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New data on two myrmecophilous laelapid mites (Acari: Mesostigmata: Laelapidae) in Western Siberia, Russia

Omid Joharchi [a], Olga S. Asyamova [a], Alexander A. Khaustov [a], Derek A. Uhey [b], Aigerim K. Issakova [a] and Andrei V. Tolstikov [a]

[a]Institute of Environmental and Agricultural Biology (X-BIO), Tyumen State University, Tyumen, Russia; [b]School of Forestry, Northern Arizona University, Flagstaff, AZ, USA

ABSTRACT

Gaeolaelaps glabrosimilis: and *Holostaspis flexuosa* are recorded for the first time in Western Siberia, Russia, collected from the ant species *Lasius fuliginosus* (Latreille) (Formicidae) and *Camponotus herculeanus* (L.), respectively. *Gaeolaelaps glabrosimilis* is redescribed on the basis of adults and a detailed comparison of this species with the very closely related species *Gaeolaelaps longichaetus* is presented. Moreover, notable variations are observed in some morphological characters of *H. flexuosa*.

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Introduction

The nests of social insects provide a favourable habitat for many symbiotic species, which may be parasitic, mutualistic, phoretic, predatory, or commensal with their hosts. A large diversity of symbionts in social insect nests are mites, which can impact the success of their insect hosts (e.g., Vissa and Hofstetter 2017). Yet most mite species remain undescribed, and this lack of understanding obscures their ecological roles. Ants are highly organized social insects that create microhabitats through nest construction (Hölldobler and Wilson 1990). Organisms that live in association with ants (i.e. myrmecophiles) are able to enter and access resources within nests, remaining largely undetected by the ant hosts. Myrmecophily is well-studied among Coleoptera, however, mites are typically the most abundant symbionts in nests (Kistner 1979). Mites are believed to largely be communalistic or beneficial to their ant hosts (Eickwort 1990; Berghoff et al. 2009), confirmed parasitic relationships are rare (Franks et al. 1991). Instead, many myrmecophilous ants seem to take advantage of detritus or microbes in the nest, while using ant hosts for transportation to new habitats (i.e. phoresy) (Houck and OConnor 1991). A remarkable diversity of mites is found in association with ants, representing three major groups: the Mesostigmata, Prostigmata, and Astigmatina (Eickwort 1990). The family Laelapidae (Mesostigmata) is highly speciose and includes about 1,520 described species sorted into more than 146 genera (Keum et al. 2017; Joharchi et al. 2018), with a rich ecological diversity not found other families of Mesostigmata. Within the Laelapidae, several genera of the subfamily Hypoaspidinae have close associations with many insect groups, including ants (Eickwort 1990). Some of these genera are mostly or entirely myrmecophilous, while others have various relationships with insects or none at all. An example of the former is *Holostaspis*, an ant-associated genus intermediate between *Laelaspis* and *Myrmozercon* which comprises 10 nominal species (Babaeian et al. 2019). In contrast, an example of the latter is *Gaeolaelaps*. Members of this large genus, comprising more than 120 species, have been described from soil-litter habitats (Bregetova 1977; Karg 1993; Beaulieu 2009), nests of vertebrates (Tenorio 1982), or associated with arthropods (or their nests), including mygalomorph spiders, millipedes, cockroaches, termites, as well as cerambycid, passalid, scarabaeid, carabid and heterocerid beetles (Rosario 1981; Strong and Halliday 1994; Fain et al. 1995; Mašán 1998; Trach 2012, 2016; Joharchi and Babaeian 2014; Saeidi et al. 2019; Joharchi et al. 2019a, 2019b). A few species of this genus have been collected in association with ants (Zeman 1982; Beaulieu 2009; Walter and Moser 2010; Joharchi et al. 2019a). The present paper is part of a project that aims to increase the knowledge of the mite fauna of the Asian part of Russia (especially, that of Western Siberia), particularly the poorly studied fauna of insect-associated species of mesostigmatid mites. Towards this aim, we record two myrmecophilous laelapid mites species *Gaeolaelaps glabrosimilis* (Hirschmann, Bernhard, Greim and Götz, 1969) and *Holostaspis flexuosa* (Michael, 1891) for the first time from Russia, which werecollected from the ant species *Lasius fuliginosus* (Latreille) and *Camponotus herculeanus* (L.), respectively. *Gaeolaelaps glabrosimilis* is redescribed on the basis of adults. Furthermore, detailed comparison of *G. glabrosimilis* with a very closely related species *Gaeolaelaps longichaetus* (Ma, 1996) is presented. Moreover, we observe notable differences in some morphological characters of West Siberian specimens of *H. flexuosa* in comparison with specimens from Slovakia, which have been presented by Babaeian et al. (2019).

Materials and methods

Host ants were collected from the nest in the forest using an aspirator and placed in vials with 96% ethanol. Thereafter, alcohol sediments from the vials were inspected for detached ant-associated mites. Mites were removed from ant nests by extraction from nest material using Berlese-Tullgren funnels. Specimens were cleared in lactic acid solution and mounted in Hoyer's medium (Walter and Krantz 2009). The line drawings and examinations of the specimens were performed with a Zeiss Axio Imager A2 and Leica DM 2500 compound microscopes equipped with differential interference contrast and phase contrast optical systems, attached to cameras AxioCam ICc 5 and ICC50 HD, respectively. Figures were elaborated with Adobe Photoshop CS2 software based on the line drawings. Images and morphological measurements were taken via ZEN 2012 software (version 8.0) and Leica Application Suite (LAS) software (version 4.2, Live and Interactive Measurements modules). Photomicrographs were taken with an AxioCam 506 camera (Carl Zeiss, Germany). Measurements of

CONTACT Omid Joharchi j.omid2000@gmail.com Institute of Environmental and Agricultural Biology (X-BIO), Tyumen State University, Tyumen, Russia

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structures are expressed as ranges (minimum–maximum) in micrometres (μm). The length and width of the dorsal shield were taken from the anterior to 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 where maximal, posteriorly to genital setae *st5*. Leg length was measured from the base of the coxa to the apex of the tarsus (excluding the pre-tarsus). The nomenclature used for the dorsal idiosomal chaetotaxy follows that of Lindquist and Evans (1965), the notations for leg and palp setae follow those of Evans (1963a, 1963b)), 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), adapted by Kazemi et al. (2014).

