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A new species of *Gaeolaelaps* Evans & Till (Acari: Laelapidae) associated with an endemic bess beetle (Coleoptera: Passalidae) in the Republic of Korea

Jaeseok Oh ^{a,b}, Seunghwan Lee ^{a,b}, Omid Joharchi ^c

^aLaboratory of Insect Biosystematics, Department of Agricultural Biotechnology, Seoul National University, Seoul, Republic of Korea.

^bResearch Institute of Agriculture and Life Sciences, Seoul National University, Seoul, Republic of Korea.

^cInstitute of Environmental and Agricultural Biology (X-BIO), Tyumen State University, Semakova Str.10, 625003 Tyumen, Russia.

Original research

ABSTRACT

A new mite species, *Gaeolaelaps leptaulax* n. sp., collected on an endemic bess beetle, *Leptaulax koreanus* Nomura, Kon, Johki & Lee (Coleoptera: Passalidae), from Republic of Korea is described and illustrated based on morphological characters of female, male and protonymph specimens. In addition, an identification key to all known Korean species of the *Gaeolaelaps* is presented, and ambiguities on the identification of some previously recorded species of the genus are discussed.

Keywords Parasitiformes; Gamasina; Dermanysoidea; taxonomy; bessbug; phoretic mite; East Palaearctic Region

Zoobank <http://zoobank.org/40992CF8-1D79-4BBF-AFFB-623E8B0A9509>

Introduction

Within the Laelapidae, one of the largest genera of the subfamily Hypoaspidae, *Gaeolaelaps*, is well known as a group of predatory mites and the most commonly encountered laelapids in soils. Based on the few species studied, members of *Gaeolaelaps* prey on nematodes, acarid mites and other soft-bodied arthropods that abound in soil and decomposing organic matter. They may therefore play an important role in the balance of the soil ecosystem (Walter and Oliver 1989; Gerson *et al.* 2003; Lindquist *et al.* 2009). However, some members of the genus have occasionally been found in the nests of vertebrates (Tenorio 1982) or in association with arthropods (or their nests), including mygalomorph spiders, millipedes, ants, cockroaches, termites, as well as cerambycid, passalid, scarabaeid, carabid and heterocerid beetles (Rosario 1981; Strong and Halliday 1994; Fain *et al.* 1995; Mařán 1998; Trach 2012, 2016; Joharchi and Babaeian 2014; Joharchi *et al.* 2019a, 2019b, 2020, 2021; Saedi *et al.* 2019; Moraes *et al.* 2022). A few species of this genus have been collected in association with passalids (Coleoptera: Passalidae) (Hyatt 1964; Hunter and Yeh 1969; Rosario 1981). Several authors have already recorded a collection of Laelapidae associated with insects and soil from the Republic of Korea (Kontschán *et al.* 2015, 2016; Keum *et al.* 2016, 2017; Joharchi *et al.* 2018, 2019c; Ji *et al.* 2023). The genus *Gaeolaelaps* currently comprises 160 nominal species (Moraes *et al.* 2022), from which only eight species have been recorded in the Korean peninsula (Kontschán *et al.* 2015; Joharchi *et al.* 2019c; Cho *et al.* 2021; Ji *et al.* 2023). However, we believe that some of these records are based on misidentifications. The present paper is part of a project that aims to increase the knowledge of the mite fauna of the Republic of Korea, particularly the

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Corresponding author

Seunghwan Lee : seung@snu.ac.kr

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poorly studied fauna of insect-associated species of mesostigmatic mites. Towards this aim, we herein describe a new species belonging to the genus *Gaeolaelaps* on the basis of female, male and protonymph specimens collected on an endemic bess beetle, *Leptaulax koreanus* (Coleoptera: Passalidae) from the Republic of Korea. In addition, an identification key to all known Korean species of *Gaeolaelaps* is presented, and ambiguities on the identification of some previously recorded species of the genus are discussed. Finally, the nature of the new *Gaeolaelaps* species-passalid associations is briefly discussed.

Material and methods

Host beetles, *Leptaulax koreanus*, were collected from various forest habitats (mostly rotten stump) by individual hand-picking (Figure 1). Mites were removed from the beetles using a fine brush, cleared in lactic acid solution and mounted in PVA medium (Downs 1943). Some beetles with mites were transferred to a rearing unit [plastic cage (23 X 14 X 18 cm in size)] with a sufficient amount of fermented sawdust and kept at room-temperature. The line drawings and examinations of the specimens were performed with Olympus BX53 compound microscope equipped with differential interference contrast optical systems, attached to camera Olympus DP27. Most images were captured in stacks (with focal depth manually controlled). Digital drawings were prepared using Adobe Illustrator CC 22.0.1 software based on the original pencil line drawings. Images and morphological measurements were taken via cellSens Standard software (version 3.1). Photomicrographs were taken with an Olympus DP27 camera. Measurements of structures are expressed as ranges (minimum–maximum) in micrometres (μm). The length and width of the dorsal shield were taken from the anterior to the posterior margins along the midline, and at level of *r3*, respectively. Length and width of the sternal shield were measured at the maximum length and broadest points (at level of endopodal between coxae II and III), respectively. The length of the genital shield was measured along the midline from the anterior margin of the hyaline extension to the posterior margin of the shield, and its width was measured where broadest, posteriorly to *st5*. Leg length was measured from the base of coxa to the apex of tarsus, excluding the pre-tarsus. The nomenclature for the dorsal idiosomal chaetotaxy follows that of Lindquist and Evans (1965), the notations for leg and palp setae follow those of Evans (1963a, b), and other anatomical structures mostly follow Evans and Till (1979). Notations for idiosomal pore-like structures (gland pores and poroids/lyrifissures) and peritrematal shield follow mostly Athias-Henriot (1971, 1975). The notations for pore-like structures on the sternal shield and for the peritrematal shield region also follow modifications and additions by Johnston and Moraza (1991) and Moraes *et al.* (2022). The holotype and paratypes are deposited at the National Institute of Biological Resources (NIBR). Paratypes are also deposited in the Laboratory of Insect Biosystematics, Seoul National University (SNU), Republic of Korea.

Taxonomy

Family Laelapidae Canestrini

Genus *Gaeolaelaps* Evans and Till

Hypoaspis (*Gaeolaelaps*) Evans and Till 1966: 159.

