the frequent occurrence of *Lasioseius muricatus* and *Lasioseius ometes* (Oudemans, 1903) on perennial fungal sporocarps might indicate that these sporocarps are a preferred habitat for these species. Based on my own observations, *L. muricatus* [considered by Schweizer (1961), Bernhard (1963), Karg (1971, 1993), and Bregetova (1977) as a member of the separate monotypic genus *Aceoseius* Sellnick, 1941] can be considered the most common and abundant fungicolous species in Slovakia, and *L. ometes* is an arboricolous inhabitant of subcorticolous habitats and the galleries of wood-boring insects, occurring frequently but usually in small numbers on polypore conks.

Like *Lasioseius muricatus*, so far the only representative of *Lasioseius* known in Europe with similar ecological requirements, *Lasioseius boleti* **sp. nov.** seems to be a specialized

fungicole, preferring the fruiting bodies of polypore bracket fungi. The new species mainly colonizes *Fomitopsis betulina* and *Laetiporus sulphureus*, rarely also *Cerioporus squamosus* (all Basidiomycota: Agaricomycetes: Polyporales), where it is found either on the underside of the active hymenophore or on both sides of the conk surface (in the case of *Laetiporus sulphureus* with its soft and non-perennial fruiting bodies) or in large tunnels left by the adult beetles in the fungi as they feed on them, but most likely directly on the bodies of the specific host beetle *Diaperis boleti*. The above fungal species are widespread in Europe and also occur in North America, where they cause decay in the heartwood of living and dead deciduous trees. In Slovakia, *Lasioseius boleti* **sp. nov.** is a widespread and common species in suitable microhabitats and in conditions dependent on the presence of host beetles, with the help of which it spreads in the environment and colonizes new living substrates (it occurs mainly in forested lowland areas and in lower mountainous regions up to 550 m altitude).

Effective dispersal of *Lasioseius boleti* **sp. nov.** is ensured by active phoresy of females on a specific host, the tenebrionid beetle *Diaperis boleti*. This beetle is a widespread and locally common species in Slovakia, occurring throughout Europe with the exception of the extreme north and extending as far as northwest Africa, the Middle East, and across Siberia to extreme eastern Asia (Burakowski *et al.*, 1987). The typical habitat of this mycophagous beetle is old deciduous forests, but it may also occur on isolated trees in parks or gardens. The fungivorous adult beetles and their developmental stages generally inhabit sporocarps of various wood-decomposing fungi growing mainly on deciduous trees, especially *Laetiporus sulphureus* and *Fomitopsis* (= *Piptoporus*) *betulinus*, less frequently *Fomitopsis pinicola*, *Fomes fomentarius*, and *Cerioporus* (= *Polyporus*) *squamosus*. Because the durability of the sporocarps of one of the main hosts (*L. sulphureus*) is only one year, some beetles that survive the winter as adults must colonize a new habitat patch every year (Burakowski *et al.*, 1987).

I am not aware of any species of the genus *Lasioseius* being found as a phoretic on an obligate fungivorous beetle or insect species. At present, there are type specimens of a few species of this genus found directly on the bodies of ecologically heterogeneous beetles, namely *Lasioseius imitans* Berlese, 1910 and *Lasioseius scutalis* Banks, 1914 on scarabs in India and Brazil; *Lasioseius neometes* McGraw & Farrier, 1969, *Lasioseius dendroctoni* Chant, 1963, and *Lasioseius ruehmi* Hirschmann, 1972 on scolytine curculionids in the USA and Chile; *Lasioseius tectus* Hyatt, 1964 on a subcorticolous histeryid in Venezuela; and four species described by Moraza and Lindquist (2018) on phytophagous chrysomelids in Costa Rica (*L. serripes*, *L. fuscina*, *L. duobtusisetis*, and *L. cassidini*). In addition, the type specimens of *Lasioseius sublaevis* Berlese, 1916 were found on tipulid Diptera in Indonesia. Of the known *Lasioseius* species collected by the author of this paper in Slovakia (unpublished records), only *Lasioseius ometes* shows considerable phoretic activity on various xylophagous or predatory saproxylic beetles occurring in the same habitat as the mite.

As mentioned earlier, mites of the genus *Lasioseius* are mostly edaphic species. *Lasioseius lacunosus* Westerboer, 1963 and *L. liuchungfui* Samšínák, 1964 were described as associates of termites or ants in subcortical habitats in the Palearctic, and three species of *Lasioseius* described by Evans and Sheals (1959) are associates of polydesmid millipedes in the Oriental region (*L. angustus*, *L. frontalis*, and *L. polydesmophilus*). From tropical and subtropical areas, there are a number of records of *Lasioseius* species in the nares of birds and in flowers pollinated by birds.

While host preference for phoresy in fungicolous mesostigmatans can be quite nonspecific, as in females of *Mycomelichares cyllodi*, which are known to be phoretic on a variety of saproxylic and mostly fungivorous beetles (*Cyllodes ater* of the Nitidulidae, *Triplax* spp. and *Dacne bipustulata* of the Erotylidae, *Corticus* sp. and *Diaperis boleti* of the Tenebrionidae, and *Platysoma* sp. of the Histeridae; Mašán, 2022), or as in *Hoploseius oblongus*, whose females are phoretically active on various fungus-associated insects (Diptera: Sciaridae, Brachineurini of the Cecidomyiidae, Phoridae, Scatopsidae, and Ceratopgonidae; Coleoptera: Staphilinidae; Hymenoptera: Scelionidae, Encyrtidae; Andrianov *et al.*, 2022), we have also obtained some information on highly specific relationships between fungivorous beetles and the mesostigmatic



mites that are specifically tied to the host phoronts of the single species or genus. This is true for *Lasioseius boleti* **sp. nov.** or only for some fungicoles of the Mesostigmata, including most species of the genus *Mycomelichares*, the specific associates of erotyloid beetles: *Tritoma bipustulata* is a specific phoront for females of *Mycomelichares slovacus* in central Europe, but for females of *Mycomelichares reductus* in the eastern part of Europe, and females of *Mycomelichares triplacis* and *Mycomelichares polypori* were found only on beetles of the genus *Triplax* (Mašán *et al.*, 2021; Mašán, 2022).

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