Systematics

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

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

Diagnosis

The concept of *Gaeolaelaps* used here is based on that of Beaulieu (2009) with modifications by Kazemi et al. (2014).

Gaeolaelaps glabrosimilis **(Hirschmann, Bernhard, Greim and Gotz)***Hypoaspis glabrosimilis* Hirschmann, Bernhard, Greim and Gotz, 1969: 134.*Hypoaspis* (*Geolaelaps*) *glabrosimilis*. – (Bregetova 1977: 501; Karg 1979: 82, 1982: 241, 1987: 298, 1993: 142).*Hypoaspis* (*Gaeolaelaps*) *glabrosimilis*. – (Faraji et al. 2008: 208).

Gaeolaelaps glabrosimilis. – (Beaulieu 2009: 36; Kavianpour et al. 2013: 8; Kavianpour and Nemati 2014: 322; Joharchi et al. 2019a: 277).(Figure 1–4).

Diagnosis

(Female). Dorsal shield weakly reticulate, more distinct in lateral regions, with 39 pairs of smooth setae, except *J4, J5* and *Z5* with 2–4 minute barbs, including two pairs *Zx* setae, podonotal setae slightly shorter than opisthonotal setae, all setae reaching well past base of next posterior seta. Sternal shield with three pairs of long and smooth sternal setae, reaching well base of next posterior setae, surface without reticulation, almost smooth, except some irregular longitudinal lines laterally, posterior margin irregularly concave; ratio of shield length/width (at broadest level) □ 0.62. Genital shield ratio of length/width (at broadest level) □ 2.32. Anal shield ratio of length/width (at broadest level) □ 1.15. Opisthosomal membrane with 16 pairs of smooth setae, uniform in length and thickness. Peritreme long, extending to mid-level of coxa I (near *s1*). Post-anal seta smooth, thick, almost twice as long as paranal setae. Tarsus IV without elongate setae, setae *ad1* on femur I–IV thickened. Fixed digit of chelicera with eight teeth.

Redescription

Female *(n = 15).* ***Dorsal idiosoma*** (Figure 1(a) and 2(a)). Dorsal shield oval-shaped, 459–471 long, 343–360 wide, covering most of idiosoma; weakly reticulate, more distinct in lateral regions. Shield with 39 pairs of long setae (52–62): 22 pairs of podonotal setae, 17 pairs of opisthonotal setae, including two pairs of *Zx* setae and three or four unpaired supernumerary setae *Jx*; most setae smooth, *J4, J5* and *Z5* with 2–4 min barbs (Figure 1(a) and 2(a)); podonotal setae slightly shorter than opisthonotal setae. Shield with about 15 pairs of discernible pore-like structures, including nine poroids (*id1, id2, id4, id5, idm1-3, idx, is1*) and six gland openings (*gd1, gd2, gd4-6, gd8*). Shape, position and relative length of setae shown in Figure 1(a) and 2(a).

Ventral idiosoma

(Figure 1(b) and 2(b,c)). Tritosternum with paired pilose laciniae (64–70), fused basally (10–12), columnar base 17–20 × 14–16 wide; presternal area with transverse lightly sclerotized lines (Figure 1(b) and 2(b,c)), fused to sternal shield. Sternal shield (length 100–105) narrowest between coxae II (100–107), widest at level of endopodal between coxae II and III (159–168), posterior margin irregularly concave; with three pairs of long and smooth sternal setae, (*st1* (44–46), *st2* (46–48), *st3* (43–45)), reaching well base of next posterior setae and two pairs of poroids (*iv1* and *iv2* slit-like, adjacent to setae *st1* and between *st2* and *st3*, respectively) (Figure 1(b) and 2(b,c)); surface without reticulate ornamentation, almost smooth, except some irregular longitudinal lines laterally, shield fused anterolaterally to narrow endopodal strip between coxae I and II, and to endopodal between coxae II and III. Metasternal setae *st4* (44–46) and metasternal poroids *iv3* inserted on soft cuticle posterior to sternal shield; metasternal platelets absent. Endopodal plates II/III completely fused to sternal shield, endopodal plates III/IV elongate, narrow, and curved. Genital shield elongated, rounded posteriorly, slightly protruding at level between setae *st5* and *Zv1*, width (113–116) and length (254–270); shield ornamented posteromedially by six cells flanked by a median Λ-shaped ornamentation, shield bearing smooth genital setae *st*5 (43–45) on edges. Paragenital poroids (*iv5*) located on soft cuticle lateral to shield behind *st*5. Anal shield subtriangular, length 79–84, width 68–73, smooth, with a pair of lateral poroids (*gv3*) on lateral margins; bearing long and thick post-anal seta (43–46), and a pair of smooth para-anal setae (25–27), cribrum small, with 3–4 irregular rows of spicules, limited to region posterior to post-anal seta. Soft opisthogastric cuticle surrounding genital and anal shields with one pair of suboval metapodal plates (26–28 long × 10–12 wide) and 16 pairs of setae (*Jv1–Jv5, Zv1 – Zv*5, *R1–R4, UR2–UR3*); all setae smooth and uniform in length (52–62) and thickness, except *Jv1* and *Zv1* (43–45) long (Figure 1(b) and 2(b)). Peritreme long, extending to mid-level of coxa I (near *s1*), peritrematal shield narrow, expanded anteriorly, free from exopodal shields, each shield bearing five discernible pore-like structures, a lyrifissure *ip* and a gland pore *gp* at level of coxa II, two lyrifissures *ip* and a gland pore *gp* on poststigmatic section (Figure 1(b) and 2(b)); anterior part of shield not fused with dorsal shield.

Gnathosoma

(Figure 1(c,d,e) and 2(d,e)). Epistome triangular, irregularly denticulate (with variation in denticulation among specimens) (Figure 1(d) and 2(d)). Hypostomal groove with six transverse rows of denticles, each row with 10–15 small denticles. Hypostome with four pairs of setae, internal posterior hypostomal setae *h3* longest (49–53), *h1* (23–25), *h2* (19–21), palpcoxal *pc* (27–30) (Figure 1 (c)). Corniculi barely reaching mid-level of palp femur. Chaetotaxy of palps: trochanter 2, femur 5, genu 6, tibia 14, tarsus 15, all setae smooth and needle-like except apically spatulate *al1* and *al2* on palp genu, palp tarsal apotele two-tined. Internal malae with median and lateral projections, coarsely fringed, inner lobes touching medially with outer lobes; labrum with pilose surface. Fixed digit of chelicera with an offset large tooth (gabelzhan) distal to, seven variously sized teeth, pilus dentilis short, somewhat thick, dorsal seta thick and prostrate; movable digit bidentate, arthrodial membrane with a rounded flap and normal filaments; cheliceral lyrifissures indistinct (Figure 1(e) and 2(e)).