Type species *Laelaps aculeifer* Canestrini, 1884, by original designation (Evans and Till 1966).

Diagnosis

The concept of *Gaeolaelaps* used here is based on that of Moraes *et al.* (2022). More information about the synonyms and nomenclatural history of the genus are available in Moraes *et al.* (2022: 241).

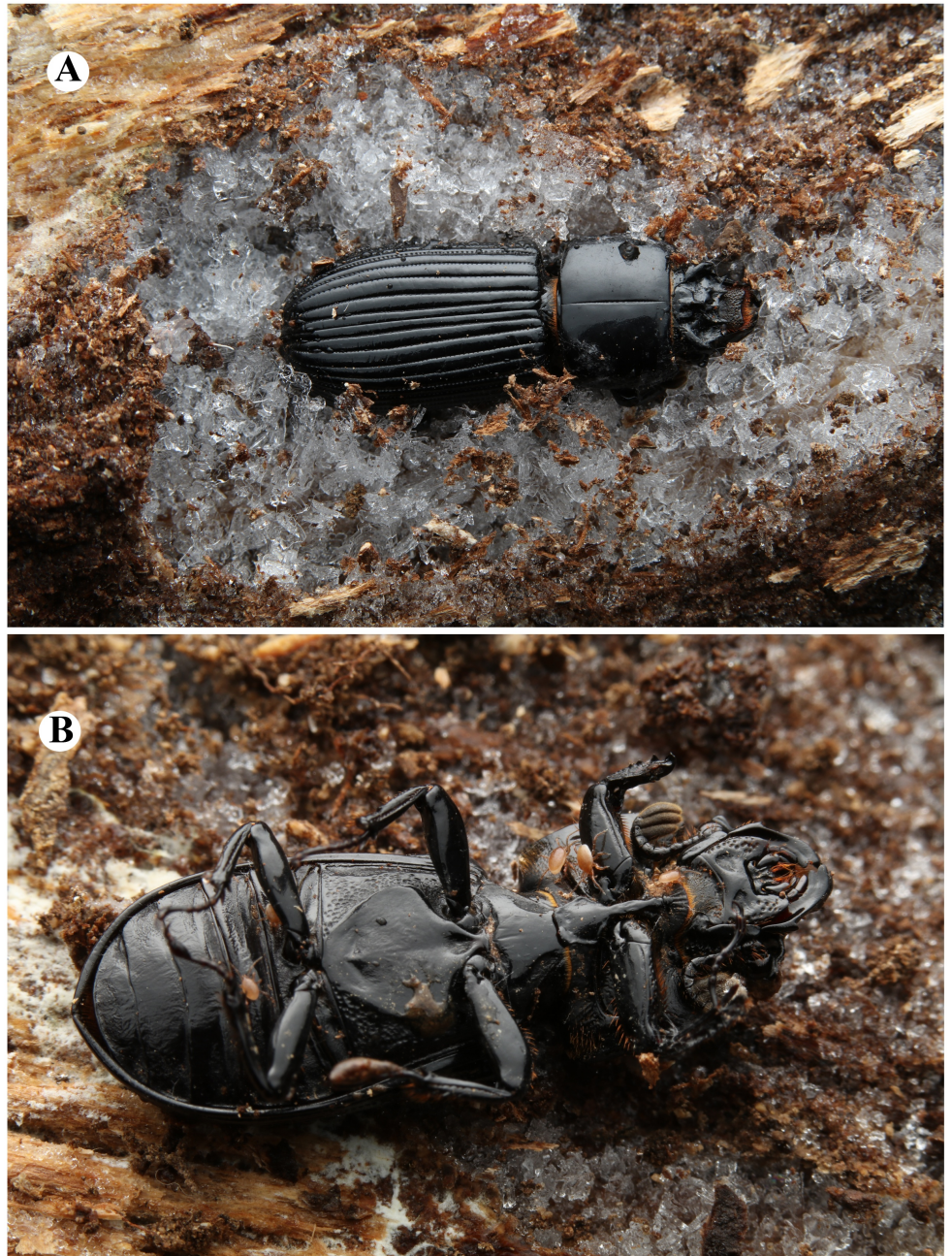


Figure 1 *Gaeolaelaps leptaulax* n. sp., on an endemic bess beetle, *Leptaulax koreanus* Nomura, Kon, Johki & Lee.

***Gaeolaelaps leptaulax* n. sp.**

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(Figures 2–6)

Type material

Holotype: female, Jikdong-ri, Sohol-eup, Pocheon-si, Gyeonggi-do, Republic of Korea, 25 May 2019, J.S. Oh coll., on *Leptaulax koreanus* Nomura, Kon, Johki and Lee (Coleoptera: Passalidae).

Paratypes (total 33 females, two males, one protonymph): 4 females, same data as holotype; 12 females, Mt. Buyongsan, San 100-14, Minrak-dong, Euijungbu-si, Gyeonggi-do, Korea, Feb–May, 2021, taken from same host specimen of *L. koreanus*; 17 females, two males, and one protonymph, Laboratory condition, Seoul National University, Seoul, Korea, 2020–2021, females on *L. koreanus*, males and protonymph from the fermented sawdust in the cage (see material and methods).

Diagnosis (adults)

Dorsal shield oval, length/width approx. 1.5, with weak reticulation, more distinct in the lateral and opisthotal sections, bearing 38 pairs of setae, including two pairs of *Zx* setae but lacking *z3*; most dorsal setae relatively short, but some setae longer, especially in anterolateral areas (e.g. *j3*, *z4*, *s4*). Presternal platelets weakly sclerotized. Sternal shield reticulate throughout, although faintly so posteromedially. Genital shield relatively large, somewhat flask-shaped, bulging posterolaterally. Opisthogastric and lateral soft cuticle with 17 pairs of setae, including seven pairs of *r-R-UR* setae. Peritremes relatively long, extending to mid-level of coxae I. Epistome triangular, with pointed apex and irregularly denticulate. Fixed digit of chelicera with 12–15 teeth. Tarsus IV without noticeably macrosetae. In male, holovenal shield bearing five pairs of sternal setae and four pairs of ventral setae. Spermatodactyl straight (60–69), progressively tapering from midway into a blunt apex.

Description (adult female)

(Figures 2, 3, 5A and 5C)

Six specimens measured.

