

REDESCRIPTION OF *HYPOASPISELLA SPICULIFER* (BERLESE, 1918) COMB.N. (ACARI: MESOSTIGMATA: LAELAPIDAE) FROM SOUTH AFRICA

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ABSTRACT: *Hypoaspisella spiculifer* comb.n. is redescribed on the basis of adult females, collected from soil in South Africa. *Hypoaspisella spiculifer* fits well with the current concept of the genus *Hypoaspisella* Bernhard. The chelicerae of this species are similar to those of free-living mites, suggesting that it may be a predator of small soil invertebrates.

KEY WORDS: Gamasina, Dermanyssoidea, Hypoaspidinae, taxonomy, Afrotropical realm, South Africa.

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INTRODUCTION

Laelapidae is a cosmopolitan mite family that is characterized by an unusually diverse variety of lifestyles and habitats. The family, which includes about 1,520 described species sorted into more than 146 genera (Joharchi *et al.* 2018; Keum *et al.* 2017), comprises obligate and facultative parasites of invertebrates and vertebrates, insect phoronts, free-living predators and species that dwell in the nests of arthropods and vertebrates (Faraji and Halliday 2009; Lindquist *et al.* 2009). Many species are beneficial predators of agricultural pests (Beaulieu 2009; Faraji and Halliday 2009; Rosario 1981; Strong and Halliday 1994; Lindquist *et al.* 2009). The most commonly encountered laelapids in soils belong to the subfamily Hypoaspidinae (especially *Gaeolaelaps*, *Hypoaspisella*, *Cosmolaelaps*, *Stratiolaelaps* spp.), which, based on the few species studied, can be biological agents for controlling various soil pests (e.g., dark-winged fungus gnats, maggots and springtails), as well as thrips pupae and root mites (*Rhizoglyphus* and *Tyrophagus* spp.). This fact points to hypoaspidins playing an important role in the balance of the soil ecosystem (Walter and Oliver 1989, Gerson *et al.* 2003; Walter and Campbell 2003, Lindquist *et al.* 2009). Most species of *Hypoaspisella* are free-living and inhabit soil-litter. They have been collected in many parts of the world (Joharchi *et al.* 2018).

Joharchi *et al.* (2018) raised *Hypoaspisella* Bernhard to genus and revised its morphological attributes. The genus *Hypoaspisella* is superficially similar in morphology to *Gaeolaelaps* Evans and Till, 1966 and *Pneumolaelaps* Berlese, 1920. This problem was briefly discussed in Joharchi *et*

al. (2018), who attempted to distinguish these genera. Using Joharchi *et al.*'s criteria, most soil-inhabiting species that have been described or classified in *Hypoaspis* (*Pneumolaelaps*) by Karg (1993) actually belong to *Hypoaspisella*.

South Africa has one of the highest rates of biological endemism in the world (33–92%) because of its topographic and climatic heterogeneity as well as its coastal influence (Janion-Scheepers *et al.* 2016). Thus far, more than 281 species of mesostigmatid mites have been recorded or described in South African soils. About half of these species are endemic (Janion-Scheepers *et al.* 2016). Many species of soil-inhabiting laelapid mites have been reported from South Africa (Ryke 1962, 1963; Marais and Loots 1969; Van Aswegen and Loots 1970; Loots 1980; Jordaan and Loots 1987; Grout and Ueckermann 1999; Halliday 2005). During a survey of Afrotropical mite species, a series of female specimens of *Hypoaspisella spiculifer* (Berlese, 1918) were collected and identified. This species was originally described from East Africa (Berlese 1918); the original description is brief and without illustration. The brief redescription and illustrations by Ryke (1963) are also incomplete and lack most important details, especially those concerning leg chaetotaxy. So, the species has never been fully redescribed, with most authors not being able to decide on its correct generic placement (e.g., Beaulieu 2009; Kazemi *et al.* 2014).

Towards this aim, we herein define the genus placement and redescribe the female of *Hypoaspisella spiculifer*, based on the specimens collected from the Faan Meintjes Nature Reserve,

located between Klerksdorp and Potchefstroom, South Africa. We also provide a revised diagnosis of the species. Moreover, we note some discrepancies between Ryke's description and the specimens we have collected close to the same locality (Potchefstroom, South Africa).