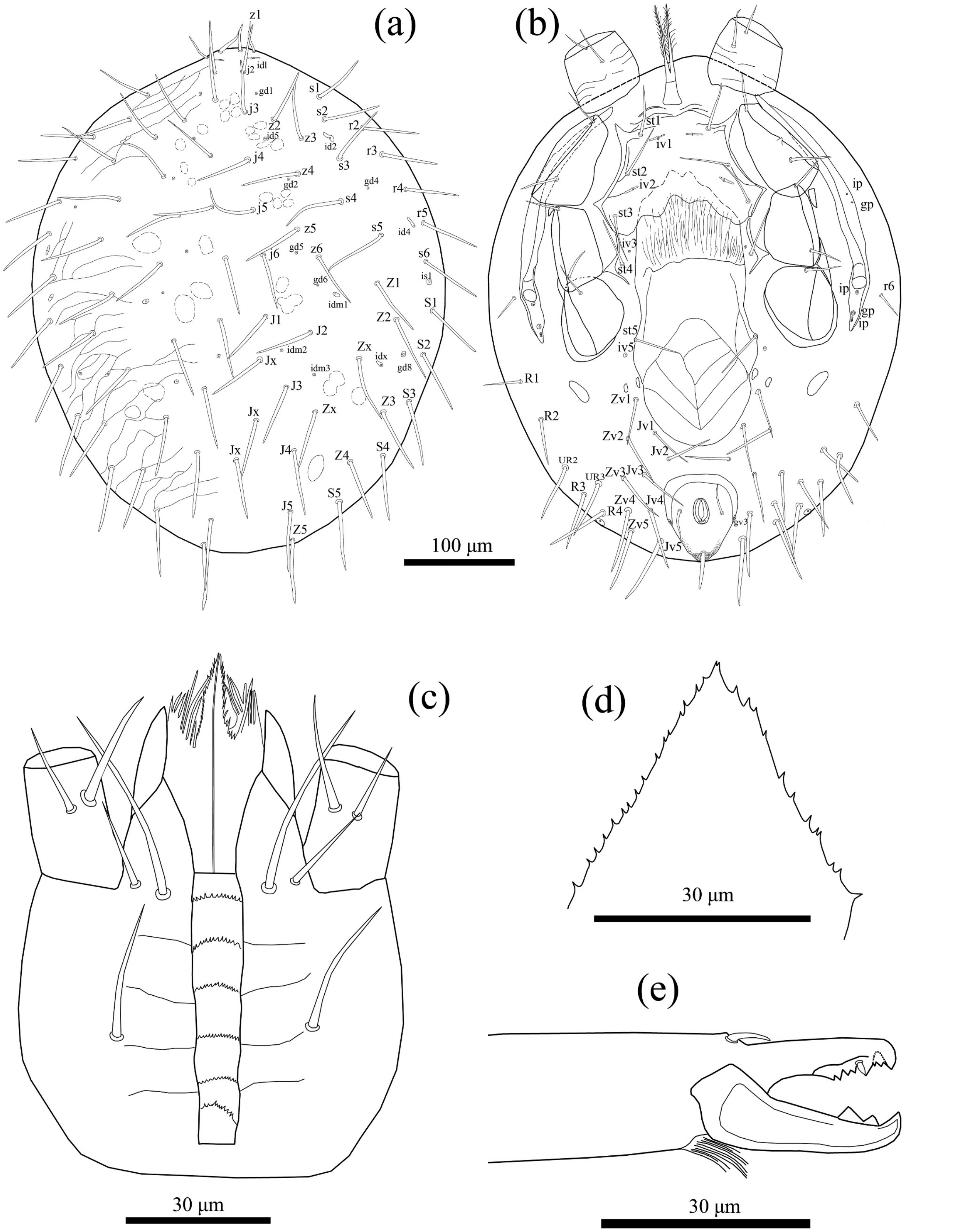

Figure 1. *Gaeolaelaps glabrosimilis* (Hirschmann, Bernhard, Greim and Gotz, 1969), female: (a) dorsal idiosoma, (b) ventral idiosoma, (c) subcapitulum, (d) epistome, (e) chelicera.

Insemination structures. Not seen, apparently unsclerotised.

Legs

(Figure 3). Legs II and III short (290–302, 301–310), I and IV longer (366–371, 397–404) (excluding pretarsus). Chaetotaxy normal for free-living Laelapidae: Leg I (Figure 3(a)): coxa 0–0/1, 0/1-0, trochanter 1–0/1, 1/2-1 (*ad1* thickened), femur 2–2/1, 3/3-2, genu 2–3/2, 3/1-2, tibia 2–3/2, 3/1-2. Leg II (Figure 3(b)): coxa 0–0/1, 0/1-0, trochanter 1–0/1, 0/2-1, femur 2–3/1, 2/2-1 (*ad1* thickened), genu 2–3/1, 2/1-2, tibia 2–2/1, 2/1-2. Leg III (Figure 3(c)): coxa 0–0/1, 0/1-0, trochanter 1–1/1, 0/1-1, femur 1–2/1, 1/0-1 (*ad1* thickened), genu 2–2/1, 2/1-1, tibia: 2–1/1, 2/1-1. Leg IV (Figure 3(d)): coxa 0–0/1, 0/0-0, trochanter 1–1/1, 0/1-1, femur 1–2/1, 1/0-1 (*ad1* thickened), genu 2–2/1, 3/0-1, tibia 2–1/1, 3/1-2. Tarsi II–IV with 18 setae (3–3/2, 3/2-3 + *mv, md*). All pretarsi with well-developed paired claws, rounded pulvilli, and a long thin stalk.