Dorsal idiosoma — (Figure 2A) — Dorsal shield oval-shaped, 950–1066 long, 632–713 wide, covering entire idiosoma dorsally; shield without distinct reticulation (faintly distinct in distinct in the lateral and opisthotal sections, posterior to *j6*), bearing 38 pairs of smooth setae, including 21 pairs of podonotal setae (*z3* absent) and 17 pairs of opisthotal setae, including two pairs of *Zx* setae; unpaired setae *Jx* absent; dorsal setae mostly homogeneous in length and thickness, medial setae (*j3–j6* and *J1–J5*) short (40–55), barely reaching more than half the distance of following setae, anteromedial setae (*j1–j3*) longer (60–86) than other medial setae (almost reaching bases of following setae), length of podonotal setae increasing from central to lateral (70–95); *z1* (22–30) shortest, and *j2*, *j3*, *z4*, *s3*, *s4* (75–95) longest, see Figure 2A. Shield with 23 pairs of discernible pore-like structures, including 16 poroids and seven gland openings (*gd1*, *gd2*, *gd4–6*, *gd8–9*).

Ventral idiosoma — (Figures 2B and 5A) — Tritosternum with paired pilose laciniae (144–155), fused basally (12–15), columnar base 54–67 long × 21–25 wide; presternal area with a pair of platelets, ornamented with two or three transverse lines, sternal shield length 184–193, narrowest between coxae II (165–178), widest at level of endopodal between coxae II and III (296–325), with reticulate ornamentation throughout, except central and posterior parts faintly reticulated (Figures 2B and 5A), anterior and posterior margins of sternal shield slightly concave, remnants of gland pores *gv1* not discerned; bearing three pairs of smooth setae (*st1* 86–93, *st2* 80–86, *st3* 66–76), almost reaching base of next setae, and two pairs of poroids (*iv1* and *iv2* slit-like, mesal to setae *st1* and between *st2* and *st3*, respectively). Metasternal setae *st4* (58–67) and metasternal poroids located on soft integument. Endopodal plates between coxae I–II and II–III completely fused to sternal shield, endopodal plates III/IV elongate, narrow and curved. Genital shield flask-shaped, slightly expanded laterally past level of setae *st5* (Figures 2B and 5A), length 338–372, maximum width 205–245, posterior margin rounded, anterior margin of shield convex, overlapping posterior area of sternal shield, but not reaching base of setae *st3*, with some irregular longitudinal and oblique lines, otherwise relatively smooth, bearing a pair of simple setae *st5* (55–61) inserted on lateral margins of shield, near level of posterior edge of coxae IV; paragenital poroids *iv5* located on soft cuticle lateral to shield near seta *st5*. Anal shield pear-shaped, rounded anteriorly, length 116–138, width 114–120, anterior

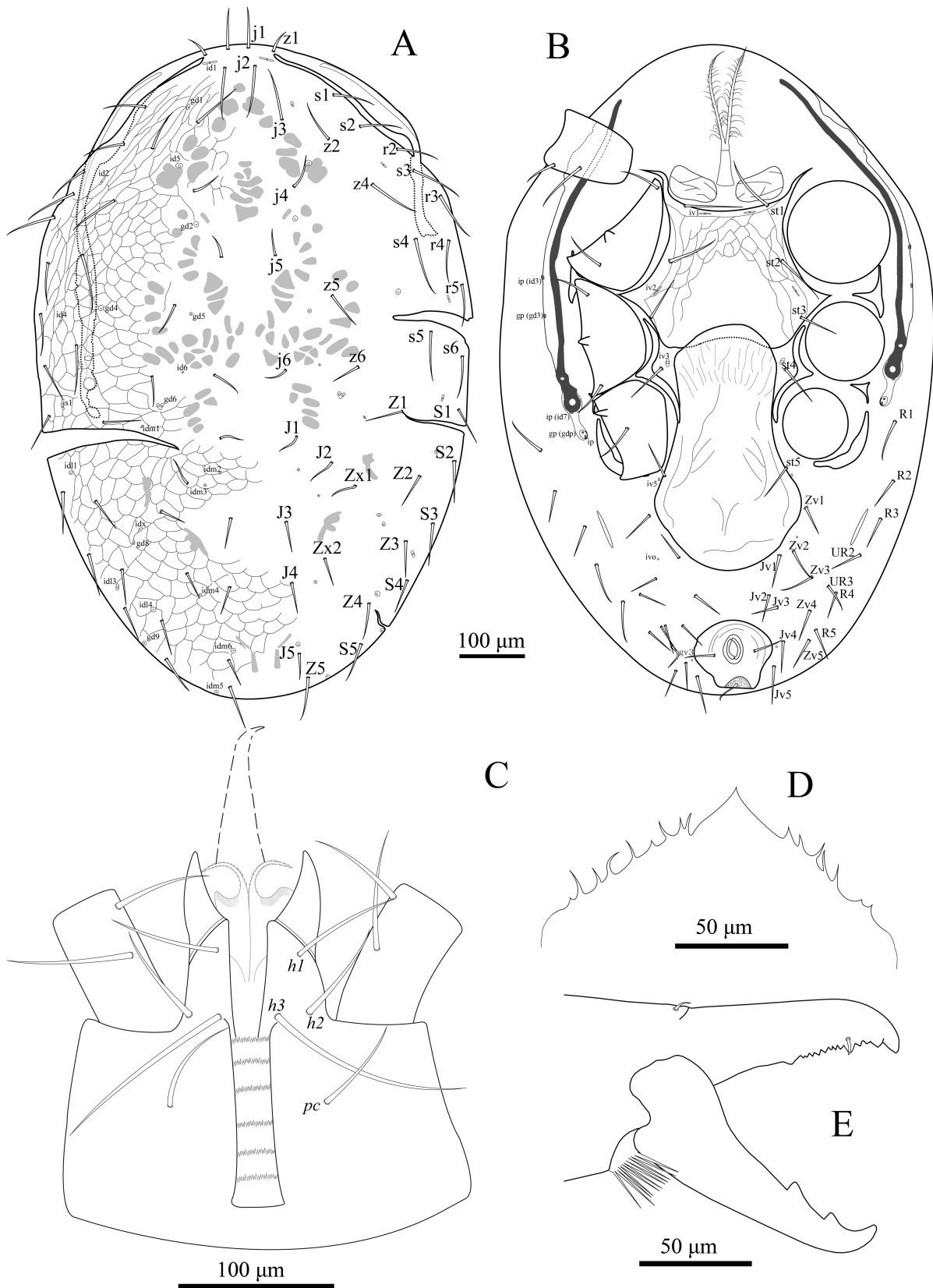


Figure 2 *Gaeolaelaps leptaulax* n. sp., adult female: A – Dorsal idiosoma; B – Ventral idiosoma; C – Subcapitulum; D – Epistome; E – Chelicera.