MATERIALS AND METHODS

Mites were extracted from soil samples using Berlese-Tullgren funnels. Mites 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 a 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. The figures were elaborated with Adobe Photoshop CS2 software based on the line drawings. Images and morphological measurements were taken via ZEN 2012 software (v. 8.0) and Leica Application Suite (LAS) software (v. 4.2, Live and Interactive Measurements modules). The photomicrographs were taken with an AxioCam 506 camera (Carl Zeiss, Germany).

Measurements of structures are expressed as ranges (minimum–maximum) in micrometers (μm). The length and width of the dorsal shield were taken from the anterior to posterior margins along the midline, and at the level of *r3*, respectively. The length and width of the sternal shield were measured at the maximum length and broadest points (at the 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*. The 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 on pore-like structures on the sternal shield and on the peritrematal shield region also follow modifications and additions by Johnston and Moraza (1991), adapted by Kazemi *et al.* (2014).

SYSTEMATICS

Family Laelapidae

Genus *Hypoaspisella* Bernhard

Hypoaspis (*Hypoaspisella*) Bernhard, in Karg 1962: 64. Type species *Hypoaspis* (*Hypoaspisella*) *heyi* Karg, 1962, by monotypy.

Hypoaspis (*Hypoaspisella*) Bernhard, 1971: 6. Type species *Hypoaspisella berlesei* Bernhard, in Hirschmann *et al.* (1969), by original designation.

Diagnosis. The concept of *Hypoaspisella* used here is based on that of Joharchi *et al.* (2018), which also includes a discussion of the nomenclatural history of the name.

Hypoaspisella spiculifer (Berlese, 1918), new combination

(Figs. 1–3)

Hypoaspis spiculifer Berlese, 1918: 118.

Hypoaspis spiculifer.—Ryke 1963: 5, Halliday 2005: 35, Beaulieu 2009: 37, Kazemi *et al.* 2014: 519.

Hypoaspis (*Hypoaspis*) *spiculifer*.—Van Aswegen and Loots 1970: 189.

Hypoaspis (*Geolaelaps*) *spiculifera*.—Karg 1982: 241, Karg 1987: 298, Karg 1989a: 118, Karg 1989b: 5.

Gaeolaelaps spiculifer.—Moreira 2014: 267.

Diagnosis (female). Dorsal shield with weak reticulation, more distinct in opisthonotal and lateral regions, bearing 39 pairs of setae, 22 pairs of podonotal setae (84–89) and 17 pairs of opisthonotal setae (55–67), including two pairs of *Zx* setae, two supernumerary setae *Jx* present between *J*-series. All setae long, reaching base of next posterior setae, length of setae slightly decreasing from anterior to posterior. Presternal area lightly sclerotized, punctate, with a few transverse curved lines, sternal shield with reticulate ornamentation throughout, except posterior part smooth (or faintly reticulated), bearing two pairs of smooth pointed setae, *st1* off shield, on poorly sclerotized cuticle, with more or less straight anterior and posterior margins, endopodal plates III/IV elongate, narrow and curved, their anterior ends narrowly fused to posterolateral angles of sternal shield, ratio of shield length/width (at broadest level) ≈ 0.82 . Genital shield elongated, ratio of length/width (at broadest level) ≈ 2.7 , surface reticulated with irregular, mostly longitudinal lines in anterior region, posteriorly comprising 6–7 elongated oblique regular cells enclosed behind an inverted V-shaped ridge. Anal shield with length/