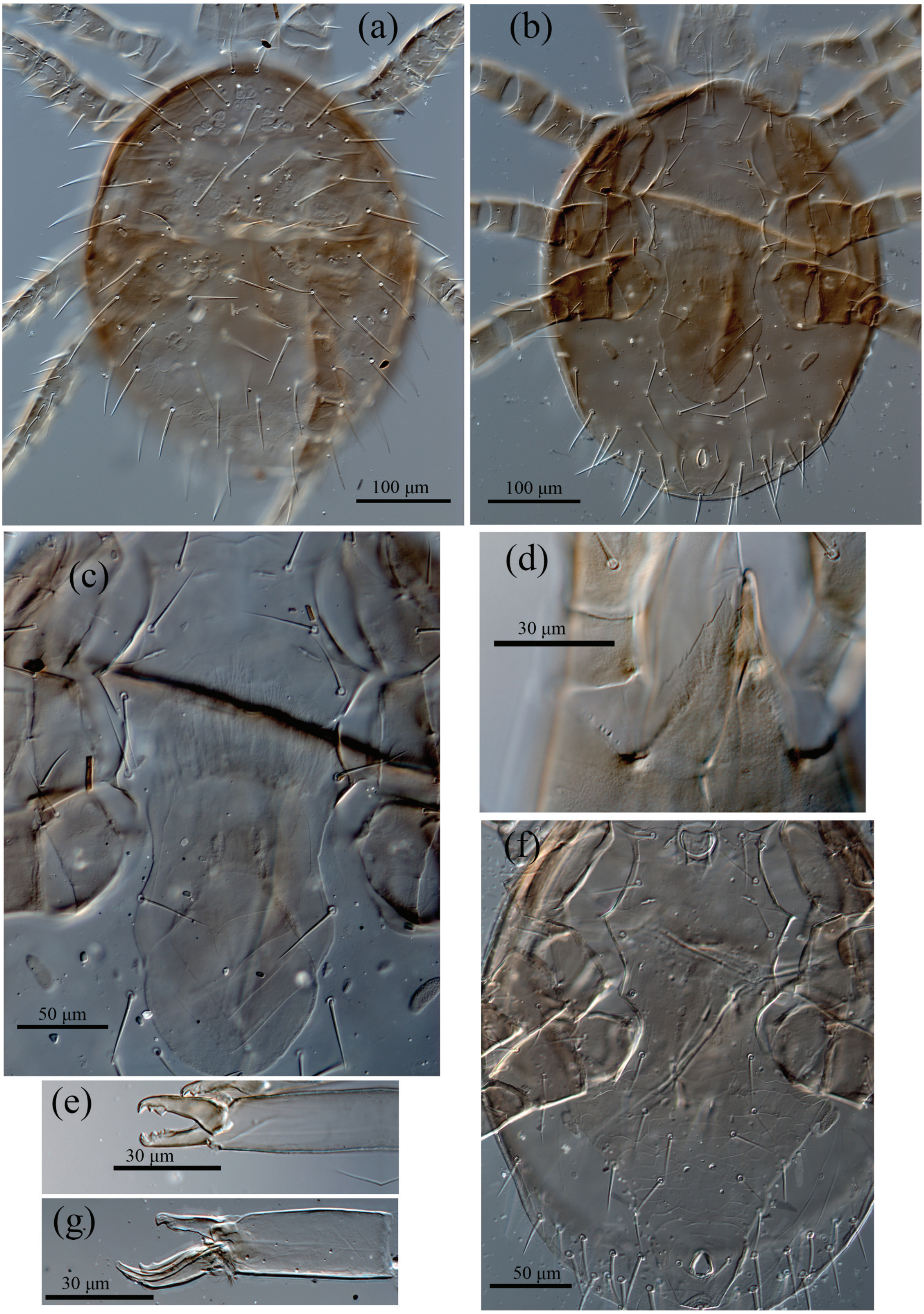

Figure 2. DIC micrographs of *Gaeolaelaps glabrosimilis* (Hirschmann, Bernhard, Greim and Gotz, 1969), female: (a) idiosoma in dorsal view, (b) idiosoma in ventral view, (c) sternal and genital shields, (d) epistome, (e) chelicera, male: (f) ventral idiosoma, (g) chelicera.

Description of male ***(n = 7 specimens).*** ***Dorsal idiosoma***. Dorsal shield (381–392) long, (254–292) wide; ornamentation and chaetotaxy as in female.

Ventral idiosoma

(Figure 2(f) and 4(a)). Sternal, genital, endopodal, ventral and anal shields fused into holoventral shield, weakly reticulate, more distinct more distinct behind *st5*, bearing *st1-5*, five pairs of opisthogastric setae (*Jv1, Jv2, Jv3, Zv1, Zv2*) in addition to circumanal setae; six pairs of poroids and a pore-like (*gv3*) laterad of para-anal setae, gland pore *gv2* behind coxa IV not discerned; cribrum with 3–4 irregular rows of spicules, restricted to region posterior to post-anal seta. Soft opisthogastric cuticle with nine smooth setae.