half lineate-reticulate, para-anal setae and post-anal seta subequal in length (38–48), cribrum consisting of a terminal tuft with three irregular rows of spicules and a pair of anterior arms extending slightly beyond post-anal seta (Figures 2B and 5A); anal gland pores (*gv3*) located on soft opisthogastric cuticle close to shield (Figures 2B and 5A). Soft opisthogastric cuticle with one pair of elongated metapodal plates (42–53 long × 3–6 wide) and 17 pairs of smooth setae (*Jv1–Jv5*, *Zv1–Zv5*, *R1–R5*, *UR2–UR3*) (40–60). Two subtriangular exopodal platelets between coxae II–III and III–IV present; parapodal platelets strip-like, gland pore *gv2* not discerned (Figures 2B and 5A). Peritrematal shield thinly developed, bearing one gland pores (*gd3*) and one poroid (*id3*) at level near coxae II–III, poststigmatic extension of shield with two pairs of poroids (*id7* and *ip*) and one pair of gland pores (*gp*) (Figures 2B and 5A); peritrematal shield fused anteriorly to dorsal shield near setae *z1* (Figures 2B and 5A). Peritremes relatively long, extending to mid-level of coxae I (Figures 2B and 5A).

Gnathosoma — (Figures 2C–E and 5C) — Epistome triangular, with pointed apex and irregularly denticulate (Figure 2D). Hypostomal groove with six transverse rows of denticles, each row with 19–25 tiny denticles, with smooth posterior transverse line (Figure 2C). Hypostome with four pairs of smooth setae, *h3* (125–127) > *h1* (67–70) > *pc* (66–68) > *h2* (64–68) (Figure 2C). Corniculi robust and horn-like, extending slightly beyond palptrochanter. Internal malae with one pair of smooth median projections, flanked by lobes with fimbriate anterior margin; labrum with pilose surface (Figure 2C); supralabral process not distinct. Chaetotaxy of palps: trochanter 2, femur 5, genu 6, tibia 14, tarsus 15, all setae smooth; palpfemur with seta *d3* thickened and *al* paddle-like; palpgenu with *al1* stout, blunt, *al2* thickened and spatulate; palptarsal apotele two-tined. Fixed digit of chelicera with an offset distal tooth (gabelzhan), followed by 12–15 various sized teeth (mostly small), a setaceous pilus dentilis, dorsal cheliceral seta small and prostrate, arthroal membrane with a rounded flap and normal filaments; cheliceral dorsal and lateral lyrifissures distinct; movable digit with two mid-sized teeth (Figures 2E and 5C).

Insemination structures – Laelapid-type sperm access system; tubulus long, wider at near the solenostome, at level of coxa III. Proximal ends of the tubulus swollen at junction with ramus, leading to irregular sacculus.

Legs — (Figure 3) — Legs II and III short (771–808, 797–860), I and IV longer (980–1060, 1090–1130). Chaetotaxy normal for free-living Laelapidae: Leg I (Figure 3A): coxa 0-0/1, 0/1-0, trochanter 1-1/1, 0/2-1 (*ad* slightly thickened), femur 2-3/1, 2/3-2, genu 2-3/2, 3/1-2, tibia 2-3/2, 3/1-2. Leg II (Figure 3B): coxa 0-0/1, 0/1-0, trochanter 1-0/2, 0/1-1, femur 2-3/1, 2/2-1 (*pd2* thickened and slightly longer than others), genu 2-3/1, 2/1-2 (*pv* slightly thickened), tibia 2-2/1, 2/1-2 (*pv* slightly thickened). Leg III (Figure 3C): coxa 0-0/1, 0/1-0, trochanter 1-1/1, 0/1-1, femur 1-2/1, 1/0-1 (*pd* slightly thickened), genu 2-2/1, 2/1-1 (all ventral setae slightly thickened), tibia: 2-1/1, 2/1-1 (all ventral setae slightly thickened). Leg IV (Figure 3D): coxa 0-0/1, 0/0-0, trochanter 1-1/2, 0/1-0, femur 1-2/1, 1/0-1 (*ad1* longest and inserted on small tubercles), genu 2-2/1, 3/0-1 (*av* slightly thickened), tibia 2-1/1, 3/1-2 (all ventral setae thickened). Tarsi II–IV with 18 setae (3-3/2, 3/2-3 + *mv*, *md*); with some ventral and lateral setae thickened, tarsus of leg IV without noticeably longer setae (macrosetae), see Figure 3. All pretarsi with well-developed paired claws, rounded pulvilli and normal ambulacral stalk.

Description (adult male)

(Figures 4, 5B and 5D)

Two specimens measured.

Dorsal idiosoma — Dorsal shield 731–751 long, 440–506 wide; ornamentation and chaetotaxy as in female.