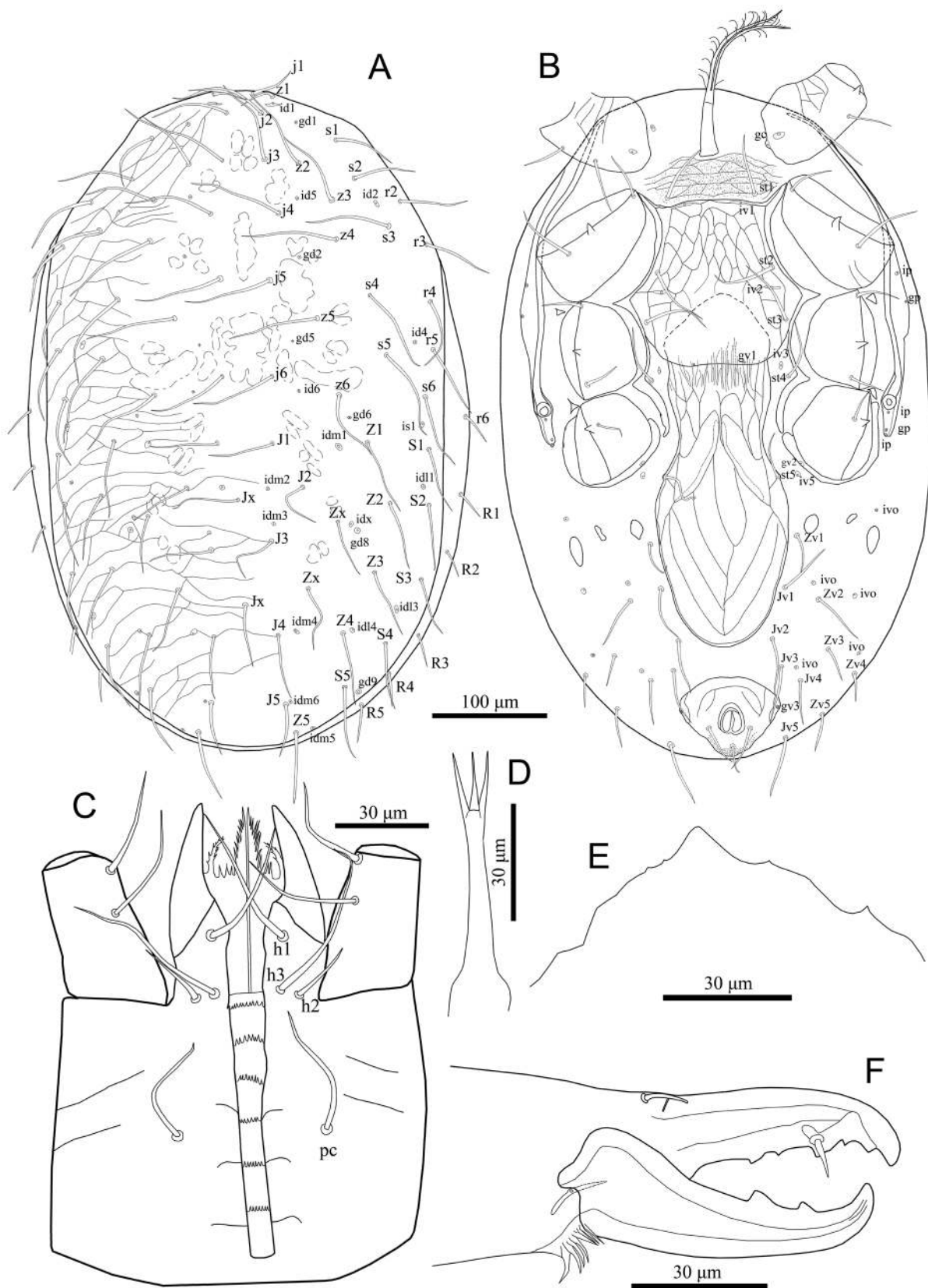


Fig. 1. *Hypoaspisella spiculifer* (Berlese, 1918), female. A—dorsal idiosoma; B—ventral idiosoma; C—subcapitulum; D—supralabral process; E—epistome; F—chelicera.