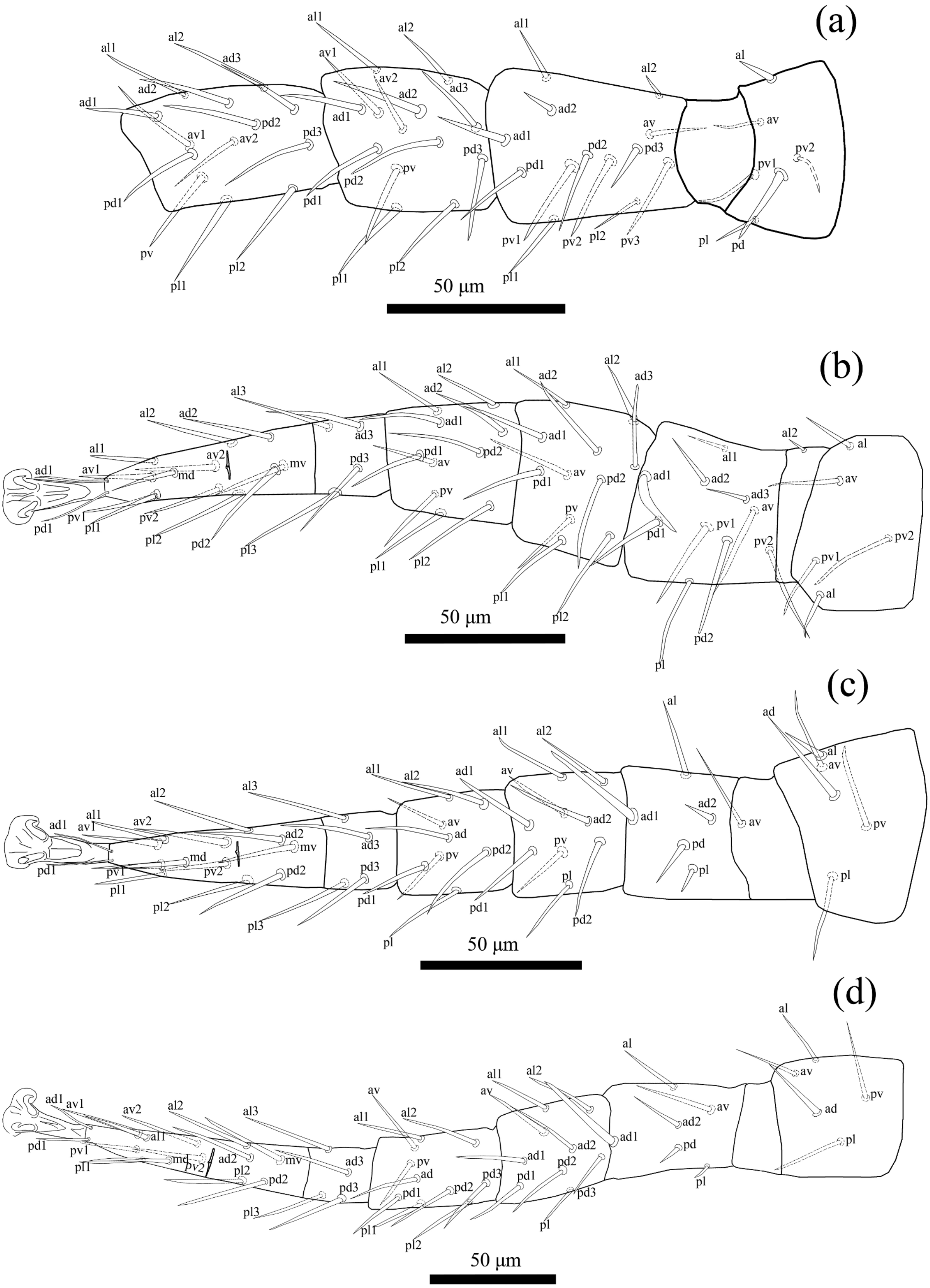

Figure 3. *Gaeolaelaps glabrosimilis* (Hirschmann, Bernhard, Greim and Gotz, 1969), female: (a) leg I (trochanter–tibia), (b) leg II (trochanter–tarsus), (c) leg III (trochanter–tarsus), (d) leg IV (trochanter–tarsus).

Gnathosoma

Epistome and subcapitulum similar to female. Fixed digit with small distal hook and slender pilus dentilis. Movable digit of chelicera with one small tooth, spermatodactyl slightly curved and slightly longer than movable digit, with blunt tip, free portion of spermatodactyl much shorter than movable digit, fringed hyaline arthrodial process at base of movable digit (Figure 2(g) and 4(b)). Palps similar to those of female.

Legs

Chaetotaxy as in female.

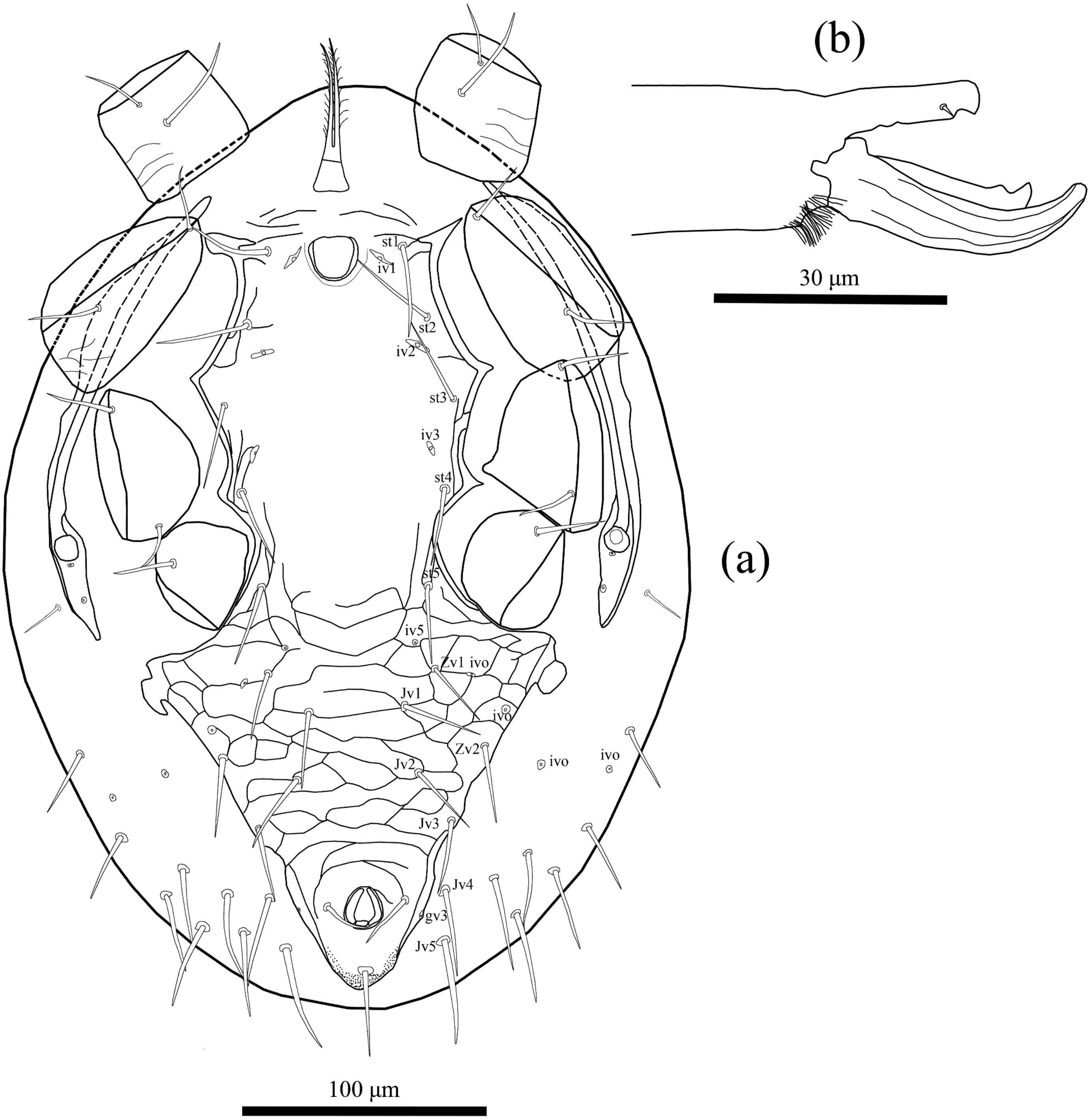

Figure 4. *Gaeolaelaps glabrosimilis* (Hirschmann, Bernhard, Greim and Gotz, 1969), male: (a) ventral idiosoma, (b) chelicera.