Ventral idiosoma — (Figures 4A and 5B) — Sternal, genital, endopodal, ventral and anal shields fused into holovenral shield, 515–520 long from anterior to posterior margins of shield, 140–147 wide at level of *st2*, 156–162 at *st3* level and 280–285 at broadest point, posteriorly to coxae IV; shield reticulate throughout (ornamentation only partly drawn on Fig. 4A), with five pairs of simple sternal setae (*st1–5*), and four pairs of smooth ventral setae (*Jv1*, *Jv2*, *Zv1*, *Zv2*),

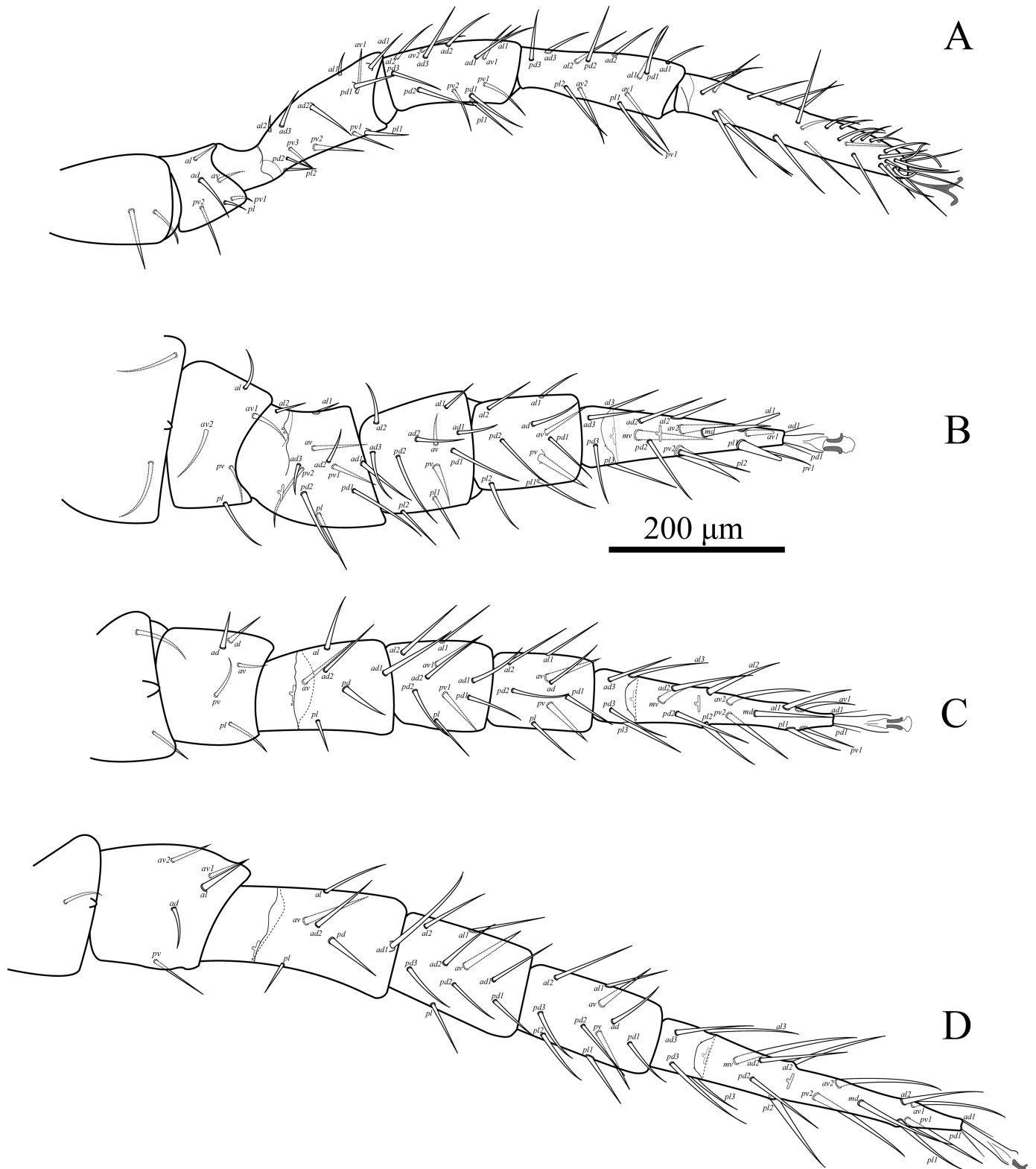


Figure 3 *Gaeolaelaps leptaulax* n. sp., adult female: A – Leg I; B – Leg II; C – Leg III; D – Leg IV.

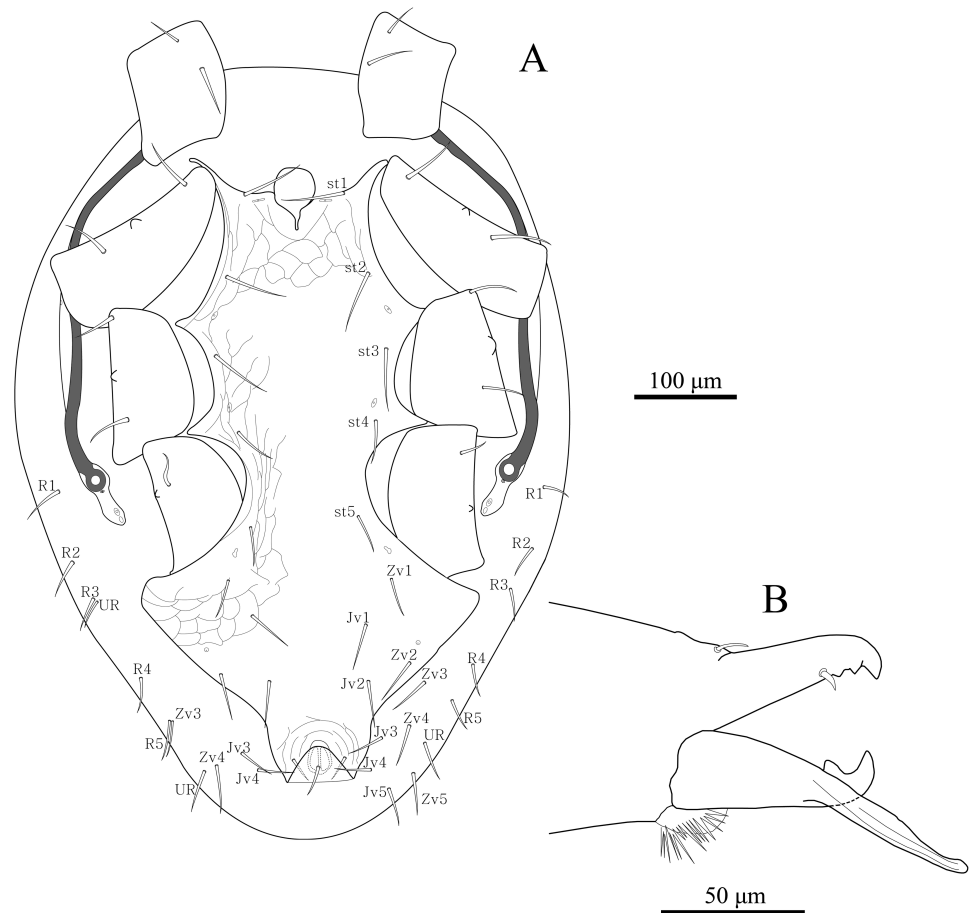


Figure 4 *Gaeolaelaps leptaulax* n. sp., adult male: A – Ventral idiosoma; B – Chelicera.

plus three smooth circumanal setae, para-anal setae and post-anal seta subequal in length, with five pairs of poroids; gland pore *gv2* behind coxa IV not discerned; cribrum with 3–4 irregular rows of spicules; metapodal platelets narrow and fused to holovenal shield (Figures 4A and 5B). Soft opisthogastric and lateral cuticle with 10–12 pairs of setae. Peritremes, peritrematal shields and other ventral structures similar to those in female.