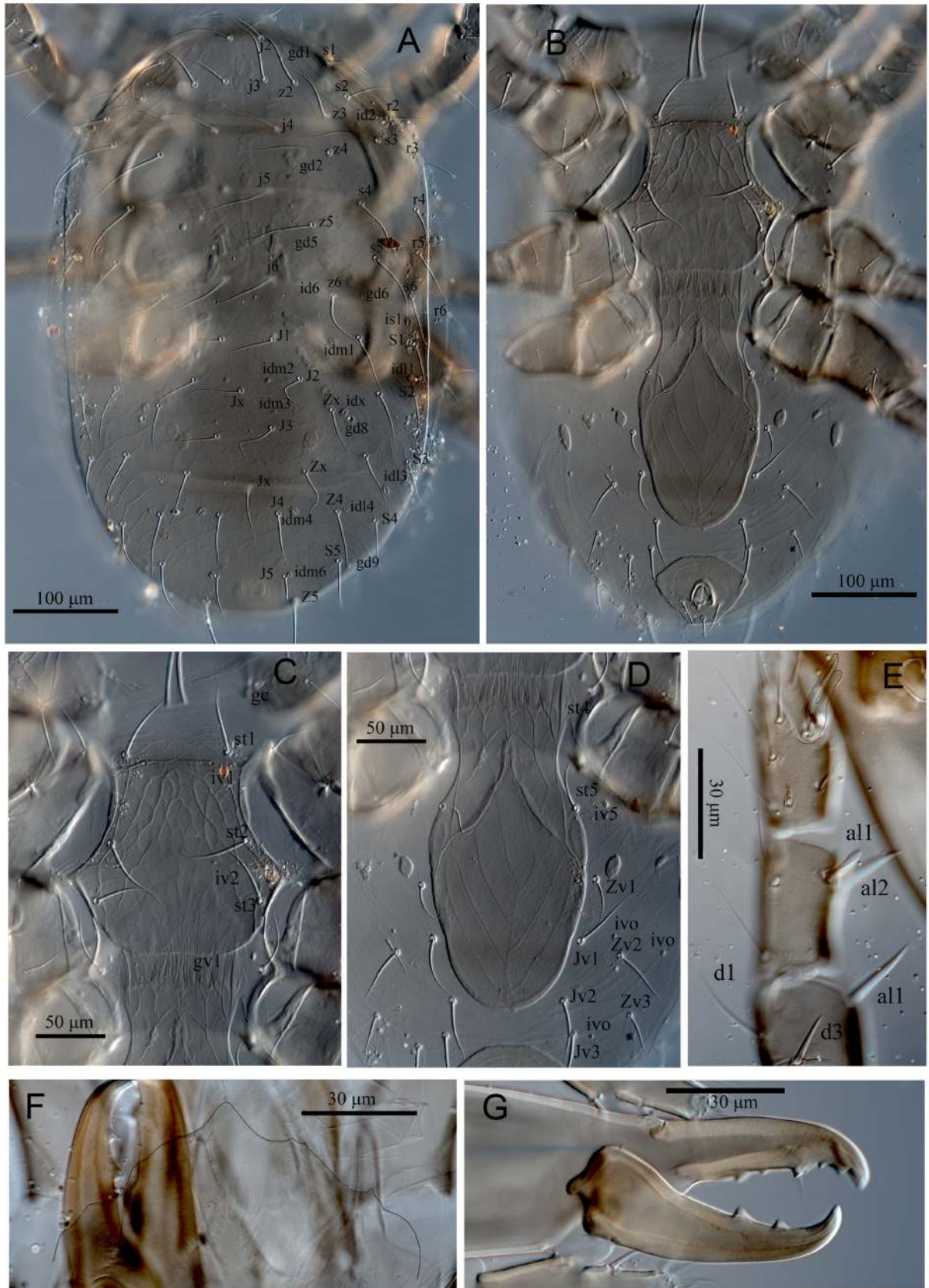


Fig. 2. DIC micrographs of *Hypoaspisella spiculifer* (Berlese, 1918), female. A—idiosoma in dorsal view; B—idiosoma in ventral view; C—sternal shield; D—genital shield and opisthogastric area; E—palp; F—epistome; G—chelicera.