Specimens examined and deposition

15 females, 7 males, Russia, Kurgan Province, Zverinogolovskiy district, vicinity of settlement Ukrainets, 54°24′11.6″N 64°49′08.6″E, in nest of ant *Lasius fuliginosus*, 20 September 2019, coll. A.A. Khaustov; deposited in the collection of the Tyumen State University Museum of Zoology, Tyumen, Russia.

Remarks

We were unable to locate the types of *G. glabrosimilis* but the following ecological, geographic and morphological features suggests that the specimens which we examined are conspecific with those described by Hirschmann et al. (1969) as *Hypoaspis glabrosimilis*: (1) host-specific association with ant of the species *Lasius fuliginosus*; (2) distributed in Europe and Asia; (3) morphological features (e.g. the reticulation pattern of the genital shield, shape and denticulation of epistome, long dorsal setae and post-anal seta, denticulation of chelicera in female and male, shape of spermatodactyl in male chelicera and body size, etc.). *Gaeolaelaps glabrosimilis* is very closely related to *Gaeolaelaps longichaetus* (Ma, 1996). Joharchi et al. (2019a) redescribed *G. longichaetus* on basis of specimens collected on adults and workers of the ant *Lasius flavus* Fabricius in the Far East of Russia, close to the type locality in China. The similarity of these species was noted by Joharchi et al. (2019a), as they share features such as the reticulation pattern of the genital shield, long dorsal setae and post-anal seta, denticulation of chelicera in female and body size. These species were so similar that Joharchi et al. (2019a) suspected they could be synonymous. They did not have the opportunity to examine type specimens of *G. glabrosimilis*, therefore they suspected this synonymy by comparing the original description and related figures of these species. On the other hand, Hirschmann et al. (1969)

did not provide a detailed description of *G. glabrosimilis* and the original description is brief, and both the description and illustrations lack some important details. This has probably led to misinterpretation in this synonymy. Here we are presenting the following notable differences (based on newly collected specimens of *G. glabrosimilis* from West Siberia) to show these species as two distinct species.

Female:

1) Body size (459–471 long, 343–360 wide) and almost all dorsal setae smooth in *G. glabrosimilis*, while in *G. longichaetus* size of body smaller, especially its width (420–430 long, 278–290 wide) and almost all setae with 2–4 minute barbs.
2) Sternal shield with three pairs of long setae (tips reaching bases of following posterior setae), posterior margin irregularly concave and ratio of shield length/width (at broadest level) ≃ 0.62 in *G. glabrosimilis*, while in *G. longichaetus* sternal shield with three pairs of short setae (tips never reaching bases of following posterior setae), posterior margin more or less straight, sometimes slightly convex but never concave and ratio of shield length/width (at broadest level) p ≃ 0.78.
3) Surface of genital shield in both species with similar pattern in general appearance but with six cells flanked by a median Λ-shaped ornamentation and ratio of shield length/width (at broadest level) ≃ 2.32 in *G. glabrosimilis*, while in *G. longichaetus* genital shield ornamentation composed with a few regular diagonal lines (three on each side), some polygonal cells and ratio of shield length/width (at broadest level) ≃ 1.5.
4) Corniculi normal (reaching mid-level of palp femur) and fixed digit of chelicera with eight teeth (including gabelzhan) in *G. glabrosimilis*, while in *G. longichaetus* corniculi short (barely reaching the anterior margin of palp trochanter) and fixed digit of chelicera with three teeth (including gabelzhan).
5) Setae *ad1* on femur I–IV thickened in *G. glabrosimilis*, while in *G. longichaetus ad1* on femur I–IV fine and needle-like (not thickened).

Male:

6) Holoventral shield well expanded posteriorly (behind *st5*), reaching and fused to metapodal shields and shield bearing five pairs of opisthogastric setae (*Jv1, Jv2, Jv3, Zv1, Zv2*) in addition to sternal setae (*st1-5*) and circumanal setae in *G. glabrosimilis*, while in *G. longichaetus* holoventral shield much narrower, never reaching to metapodal shields and bearing four pairs of opisthogastric setae (*Jv1, Jv2, Zv1, Zv2* and *Jv3* out of shield) in addition to sternal setae (*st1-5*) and circumanal setae.
7) Fixed digit of chelicera with small distal hook and spermatodactyl slightly curved, just slightly longer than movable digit and free portion of spermatodactyl much shorter than movable digit in *G. glabrosimilis*, while in *G. longichaetus* fixed digit edentate (distal hook absent), spermatodactyl abruptly bent proximally, strongly tapered and free portion of spermatodactyl longer than a movable digit.

Genus *Holostaspis* Kolenati

Holostaspis Kolenati, 1858: 87.

Type species *Holostaspis isotricha* Kolenati, 1858, by monotypy.

Diagnosis

The concept of *Holostaspis* used here is based on that of Babaeian et al. (2019).

Holostaspis flexuosa **(Michael)***Laelaps flexuosa* Michael, 1891: 650.*Myrmonyssus flexuosus*. – (Berlese 1904: 440; Freire 2007: 218).*Myrmonyssus flexuosa*. – (Hunter and Hunter 1963: 337).*Laelaspulus flexuosus*. – (Evans and Till 1965: 284). *Myrmozercon flexuosa*. – (Shaw and Seeman 2009: 54; Joharchi and Moradi 2013: 253; Joharchi et al. 2015: 556).

Holostaspis flexuosa. – (Babaeian et al. 2019: 312).(Figures 5 and 6).