Gnathosoma – (Figures 4B and 5D) — Fixed digit of chelicera with two teeth of various sizes in addition to apical hook, pilus dentilis setaceous, slightly thicker than in female. Movable digit of chelicera with a relatively large tooth, spermatodactyl straight, progressively tapering from midway into a blunt apex, free portion of spermatodactyl almost as long as movable digit (90% of movable digit length at most) (60–69). Other gnathosomal structures similar to those in female.

Legs – Chaetotaxy as in female.

Description (protonymph)

(Figure 6)

One specimen measured.

Dorsal idiosoma — (Figure 6A) — Whitish, oval (646 long × 463 wide), with podonotal (414 long × 368 wide) and pygidial (171 long × 240 wide) shields, three pairs of mesonotal scutellae, the largest 54 long × 20 wide, and six pairs of setae located between podonotal and pygidial shields (*J1*, *J2*, *Z1*, *Z2*, *S2*, *S3*) (Figure 6A). Podonotal shield weakly reticulated, only

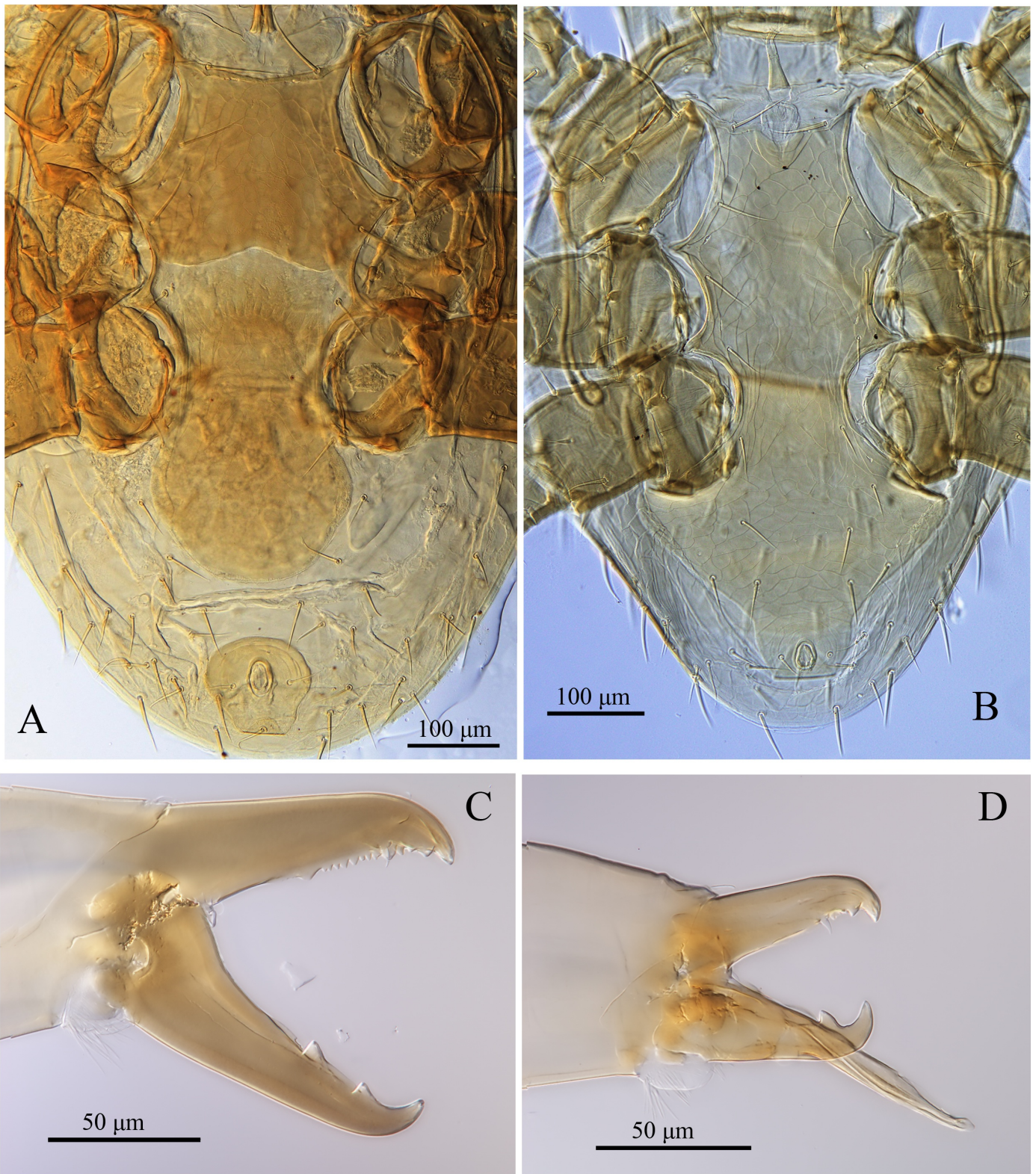


Figure 5 DIC micrographs of *Gaeolaelaps leptaulax* n. sp., A – Ventral idiosoma of female; B – Ventral idiosoma of male; C – Chelicera of female; D – Chelicera of male.