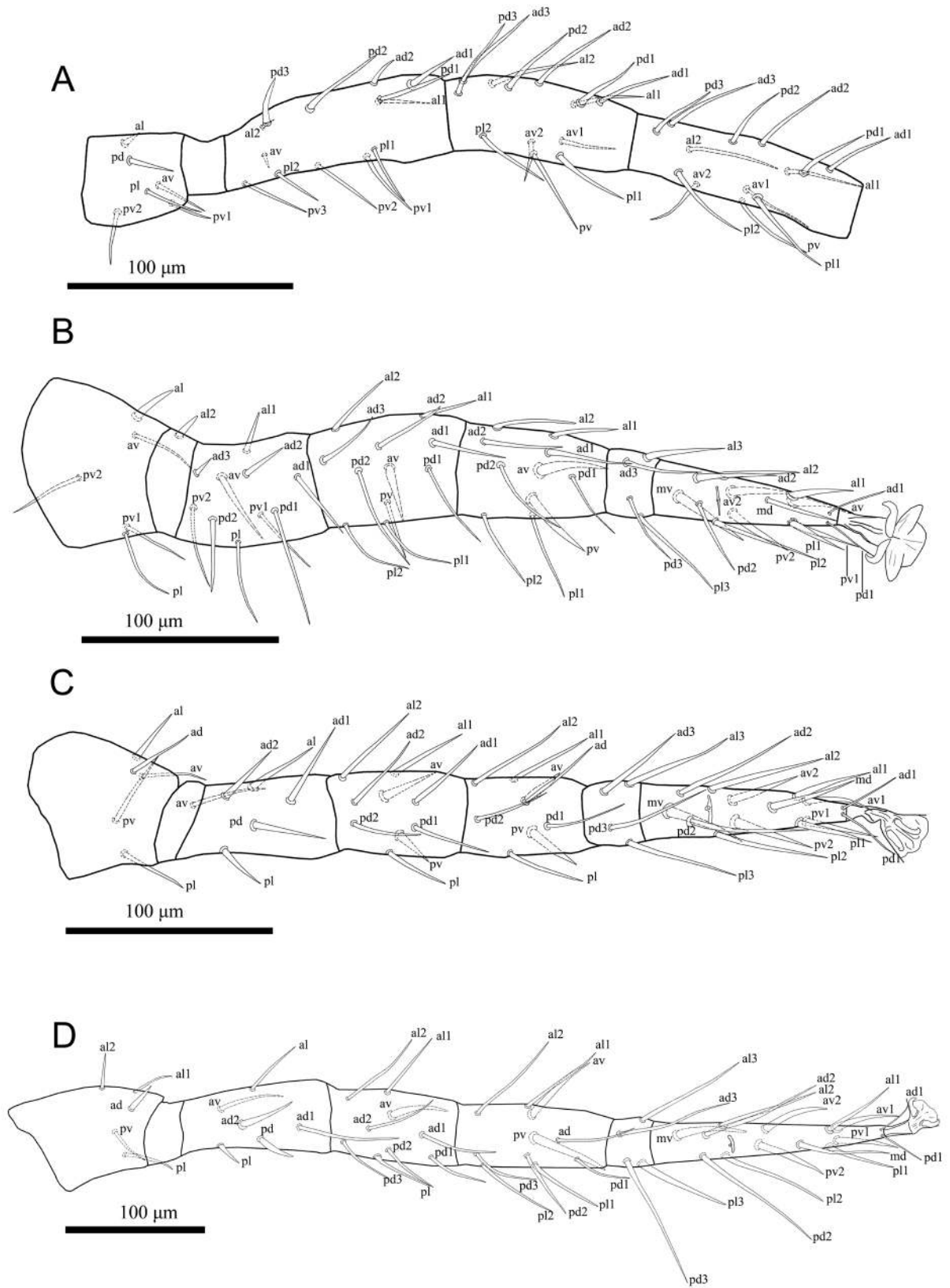


Fig. 3. *Hypoaspisella spiculifer* (Berlese, 1918), female. A—leg I (trochanter-tibia); B—leg II; C—leg III; D—leg IV.

width ratio (at broadest level) ≈ 0.8 , para-anal setae almost twice as long as post-anal seta. Opisthosomal integument with ten pairs of smooth setae and three pairs of oval metapodal plates, peritremes long, reaching to slightly beyond mid-level of coxae I. Ventral setae on tarsi, genua and tibiae II–IV spine-like, *ad2* and *pd* on femur IV thickened, *ad1* on femur IV and *pd1* on femur II elongated, tarsus IV with four elongate setae (*pd2*–3, *ad2*–3). Palp tarsal apotele two-tined, fixed digit of chelicera with 5–6 teeth and epistome with reduced denticulation.

Redescription. *Female* (n = 4).

Dorsal idiosoma (Figs. 1A, 2A). Dorsal shield oval-shaped, 590–610 long 349–365 wide, covering most of dorsal idiosoma, narrow strip of unsclerotized integument visible from *r3*, shield with weak reticulation, more distinct in opisthonotal and lateral regions. Shield bearing 39 pairs of setae, 22 pairs of podonotal setae (84–89) and 17 pairs of opisthonotal setae (58–70), including two pairs of *Zx* setae, two supernumerary setae *Jx* present between *J*-series. All setae long, reaching base of next posterior setae, lengths of setae slightly decreasing from anterior to posterior. Shield with 22 pairs of discernible pore-like structures, including 16 poroids (*id1*, *id2*, *id4*, *id5*, *idm1*–*idm6*, *idx*, *isl*, *idll1*, *idll3*, *idll4*) and six gland openings (*gd1*–2, *gd5*–6, *gd8*–9) (Figs. 1A and 2A). Dorsolateral soft integument bearing six pairs of setae, *r6*, *R1*–5 (28–35).