Remarks

This species was described by Michael (1891) and he considered it as member of Laelaps Koch. Evans and Till (1965) treated *Laelaps flexuosa* as a member of *Laelaspulus*. Shaw and Seeman (2009) placed it in *Myrmozercon* Berlese and some other authors also followed their concept (Joharchi and Moradi 2013; Joharchi et al. 2015). Babaeian et al. (2019) revised the generic concept and morphological attributes of the genus *Holostaspis* by reviewing all species in genus. They excluded this species from *Myrmozercon* and put it in *Holostaspis*, a tentative decision because the species does not completely agree with their concept of the genus *Holostaspis*. This decision was based on its legs with well-developed ambulacral claws and the holotrichous dorsal shield having 39 pairs of setae (including two pairs of *Zx* setae). Our concept of the species is based on that of Babaeian et al. (2019), but by comparing the redescription of Babaeian et al. (2019, Figures 19–32), which was based on Slovakian specimens and our observations on Western Siberian specimens, we could find considerable differences in some characters as follows: (1) Western Siberian specimens with moderate hypertrichy on opisthonotal area of dorsal shield (opisthonotal area with 18 pairs of setae, including three pairs of *Zx* setae between *J* and *Z* setae and 6–7 unpaired supernumerary setae *Jx* between *J1–J5*) (Figure 5(a) and 6(a)), while in Slovakian specimens opisthonotal area with 17 pairs of setae, including two pairs of *Zx* setae between *J* and *Z* setae and 4–5 unpaired supernumerary setae *Jx* between *J1–J5* (Babaeian et al. 2019, Figure 19); (2) setae *j1* slightly longer (tips reaching posterior bases of setae *j3*) (Figure 5(a) and 6(a,c)), while in Slovakian specimens *j3* shorter (tips never reaching posterior bases of setae *j3*) (Babaeian et al. 2019, Figure 19); (3) sternal setae long with tips reaching well beyond bases of following setae in West Siberian specimens (Figure 5(b) and 6(b,d)), while in Slovakian specimens much shorter with tips not reaching bases of following setae (Babaeian et al. 2019, Figure 21); (4) corniculi with completely rounded apex in West Siberian specimens (Figure 5(c) and 6(f)), while in Slovakian specimens with bluntly pointed apex (Babaeian et al. 2019, Figure 23); (5) chelicerae edentate (both fix and movable digits) in West Siberian specimens (Figure 5(e) and 6(g)), while in Slovakian specimens fixed digit of chelicera with two teeth (including gabelzhan) (Babaeian et al. 2019, Figure 25). We believe that such morphological differences may represent intraspecific variation in two different geographical zones.

Specimens examined and deposition

10 females, Russia, Tyumen Province, vicinity of Uspenka, 57°04′N, 65°04′E, 20 May 2019, O. Joharchi and Derek A. Uhey coll., in the nest of *Camponotus herculeanus* (Hymenoptera: Formicidae), deposited in the collection of the Tyumen State University Museum of Zoology, Tyumen, Russia.

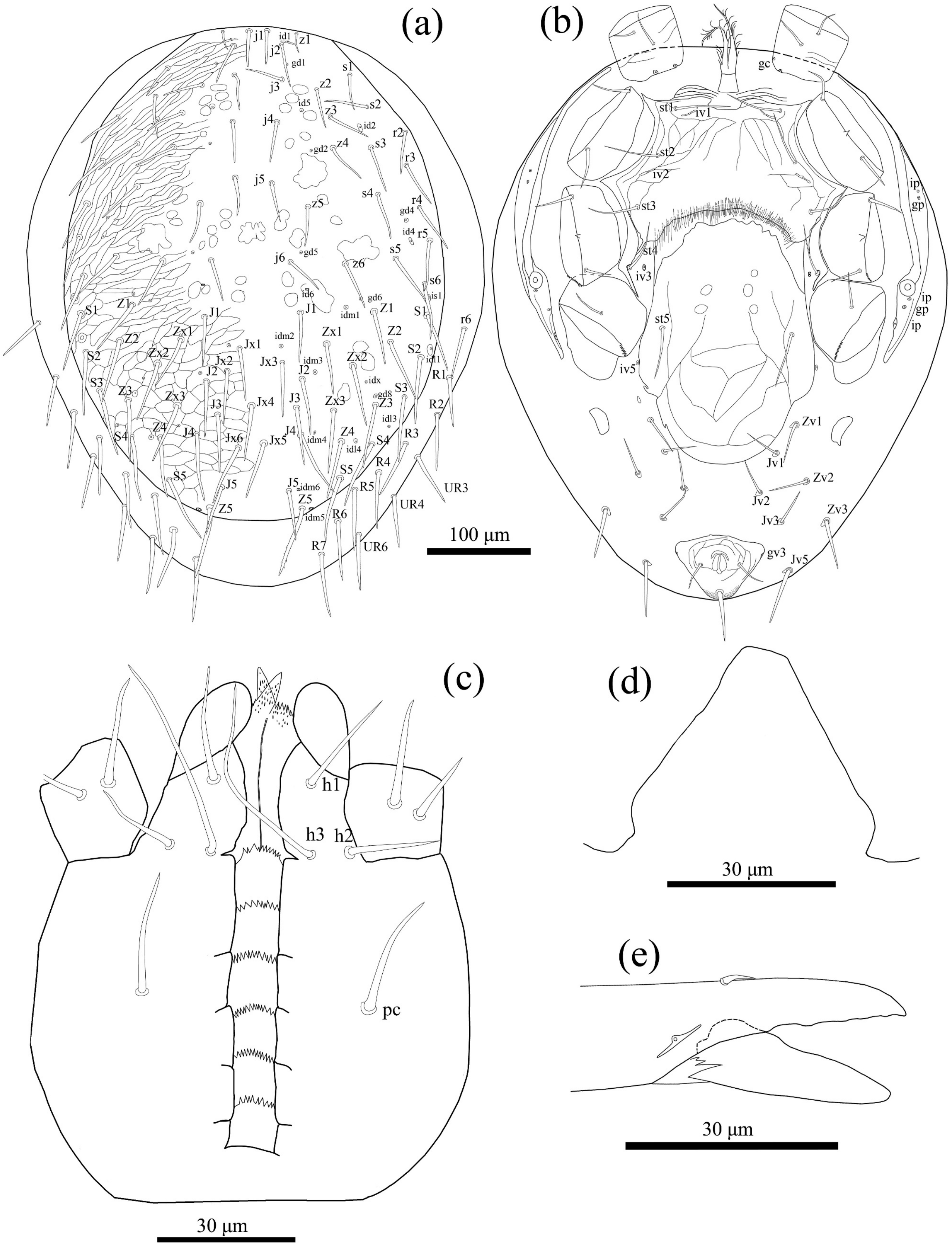

Figure 5. *Holostaspis flexuosa* (Michael, 1891), female: (a) dorsal idiosoma, (b) ventral idiosoma, (c) subcapitulum, (d) epistome, (e) chelicera.