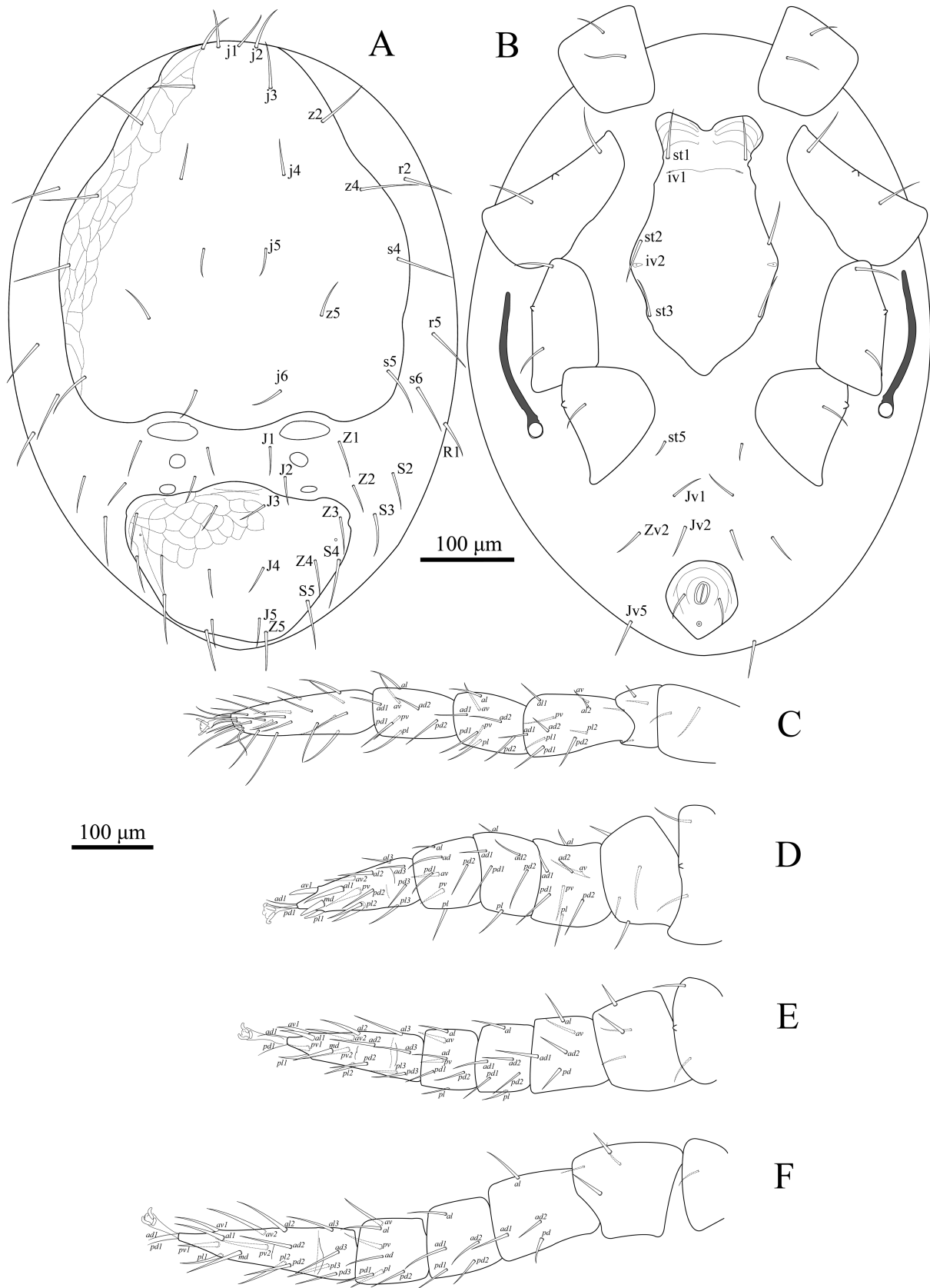


Figure 6 *Gaeolaelaps leptaulax* n. sp., protonymph: A – Dorsal idiosoma; B – Ventral idiosoma; C – Leg I; D – Leg II; E – Leg III; F – Leg IV.

distinct in lateral regions, with 11 pairs of simple setae ($j1-6$, $z2$, $z4$, $z5$, $s4-5$) ($r2$, $r5$ and $R1$ on lateral soft cuticle), medial setae ($j4-6$, $z5$) shorter (30–40), other setae longer (55–65). Pygidial shield faintly reticulated throughout, with eight pairs of simple setae ($J3-5$, $Z3-5$, $S4-5$). All setae similar in length (30–40) except $S4$, $S5$ and $Z5$ longer (45–55) (Figure 6A).

Ventral idiosoma — (Figure 6B) — Sternal shield distinct, length 270, narrowest between $st1$ and $st2$ (110), widest between $st2$ and $st3$ (160), with three pairs of smooth setae ($st1-3$, 50–55) and sternal poroids, metasternal setae $st4$ absent. Anal shield length 85, width 75, cribrum consisting of irregular rows of spicules extending slightly beyond post-anal seta. Opisthogastric cuticle with five pairs of smooth setae ($st5$, $Jv1-2$, $Jv5$, $Zv2$). Peritreme short, located in the region of coxae III/IV (Figure 6B), peritrematal shield and post-stigmatic section not developed.

Gnathosoma — similar to the adult.

Legs — (Figures 6C–F) — Legs II (526) and III (536) short, I (621) and IV (700) longer. Chaetotaxy: Leg I (Figure 6C): coxa (2) 0-0/1, 0/1-0, trochanter (4) 1-0/2, 0/1-0, femur (10) 2-2/1, 2/1-2, genu (8) 1-2/1, 2/1-1, tibia (8) 1-2/1, 2/1-1. Leg II (Figure 6D): coxa (2) 0-0/1, 0/1-0, trochanter (4) 1-0/1, 0/1-1, femur (8) 1-2/1, 2/1-1, genu (6) 1-2/0, 2/0-1, tibia (7) 1-1/1, 2/1-1. Leg III (Figure 6E): coxa (2) 0-0/1, 0/1-0, trochanter (4) 1-1/1, 0/1-0, femur (5) 1-2/1, 1/0-0, genu (6) 1-2/0, 2/0-1, tibia (7) 1-1/1, 2/1-1. Leg IV (Figure 6F): coxa (1) 0-0/1, 0/0-0, trochanter (4) 1-1/1, 0/1-0, femur (4) 1-2/0, 1/0-0, genu (5) 1-2/0, 2/0-0, tibia (7) 1-1/1, 2/1-1. Tarsi II–IV with 17 setae (3-3/2, 3/2-3 + *md*); most setae on ventral and lateral aspects thickened (or spine-like). All pretarsi with well-developed paired claws, rounded pulvilli and normal ambulacral stalk.