Ventral idiosoma (Figs. 1B, 2B–D). Tritosternum with paired pilose laciniae (92–96), fused basally (8–10), columnar base 49–53 \times 14–16 wide; presternal area lightly sclerotized and granulate-lineate. Sternal shield (length 146–149) narrowest between coxae II (100–102), widest (177–180), with more or less straight anterior and posterior margins; bearing two pairs of smooth setae (*st2* 55–57, *st3* 58–61), *st1* (50–52) off shield, on poorly sclerotized cuticle (Fig. 2C), one pair of lyrifissures adjacent to setae *st1*, and a pair of slit-like poroids between *st2* and *st3*; setae not reaching base of next setae; sternal shield with reticulate ornamentation throughout, except posterior part smooth (or faintly reticulated) (Fig. 2C). Metasternal setae *st4* (49–51) and metasternal poroids located on soft integument; metasternal platelets absent. Endopodal plates II/III completely fused to sternal shield, endopodal plates III/IV elongate, narrow and curved, their anterior ends narrowly fused to posterolateral angles of sternal shield. Genital shield elongated, slightly expanded laterally past level of setae *st5*

(Fig. 2D), length 316–322, maximum width 117–120, posterior margin rounded, clearly separated from anal shield, the distance midline between posterior margin of genital shield and anterior margin of anal shield nearly as long as anal opening (22–24), surface reticulated with irregular, mostly longitudinal lines in anterior region, posteriorly comprising 6–7 elongated oblique regular cells enclosed behind an inverted V-shaped ridge; bearing a pair of simple setae *st5* (48–51); paragenital poroids *iv5* located on soft cuticle lateral to shield near seta *st5*. Anal shield subtriangular, rounded anteriorly, length 72–76, width 89–95, anterior half lineate-reticulate, para-anal setae (40–42) almost twice as long as post-anal seta (23–25), cribrum small, with 3–4 irregular rows of spicules, mostly limited to region posterior to post-anal seta, except a pair of anterior rows reaching about to mid-level of distance between post-anal and para-anal setae; anal poroids *gv3* on anterolateral margin of anal shield. Soft opisthogastric cuticle with three pairs of oval metapodal plates, most lateral largest (24–30 long \times 7–8 wide), more median (posterior to coxae IV) smallest (10–13 long \times 3–5 wide) and ten pairs of smooth setae (*Jv1*–*Jv5*, *Zv1*–*Zv5*) (46–51), except *Zv1*, *Zv3*–4 shorter (28–33) and five pairs of poroids, including *iv5* and four pairs of *ivo*. Two small and subtriangular exopodal platelets between coxae II–III and III–IV present; parapodal platelets strip-like, bearing gland pore *gv2* (Fig. 1B). Peritreme extending anteriorly to slightly beyond mid-level of coxa I; peritrematal shield narrow, more or less expanded anteriorly, fused to dorsal shield behind setae *s1*, bearing one pair of gland pores (*gp*) near external margin of shield at level of anterior edge of coxae III and one pair of poroids (*ip*) at level of posterior edge of coxae II, free from exopodal shields; poststigmatic region with a longitudinal line from stigmata to shield apex, and with two lyrifissures *ip* and a gland pore *gp* (Fig. 1B).