Discussion

The ecological role of the mites discussed here is unknown. The limited information available on ant-associated mites suggests that they are predatory (Eickwort 1990; Berghoff et al. 2009), but the edentate hyaline chelicerae of *Holostaspis* suggests other modes of feeding. According to Wilson and Knollenberg (1987), the strongest phoretic associations have evolved to remove their own negative effects on the host; even having positive effects when the ecological situation permits. Phoretic mites associated with ants are generally believed to be commensals or mutualists (Eickwort 1990). Comparison among close relatives of our mites also suggests that these mites are likely communalistic or beneficial to their symbiotic ants. Wasmann (1897a, 1897b)) found that *Holostaspis oophila* (Wasmann, 1897a) received nourishment from

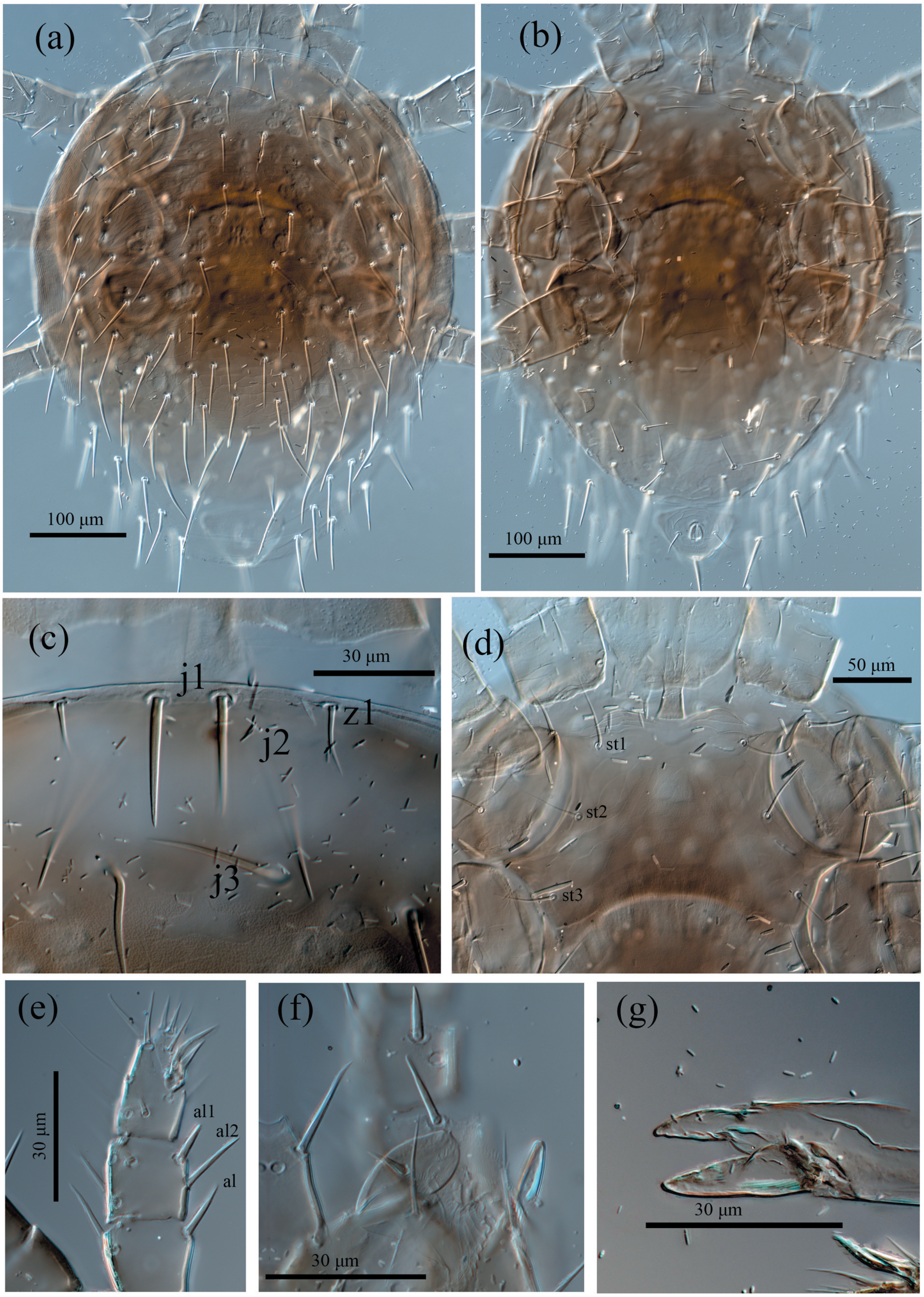

Figure 6. DIC micrographs of *Holostaspis flexuosa* (Michael, 1891), female: (a) idiosoma in dorsal view, (b) idiosoma in ventral view, (c) general view of some dorsal setae (including vertical setae (*j1*)), (d) sternal shield, (e) distal portion of palp, with a focus on apotele, (f) shape of corniculi, lateral view, (g) chelicera.

substances around the egg masses of ants, but did not attack the eggs themselves. *Gaeolaelaps* appears to be a genus of predators that feed on other small invertebrates in their hosts' nests, but are not harmful to the ants. High populations of acarids may be harmful to ants, and the presence of predators such as *Gaeolaelaps* and *Holostaspis* may be beneficial, forming a mutualistic symbiotic relationship with their ant hosts. However, this has not been established and we stress that experimental work is needed to find out the ecological role of these mites.

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ORCID

Omid Joharchi http://orcid.org/0000-0002-2741-4946
Olga S. Asyamova http://orcid.org/0000-0002-3736-7848
Alexander A. Khaustov http://orcid.org/0000-0002-0306-112X
Derek A. Uhey http://orcid.org/0000-0003-2489-1605
Aigerim K. Issakova http://orcid.org/0000-0003-1601-9876
Andrei V. Tolstikov http://orcid.org/0000-0002-8537-038X

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