Etymology

The specific name of this species is treated as a noun in apposition and refers to its occurrence on beetles of the genus *Leptaulax*.

Remarks

Since all specimens of new species were found on passalids, this strongly suggests that there is a biological link between the mite species and the passalid host. Thus, the possibility of accidental phoresy can be ruled out. Prior to our work, only five species regarded to belong to *Gaeolaelaps* have been reported on bess beetles (Coleoptera: Passalidae) (Morales *et al.* 2022): *Gaeolaelaps circularis* Hyatt, 1964; *G. disjuncta* (Hunter and Yeh, 1969); *G. paraculeifer* Rosario, 1981; *G. passalus* Rosario, 1981; and *G. rarosae* Rosario, 1981. *Gaeolaelaps leptaulax* can be easily distinguished from all of these species by its rather large body size (ca. 950–1066 in length, 632–713 in width), dorsal shield with 38 pairs of setae ($z3$ absent), and presternal area with a pair of platelets, while all five above-mentioned species have smaller body size, with 37 pairs or fewer dorsal setation and presternal area without platelets (= with a few transverse curved lines) (except for *G. disjuncta* there is a similar pair of platelets in sternal region).

Kontschán *et al.* (2015) reported *G. kargi* (Costa, 1968) from the Democratic People's of Republic of Korea basis on one specimen collected from litter. We have had the opportunity to examine that specimen deposited in NIBR, but the species identity of the specimen could not be confirmed due to its poor condition. Therefore, the record of *G. kargi* remains unconfirmed. *Gaeolaelaps praesternalis* (Willmann, 1949) has also been recorded by Kontschán *et al.* (2015) (as *Hypoaspis presternalis* [sic]) from moss and lichen samples collected in the Democratic People's of Republic of Korea. We have not had the opportunity to examine any specimens to confirm this identification. Nevertheless, based on the illustration of the specimen provided by Kontschán *et al.* (2015: 36, Figure 1e), as well as comparing it with supplementary descriptions and photomicrographs of *G. nolli* and *G. praesternalis* which were based on the type series of the species (see Joharchi and Negm, 2020: 499), we believe that this was a misidentified specimen of *Gaeolaelaps nolli* (Karg, 1962). There is some confusion about the identification of these two species, and that was discussed by Joharchi and Negm (2020: 499), who listed the

main differences of these two species by making a list of differences between *G. nolli* and *G. praesternalis*. The following key is based on the direct examination of specimens of all species included.

Key to species of *Gaeolaelaps* occurring in Republic of Korea

1. Peritreme long, reaching coxa I 2
— Peritreme short, reaching coxa II 7
2. Palp tarsal claw three-tined; dorsal shield caudally with a curvature (tapering caudally)
..... *G. queenslandicus* (Womersley, 1956)
— Palp tarsal claw two-tined; dorsal shield not tapering caudally and without any curvature in
posterior part 3
3. Dorsal shield with 39 pairs of setae, including *z3* 4
— Dorsal shield with 38 pairs of setae, lacking *z3* 6
4. Sternal seta *st1* inserted in presternal region 5
— Sternal seta *st1* inserted on sternal shield. *G. aculeifer* Canestrini, 1884
5. Dorsal shield obviously narrowing from level of setae *r3*; progressively tapering, genital
shield not abuts the anal shield, the distance between the genital and anal shields almost as long
as anal shield *G. aculeiferoides* (Teng, 1982)
— Dorsal shield oval-shaped; genital shield closely abuts the anal shield
..... *G. debilis* (Ma, 1996)
6. Tarsus IV with two elongate setae, idiosoma mid-sized, dorsal shield parallel-sided, all
dorsal setae mid-sized and subequal; opisthogastric and lateral soft cuticle with only eight pairs
of setae *G. kargi* Costa, 1968
— Tarsus IV without elongate setae, idiosoma large, dorsal shield oval-shaped, with rounded
lateral margins, some anterolateral dorsal setae are longer in contrast to short posteromedian
setae; opisthogastric and lateral soft cuticle with 17 pairs of setae *G. leptaulax* **n. sp.**
7. Dorsal shield with 39 pairs of setae, including two pairs of *Zx* setae 8
— Dorsal shield with 37 pairs of setae, lacking *Zx* setae *G. zhoumanshuae* (Ma, 1997)
8. Fixed digit of female chelicera with four teeth, tarsus IV without elongated macrosetae
..... *G. similisetae* (Karg, 1965)
— Fixed digit of female chelicera with six teeth, tarsus IV with two elongated macrosetae
(*pd2–3*) *G. nolli* (Karg, 1962)

Passalids live in hardwood logs and exhibit subsocial behavior quite unusual for beetles. Both bess beetle parents live in their log homes with their offspring, and family members guard their home against intruders. The beetles dig tunnel systems in rotting wood where the females then lay their eggs and care for their young by preparing food for them and helping the larvae build the pupal case (Hadley 2021). The ecological role of *G. leptaulax* is unknown. Nevertheless, the specimens of *G. leptaulax* collected have a morphology largely typical of free-living *Gaeolaelaps* (e.g. dentate chelicerae; sclerotized, horn-like corniculi, well-developed deutosternum, almost holotrichous dorsal chaetotaxy), and no specimens were considerably swollen, overall suggesting that this species is not parasitic. For that reason, we suspect that *G. leptaulax* has a commensal or mutualistic relationship with its beetle host, perhaps feeding on other small invertebrates such as astigmatic mites or nematodes in its rotting wood nest. If they prey on parasitic invertebrates, then the relationship could be mutualistic. Alternatively,

commensal or even antagonistic relationships are possible if their preferred bess beetles eggs or larvae, and they feed either on substances around the egg masses or larvae of their beetle host (as harmless feeders) or on the eggs and larvae themselves. Regardless of their habits, we stress the true ecological role of these mites must be determined experimentally.

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ORCID

Jaeseok Oh  <https://orcid.org/0000-0001-9434-053X>

Seunghwan Lee  <https://orcid.org/0000-0003-3026-5328>

Omid Joharchi  <https://orcid.org/0000-0002-2741-4946>

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