Gnathosoma (Figs. 1C–F and 2E–G). Epistome subtriangular, with three small denticles and arch-shaped apex, almost entirely smooth margin (Figs. 1E, 2F). Hypostomal groove with six rows of denticles, each row with 7–11 denticles, with smooth anterior and posterior transverse lines (Fig. 1C). Hypostome with four pairs of setae, internal posterior hypostomal setae *h3* (53–56), *h1* (49–52), *h2* (21–23), palpcoxal *pc* (45–48) (Fig. 1C). Internal malae fringed, with a pair of adjacent median pilose projections, flanked by a pair of shorter and thinner

lateral projections (Fig. 1C). Corniculi robust and horn-like, extending slightly beyond palptrochanter. Supralabral process with apically tri-tined anterior projection (Fig. 1D). Chaetotaxy of palps: trochanter 2, femur 5, genu 6, tibia 14, tarsus 15, all setae smooth and needle-like except *all*, *d3* on palp femur and *all*, *al2* on palp genu thickened and *all* on palp genu apically spatulate, palp tarsal apotele two-tined (Fig. 2E). Fixed digit of chelicera with an offset and most distal tooth (gabelzhan), followed by 4–5 variously sized teeth, 2nd and 4th larger, a setaceous pilus dentilis, dorsal cheliceral seta prostrate, arthrodial membrane with a rounded flap and normal filaments; cheliceral lyrifissures distinct, movable digit with two teeth (Figs. 1F, 2G).

Legs (Fig. 3A–D). Legs II (450–456) and III, (425–450) short, I (598–607) and IV (675–687) longer. Chaetotaxy normal for free-living Laelapidae: Leg I (Fig. 3A): coxa 0–0/1, 0/1–0, trochanter 1–0/1, 1/2–1 (*pd* slightly thickened), femur 2–2/1, 3/3–2 (*ad1* and *pd3* slightly thickened), genu 2–3/2, 3/1–2, tibia 2–3/2, 3/1–2. Leg II (Fig. 3B): coxa 0–0/1, 0/1–0, trochanter 1–0/1, 0/2–1 (*al* slightly thickened), femur 2–3/1, 2/2–1 (*av* and *al2* thickened, *pd1* longest 73–75), genu 2–3/1, 2/1–2 (*av* spine-like, *pd2* longest 65–67), tibia 2–2/1, 2/1–2 (all ventral setae spine-like). Leg III (Fig. 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 spine-like), tibia: 2–1/1, 2/1–1 (all ventral setae spine-like). Leg IV (Fig. 3D): coxa 0–0/1, 0/0–0, trochanter 2–1/0, 0/1–1, femur 1–2/1, 1/0–1 (*ad2*, *pd* thickened, *ad1* longest 76–79), genu 2–2/1, 3/0–1 (*av* spine-like), tibia 2–1/1, 3/1–2 (*av* and *pv* spine-like). Tarsi II–IV with 18 setae (3–3/2, 3/2–3+ *mv*, *md*); tarsus II–IV with some spine-like ventral and lateral setae, (Fig. 3B–D) and tarsus IV with four elongate setae: *pd2* (95–98), *pd3* (105–108), *ad2* (92–95), *ad3* (109–113). All pretarsi with well-developed paired claws, rounded pulvilli and normal ambulacral stalk.

Specimens examined and deposition: Four females, South Africa, North-West Province, between Klerksdorp and Potchefstroom, Faan Meintjes Nature Reserve, 26°42'S, 26°42'E, 16 October 2018, V.A. Khaustov, S.G. Ermilov coll., from soil. Two females are deposited in the acarological collection of the National Museum, Bloemfontein, South Africa (NMBS), and two females are deposited in the mite collection of the Tyumen State University Museum of Zoology, Tyumen, Russia (TSUMZ).

The Reserve covers an area of approximately 930 ha and is situated at an altitude of 1,300 m a.s.l. (Bredenkamp and Bezuidenhout 1990). It receives summer rains; temperatures are high in summer and low in winter. The soil has high clay content and is shallow and rocky. The habitat is typical grassland, where dominating grasses are interspersed with occasional shrubs or trees (mostly *Vachellia karroo*) (see Bredenkamp and Bezuidenhout 1990 for details on the vegetation).

Remarks. Berlese (1918) described *Hypoaspis spiculifer* as a new species from East Africa, but his description is very brief and without illustration. Ryke (1963) presented a supplementary description of this species, based on one female specimen collected from a straw heap in Potchefstroom in South Africa, but his description and illustrations are also incomplete; they lack some of the most important details concerning leg chaetotaxy. Van Aswegen and Loots (1970), who presented a supplementary description of *H. spiculifer*'s subcapitulum and epistome, considered this species a part of the *Gaeolaelaps* species group. Halliday (2005) recorded this species from Hermanus, Western Cape, South Africa, but did not provide any explanation concerning its definition. Beaulieu (2009) revised the concept of *Gaeolaelaps*, but could not decide on the correct generic placement for *H. spiculifer*. Moreira (2014), in her Ph.D. thesis, assigned this species to *Gaeolaelaps*, but did not provide any explanation for her conviction. Then, Kazemi *et al.* (2014) excluded this species from *Gaeolaelaps* and treated it as a member of *Hypoaspis sensu lato*. This decision was based on its epistome with an almost entirely smooth margin. The fact that *H. spiculifer* has never been fully described has probably led to the aforementioned authors' inability to decide on the correct generic placement of this species, choosing instead to place it onto a very broadly conceived genus *Hypoaspis sens. lat.*

We consider *H. spiculifer* to be a member of *Hypoaspisella* because this species agrees well with *Hypoaspisella* in the following main character states: dorsal shield sub-oval and bearing 39 pairs of simple setae (including *Zx* setae); dorsolateral soft integument with six pairs of simple setae; presternal region weakly sclerotized and granulate; shapes of sternal and genital shields normal for genus; setae *st4* on soft cuticle; genital shield bearing a pair of setae; anal shield sub-triangular; epistome subtriangular and anterior margin almost entirely smooth (has few denticles); internal malae fringed, with a

pair of adjacent median pilose projections, flanked by just a pair of shorter and thinner lateral projections; chelate-dentate chelicerae, cheliceral digits markedly dentate; deutosternal groove with six rows of denticles, each row bearing 7–11 denticles; peritremes long extending to coxa I; peritrematal shield not enlarged around stigmatic opening; opisthogastric soft cuticle bearing ten pairs of smooth pointed setae; all legs with ambulacra and claws; leg chaetotaxy normal for Laelapidae and genu IV with nine setae (2–2/1, 3/0–1).

Our diagnosis, which is based primarily on specimens from South Africa, matches well with the original description presented by Berlese (1918). However, when comparing our material with the description of *Hypoaspis spiculifer* by Ryke (1963) from Potchefstroom, South Africa, a number of discrepancies in the morphological traits and measurements were observed: (1) size of body 590–610 long 349–365 wide [does match with the original description presented by Berlese (1918) but 500 long × 366 wide in the redescription presented by Ryke (1963)]; (2) fixed digit of chelicera with 5–6 teeth and the dorsal cheliceral seta is present [the chelicerae were not described at all in the original description by Berlese (1918); fixed digit described and illustrated as bidentate by Ryke (1963), while the dorsal cheliceral seta was neither illustrated nor mentioned in the redescription by Ryke (1963)].

Hypoaspisella spiculifer is closely related to *Hypoaspis egenus* (Berlese, 1918) (e.g., the reticulation pattern of the genital and sternal shields similar, *stI* inserted on weak presternal area, dorsal setae are long, reaching base of next posterior setae, similar body size, etc.), originally described from South Africa. However, *H. egenus* was described from Mfongosi, KwaZulu-Natal, close to the eastern coast of South Africa. Kazemi *et al.* (2014) suspected that Berlese (1918) described the same species under two different names and that they are synonyms. We have not had the opportunity to examine the type specimens of *H. egenus* in order to confirm the suspicion of synonymy.

However, by comparing the redescriptions and illustrations of the holotype by Van Aswegen and Loots (1970), we found the following distinguishing morphological differences: (1) genital shield longer and extending close to anal shield, the distance midline between posterior margin of genital shield and anterior margin of anal shield nearly as long as anal opening in *H. spiculifer*, while in *H. egenus* genital shield much shorter, the distance

midline between posterior margin of genital shield and anterior margin of anal shield more than twice as long as anal shield; (2) soft opisthogastric cuticle with three pair of oval metapodal plates in *H. spiculifer*, while in *H. egenus* soft opisthogastric cuticle without metapodal plates. These differences show provisionally that *H. spiculifer* and *H. egenus* are two distinct species, until further comparative studies clarify this relationship.

Nothing is known about the feeding patterns or any other aspects of *H. spiculifer*'s behavior. Its normal morphology (like other free-living *Hypoaspisella* species; e.g., dentate chelicerae, sclerotized and horn-like corniculi) suggests that it may be a predator of small soil invertebrates. Therefore, *H. spiculifer* may be used as a biological control agent of soil pests. We stress that further experimental work is needed to establish the role of this mite in the soil ecosystem.

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